Comparison of the Selvester QRS scoring system and GRACE scale in the evaluation of the risk of sub-acute myocardial infarction

Maryam Bilal Butt

Supervisor:

Prof. Eglė Kalinauskienė
Department of Internal Medicine
Medical Academy of Lithuanian University of Health Sciences
Josvainių 2, LT-47144 Kaunas
Lithuania
Phone: 370-37 306093
Fax: 370-37 306093
E-mail: eglekalin@yahoo.com

Thesis preparation in 2015/2016, Department of Internal Medicine
Medical Academy of Lithuanian University of Health Sciences

Table of Contents

1.0 Summary

Maryam Bilal Butt

Comparison of the Selvester QRS scoring system and GRACE scale in the evaluation of the risk of sub-acute myocardial infarction

Aim. To compare the performance of Selvester and GRACE scale in evaluating the risk prognosis of sub-acute myocardial infarction. **Objectives.** 1. To predict in-hospital mortality of sub-acute STEMI by Selvester QRS scoring system. 2. To predict in-hospital mortality of sub-acute STEMI by GRACE scale. 3. Comparison of Selvester QRS scoring system and GRACE scale in predicting in-hospital mortality of sub-acute STEMI. **Material and Methods.** Consecutive 48 patients (male 33.3 %, female 66.7 %) with the age of 80.31 ± 7.47 years were investigated in this study. The inclusion criteria were: confirmed MI by troponin and ECG criteria of sub-acute MI at admission to a hospital: still elevated ST segment >= 1 mV with inverted T wave at least 1 mV. Exclusion criteria were only the following: ventricular pacemaker and intraventricular conduction defects. The patients' ECG, taken at the arrival to the hospital, were considered to predict the risk of in-hospital mortality by Selvester QRS score and clinical findings including ECG changes were used to interpret the high-risk of in-hospital mortality by GRACE score. The data analysis was performed by using the package SPPS 22.0. McNemar's test was used to compare the scores. **Results.** Even high GRACE score > 154 points and Selvester score > 6 did not predict the death (significant difference in comparison with actual in-hospital mortality was found for both scores, $p = 0.000$ and $p = 0.001$, respectively). But Selvester score > 8 was predicting the death (there was no difference in comparison with actual in-hospital mortality, $p = 0.092$) with the accuracy 72.9%. **Conclusion.** Selvester score > 8 was predicting the in-hospital mortality in cases of sub-acute STEMI, even high GRACE score did not predict.

Keywords: Electrocardiology; Myocardial infarction; QRS system; GRACE score, In-hospital mortality;

2.0 Acknowledgements

I am grateful to my supervisor, Prof. Egle Kalinauskiene, whose expertise, understanding, generous guidance and support made it possible to work on a topic that was of great interest to me. It was a pleasure working with her. You definitely provided me with the tools that I needed to choose the right direction and successfully complete my thesis.

I would like to thank Dr. Dalia Gerviene for her wonderful collaboration. We were not only able to support each other by deliberating over our problems and findings, but also always happily willing to help each other. I was a co-author in Dr. Dalia Gerviene research work for her PhD and I contributed in writing the research work and find the conclusion.

In addition, i would also like to thank Jurate Tomkeviciute, Assistant in Department of Physics, Mathematics and Biophysics, LUHS (LSMU) who helped me to do calculation in my thesis.

Thank you very much, everyone!
Maryam Bilal Butt

3.0 Conflict of interest

Non conflict of interest.

Ethics Committee Clearance

The study was approved by the Ethics Committee of the Lithuanian University of Health Sciences, code: 302536989

4.0 Abbreviations list

NSTE-ACS – Non-ST segment elevation acute coronary syndrome

STEMI – ST elevated myocardial infarction

NSTEMI – Non-ST elevated myocardial infarction

AMI – Acute Myocardial infarction

MI – Myocardial infarction

ECG – Electrocardiogram

CAD – coronary artery disease

CHD – Coronary heart disease

ACS – Acute coronary syndrome

LV – Left ventricle

MRI – Magnetic resonance image

TIMI – Thrombolysis in myocardial infarction

HF – Heart failure

LGE-CMR – Late gadolinium hyper-resonance cardiac magnetic resonance

ACC – Accuracy

TP – True Positive

TN – True Negative

FP – False Positive

FN – False Negative

5.0 Terms

- Sub-acute myocardial infarction - a returning ST segment to the baseline and an inverting T wave on electrocardiogram.

- GRACE score – a global registry of acute coronary events (2.0) risk score have been developed for the assessment of the risk of death among patient with acute coronary syndrome.

- Selvester QRS score – a scoring system based on quantitative criteria from the standard 12-lead electrocardiogram (ECG), which estimates the size and location of myocardial scar in the left ventricle.

6.0 Introduction

Coronary heart disease, one of the leading cause of death, possess three clinical types; Non-ST segment elevation acute coronary syndrome (NSTE-ACS), ST-segment elevation myocardial infarction (STEMI) and unstable angina. Sub-acute infraction (within weeks or more) - a returning ST segment to the baseline and an inverting T wave. Correct diagnosis and early management are keen important to improve adverse cardiac events in patients with acute myocardial infarction (MI). The manifestation of serious cardiovascular adverse events varies in Acute coronary syndrome (ACS) patients related to enzyme markers, clinical features and electrocardiogram (ECG). Risk stratification can be helpful for the early treatment decision taking either with drugs or by different therapeutic procedures (e.g coronary angioplasty). However, to identify the accuracy of risk stratification the normal or elevated value of cardiac marker (troponin) and abnormal changes in ECG is inadequate for prognosis interpretation, hence, more information is required.

