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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

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Abstract

Background and aim: To compare the long-term predictive value of six risk scores in a seven-year follow-up of acute coronary syndrome (ACS) patients.

Methods: We followed 906 patients diagnosed with ACS for seven years prospectively. The following risk scores (RS) were calculated: TIMI STEMI, TIMI NSTEMI, GRACE, SIMPLE, ZWOLLE and BANACH. Based on the survival data, the predictive value for each RS was calculated with receiver operating characteristics (ROC) curve analysis and presented as area under curve (AUC).

Results: The seven-year survival was 71%. The RS showed diverse long-term predictive values and AUC. The best estimation was demonstrated by the TIMI STEMI (0.779 [95% CI 0.743–0.812]), GRACE RS (0.766 [95% CI 0.737–0.794]) and BANACH RS (0.743 [95% CI 0.713–0.771]). Other scores presented were SIMPLE (0.714 [95% CI 0.683–0.743], TIMI NSTEMI (0.635 [95% CI 0.580–0.688]) and ZWOLLE (0.739 [95% CI 0.697–0.779].

Conclusions: The predictive values of currently recommended RSs are good for long-term perspective (seven years). RSs with high usability, such as BANACH RS, demonstrate accuracy similar to the more advanced RS.

Key words: acute coronary syndrome, risk stratification, myocardial infarction, long-term prognosis, Poland

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INTRODUCTION

Long-term clinical outcomes in patients with acute coronary syndromes (ACS) are dependent on various factors such as the demographic profile of the patient, the extent of myocyte necrosis, and the development of arrhythmic and haemodynamic complications [1]. Fox et al. [1] found that the timing of events after ACS depends on the ST category and is predisposed by the Global Registry of Acute Coronary Events (GRACE) risk score (RS). Later, a multinational study demonstrated the long-term complications of ACS and the use of GRACE RS for predicting the prognosis [2]. Except for this landmark study, the majority of RSs have mostly been used for predicting the prognosis in a six-month or a one-year timeframe after an episode of ACS.

Cardiovascular RSs are recommended and should be used for the diagnosis and treatment of individuals presenting with both non-ST segment elevation ACS and ST-segment elevation ACS, as well as for the stratification of all ACS survivors in a long-term follow up [3–5]. The number of RSs available for predicting a good or bad prognosis of ACS increases. The European Society of Cardiology (ESC) recommends the GRACE RSs as the preferred tool for in-hospital and long-term risk stratification [3]. The American College of Cardiology and the American Heart Association recommend the use of Thromboly-

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sis In Myocardial Infarction (TIMI) for unstable angina/non-ST elevation myocardial infarction (UA/NSTEMI), the TIMI for ST-elevation myocardial infarction (STEMI), and the Platelet Glycoprotein IIb-IIIa in Unstable Angina: Receptor Suppression Using Integrilin Therapy (PURSUIT) RS in addition to the GRACE RS [6–8]. All the above scales have been validated with respect to in-hospital and short-term (30-day) use. However, data on long-term prediction differs depending on the duration of the follow-up periods in the clinical trials and registries. The longest observation periods vary from two years for PURSUIT [9], three years for TIMI NSTEMI and TIMI STEMI [10], and five years [2, 11] to 5.8 years [12] for the GRACE RS. In addition to these RSs, there are a number of other RSs that demonstrate certain advantages over the traditional RS, but are not included in the present guidelines. Among these are: SIMPLE RS that consists just of three variables [13], the ZWOLLE RS that takes into consideration the TIMI grade reperfusion grade [14], and the BANACH RS that is based only on the clinical examination on admission and past medical history allowing for immediate bedside risk stratification [15].

The aim of our study was to compare the long-term predictive value of the six selected RSs in a seven-year follow-up of patients suffering from ACS.

METHODS

Study plan

We conducted an open label nonrandomised observational study. The study was started after approval from the local ethics committee of our institution. We followed-up consecutive patients diagnosed with ACS and included in the hospital registry between January 2001 and June 2003. All patients > 18 years of age were included in the study. All cases (n = 906) were managed at the tertiary referral hospital, with 24-h invasive cardiology duty, at the Medical University of Warsaw, Poland. Based on the medical data from the admission, in-hospital stay and discharge letters, we derived the RS values for each patient. The routine hospital protocol at that time required documentation of the TIMI STEMI RS and TIMI NSTEMI RS only. The treatment strategy was based on the TIMI RS stratification mainly because both TIMI STEMI RS and TIMI NSTEMI RS were recommended as the primary risk stratification tool in the hospital almanac at that time. The remaining four RSs, namely GRACE, SIMPLE, ZWOLLE and BANACH, were calculated retrospectively from the registry data available and thus these have not influenced the clinical decisions at the time of the patients' hospitalisation. The fact that some of the RSs were calculated afterwards did not influence their completeness and accuracy, as all the data needed for the calculation was collected at the baseline.

Risk scores

ACS RSs differ in terms of their predictive values, variables and time frames. Below, we present a brief characteristic of each RS.

The TIMI RS is based on seven predictor variables including age 65 years or older, at least three risk factors for coronary artery disease, prior coronary stenosis of 50% or more, ST-segment deviation on electrocardiogram (ECG) at presentation, at least two anginal events in prior 24 h, the use of aspirin in the prior seven days, and elevated serum cardiac markers [6].

The SIMPLE RS is a simplified model that originated from the registry of the fibrinolytic InTime II study [9]. This scale has only three parameters, but at the same time is characterised by low prognostic value, especially in patients with other concomitant ailments.

The ZWOLLE scale is a 16-point scale and one of the few that incorporates the coronary flow measure expressed as the post reperfusion TIMI Grade Flow. It has a relatively high predictive value of c-statistics up to 0.91 and assesses the feasibility of early discharge in low-risk patients [16].

