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Predicted and observed in-hospital mortality after left main coronary artery stenting in 204 patients

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Abstract

Background: *The purpose of this study was to compare risk predicted using available risk scores and actual outcomes in patients with left main coronary artery disease undergoing percutaneous coronary intervention with stent implantation (PCI LM).*

Methods: *We studied 204 patients treated with elective or emergent coronary angioplasty. We estimated in-hospital mortality using the EuroSCORE, Parsonnet and GRACE risk scores and compared this data with actual in-hospital mortality.*

Results: *There were no deaths among 62 patients undergoing elective PCI LM regardless of the estimated risk. Acute coronary syndrome (ACS) was diagnosed in all 142 patients undergoing emergent PCI LM. Mortality in this group was 24% (34/142). Area under receiver operating characteristic curve (AUC) values for the EuroSCORE, Parsonnet and GRACE risk scores in patients with ACS were 0.812 ($p = 0.0001$), 0.857 ($p = 0.0001$), and 0.870 ($p = 0.0001$), respectively. No statistically significant differences were found when these AUC values for different evaluated risk scores were compared. Overall, the EuroSCORE and Parsonnet risk scores had no discriminative value, as all deaths occurred in the highest risk group. Only the GRACE risk score discriminated risk among intermediate- and high-risk patients with ACS.*

Conlusions: *The EuroSCORE and Parsonnet scoring systems are of no value in predicting periprocedural mortality risk in patients undergoing elective PCI LM. Overall, discriminative ability of the EuroSCORE, Parsonnet, and GRACE risk scores in unselected patients with ACS undergoing emergent PCI LM was good. In this group of patients, the EuroSCORE and Parsonnet scoring systems had no discriminative value in low and moderate risk patients. Only the GRACE risk score discriminated risk among intermediate and high risk patients.* (Cardiol J 2008; 15: 268–276)

Key words: left main coronary artery disease, percutaneous coronary angioplasty, EuroSCORE, Parsonnet risk score, GRACE risk score

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Introduction

Left main coronary artery disease (LM CAD), present in 5–9% of patients with angina pectoris, is associated with particularly unfavorable prognosis when treated medically, because 1- and 3-year mortality of 19% and 50%, respectively, has been reported in such patients [1, 2]. Coronary Artery Study (CASS) showed large advantage of coronary artery bypass grafting (CABG) over medical treatment in patients with LM CAD, as 5-year survival following CABG was 84% compared to 58% among patients treated medically [3]. Thus, revascularization is the method of choice when significant LM CAD is detected. In American College of Cardiology/American Heart Association guidelines, CABG is the treatment of choice for unprotected left main coronary artery stenosis (Class I recommendation, level of evidence A) [4].

The first percutaneous coronary intervention (PCI) in a patient with unprotected left main coronary artery stenosis was performed by Andreas Gruentzig in 1978 [5]. However, despite good immediate results this treatment was soon abandoned in favor of CABG due to unfavorable long-term outcomes [6]. During later years, hemodynamically significant left main coronary artery stenosis, particularly when unprotected by at least one patent coronary bypass graft, was considered an absolute contraindication for percutaneous revascularization [2, 3].

However, dynamic growth of invasive cardiology, widespread use of stents, including antimitotic drug-eluting stents, and introduction of new antiplatelet agents created new therapeutic possibilities also in the treatment of LM CAD. Despite these advances, current guidelines state that PCI of left main coronary artery stenosis should only be performed (Class IIa recommendation, level of evidence B) if surgical revascularization is not possible or the operative risk is prohibitively high (e.g. > 10 points using the EuroSCORE scoring system) [7, 8].

Risk prediction in cardiac surgery is based on several commonly used risk scores, such as the Parsonnet risk score [9, 10] and the EuroSCORE scoring system [11–14]. Risk prediction in patients with acute coronary syndromes is currently based on the Global Registry of Acute Coronary Events (GRACE) risk score [15,16]. These risk scores were validated in large patient populations. However, LM CAD is a unique clinical condition and the predictive value of these risk scores in such patients is not necessarily as good as in more general population of cardiac patients. Currently, only few data are available regarding the use of these risk scores in LM CAD, as their predictive value was not comprehensively evaluated in such patients and existing studies were performed in relatively small groups.