Global Registry of Acute Coronary Events (GRACE) (range 1 to 372) in Myocardial Infarction risk scores have been widely used for risk prognosis in patients with acute coronary syndrome (ACS), all around the world. The factors of the GRACE risk score are age, variable heart rate, systolic blood pressure value, elevated serum creatinine value, ST-segment deviation in ECG and elevated cardiac biomarker values including Killip class (I-IV). A prognostic score is calculated based on above mentioned factors to estimates the risk of mortality in individual patient.

To estimate the size of MI in the left ventricular (LV) by using ECG, the Selvester QRS-scoring system have been designed. For the Selvester QRS score's criteria following ECG features have to be measured; the amplitude of Q, R, and S wave in mV, duration of Q and R wave in ms, and R/Q and R/S ratio. The QRS scoring system have a total of 31 points, which was used in this study based on 50 ECG criteria. Each point in Selvester QRS scoring system was designed to show approximately 3% MI of the LV (point multiply by 3). Many versions of the Selvester QRS scoring system have been described in previous studies. Patient admission ECG changes have to be measured by using the simplified QRS score. Aim of this study is to compare the accuracy of the GRACE score and Selvester QRS scoring system to evaluating the risk prognosis of sub-acute myocardial infarction (acute MI). Not enough research data is available regarding the sub-acute STEMI and more studies should be done.

7.0 Aim

To compare the performance of Selvester QRS scoring system and GRACE risk score in evaluating the risk prognosis of sub-acute STEMI.

Objectives

1. To predict in-hospital mortality of sub-acute STEMI by Selvester QRS scoring system.
2. To predict in-hospital mortality of sub-acute STEMI by GRACE scale.
3. Comparison of Selvester QRS scoring system and GRACE scale in predicting in-hospital mortality of sub-acute STEMI.

9.0 Literature review

Myocardial infarction (MI) can be identified by clinical features, including electrocardiographic (ECG) changes, elevated values of cardiac markers (biomarkers) which elevates due to myocardial damage or necrosis. The magnetic resonance image (MRI) also help to recognize MI. It is one of the major cause of death and disability in older patients. MI may be the first indication of coronary artery disease (CAD) or it may occur repeatedly in various patients. Information about the MI size can be useful regarding the incidence of cardiac adverse event within the population and worldwide, especially if standardized data are collected in such a manner that differentiate between incidence and recurrent events. From the epidemiological point of view, in order to estimate the prevalence of cardiovascular disease in a population the information of incidence of MI in that population can be helpful. The different causes of CAD may have great impact on the healthy life style of population as it may result in arrhythmia, ventricular dysfunction, cardiac shock and death because Bigger the MI size higher the risk of adverse cardiac event. MI is characterized by ECG abnormal findings, typical clinical findings included elevated biomarkers status due to myocardial damage [1].

It is one of the major cause of mortality and morbidity in many countries [2]. The prevalence and incidence of cardiovascular diseases are increasing these days, all around the world [3]. The mortality rate has been increasing due to cardiovascular disease each year in the European Union. However, the incidence rates of Non-ST elevation MI have been increased as compare to acute ST-segment elevation MI over the past few decades in many countries, to great extent. Coronary heart disease (CHD) is a major cause of premature mortality (death in people aged under 75) in Scotland [4].

All patients with ST elevated and non-ST elevation ACS should undergo risk stratification as soon as possible after the diagnosis is confirmed because it is useful to predict who are at low, intermediate or high risk for short or long-term adverse cardiovascular outcomes [5,6]. For early risk stratification, the GRACE risk model have been recommended in many research studies to treat the individual patient accordingly [7]. The rate of mortality and morbidity in ACS individual patient depends upon the size and location of MI. As GRACE score is an excellent means to discriminate risk of death in patients with ACS [8], the Risk stratification of ACS play significant role for the selection of better therapeutic measures as [9, 10, 11, 12] such as; immediate percutaneous coronary angiography, an early invasive strategy, or a conservative approach [13, 14].

Individuals with any one of the following clinical features are consider to be at high risk of cardiovascular outcomes; Cardiogenic shock, left ventricular (LV) dysfunction, incidence/recurrent angina at rest, hemodynamic instability due to mechanical cardiac problems (e.g., acute mitral regurgitation) and ventricular arrhythmias which is usually unstable. Preservation of LV function became the major component for normal cardiac function and systemic circulation [15].

It is hypothesized that the GRACE risk score demonstrate its accuracy in post-discharge and over the longer term follow-up of post-Acute MI patients for risk prognosis of cardiac adverse outcomes.