The GRACE RS is based on a wide spectrum of ACS patients from a prospective, multicentre, global registry and it considers additional risk factors such as sudden cardiac arrest. Initially, it was designed to predict in-hospital mortality or the six-month outcome, but now it is one of the most popular RSs for long-term outcome as well. The components of the GRACE RS (range 2–372) are age, heart rate, systolic blood pressure (SBP), Killip class, cardiac arrest, serum creatinine, ST-segment deviation and cardiac biomarker status [17].

The BANACH RS (developed in Banach Medical Campus, Medical University of Warsaw), is based on 12 variables including aborted sudden cardiac death before or on admission, cardiogenic shock/pulmonary oedema before or on admission, age > 65 years, heart failure (NYHA III/IV) in patient's history, heart rate > 78 bpm in admission findings, elevated cardiac markers on admission, angina de novo < 2 weeks in patient's history as the presenting complaint, and SBP > 130 mm Hg on admission, His bundle block, any ST-depression, ST-elevation (anterolateral), pathological Q wave in two contiguous leads on the first ECG on admission. The patient gets one risk point for each of ten variables, but the score may be reduced by two points if SBP is over 130 mm Hg on admission and angina de novo < 2 weeks in history are present. Thus, the highest possible score in BANACH RS is 10 points, and the lowest is minus 2 points.

Study group

Patients included in the present study were treated according to the hospital protocol compliant with the ESC guidelines presented by the Task Force on the Management of Chest Pain published in the 2002 [18]. According to the algorithm, patients were referred for an invasive diagnostics with an angiographic imaging at the local 24/7 catheterisation laboratory. In total, 85.4% (n = 774) of patients underwent coronary catheterisation (87.7% of STEMI and 81.6% of non-STEMI), 80.7% of these were treated with a primary percutaneous coronary intervention (pPCI). Of the UA/NSTEMI, 12.1%

(n = 40) needed urgent coronary artery bypass grafting (CABG), 12.7% (n = 41) underwent plain old balloon angioplasty (POBA), and 35.4% (n = 114) had a stent implanted. Among the STEMI patients, urgent CABG, POBA and stent implantation were performed in 4.8% (n = 29), 17.14% (n = 103), and 58.24% (n = 350), respectively. The in-hospital medical therapy was compliant with the ESC recommendations with more than 95% of patients receiving acetylosalicylic acid (ASA), 70% clopidogrel, and 54.91% IIb/IIIa inhibitor; 100% took either low molecular weight heparin or unfractionated heparin. On discharge from the hospital, patients received ASA (79.5%), clopidogrel or ticlopidine (61.9%), angiotensin converting enzyme inhibitor (78.2%), statin (82%) and beta-blocker (82.3%) [19].

Follow up

After discharge from the hospital, the patients were followed-up at 30 days, six months, and one year during visits to the outpatient clinic, by phone, post or home visits. The seven-year follow-up was completed with the use of records from the Government Central Statistical Office (CSO, PESEL database). The incidence of death was chosen as the hard end-point for prediction performance analysis of the six RSs. Using the personal identification numbers (PESEL) of the patients, the survival data (which included the incidence and the date of death) were obtained and matched with the hospital registry. Follow-up was not possible for non-Polish residents who did not have a CSO registered PESEL (four patients).

We determined the predictive value for each RS using the methods described in the statistical analysis section. To understand the independent association of risk factors with the long-term mortality, a multivariate analysis was performed. Additionally, patients were categorised into risk groups according to the BANACH score, GRACE RS, ZWOLLE RS, SIMPLE RS, TIMI STEMI RS and TIMI NSTEMI RS. The dynamics in the survival were evaluated for these pre-specified risk groups and plotted as the Kaplan-Meier curve.

Statistical analysis

All the tests were performed with the significance level of 0.05. The comparison of the seven-year vs. one-year predicted mortality was performed using χ^2 test and Fisher's exact test as required. Several techniques were used to evaluate the model adequateness. Model's goodness-of-fit was verified by Pearson's or Hosmer-Lemeshow test. A discriminative ability of each model was verified using area under receiver operating curve (ROC). The relationship between clinical factors and seven-year mortality was analysed using multivariate logistic regression. The selection of significant factors was based on backward selection procedure, with removal of predictor when 'α' was greater than 0.1. The survival was presented with a Kaplan-Meier curve. The comparison of different ROC curves was performed based on the Hanley & McNeil methodology [20].

RESULTS

Of the 931 patients, most were assigned for an invasive strategy (795, 85.4%); primary angioplasty was performed in 610 (65.5%) patients with more stent implantation in the STEMI (453, 75.4%) than in the NSTEMI (157, 47.6%) patients. A minority (69, 7.41%) were sent for CABG, more in the NSTEMI subgroup (40, 12.1%).

The data set for RS calculations was complete and there were no missing variables. The total seven-year follow-up was completed in 97.3% i.e. 906 out of the total of 931 qualified to enter the study. The mean age of the patients was 62.6 ±12.1 years; the youngest patient was 23 and the oldest 94 years old. The baseline characteristics show that 64.34% were male patients (n = 583). Although the study included all-comers, the population represents high risk individuals. The majority of patients were diagnosed with myocardial infarction (96.47%), and only 3.5% presented with UA. The population characteristics on admission are presented in Table 1.

The total seven-year mortality was 28.8% (n = 261). The ability to predict the long-term mortality differed among the tested RSs. Initially, the predictive value was calculated for RSs that are dedicated for the entire population of STEMI and NSTEMI patients, i.e. GRACE RS, BANACH RS and SIMPLE RS. An equally good result was demonstrated by the GRACE RS, with AUC of 0.763 (95% CI 0.734–0.790), and the BANACH RS, with AUC of 0.737 (95% CI 0.706–0.765). The SIMPLE RS with AUC of 0.714 (95% CI 0.683–0.743) revealed significantly lower predictive value compared to the GRACE RS ($p < 0.01$) (Fig. 1).