Purpose of the study

The purpose of this study was to compare periprocedural mortality risk predicted using available risk scores and actual outcomes in our patients with LM CAD undergoing PCI with stent implantation.

Methods

From August 2001 do January 2006, coronary angioplasty with stenting of the left main coronary artery was performed in 204 patients treated in the Department of Cardiology and Internal Medicine at the University Hospital in Bydgoszcz, Poland. These procedures amounted to 2.8% of all PCI procedures performed during the study period. All interventions were performed according to standard PCI procedures. Prior to PCI, patients were given 1 mg/kg of heparin (or 0.7 mg/kg if abciximab was concurrently used), acetylsalicylic acid and ticlopidine or clopidogrel. Following the procedure, all patients were treated with acetylsalicylic acid and ticlopidine or clopidogrel. PCI was preceded by coronary angiography. Bare metal stents or, in 15 patients, drug-eluting stents (DES) were implanted into the left main coronary artery at the discretion of the physician performing the procedure. In addition, 72 patients were treated with abciximab infusion.

All patients gave informed consent for coronary angioplasty. The study protocol was revised and approved by a local Ethics Committee. The study group characteristcs is presented in Table 1.

Table 1. Clinical characteristics of the study population.

Diabetes	77 (37.7%)
Hypertension	140 (68.6%)
Hypercholesterolemia	153 (75%)
Cigarette smoking	113 (55.4%)
Creatinine level ≥ 2 mg/dL	11 (5.4%)
Previous stroke	29 (14.2%)
UA/NSTEMI as the indication for PCI	58 (28.4%)
STEMI as the indication for PCI	84 (41.2%)
Resuscitated cardiac arrest	22 (10.8%)
Cardiogenic shock on admission	65 (31.9%)
Intra-aortic balloon pump necessary during treatment	22 (10.8%)

PCI — percutaneous coronary intervention; NSTEMI — non-ST segment elevation myocardial infarction; STEMI — ST segment elevation myocardial infarction; UA — unstable angina

We studied 204 patients (mean age 65.5 years, range 26–85 years), including 55 women (mean age 70 years, range 44–85 years) and 149 men (mean age 63 years, range 26–83 years). The study group was divided into two subgroups of 62 patients (30%) undergoing elective treatment and 142 patients (70%) undergoing emergent treatment.

Among patients undergoing elective coronary angioplasty, left main coronary artery was protected by at least one patent coronary bypass graft in 8 patients, 6 patients were deemed not suitable for CABG, and 46 patients did not give consent for CABG.

Acute coronary syndrome (ACS) was diagnosed in patients undergoing emergent coronary angioplasty, including 58 patients (41%) with non-ST segment elevation ACS and 84 patients (59%) with ST segment elevation ACS. On admission, 65 patients (46%) were in cardiogenic shock, and 20 patients (14.1%) have been resuscitated following a cardiac arrest. Left main coronary artery was protected by at least one patent coronary bypass graft in 16 patients. Intra-aortic balloon pump was used in 22 patients (15.5%). In five cases, the immediate cause of stent implantation was iatrogenic dissection of the left main coronary artery during catheterization and angiography.

The most obvious alternative treatment in such patients is cardiac surgery. Therefore, we evaluated cardiac surgery risk using a European scoring system known as the EuroSCORE. According to this system, patients assigned 0–2 points are considered a low surgical risk group with estimated perioperative mortality of 0.8%, patients assigned 3––5 points are considered an intermediate surgical risk group with estimated perioperative mortality of 3%, and patients assigned 6 or more points are considered a high surgical risk group with estimated perioperative mortality exceeding 11.2%. Another risk score allowing rapid, bedside estimation of the perioperative risk is the Parsonnet score. In this scoring system, 0–4, 5–9, 10–15, 15–19, and 20+ points correspond to the estimated mortality of 1%, 5%, 9%, 17%, and 31%, respectively. In all patients with ACS, we also evaluated in-hospital mortality risk using the GRACE risk score.