In the research article which was conducted in 2013 [16], 64 patients with ACS were investigated. A modified QRS score was measured on the ECG performed in patients on hospital arrival before their medical therapy. QRS score was associated with surface area infarction [16, 17, 18, 19, 20], but not sub-endocardial infraction scar. Although good performance was seen in those patients who had transmural scar only. During follow-up, QRS score predict patient mortality and it was well related to all-cause mortality and patients avoided arrhythmic death while treated with medical therapy. ACS patients with low cardiac output or left ventricular dysfunction will still go on to die and it was wished to explore the reason of different mode of death in research work as ventricular arrhythmia is one of the adverse cardiac outcomes. It was not clear either to use QRS scoring or not, in order to predict clinical arrhythmia in ACS patients. The result showed that QRS scoring performed best in measuring transmural infarction scar and it was helpful to predict mortality risk prognosis, but on the other side it was not proved helpful to predict risk of ventricular arrhythmia. This study had limitation such as, it was an observational study and the performance of QRS score was unclear to quantify sub-endocardial scar, could not predict ventricular arrhythmia and association between QRS score and mortality was uncertain and surprising. To estimate size of MI in the LV of the heart to predict the mortality by using ECG changes, the Selvester QRS-scoring system was used [19, 20].

In the research article which was conducted in 2010 [21], 154 patients were investigated, 46% had Non-STEMI and others had unstable angina. The initial management was started 4.6 hours after the onset of typical symptoms. The GRACE risk score provided a median of 117 and the thrombolysis in myocardial infarction score (TIMI score) provided a median of 3. However, 105 patients underwent percutaneous coronary angiography in-hospital and 97 of these did so as part of an invasive strategy. The remaining 8 patients underwent coronary angiography after positive scintigraphy for ischemia. The GRACE risk score is simple to use and applicable to clinical practice [22, 23, 24]. It has been showing a greater prognostic value in hospital risk assessment [25, 26]. This study had limitation such as, this work did not get long term outcomes because follow-up of patients

was still in progress. The diagnostic performance of different risk scoring systems was related to the number, depth and width of Q waves as well as increasing infarct size and transmurality [27, 28].

In another research article which was conducted in 2014 [29], 19122 patients were investigated for follow-up; by 2 years post-discharge, some of them went through different types of therapeutic procedures such as, 14.3% had angiography, 8.7% had percutaneous coronary intervention, 2.0% had coronary bypass surgery, and 24.2% were hospitalized again. Although, many patients had cardiovascular outcomes such as heart failure (HF) occurred in 6.3% of patients but 4.4% had re-infarction and 7.1% patients were died. In this study, from post-discharge to 6-month follow-up GRACE risk score was highly predictive of mortality due to different causes. This study had limitations; First, not all patients were participated in the post-discharge 6-month and 2-year follow-up. Second, in most cases the follow-up information was provided by the patient its self and that could be false information regarding the procedures, events and medical therapy used by them. However, there were significant later consequences in post-discharge patients, including frequent morbidity and mortality. The accuracy of the GRACE risk score in post-discharge patients for predicting high risk longer-term mortality was observed [29, 30]

In the research article which was conducted in 2008 [31], 162 consecutive patients were investigated .95 out of 162 in the ischemic (prior MI) cohort and 67 out of 162 in the non-ischemic cohort. Thus, 94 of 95 had at least 1 QRS point with evidence re-infarction. Median QRS-estimated scar size was 24% LV which is equivalent to 8 QRS points. It was found that patients with QRS-estimated scar < median had similar baseline characteristics but had a difference ECG conduction abnormality as compared to the QRS-estimated scar ≥ median. In the non-ischemic cohort, 30 out of 67 patients had late gadolinium hyper-enhancement cardiac magnetic resonance (LGE-CMR) and 46 out of 67 had ≥1 QRS point. Non-ischemic patients with ≥1 QRS point had similar baseline characteristics but that didn't work for larger LV volumes. The study demonstrated that QRS scores accurately identified the presence of MI in ischemic and non-ischemic cardiac patients who had different types of ventricular dysfunction and it was well related with the extent of infraction. QRS-scores identify and quantify scar in ischemic and non-ischemic cardiomyopathy patients even ECG was uncertain. Higher QRS-estimated scar size was associated with increased ventricular conduction abnormality. This study had limitation such as, larger numbers of patients should have been taken to assess the sensitivity and specificity of each of the QRS criteria in the presence of ventricular dysfunction/conduction abnormalities to localize LV scar [31].

In the research article which was conducted in 2015 [32], 396 patients were investigated. 270 out of 396 had NSTE-ACS. Among them 8 had died in-hospital due to adverse cardiac outcomes. By one-year post-discharge, 41 patients had died who were diagnosed with NSTE-ACS. The results for

in-hospital mortality were unclear. Because only 8 out of 396 patients were died in hospital, which is very low rate of mortality. Although, different results were noticed for the subgroups; it was accurate for low-risk patients but not for high-risk patients. Since during the study they demonstrated the risk of mortality among intermediate and high risk patients. In NSTE-ACS patients, the GRACE score was valid for 1-year mortality evaluation with great accuracy. The study had limitation such as, they did not calculate the probability of death/MI at 1 year, or death/MI at 3 years. It was difficult to monitor patients for MI, contradictive to the precise determination of death [32, 33].

9.0 Research methodology and Methods

9.1 Study population and design

The patients arriving to the Internal medicine department of Kaunas Republic hospital and Kaunas Clinic hospital from 1st January 2013 to 1st January 2014 with sub-acute MI were considered for inclusion into this study.