In the STEMI subgroup, the predictive value was calculated for GRACE RS, BANACH RS, SIMPLE RS and TIMI STEMI RS. The best predictive value was shown by the GRACE RS with AUC of 0.778 (95% CI 0.742–0.811), the TIMI STEMI RS with AUC of 0.776 (95% CI 0.738–0.809), and the BANACH RS with AUC of 0.745 (95% CI 0.708–0.780). The SIMPLE RS with AUC of 0.718 revealed significantly lower predictive value compared to the GRACE RS and the TIMI STEMI ($p < 0.01$) (Fig. 2). The ZWOLLE RS was calculated only for STEMI patients who underwent invasive treatment. The predictive value for ZWOLLE RS did not significantly differ compared to other RSs (AUC = 0.735; 95% CI 0.692–0.775).

The TIMI NSTEMI RS was tested only in the NSTEMI subgroup and demonstrated moderate predictive value with AUC of 0.634 (95% CI 0.743–0.812). It was significantly lower compared to the GRACE RS (AUC = 0.748, 95% CI 0.696––0.794) and BANACH RS (AUC = 0.733, 95% CI 0.682–0.781); $p < 0.01$. The predictive value of the SIMPLE RS in the NSTEMI population was moderate (AUC = 0.704, 95% CI 0.651–0.754) (Fig. 3). Comparison of the RSs is presented in Table 2.

To better understand the long-term mortality risks, we conducted a subgroup analysis with regard to the in-hospital risk stratification defined by each RS. Based on the BANACH RS group stratification, we found significant seven-year mortality risk differences among the low, moderate and

Table 1. Demographic profile of patients (n = 906, all patients) analysed in the study

ON ADMISSION	
Age:	
Value interval	23–94
Mean ± SD	62.6 ± 12.08
Median	63.0
Gender:	
Male	583 (64.4%)
Female	323 (35.6%)
Diagnosis:	
STEMI	584 (64.4%)
NSTEMI	290 (32.0%)
UA	32 (3.5%)
Weight [kg]:	
Value interval	45–130
Mean ± SD	77.6 ± 15.5
Median	77
PAST MEDICAL HISTORY	
Increased angina	103 (11.4%)
Angina de novo < 2 weeks as the presenting symptom	290 (32%)
Angina at night	42 (4.6%)
Angina at rest	357 (39.4%)
Duration of chest pain [h]:	
Value interval	0–336
Mean ± SD	5.7 ± 7.9
Median	3
Aborted sudden cardiac death	31 (3.4%)
Angina post MI	46 (5.1%)
Myocardial infarction	241 (26.6%)
PCI	52 (5.7%)
CABG	30 (3.3%)
Stroke	42 (4.6%)
Hypertension	527 (58.1%)
Smoker	327 (36.1%)
Diabetes mellitus	149 (16.4%)
Dyslipidaemia	301 (33.2%)
Asthma/COPD	51 (5.6%)
HF (NYHA class III/IV)	56 (6.0%)
PAD	94 (10.4%)
BLOOD RESULTS	
LDL [mg/dL]:	
Mean ± SD	115.25 ± 40.49
Median	113
OBSERVATIONS	
Heart rate [bpm]:	
Value interval	30–210
Mean ± SD	79.02 ± 19.3
Median	78
SBP [mm Hg]:	
Value interval	60–270
Mean ± SD	133.9 ± 28.5
Median	130
Killip scale:	
I class	772 (85.2%)
II class	102 (11.2%)
III class	17 (1.9%)
IV class	14 (1.5%)

CABG — coronary artery by-pass grafting; COPD — chronic obstructive pulmonary disease; HF — heart failure; LDL — low density lipoprotein; MI — myocardial infarction; NSTEMI — non-ST elevation myocardial infarction; NYHA — New York Heart Association (heart failure classification); PAD — peripheral artery disease; PCI — percutaneous coronary intervention; SBP — systolic blood pressure; STEMI — ST elevation myocardial infarction; UA — unstable angina

high-risk groups. In the high risk group, there was a 4.48 fold increase in mortality when compared to the low risk group (56.9% vs. 13.7%, $p < 0.05$). The survivals presented in the Kaplan-Meier curves show a split of the curves at the early stage of the observation with a continuous diversion throughout the long-term observation period. The differences among the subgroups along time were statistically significant ($\chi^2 = 143.8489$, $p < 0.0001$) (Fig. 4). Based on the GRACE RS group stratification, we found significant seven-year mortality differences between the high-risk group (> 118 points) and the moderate (89–118 points) (38.4% vs. 13.1%), as well as between the high-risk group and the low risk group (< 89 points) (38.4% vs. 11%). However, there was no difference between the low and moderate risk groups ($p = 0.76$) (Fig. 5). The ZWOLLE RS stratified the population into four risk groups: very high (≥ 10 points), high (7–9 points), moderate (4–6 points), and low (0–3 points). There was a significant seven-year mortality difference between the low (18%), moderate (30.8%) and high-risk groups (65.5%) ($p < 0.0001$). The high and very high-risk groups did not differ in terms of mortality at seven years (65.5% vs. 68.2%, $p = 0.66$) (Fig. 6). It is worth noting that the latest death in the high risk and very high risk subgroups occurred in the fifth year. Risk stratification with SIMPLE RS divides a population into five subgroups as per the quintiles defined in the paper by Morrow et al. [13]. In terms of seven-year mortality risk, there are significant differences between the first quintile (risk index [RI] ≤ 12.5), characterised by the lowest risk (16.9%), and the second quintile (RI = 12.5–17.5; 14.3%), as well as between the fourth quintile (RI = 22.5–30; 23.5%) and fifth quintile (RI ≥ 30; 59.7%). However, there were no statistically significant differences between the second and third (RI = 17.5–22.5; 19.3%) quintiles as well as between the third and fourth quintiles (Fig. 7). The TIMI STEMI RS divides