Statistical analysis

All calculations and analyses were performed using Statistica package, version 7.1 PL (StatSoft, Tulsa, USA), and MedCalc for Windows, version 9.2.0.0 (MedCalc Software, Mariakerke, Belgium). $P<0.05$ was considered statistically significant. Normal distribution of variables was tested using Kolmogorov-Smirnov and Shapiro-Wilk tests. For variables with skewed distribution, data were presented as median values and ranges. Receiver operating characteristic (ROC) curves were used for statistical analysis [17, 18]. Area under ROC curve (AUC) was calculated to determine discriminative value of a given score. AUC values were compared using Hanley and McNeil method [19].

Results

Among 62 patients undergoing elective PCI with stent implantation, the EuroSCORE scoring system indicated low operative risk in 23 (37.1%) patients, intermediate risk in 23 (37.1%) patients, and high risk in 16 (25.8%) patients. According to the Parsonnet score, perioperative mortality risk was 1% in 4 (6.5%) patients, 5% in 14 (22.6%) patients, 9% in 16 (25.8%) patients, 17% in 13 (21%) patients, and 31% in 15 (24,2%) patients. However, there were no deaths in this patient group regardless of the estimated risk.

Among 142 patients with ACS undergoing emergent PCI with stent implantation, 34 deaths (24%) occurred, including 7 deaths (12.1%) among 58 patients with unstable angina/non-ST segment elevation myocardial infarction (UA/NSTEMI), and 27 deaths (32.1%) among 84 patients with ST segment elevation myocardial infarction (STEMI). Among patients with UA/NSTEMI, 14 patients were in cardiogenic shock and half of them died. Among patients with STEMI, 51 patients were in cardiogenic shock and 25 of them (49%) died. Overall, death ensued in 32 (49.2%) of 65 patients (45.8% of all patients with ACS) who were in cardiogenic shock prior to PCI.

Evaluation using the EuroSCORE scoring system indicated low operative risk in 4 (2.8%) patients with ACS, intermediate risk in 14 (9.9%) patients, and high risk in 124 (87.3%) patients. All 34 patients who died (24%) belonged to the latter group (Fig. 1). According to the Parsonnet score, perioperative mortality risk was 1% in 4 patients, 5% in 2 patients, 9% in 13 patients, 17% in 18 patients, and 31% in 105 (73.9%) patients. Again, all 34 patients who died (32.4%) belonged to the highest risk group (Fig. 2).

Among 142 patients with ACS, in-hospital mortality risk estimates based on the GRACE risk score were as follows: estimated risk was less than 1% in 7 (4.9%) patients and 1–4% in 30 (21.1%) patients, with no deaths in these two groups; while one patient (4%) died out of 25 (17.6%) patients with the estimated mortality risk of 5–8%, 4 patients (21.1%) died out of 19 (13.4%) patients with the estimated mortality risk of 9–19%, and 29 patients

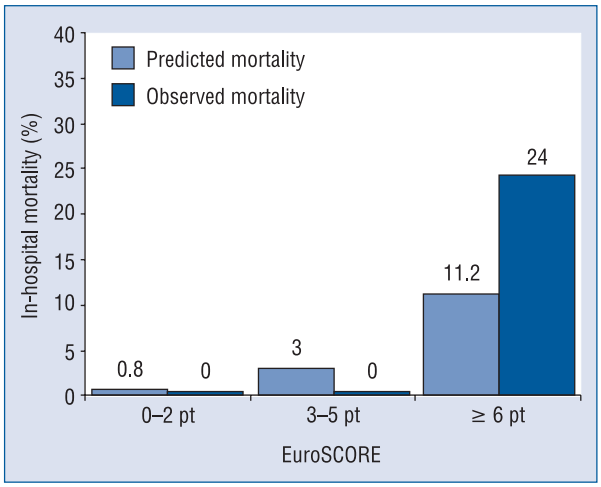

Figure 1. Predicted operative risk by the additive EuroSCORE scoring system and the actual risk in patients undergoing emergent percutaneous coronary intervention of the left main coronary artery stenosis (pt — points).