Consecutive 48 patients with age of 80.31 ± 7.47 years were investigated in this study. The inclusion criteria were: confirmed MI by troponin and ECG criteria of sub-acute MI at admission to a hospital: still elevated ST segment >= 1 mV with inverted T wave at least 1 mV. Exclusion criteria were only the following: ventricular pacemaker and intraventricular conduction defects. Patient age, heart rate/pulse, systolic blood pressure, creatinine value, Killip classification I to IV (including no evidence of heart failure, findings of mild to moderate heart failure, pulmonary edema and cardiogenic shock) and electrocardiographic QRS changes were analysed. The patients' ECG, taken at the arrival to the hospital, were considered to predict the risk of in-hospital mortality by Selvester QRS score and clinical findings including ECG changes were used to interpret the high-risk of in-hospital mortality by GRACE score. The last modification of Selvester QRS score [33] was used which is shown in table 1. GRACE score was calculated by available calculator recommended in the last guidelines of STEMI management [32].

Table 1. The last modification of Selvester QRS score

QRS Scoring

Patient ID _____ QRS duration _____ Amplitude adjust _____
(↑1%/yr age 20-54; ↓1%/yr >55 yrs; ↓10% for females)

Age & gender _____ QRS axis _____ Duration adjust _____ RAO(**, ***)Yes/No
(↓ 10% for females)

Lead	RBBB Criteria	Pts	LAFB Criteria	Pts	LAFB + RBBB Criteria	Pts	LVH Criteria	Pts	No Confounders Criteria	Pts
I	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1
	R ≤ 0.2 mV		R ≤ 0.2 mV		R ≤ 0.2 mV		R ≤ 0.2 mV		R ≤ 0.2 mV	
II	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 40 ms	2
	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1
aVL	Q ≥ 30 ms	1	Q ≥ 40 ms	1	Q ≥ 40 ms	1	Q ≥ 40 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1
aVF	Q ≥ 50 ms	3	Q ≥ 50 ms	3	Q ≥ 50 ms	3	Q ≥ 60 ms	3	Q ≥ 50 ms	3
	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 40 ms	2	Q ≥ 50 ms	2	Q ≥ 40 ms	2
	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 40 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2
	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1
V1 Ant.	Q ≥ 50 ms	2			Q ≥ 50 ms	2	any QR			
	any Q	1	any QR	1	any Q	1	(or any Q if *)	1	any Q	1
	Init R ≤ 20 ms						NtchInit40			
V1 Post.**			R/S ≥ 1	1		1	R/S ≥ 1	1	R/S ≥ 1	1
	Init R ≥ 60 ms	2	R ≥ 50 ms	2	Init R ≥ 60 ms	2	R ≥ 50 ms	2	R ≥ 50 ms	2
	Init R ≥ 15 mV		R ≥ 1mV		Init R ≥ 15 mV		R ≥ 1mV		R ≥ 1mV	
	Init R ≥ 50 ms	1	R ≥ 40 ms	1	Init R ≥ 50 ms	1	R ≥ 40 ms	1	R ≥ 40 ms	1
	Init R ≥ 10 mV		R ≥ 0.7 mV		Init R ≥ 10 mV		R ≥ 0.7 mV		R ≥ 0.7 mV	
			Qs≤0.2&Ss≤0.2mV	1			Qs≤0.2&Ss≤0.2 mV	1	Qs≤0.2&Ss≤0.2mV	1
V2 Ant.	Q ≥ 50 ms	2			Q ≥ 50 ms	2				
	any Q	1	any QR	1	any Q	1	any QR	1	any Q	1
	R ≤ 10 ms		R ≤ 10 ms		R ≤ 10 ms		(or any Q if *)		R ≤ 10 ms	
	R ≤ 0.1mV		R ≤ 0.1mV		R ≤ 0.1mV		NtchInit40		R ≤ 0.1mV	
V2 Post.**			R/S ≥ 15	1			R/S ≥ 15	1	R/S ≥ 15	1
	Init R ≥ 70 ms	2	R ≥ 60 ms	2	Init R ≥ 70 ms	2	R ≥ 60 ms	2	R ≥ 60 ms	2
	Init R ≥ 2.5 mV		R ≥ 2 mV		Init R ≥ 2.5 mV		R ≥ 2 mV		R ≥ 2 mV	
	Init R ≥ 50 ms	1	R ≥ 50 ms	1	Init R ≥ 50 ms	1	R ≥ 50 ms	1	R ≥ 50 ms	1
	Init R ≥ 2.0 mV		R ≥ 15 mV		Init R ≥ 2.0 mV		R ≥ 15 mV		R ≥ 15 mV	
			Qs≤0.3&Ss≤0.3mV	1			Qs≤0.3&Ss≤0.3mV	1	Qs≤0.3&Ss≤0.3mV	1
V3	Q ≥ 30 ms	2	Q ≥ 30 ms	2	Q ≥ 30 ms	2	QR& (Q ≥ 30 ms)	2	Q ≥ 30 ms	2
	R ≤ 10 ms		R ≤ 10 ms		R ≤ 10 ms		NtchInit40	1	R ≤ 10 ms	
	Q ≥ 20 ms	1	Q ≥ 20 ms	1	Q ≥ 20 ms	1	any QR		Q ≥ 20 ms	1
	R ≤ 20 ms		R ≤ 20 ms		R ≤ 20 ms		(or any Q if *)		R ≤ 20 ms	
V4	Q ≥ 20 ms	1	Q ≥ 20 ms	1	Q ≥ 20 ms	1	Q ≥ 20 ms	1	Q ≥ 20 ms	1
	R/Q ≤ 0.5	2	R/Q ≤ 0.5	2	R/Q ≤ 0.5	2	R/Q ≤ 0.5	2	R/Q ≤ 0.5	2
	R/S ≤ 0.5		R/S ≤ 0.5		R/S ≤ 0.5		R/S ≤ 0.5		R/S ≤ 0.5	
	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1	R/Q ≤ 1	1
	R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1	
	R ≤ 0.5 mV		R ≤ 0.5 mV		R ≤ 0.5 mV		R ≤ 0.5 mV		R ≤ 0.5 mV	
	NtchInit40		NtchInit40		NtchInit40		NtchInit40		NtchInit40	
V5	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2
	R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1	
	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1	R/Q ≤ 2	1
	R/S ≤ 2		R/S ≤ 15		R/S ≤ 15		R/S ≤ 2		R/S ≤ 2	
	R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV	
	NtchInit40		NtchInit40		NtchInit40		NtchInit40		NtchInit40	
V6	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1	Q ≥ 30 ms	1
	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2	R/Q ≤ 1	2
	R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1		R/S ≤ 1	
	R/Q ≤ 3	1	R/Q ≤ 3	1	R/Q ≤ 3	1	R/Q ≤ 3	1	R/Q ≤ 3	1
	R/S ≤ 3		R/S ≤ 2		R/S ≤ 2		R/S ≤ 3		R/S ≤ 3	
	R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV		R ≤ 0.6 mV	
	NtchInit40		NtchInit40		NtchInit40		NtchInit40		NtchInit40	
Total	Points		Points		Points		Points		Points	
	%LV infarct (3 x #pts) ____		%LV infarct (3 x #pts) ____		%LV infarct (3 x #pts) ____		%LV infarct (3 x #pts) ____		%LV infarct (3 x #pts) ____	