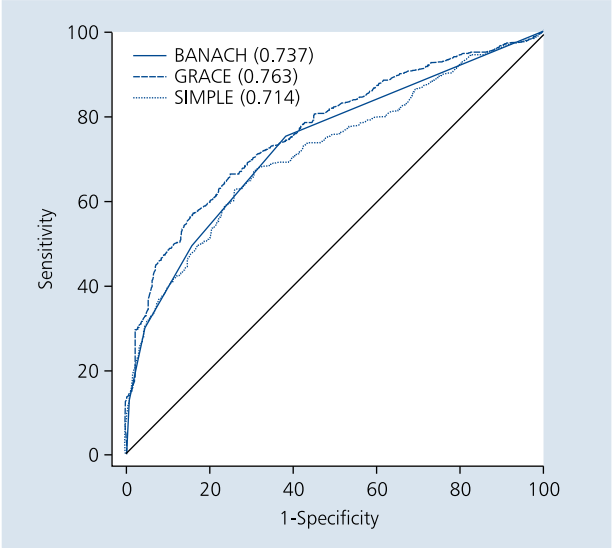

Figure 1. Predictive values of the SIMPLE, ZWOLLE, GRACE, TIMI STEMI RS, TIMI NSTEMI/UA RS; risk scores for the analysed registry by ROC analysis; ROC — receiver-operating characteristics; TIMI STEMI — TIMI risk score for myocardial infarction with ST-segment elevation; TIMI NSTEMI/UA RS — TIMI risk score for myocardial infarction with non-ST segment elevation/unstable angina; AUC — area under curve

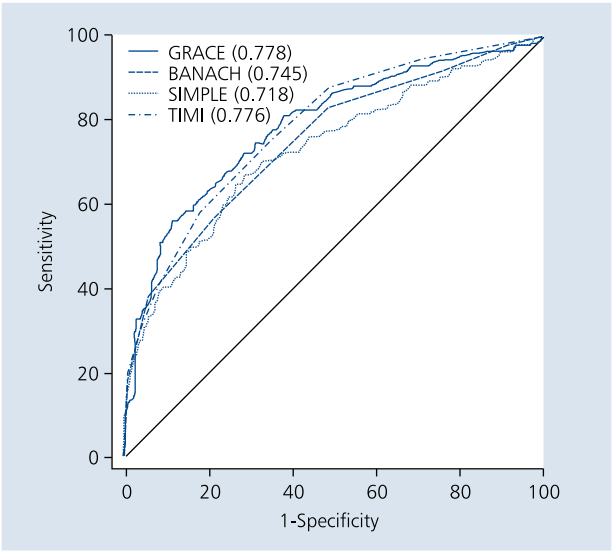

Figure 2. Receiver-operating curve with TIMI STEMI (Thrombolysis in Myocardial Infarction [TIMI] risk score for ST-elevation myocardial infarction [STEMI]

the STEMI population into four risk groups. The seven-year mortality in the very high-risk group (≥ 8 points) was 89.7%, in the high risk group (7–8 points) it was 64.5%, in the moderate risk group (4–6 points) it was 38.2%, and in the low risk group (0–3 points) it was 14.7%. The differences were statistically significant ($p < 0.001$) (Fig. 8).

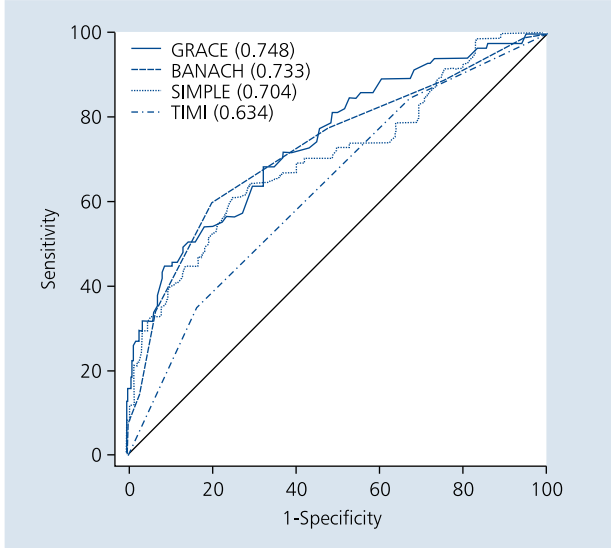

Figure 3. Receiver-operating curve with TIMI NSTEMI/UA (Thrombolysis in Myocardial Infarction [TIMI] risk score for non-ST-elevation myocardial infarction/unstable angina [NSTEMI/UA])

Table 2. Comparison of risk scores according to predictive value (area under curve)

	STEMI	NSTEMI	Number of variables
BANACH	0.745	0.733	12
GRACE	0.778	0.748	8
SIMPLE	0.718	0.704	3
TIMI STEMI	0.776	N/A	7
TIMI NSTEMI	N/A	0.634	7
ZWOLLE	0.735	N/A	16

NSTEMI — non-ST elevation myocardial infarction; STEMI — ST elevation myocardial infarction

The TIMI NSTEMI RS divided the NSTEMI population into four risk groups: very high risk (5–7 points), high risk (4 points), moderate risk (3 points), and low risk (0–2 points). The risks associated differed significantly between all but two subgroups: very high risk 43.1%, high risk 38.3%, moderate 33.9%, and low risk 24.3%. The seven-year mortality risks in the high risk groups and moderate risk group were statistically not different (Fig. 9).