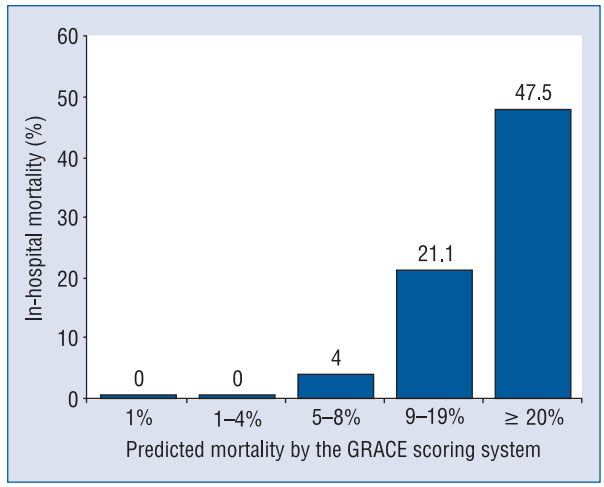

Figure 3. Predicted mortality risk by the GRACE scoring system and the actual risk in patients undergoing emergent percutaneous coronary intervention of the left main coronary artery stenosis.

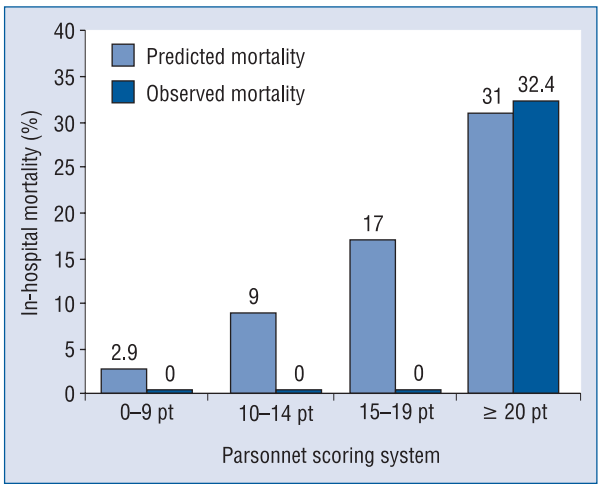

Figure 2. Predicted mortality risk by the Parsonnet scoring system and the actual risk in patients undergoing emergent percutaneous coronary intervention of the left main coronary artery stenosis (pt — points).

(47.5%) died out of 61 (43%) patients with the estimated mortality risk of ≥ 20% (Fig. 3).

Overall, AUC was 0.876 (p = 0.0001) for the EuroSCORE scoring system and 0.870 (p = 0.0001) for the Parsonnet risk score. No statistically significant difference was found when these AUC values were compared (p = 0.860) (Fig. 4, Table 2).

In patients with ACS, AUC values for the EuroSCORE, Parsonnet and GRACE risk scores were 0.812 (p = 0.0001), 0.805 (p = 0.0001), and 0.857 (p = 0.0001), respectively. No statistically significant differences were found when these AUC values were compared pair-wise (Fig. 5, Table 3).

Discussion

In the current era of widespread use of coronary stents, including antiproliferative DES, and antiplatelet drugs such as clopidogrel and ticlopidine, it is debatable whether left main coronary artery stenosis should still be considered an absolute contraindication to PCI [20]. This debate regarding the optimal treatment of the left main coronary artery stenosis has been fueled by the results of multicenter French Left Main study (FLM) and the recent results of the LE MANS study, showing lower one-year mortality in patients treated with coronary angioplasty and stenting compared to CABG [21, 22].