Lead	LBBB Critera	Pts
I	any Q	1
	R/Q ≤ 1	2
	R/S ≤ 1	
	R/Q ≤ 15	1
	R/S ≤ 15	
II	Q ≥ 40 ms	2
	Q ≥ 30 ms	1
	R/Q ≤ 0.5	1
	R/S ≤ 0.5	
aVL	Q ≥ 50 ms	2
	Q ≥ 40 ms	1
	R/S ≤ 0.5	2
	R/Q ≤ 0.5	
	R/S ≤ 1	1
	R/Q ≤ 1	
aVF	Q ≥ 50 ms	2
	Q ≥ 40 ms	1
	R/Q ≤ 0.5	1
	R/S ≤ 0.5	
V1 Ant.***	Nchlnit40	1
	R ≥ 0.3 mV	2
	R ≥ 30 ms	
	R ≥ 0.2 mV	1
	R ≥ 20 ms	
V1 Post	S/S' ≥ 2.0	3
	S/S' ≥ 1.5	2
	S/S' ≥ 1.25	1
V2 Ant.***	Nchlnit40	1
	R ≥ 0.4 mV	2
	R ≥ 30 ms	
	R ≥ 0.3 mV	1
	R ≥ 20 ms	
V2 Post	S/S' ≥ 2.5	3
	S/S' ≥ 2.0	2
	S/S' ≥ 1.5	1
V5	any Q	1
	R/R' ≥ 2	2
	R/R' ≥ 1	1
	R/S ≤ 2	
	R ≤ 0.5 mV	1
V6	Q ≥ 20 ms	1
	R/R' ≥ 2	2
	R/R' ≥ 1	1
	R/S ≤ 2	
	R ≤ 0.6 mV	1
Total	Points	

%LV infarct ____
(3 * #pts)

* (for LVH) if ≥4 other points in leads I, aVL, V4, V5 or V6 then count QS in V1-V3

** (RAO) if P positive amp in V1≥0.1mV or aVF P ≥0.175 mV, then exclude V1-V2 Post criteria

*** (RAO) if P positive amp in V1 ≥0.1mV or aVF P ≥0.175 mV, then exclude V1-V2 R-criteria points

Patients with >154 points are at high risk of in-hospital mortality means > 23 percentage of chances of death. The GRACE score with different scores and mortality percentage is given below in table 2.

Table 2. Interpretation of risk of mortality in ST elevation Acute Coronary Syndrome by GRACE risk score.

Risk category	GRACE risk score	Mortality percentage
Low	> 126	> 10
Intermediate	126 – 154	10-23
High	> 154	> 23

The study was approved by the Ethics Committee of the Lithuanian University of Health Sciences, code: 302536989**.**

9.2 Statistical analysis

For the prediction of mortality, the comparison of the accuracy of GRACE risk score and Selvester QRS system scoring were calculated. The criteria of the Selvester QRS score was < 8 points – patient will not die and > 8 point (> 24% of LV) – patient will die. Also, we assessed the less criteria - < 6 points – patient will not die and > 6 point (> 18% of LV) – patient will die. Similarly, the criteria of GRACE score was < 154 points (in-hospital mortality < 23 %– patient will not die and > 154 (in-hospital mortality > 23 %) – patient will die. The data analysis was performed by using the package SPPS 22.0. McNemar's test was used to compare the scores. The p value < 0.05 was defined as statistically significant.