The comparison of survival probability in seven-year perspective between STEMI and UA/NSTEMI patients did not reveal any statistical difference. The respective values were 0.724 (standard error [SE] = 0.0259) and 0.694 (SE = 0.0203) (Fig. 10).

The majority of deaths occur within the first months after the index event. To better understand the ability to predict the survival after ACS beyond this timeframe, we have made

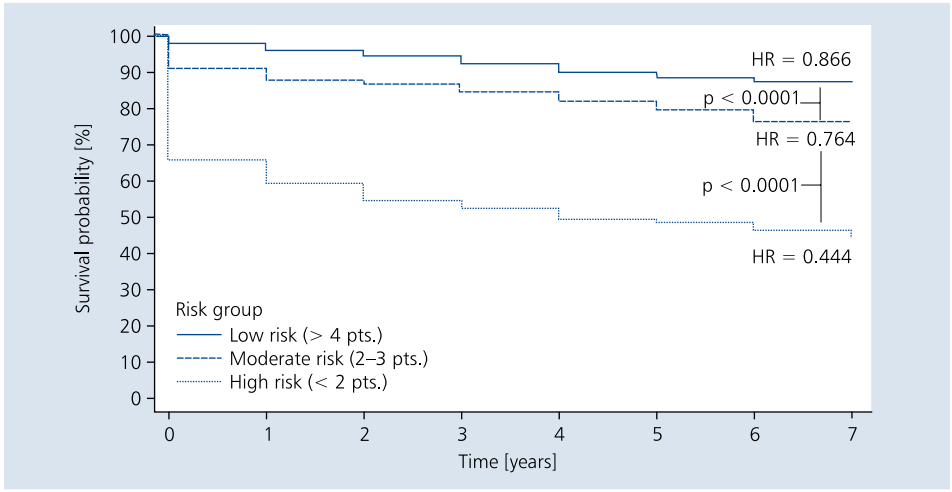

Figure 4. Seven-year survival after myocardial infarction in low, moderate and high risk population according to BANACH risk score; hazard ratio (HR) demonstrated at seven-years; pts. — points

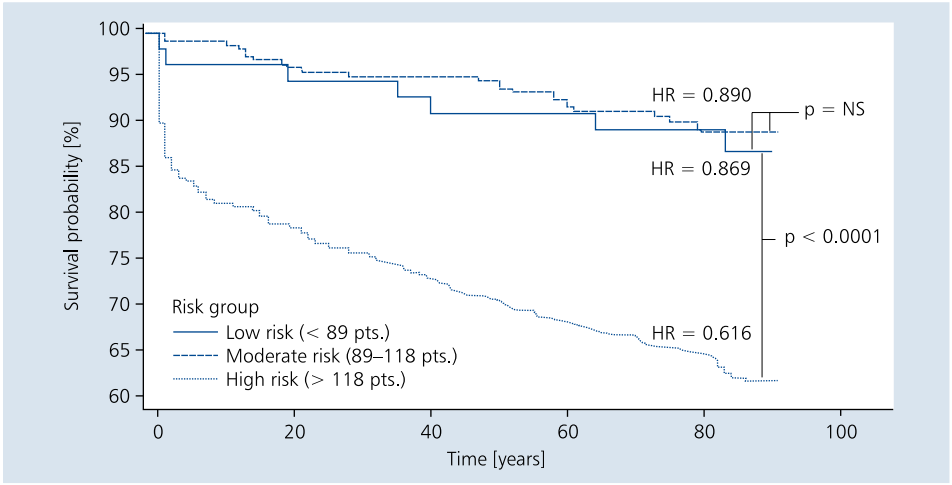

Figure 5. Seven-year survival after myocardial infarction in ST-elevation myocardial infarction (STEMI) and unstable angina (UA)/ /non-STEMI patients according to GRACE risk score; hazard ratio (HR) demonstrated at seven-years; pts. — points

a comparison of survival at later time points, according to different strata for GRACE RS and BANACH RS. After the first year, we found that there was a significant difference between the low/moderate risk groups and the high-risk group defined by both the GRACE RS and the BANACH RS. This difference was maintained when we looked at survival beyond the second and the third year ($p < 0.05$) (Figs. 11, 12).

DISCUSSION

Our study shows that the currently recommended RSs help predict the long-term outcome after ACS, even beyond five years. ACS is associated with immediate and long-term risk to the patient's health and life. The short-term mortality is well understood and has been evaluated in previous studies; however there is still limited data on the long-term survival of ACS and the risk factors associated with worsened prognosis of the patients.

The short-term and long-term risks among patients with ACS vary, and therefore not all RSs are able to perform well in both time frames. From a clinical standpoint, it is important to determine the short-term and long-term risks of adverse events during the initial screening already at the emergency department. By identifying patients at high risk, the treating physician can utilise the benefits from more potent invasive therapies and implement them at an early stage.

The two RSs that showed the greatest seven-year predictive value in the unselected ACS population were GRACE and BANACH. The GRACE RS is recommended by the ESC, although its ease of use is limited as it requires dedicated PC software to calculate it. This limitation does not apply to the