Previous studies suggest that the early and long-term results of PCI in patients with LM CAD depend on the baseline clinical status [23]. Risk factors for mortality among patients undergoing angioplasty of the left main coronary artery stenosis include low left ventricular ejection fraction (LVEF), significant mitral regurgitation, cardiogenic shock, acute myocardial infarction, renal failure, multivessel coronary artery disease and postprocedural stent lumen diameter [1, 24–26]. Recently, an increased preprocedural high-sensivity C-reactive protein (hsCRP) level has also been shown to be a risk factor for adverse outcomes [27].

Our data show no major complications and deaths during in-hospital follow-up of patients

Table 2. Area under ROC curve (AUC) values for the EuroSCORE and Parsonnet risk scores and their comparison in the overall study population.

	AUC	Standard error	95% confidence interval	p
Risk estimation model				
EuroSCORE	0.876	0.0396	0.823 to 0.918	0.0001
Parsonnet	0.870	0.0404	0.816 to 0.913	0.0001
Comparison of models	**ΔAUC**			
EuroSCORE *vs*. Parsonnet	0.00588	0.0333	–0,0594 to 0.0712	0.860

ΔAUC — difference between AUC values for the two risk scores

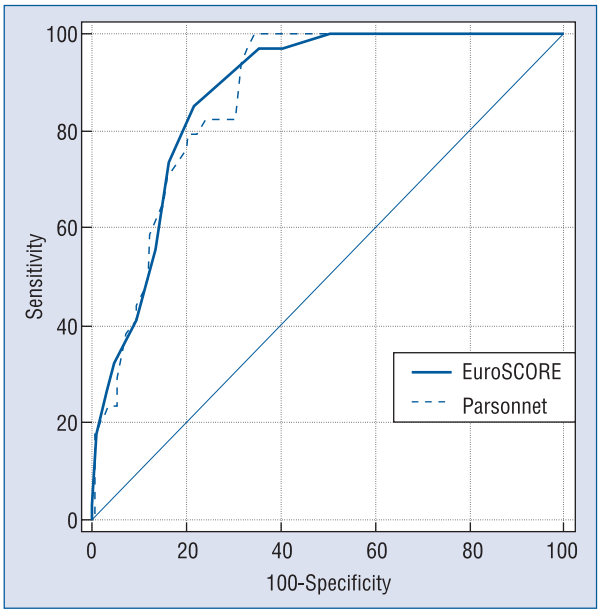

Figure 4. ROC curves for the EuroSCORE and Parsonnet risk scores in the overall study population.

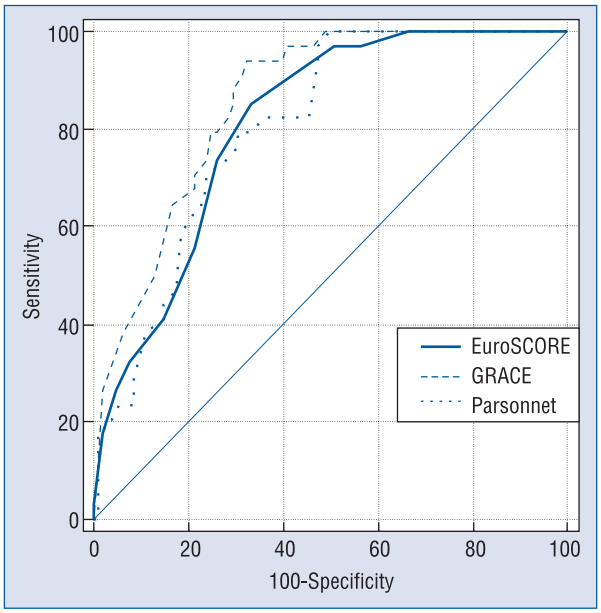

Figure 5. ROC curves for the EuroSCORE, GRACE and Parsonnet risk scores in patients with acute coronary syndromes.

Table 3. Area under ROC curve (AUC) values for the EuroSCORE, GRACE and Parsonnet risk scores and their comparison in patients with acute coronary syndromes.