Continuous values are expressed as mean ± standard deviation. Categorical variables are presented as number (percentage).

To calculate the accuracy of mortality prediction, following formula was used:

Accuracy (ACC):

ACC = (TP + TN)/ (TP+FP +FN+TN),

10.0 Results

According to the GRACE risk score > 154 points prediction – 24 (50 %) out of 48 patients were supposed to die and 24 (50 %) patients were supposed not to die but the actual number of mortality were 3 patients (6.3 %) and 45 (93.8 %) survived in-hospital shown in table 3.

Table 3. Comparison between actual number of death and prediction by GRACE score.

Actual number of patients	**GRACE score > 154 points**		
	Died	Not died	Total
Died	2	1	3
Not died	22	23	45
Total	24	24	48

According to the Selvester QRS system > 6 points prediction – 19 (39.6 %) out of 48 patients were supposed to die and 29 (60.4 %) patients were supposed not to die but the actual number of mortality were 3 patients (6.3 %) and 45 (93.8 %) survived in-hospital shown in table 4.

Table 4. Comparison between actual number of death and prediction by Selvester QRS score > 6 points.

Actual number of patients	Died (Selvester score > 6 points)	Not died (Selvester score < 6 points)	Total
Died	0	3	3
Not died	19	26	45
Total	19	29	48

According to the Selvester QRS system > 8 points prediction – 10 (20.8 %) patients were supposed to die and 38 (79.2 %) patients were supposed not to die but the actual number of mortality were 3 patients (6.3 %) and 45 (93.8 %) survived in-hospital shown in table 5.

Table 5. Comparison between actual number of death and prediction by Selvester QRS score > 8 points.

Actual number of patients	Died (Selvester score > 8 points)	Not died (Selvester score < 8 points)	Total
Died	0	3	3
Not died	10	35	45
Total	10	38	48

Accuracy of mortality prediction by various scores is showed in table 6.

Table 6. Accuracy of mortality prediction by various scores.

Risk score	**Accuracy %**
GRACE score >154 points	52.08
Selvester score > 6 points	54.16
Selvester score > 8 points	72.91

Significant difference between actual mortality and predicted by GRACE score was found (p = 0.000). Also, significant difference between actual mortality and predicted by Selvester QRS score > 6 points was found (p = 0.001). But there was no difference between actual mortality and predicted by Selvester QRS score > 8 points because the p value was 0.092.

11.0 Discussion

This study showed that Selvester QRS score > 8 was predicting the in-hospital mortality in cases of sub-acute MI, even high GRACE score did not predict.

MI is defined as myocardial damage due to cardiovascular disease, characterized by ECG abnormal findings, typical clinical findings [1]. It is one of the major cause of mortality and morbidity in many countries. The prevalence and incidence of cardiovascular diseases are increasing these days [2, 3]. The mortality rate has been increasing due to Non-ST elevation MI as compare to acute ST- segment elevation MI over the past few decades to great extent. Coronary heart disease (CHD) is a major cause of premature mortality. All patients with ST elevated and non-ST elevation ACS should undergo risk stratification as soon as possible after the diagnosis is confirmed because it is useful to predict who are at low, intermediate or high risk for short or long-term adverse cardiovascular outcomes [5,6].

The results demonstrate that the GRACE score has a significant discriminative power in assessing the risk of in-hospital mortality and post-discharge-6 months to 3 years mortality [7, 8]. It was accurate in the intense phase and over the longer term which make it useful in a variety of clinical settings to aid treatment decisions [7, 8, 9, 10]. Although it has only been validated for use in acute/intense phase of AMI but had excellent performance in discriminating between low and high risk patients with Non-ST elevated ACS [11, 12, 13, 14]. Preservation of LV function became the major component for normal cardiac function and systemic circulation [15]. QRS scoring performed best in measuring transmural infarction scar and it was helpful to predict mortality risk prognosis [16, 17, 18, 19, 20]. Patients with different infarct locations and size recently have been studied and got compared with in postmortem anatomic studies and with MRI [17, 18, 19, 20]. The GRACE risk score is simple to use and applicable to clinical practice [21, 22, 23, 24]. GRACE score has been showing a greater prognostic value in hospital risk assessment [25, 26]. The diagnostic performance of different risk scoring systems was related to the number, depth and width of Q waves as well as increasing infarct size and transmurality [27, 28]. The accuracy of the GRACE risk score in post-discharge patients for predicting high risk longer-term mortality was observed [29, 30]. Taken together, several studies have been conducted regarding validation of the previous risk score in different countries and with different types of ACS and different follow-up periods (28, 29, 30, 31, 32, 33); of these in-hospital, 6 months to 3 year mortality.

In this study, one dead patient has Selvester QRS score only 0, because it was MI without pathological Q wave. So, in my opinion, Selvester QRS scoring should be used in prediction of risk in cases of transmural MI only. Further larger studies are warranted to evaluate the accuracy of

selvester score system in sub-acute MI patients, in order to assess the risk prognostic.