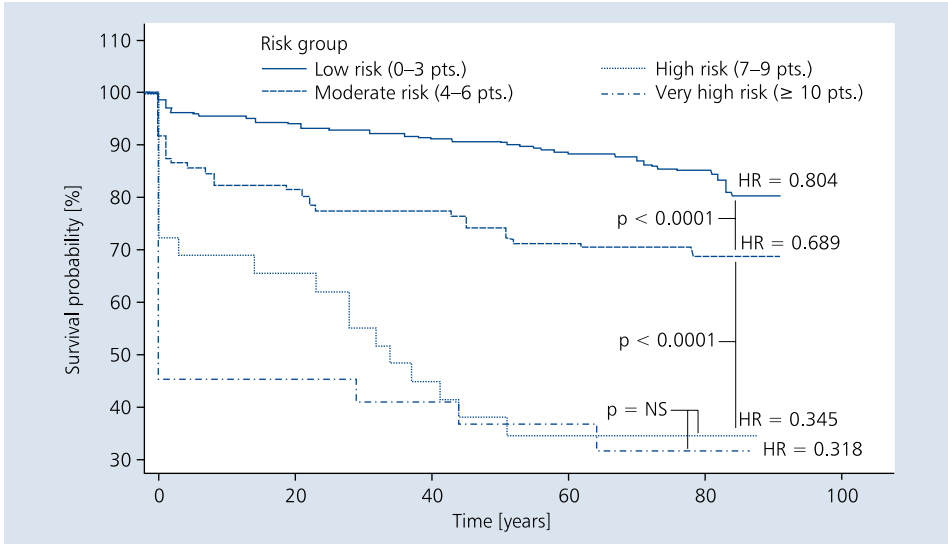

Figure 6. Seven-year survival after myocardial infarction in ST-elevation myocardial infarction (STEMI) and unstable angina (UA)/ /non-STEMI patients according to ZWOLLE risk score; hazard ratio (HR) demonstrated at seven-years; pts. — points

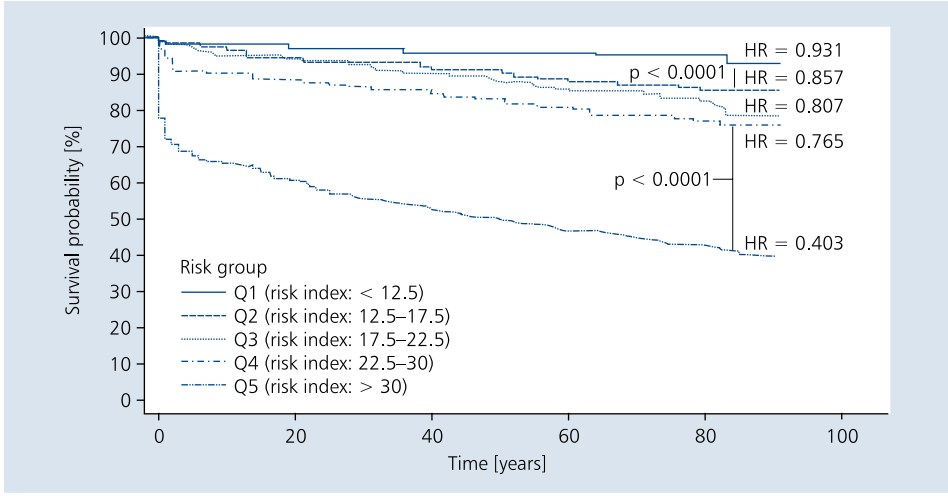

Figure 7. Seven-year survival after myocardial infarction in ST-elevation myocardial infarction (STEMI) and unstable angina (UA)/ /non-STEMI patients according to SIMPLE risk score; hazard ratio (HR) demonstrated at seven-years; pts. — points

BANACH RS, which is based on a simple calculation of a maximum 12 points. As we analysed the STEMI subgroup, we found that among the best RSs, apart from the GRACE and BANACH, a similarly good predictive value revealed the TIMI STEMI RS. This RS was derived from a large fibrinolytic therapy study and includes electrocardiographic and clinical features [21]. It is still popular among attending physicians, mainly because of its ease of use (14-point scale) [19]. A simple bedside calculation of the TIMI STEMI RS provides rapid risk stratification, allowing facilitation of therapeutic decision-making in patients with symptoms suggestive of ACS [21]. However, as the TIMI STEMI RS, as well as the TIMI NSTEMI RS, has been developed in the non-PCI era, it is questionable whether these should still be used.

Some long-term studies have evaluated and compared the predictive value of the RSs. Fox et al. [2] found that the GRACE score showed good predictive accuracy for the combined end-point of cardiovascular diseases or myocardial infarction in hospital (χ^2 likelihood ratio 219.2, $p < 0.0001$, c-statistic 0.86) and the same combined end-point at five years (χ^2 likelihood ratio 477.1, $p < 0.0001$, c-statistic 0.68). This is the largest study analysing the long-term survival. The GRACE risk score demonstrates similar predictive accuracy for the in-hospital phase and long-term follow-up [3]. Eggers et al. [12] found that the GRACE risk score was significantly higher in patients who died ($p < 0.001$) and provided a c-statistic regarding mortality of 0.78. GRACE

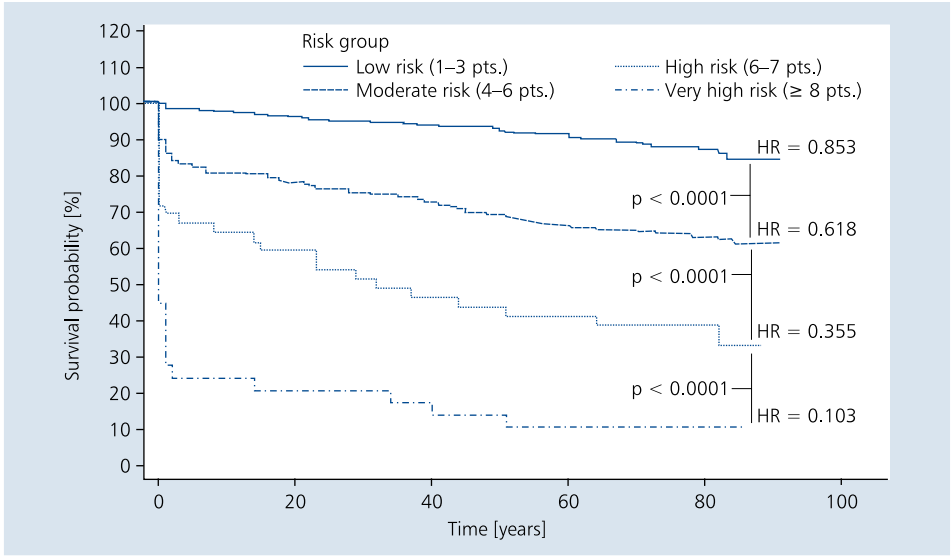

Figure 8. Seven-year survival after myocardial infarction in ST-elevation myocardial infarction (STEMI) patients according to TIMI STEMI risk score; hazard ratio (HR) demonstrated at seven-years; pts. — points