	AUC	Standard error	95% confidence interval	p
Risk estimation model				
EuroSCORE	0.812	0.0475	0.738 to 0.872	0.0001
GRACE	0.857	0.0427	0.788 to 0.910	0.0001
Parsonnet	0.805	0.0481	0.730 to 0.867	0.0001
Comparison of models	**ΔAUC**			
EuroSCORE *vs*. GRACE	0.0451	0.0349	–0.234 to 0.114	0.197
EuroSCORE *vs*. Parsonnet	0.00681	0.0388	–0.0692 to 0.0828	0.861
GRACE *vs*. Parsonnet	0.0519	0.0366	–0.0199 to 0.124	0.157

ΔAUC — difference between AUC values for risk scores compared pairwise

undergoing elective PCI of LM CAD. Notably, some of these patients were previously refused CABG due to perceived high surgical risk, and some patients did not give consent for CABG. In the study by Brener et al. [28] in 97 patients with LM CAD treated with stent implantation, risk factors for adverse outcomes were the number of points by the EuroSCORE scoring system and diabetes. In the

study by Silvestri et al. [29] who evaluated 140 patients who underwent elective PCI of the left main coronary artery stenosis (excluding patients with acute myocardial infarction and/or cardiogenic shock), 30-day mortality was 0% in the low operative risk group and 9% in the high operative risk group. The latter included patients with contraindications to CABG and patients with at least one of the following risk factors: advanced age (> 75 years), previous cardiac surgery, LVEF < 35%, renal failure, severe respiratory failure, and poor distal coronary outflow [29]. In our study, no in-hospital deaths were noted among patients who underwent elective angioplasty of the left main coronary artery even in high surgical risk groups by the EuroSCORE and Parsonnet risk score criteria. These results are comparable to those reported by Kim et al. [30], with no periprocedural deaths in a group of 324 patients who underwent elective angioplasty of the left main coronary artery. Patients with acute STEMI and patients undergoing urgent angioplasty within 24 hours from the onset of symptoms were excluded from that study. In contrast to studies by Silvestri et al. [29] and by Kim et al. [30], we analyzed all patients undergoing angioplasty of the left main coronary artery, including patients with acute STEMI (41.2% of all patients) and patients with cardiogenic shock (31.9% of patients). In a study involving 104 patients, Christiansen et al. [31] showed that 30-day mortality in low and high operative risk groups and in patients with acute myocardial infarction was 0%, 16% and 37%, respectively, and predicted mortality using the EuroSCORE scoring system was 2%, 8% and 18%, respectively. Among our patients undergoing emergent PCI of the left main coronary artery, mortality in low, intermediate and high operative risk groups was 0%, 0% and 24%, respectively, while predicted mortality using the EuroSCORE scoring system was 0.8%, 3% and 11.2%, respectively. Multicenter ULTIMA registry, involving the largest patient population so far (n = 279), showed that the outcomes following angioplasty of an unprotected left main coronary artery stenosis in patients with low operative risk were better (no periprocedural deaths, one-year mortality of 3.4%) than the results of CABG in similar patients. One-year mortality among patients with intermediate operative risk was 24.4%, and it exceeded 56% among patients with high operative risk [1]. Among patients with acute myocardial infarction treated with angioplasty and stenting of the left main coronary artery, periprocedural mortality was 35%, and one-year mortality was 55% [32]. Outcomes of stenting were worse in patients with impaired left ventricular function (LVEF < 30%), significant mitral regurgitations, renal disease, and advanced age (> 75 years) [25, 33, 34]. However, these were high operative risk patients who were often denied surgical treatment. In contrast to the above results, in-hospital mortality was only 1.7% and one-year mortality was 5.1% among 297 patients treated with PCI of the left main coronary artery, reported by Han et al. [35] in a single-center Chinese study. This group included 23.9% patients undergoing emergent PCI, 45.1% patients with unstable angina, 7.1% patients with acute myocardial infarction and 4% patients in cardiogenic shock.