12.0 Conclusions

High GRACE score > 154 points and Selvester QRS score > 6 did not predict the in-hospital mortality. But Selvester QRS score > 8 was predicting the in-hospital mortality in cases of sub-acute STEMI.

13.0 Practical recommendations

Selvester QRS score > 8 could be used in clinical practice to predict the in-hospital mortality in cases of sub-acute MI. However, larger studies are required to confirm these findings.

14.0 References

1. Roffi M, Patrono C, Collet JP, et al. 2015 ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: Task Force for the Management of Acute Coronary Syndromes in Patients Presenting without Persistent ST-Segment Elevation of the European Society of Cardiology (ESC). Eur Heart J 2016; 37:267.

2. Fox KAA, FitzGerald G, Puymirat E, Huang W, Carruthers K, Simon T, 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. 2014; 4(2): e004425.Published online 2014 Feb 21.

3. Patel MR, Chen AY, Peterson ED, Newby LK, Pollack CV Jr, Brindis RG, et al. Prevalence, predictors and outcomes of patients with non ST-segment elevation MI and insignificant coronary artery disease: results from the Rapid risk stratification of Unstable angina patients Suppress Adverse outcomes with Early implementation of the ACC/AHA Guidelines (CRUSADE) initiative. Am Heart J. 2006 Oct;152(4):641-7.

4. Scottish Intercollegiate Guidelines Network (SIGN). Acute coronary syndromes. Edinburgh: SIGN; 2013. (SIGN publication no. 93). [February 2013]. Available from URL: http://www.sign.ac.uk

5. The Task Force for the Management of Acute Coronary syndromes of the European Society of Cardiology. ESC guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation. E Heart J 2011;32:2999–3054.

6. The Task Force for the Management of unstable angina/non ST elevation myocardial infarction of the American College of Cardiology Foundation/ American Heart Association. ACCF/AHA focused update of the guideline for the management of patients with unstable angina/non ST elevation myocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation 2012;126:875–910.

7. Steg PG, FitzGerald G, Fox KAA. Risk stratification in non-ST-segment elevation acute coronary syndromes: troponin is not enough. Am J Med 2009;122:107–8. [PubMed].

8. Pieper KS, Gore JM, Fitzgerland G. Validity of a risk-prediction tool for hospital mortality: the Global Registry of Acute Coronary Events. Am Heart J 2009;157:1097–105.

9. Barra S, Providência R, Paiva L, Caetano F, Almeida I, Gomes P et al. ACHTUNG-Rule: a new and improved model for prognostic assessment in myocardial infarction. Eur Heart J Acute Cardiovasc Care. 2012 Dec; 1(4): 320–336.

10. Elbarouni B, Goodman SG, Yan RT, Welsh RC, Kornder JM, Deyoung JP et al. Validation of the Global Registry of Acute Coronary Event (GRACE) risk score for in-hospital mortality in patients with acute coronary syndrome in Canada. Am Heart. 2009 Sep;158(3):392-9. doi: 10.1016/j.ahj.2009.06.010.

11. Raposeiras-Roubín S, Abu-Assi E, Cabanas-Grandío P, Agra-Bermejo RM, Gestal-Romarí S, Pereira-López E et al. Walking beyond the GRACE (Global Registry of Acute Coronary Events) model in the death risk stratification during hospitalization in patients with acute coronary syndrome: what do the AR-G (ACTION [Acute Coronary Treatment and Intervention Outcomes Network] Registry and GWTG [Get With the Guidelines] Database), NCDR (National Cardiovascular Data Registry), and EuroHeart Risk Scores Provide? JACC Cardiovasc Inter. 2012 Nov;5(11):1117-25. doi: 10.1016/j.jcin.2012.06.023.

12. Álvarez-Álvarez B, Raposeiras-Roubín S, Abu-Assi E, Cambeiro-González C, Gestal-Romaní S, López-López A et al. Is 6-month GRACE risk score a useful tool to predict stroke after an acute coronary syndrome? Open Heart. 2014; 1(1): e000123.Published online 2014 Dec 22.

13. Van Hellemond IEG, Bouwmeester S, Olson ChW, Hassell M, Bøtker HE, Kaltoft AK et al. Consideration of QRS complex in addition to ST segment abnormalities in the estimation of the 'risk region' during acute inferior myocardial infarction. Journal of Electrocardiology, Volume 46, Issue 3, 215 – 220 May-June 2013.

14. Romano ER, Liguori IM, Farran JA, do Egito RM, Romano ML, Werneck VA et al. Prognostic Score for Acute Coronary Syndrome in a Private Terciary Hospital. Arq Bras Cardiol. 2014 Mar; 102(3): 226–236. DOI: 10.5935/abc.20140012

15. Ginghina C, Bejan I, and Ceck CD. Modern risk stratification in coronary heart disease. J Med Life. 2011 Nov 14; 4(4): 377–386. Published online 2011 Nov 24.
16. Rosengarten JA, Scott PA, Chiu OK, Shambrook JS, Curzen NP, Morgan JM et al. Can QRS scoring predict left ventricular scar and clinical outcomes? Europace. 2013 Jul;15(7):1034-41. doi: 10.1093/europace/eut014. Epub 2013 Mar 14.