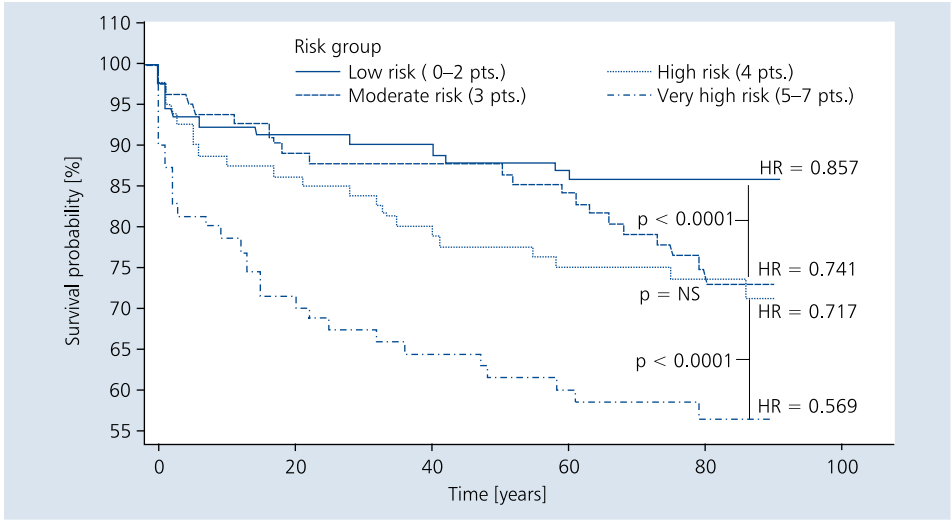

Figure 9. Seven year-survival after myocardial infarction in unstable angina (UA)/ST-elevation myocardial infarction (NSTEMI) patients according to TIMI NSTEMI risk score; hazard ratio (HR) demonstrated at seven-years; pts. — points

risk score allowed for the prediction of mortality in chest pain patients even after 5.8 years of follow-up [22]. It is worth noting that GRACE RS can also be used to predict risk in low risk populations for ACS and to identify those at almost no risk of complications [12]. Kozieradzka et al. [11] found that prognostic values for five-year mortality were: 0.742 (95% CI 0.69–0.79) for the GRACE RS, 0.727 (95% CI 0.67–0.78) for TIMI, 0.72 (95% CI 0.67–0.77) for ZWOLLE, and 0.687 (CI 0.63–0.74) for CADILLAC RS. GRACE RS has proved to be better than TIMI and an advantageous and easy tool to calculate the outcomes after ACS. Tang et al. [23] found that GRACE measured post discharge contained relevant prognostic factors and accurately distinguished survivors from non survivors over the longer term (up to four years) in all subsets of ACS patients [23]. Elbarouni et al. [24] found that GRACE RS is a valid and powerful predictor of adverse outcomes across a wide range of Canadian patients with ACS. Its excellent discrimination is maintained despite advances in management over time, and is evident in all patient subgroups [23, 24].

A single centre ACS registry based study has shown that the BANACH score offers both high goodness-of-fit and predictive value in the Polish population. The BANACH score includes novel predictors not found in the other RSs, i.e. 'sudden car-

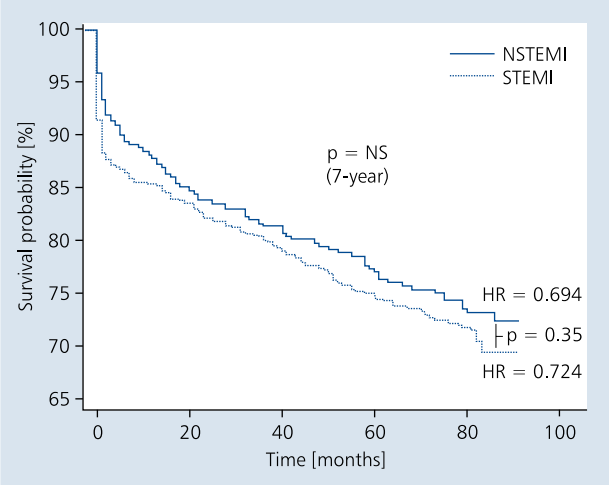

Figure 10. Seven-year survival after myocardial infarction comparison between ST-elevation myocardial infarction (STEMI) and unstable angina (UA)/non-STEMI patients

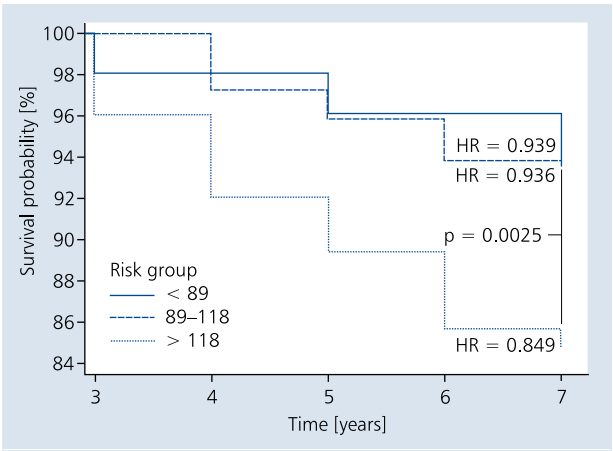

Figure 11. Survival from year 3 after myocardial infarction in ST-elevation myocardial infarction (STEMI) and unstable angina (UA)/non-STEMI patients according to GRACE risk score

diac arrest' (also in GRACE RS) and 'pathologic Q waves on admission ECG' [15]. It has been developed after evaluating and comparing prospectively the main RSs and was formulated on the basis of our Polish single registry. It performed well also in a seven-year time frame in the present study. All variables needed to calculate the BANACH RS are available early at the admission to the hospital, and no additional time is needed for such data as troponin levels or coronary angiogram. This feature assures the high usability of BANACH RS.