LM CAD is a rare cause of an acute myocardial infarction (0.37–0.6%) [36, 37]. However, prognosis is very poor in patients with a left main coronary artery stenosis that led to an acute myocardial infarction complicated by a cardiogenic shock (so called left main shock syndrome), with periprocedural mortality of 32–94% [25, 32, 33, 38–41]. Few studies have been published that reported results of surgical revascularization in such patients. Nakanishi et al. reported mortality of 46% among patients undergoing CABG due to an acute myocardial infarction (n = 13), including 53% patients in cardiogenic shock [42]. Despite indications for CABG, significant logistic problems (time required for preparation to operation, patient transport to the operating room) commonly make the performance of the surgical procedure impossible. Thus, it seems that immediate PCI with stenting might often be the only practical effective treatment. Despite lack of large studies, mounting evidence from smaller groups of patients show effectiveness of such strategy, with mortality reduced to 32–44% [32, 39–41, 43].

Risk prediction models, such as the EuroSCORE and Parsonnet risk scores, are commonly used in cardiac surgery to predict operative risk [9–14]. Usefulness of the EuroSCORE scoring system was also shown for predicting PCI-related risk for high risk procedures [44–46]. Despite independent relation between the number of points and the risk of death, these scores have limited usefulness in predicting PCI-related risk. As these models were derived from data on the outcomes of surgical treatment, some parameters might bear no relation to PCI-related risk. This limitation may explain lack of relation between the number of points by these scoring systems and PCI outcomes in patients undergoing elective treatment that was observed in our study. In this population, no deaths were noted during short-term follow-up among patients undergoing

elective PCI, although about 25% of patients could be categorized as highest risk. This might be explained by a low number of patients in our study, but it might also result from limited usefulness of such scoring systems in patients undergoing PCI due to associated low mortality.

We found good discriminative ability of the EuroSCORE and Parsonnet risk scores in patients undergoing emergent PCI, as evaluated using AUC values for respective ROC curves (0.812 and 0.805, respectively). However, mortality risk analysis using these scoring systems showed poor discriminative value among low and moderate risk patients, as all deaths occurred in the highest risk group (Fig. 1, 2). These discrepant findings may be explained by a large number of patients in cardiogenic shock (45.8%), mostly related to STEMI. This population is characterized by high mortality exceeding 50% [25, 32, 47, 48].

Discriminative value of the GRACE risk score in the same group of patients tended to be highest (AUC = 0.857), although we found no significant difference compared to the other risk scores. This model also had no discriminative value among low risk patients (estimated mortality risk 1–4%) but tended to have better discriminative value among moderate risk patients (estimated mortality risk 5––19%) and high risk patients (estimated mortality risk ≥ 20%) (Fig. 3). These findings suggest an advantage of the GRACE risk score over the other evaluated risk prediction models in regard to the estimation of PCI-related risk in patients with ACS undergoing PCI of the left main coronary artery.

Study limitations

We studied unselected patients with LM CAD, including 24 (11.8%) patients with protected left main coronary artery stenosis. Most patients underwent emergent angioplasty and stenting of the left main coronary artery, including 46% patients in cardiogenic shock and 14.1% patients who had been resuscitated following a cardiac arrest. Due to all these factors, precise determination of the baseline clinical status as related to risk estimation using the EuroSCORE and Parsonnet scoring systems (no baseline echocardiographic evaluation, incomplete history regarding risk factors) was difficult and resulted in underestimation of predicted risk in critically ill patients. The EuroSCORE scoring system may underestimate risk in higher risk patients. Due to relatively low number of patients, multivariate analysis of the differences between predicted and actual risk could not be reliably performed.

Conclusions

The EuroSCORE and Parsonnet scoring systems are of no value in predicting periprocedural mortality risk in patients undergoing elective left main coronary artery stenting. Overall, discriminative ability of the EuroSCORE, Parsonnet, and GRACE risk scores in unselected patients with ACS undergoing emergent PCI of LM CAD was good. In this group of patients, the EuroSCORE and Parsonnet scoring systems had no discriminative value in low and moderate risk patients, as all deaths occurred in the highest risk group. Only the GRACE risk score discriminated risk among intermediate and high-risk patients with acute coronary syndrome.

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The authors do not report any conflict of interest regarding this work.

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