17. Loring Z, Chelliah S, Selvester RH. A detailed guide for quantification of myocardial scar with the Selvester QRS score in the presence of electrocardiogram confounders. J Electrocardiol. 2011 Sep-Oct;44(5):544-54.

18. Geerse DA, Wu KC, Gorgels AP, Zimmet J, Wagner GS, Miller JM et al. Comparison between contrast-enhanced magnetic resonance imaging and Selvester QRS scoring system in estimating changes in infarct size between the acute and chronic phases of myocardial infarction. Ann Noninvasive Electrocardiol. 2009 Oct;14(4):360-5.

19. Xia X, Wieslander B, Strauss DG, Wagner GS, Zareba W, Moss AJ et al. Automatic QRS Selvester scoring system in patients with left bundle branch block. Europace. 2015 Mar 23. pii: euv040.

20. Weinsaft JW, Kochav JD, Afroz A. Q Wave Area for Stratification of Global Left Ventricular Infarct Size – Comparison to Conventional ECG Assessment using Selvester QRS-score. Coronary artery disease. 2014;25(2):138-144. doi:10.1097/MCA.0000000000000062.

21. Correia LC, Freitas R, Bittencourt AP, Souza AC, Almeida MC, Leal J, et al. [Prognostic value of GRACE scores versus TIMI score in acute coronary syndromes]. Arq Bras Cardiol. 2010;94(5):613-9. [PubMed].

22. Eagle KA, Lim MJ, Dabbous OH, Pieper KS, Goldberg RJ, Van de Werf F et al. GRACE Investigators. A validated prediction model for all forms of acute coronary syndrome: estimating

the risk of 6-month postdischarge death in an international registry. AMA. 2004 Jun 9;291(22):2727-33.

23. Pesarini G, Santini F, Geremia G. Risk stratification in acute coronary syndromes. J of Cardiovasc. Trans. Res., February 2012, Volume 5, Issue 1, pp 1-10 DOI 10.1007/s12265-011-9337-4.

24. Polat N, Yildiz A, Oylumlu M, Kaya H, Acet H, Akil MA et al. Relationship Between Red Cell Distribution Width and the GRACE Risk Score With In-Hospital Death in Patients With Acute Coronary Syndrome. Clin Appl Thromb Hemost. 2014 Sep;20(6):577-82. doi: 10.1177/1076029613500707. Epub 2013 Aug 12.

25. Barbosa CE, Viana M, Brito M, Sabino M, Garcia G, Maraux M et al. Accuracy of the GRACE and TIMI scores in predicting the angiographic severity of acute coronary syndrome. Arq Bras Cardiol. 2012 Sep;99(3):818-24. Epub 2012 Aug 30.

26. Yan AT, Yan RT, Tan M, Casanova A, Labinaz M, Sridhar K et al. Risk scores for risk stratification in acute coronary syndromes: useful but simpler is not necessarily better. Eur Heart J. 2007;28(9):1072-8. [PubMed]

27. Jaarsma C, Bekkers SC, Haidari Z, Smulders MW, Nelemans PJ, Gorgels AP et al. Comparison of Different Electrocardiographic Scoring Systems for Detection of any Previous Myocardial Infarction as Assessed With Cardiovascular Magnetic Resonance Imaging American Journal of Cardiology, 2013-10-15, Volume 112, Issue 8, Pages 1069-1074.

28. Cheng JM, Helming AM, van Vark LC, Kardys I, Den Uil CA, Jewbali LS et al. A simple risk chart for initial risk assessment of 30-day mortality in patients with cardiogenic shock from ST-elevation myocardial infarction. Eur Heart J Acute Cardiovasc Care. 2015 Jan 14. pii: 2048872615568966

29. Alnasser SM, Huang W, Gore JM, Steg PG, Eagle KA, Anderson FA Jr et al. Late Consequences of Acute Coronary Syndromes: Global Registry of Acute Coronary Events

(GRACE) Follow-up. Am J Med. 2015 Jul;128(7):766-75. doi: 10.1016/j.amjmed.2014.12.007. Epub 2014 Dec 29.

30. Lin A, Devlin G, Lee M. Performance of the GRACE scores in a New Zealand acute coronary syndrome cohort. Heart. 2014 Dec;100(24):1960-6. doi: 10.1136/heartjnl-2014-306062. Epub 2014 Sep 4.

31. Strauss DG, Selvester RH, Lima JAC, Arheden H, Miller JM, Gerstenblith G et al. ECG quantification of myocardial scar in cardiomyopathy patients with or without conduction defects: correlation with cardiac magnetic resonance and arrhythmogenesis. Circ Arrhythm Electrophysiol 2008;1:327-36

32. Akyuz S, Yazici S, Bozbeyoglu E, Onuk T, Yildirimturk O, Karacimen D et al. Validity of the updated GRACE risk predictor (version 2.0) in patients with non-ST-elevation acute coronary syndrome. Rev Port Cardiol. 2016 Jan;35(1):25-31. doi: 10.1016/j.repc.2015.07.010. Epub 2015 Dec 22.

33. Zak Loring, BS, Sreetharan Chelliah, David G. Strauss, MD, PhD. A Detailed Guide for Quantification of Myocardial Scar with the Selvester QRS Score in the Presence of ECG Confounders. Journal of electrocardiology Author Manuscript NIH Public Access 2011