Looking at the long-term survival rates, various studies have demonstrated high mortality rates within five years of ACS. Fox et al. [2] showed that at five years after STEMI 19% died, which is comparable to non-STEMI (22%) and UA groups (17%). Kozieradzka et al. [11] found that 6.3% of STEMI patients died during the first 30 days, and 15.6% died

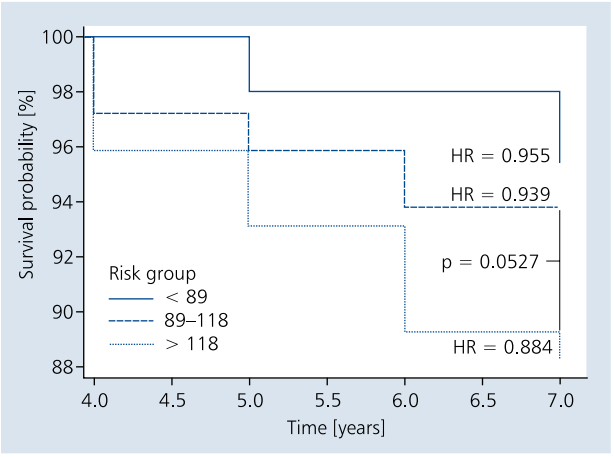

Figure 12. Survival from year 4 after myocardial infarction in ST-elevation myocardial infarction (STEMI) and unstable angina (UA)/non-STEMI patients according to GRACE risk score

within five years. The mortality rates observed by Fox et al. [2] and Kozieradzka et al. [11] are similar to our results. The long-term survival among STEMI and non-STEMI patients remains a complex issue and requires deeper analysis in order to understand the underlying demographic, clinical and procedural characteristics of the two populations. As this is beyond the scope of the present work, this analysis will be published separately.

Limitations of the study

Despite the prospective planning of the methodology used in our study, there are important aspects that should be considered as limitations. The main weakness of the study is that it is designed as a single-centre analysis. There is a potential bias related to the local population characteristics, procedures and guidelines adherence. Most of the patients admitted to the hospital lived not more than 200 km away from the medical centre that covered urban and rural infrastructure with a medium to high level of pollution. Despite the fact that the hospital's diagnostic and treatment guidelines followed the European recommendations, the study results should not be extrapolated on centres where ECS guidelines are not applicable.

Furthermore, at the time when the study was performed, percutaneous techniques and intracoronary devices were in an early stage of development. The currently available state-of-the-art technologies, including third and fourth generation drug eluting stents, demonstrate improved results that potentially may also influence the long-term survival analysed in our study.

CONCLUSIONS

The currently recommended RSs provide good predictive value also in a long-term, seven-year perspective. RSs that are

easy to use in the emergency setting, especially for physicians with limited access to advanced PC software, such as BANACH RS, still demonstrate an accuracy similar to that of the GRACE RS — a RS perceived as the gold standard.

We would like to conclude by saying that the use of RSs in everyday clinical practice should be strongly encouraged as it provides reliable identification of ACS patients who remain at high risk of short- and long-term mortality.

Conflict of interest: *none declared*

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Predykcja siedmioletniego ryzyka sercowo-naczyniowego: porównanie sześciu skal ryzyka u chorych z ostrym zespołem wieńcowym: GRACE, TIMI STEMI, TIMI NSTEMI, SIMPLE, ZWOLLE i BANACH

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Streszczenie

Wstęp i cel: Celem pracy było porównanie 6 skal oceny ryzyka u chorych z ostrym zespołem wieńcowym (ACS) w perspektywie 7-letniej.

Metody: Obserwacji 7-letniej poddano 906 chorych z ACS, u których oszacowano ryzyko sercowo-naczyniowe za pomocą następujących skal ryzyka: TIMI STEMI, TIMI NSTEMI, GRACE, SIMPLE, ZWOLLE i BANACH. Na podstawie analizy ROC wyznaczono wartość predykcyjną dla każdej ze skal.

Wyniki: Przeżycie 7-letnie wyniosło 71%. Zaobserwowano istotne różnice między zdolnością predykcyjną poszczególnych skal ryzyka. Najwyższą wartość predykcyjną wykazano dla skali TIMI STEMI (0,779 [95% CI 0,743–0,812]), skali GRACE (0,766 [95% CI 0,737–0,794]) i skali BANACHA (0,743 [95% CI 0,713–0,771]). W dalszej kolejności uplasowały się skale: SIMPLE (0,714 [95% CI 0,683–0,743], TIMI NSTEMI (0,635 [95% CI 0,580–0,688]) i ZWOLLE (0,739 [95% CI 0,697–0,779].

Wnioski: Aktualnie rekomendowane skale ryzyka wykazują wysoką wartość predykcyjną dla długoterminowego ryzyka sercowo-naczyniowego (7-letniego). Wygodna w użyciu skala BANACHA cechuje się wartością predykcyjną porównywalną do bardziej zaawansowanych i skomplikowanych skal ryzyka.

Słowa kluczowe: ostry zespół wieńcowy, stratyfikacja ryzyka, zawał serca

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