Folia Cardiologica 2020
tom 15, nr 6, strony 398–406
DOI: 10.5603/FC.a2020.0056

ISSN 2353–7752

Cardiac, non-cardiac complications and predictors of prolonged hospital stay in non-diabetes patients with acute myocardial infarction undergoing primary percutaneous coronary intervention

Kardiologiczne, niekardiologiczne powikłania i czynniki predykcyjne przedłużonej hospitalizacji u pacjentów bez cukrzycy z zawałem serca leczonych pierwotną przezskórną angioplastyką wieńcową

Marta Migała[1], Justyna Chałubińska-Fendler[2], Marzenna Zielińska[1]

[1]Department of Intensive Cardiac Therapy, Medical University of Lodz, Łódź, Poland
[2]Radiotherapy Department, Military Institute of Medicine, Warszawa, Poland

Abstract

Introduction. Prolonged patient stay after acute myocardial infarction (MI) results in higher costs. This study evaluated factors prolonging hospitalization after admission due to MI. Complications which also influence on longer hospital stay: both cardiac (CC) and non-cardiac (NCC), were analysed.

Material and methods. The authors included prospectively 131 patients with MI undergoing primary percutaneous intervention. Following factors were collected: demographic and anthropomorphic data, types of infarction, 12-lead electrocardiography (ECG), echocardiography, standard blood tests including admission blood glucose level, fasting glycaemia, oral glucose tolerance test (OGTT) at discharge as well as renal filtration and lipid parameters. Length of hospital stay of < 6 days or longer, the occurrence of CC and NCC were analysed.

Results. The mean age of patients was 62 ± 10.9 years, 71.8% were male. Factors which correlated significantly with longer hospitalisation were: older age (R = 0.47, p = 0.001), higher fasting glycaemia (R = 0.25, p = 0.027), reduced left ventricular ejection fraction (LVEF) (R = –0.36, p = 0.04), occurrence of ST-elevation MI (p = 0.0166), presence of CC (p = 0.0007) and NCC (p = 0.0001). Age, high blood glucose in OGTT and LVEF remained significant in a multivariate model predicting the duration of stay (R^2 = 0.32). Factors predicting hospital stay ≥ 6 days in the multivariate model were: older age (p = 0.000), hip circumference (p = 0.014), anterior wall MI (p = 0.026) and usage of glycoprotein IIb/IIIa inhibitors (p = 0.022) with and area under the receiver operating characteristic curve (ROC): 0.792 [95% confidence interval (CI) 0.71–0.87] with specificity 71% and sensitivity 79%. Factors influencing CC occurrence in the multivariate model were: estimated glomerular filtration rate (p = 0.009), LVEF (p = 0.003) with ROC 0.735 (95% CI 0.65–0.82) with specificity 76% and sensitivity 60%. Factors influencing the occurrence of NCC were hyperlipidaemia (p = 0.021), and LVEF (p = 0.004) with an ROC: 0.792 (95% CI 0.71–0.87) with specificity 55% and sensitivity 90%.

Conclusions. LVEF, age and blood glucose levels significantly prolonged hospital stay. The major factor associated with an increased risk of both CCs and NCCs was LVEF.

Key words: myocardial infarction (MI), length of stay, complications

Folia Cardiologica 2020; 15, 6: 398–406

Address for correspondence: lek. Marta Migała, Klinika Intensywnej Terapii Kardiologicznej, Uniwersytet Medyczny w Łodzi, ul. Kościuszki 4, 91–419 Łódź, Poland, e-mail: martamigala@interia.pl

Introduction

European Society of Cardiology (ESC) guidelines from 2017, concerning patients with ST-segment elevation myocardial infarction (STEMI), recommend the optimal duration of hospital stay based on individual features such as cardiac risk, coexisting diseases, functional status and social support. Several studies have revealed that low–risk patients treated with a primary percutaneous coronary intervention (pPCI) could be safely discharged within 48–72 h. These candidates could be identified using The Second Primary Angioplasty in Myocardial Infarction (PAMI II). PAMI II criteria in low risk include: patients age < 70, left ventricular ejection fraction (LVEF) > 45%, one or two-vessel disease, successful pPCI and no persistent arrhythmias [1]. However, data from registries report that the hospital stay is often longer because of clinical and angiographic characteristics, adverse events, hospital policy, physician approach and the fears experienced by patients and relatives [2, 3] prolonged hospitalization after myocardial infarction (MI) is associated with higher costs [3].

Also, little is known about the abovementioned cohort who present no chronic kidney disease or diabetes mellitus. Thus, the purpose of the present study was to define the real length of hospital stay after MI in patients without chronic kidney disease or diabetes mellitus and emphasize predictors particularly cardiac (CC) and non-cardiac complications (NCC) on hospitalization after MI.

Material and methods

Study population

We prospectively enrolled patients with MI, who had been admitted to the Intensive Cardiac Care Unit (ICCU) and underwent pPCI. Patients both with STEMI and non-ST-segment elevation myocardial infarction (NSTEMI) were included in the study. Patients with cardiogenic shock, chronic kidney failure and diabetes mellitus were excluded from the analyses. The final study population consisted of 131 patients. These were hospitalized between December 2015 and July 2016. The study protocol was approved by the Local Ethics Committee. Patients baseline characteristics and in-hospital period were analysed according to < 6, ≥ 6 days of stay, CC and NCC. CC were defined as supraventricular arrhythmia, atrioventricular block, acute heart failure, sudden cardiac arrest, thrombus in the left ventricular, re-angioplasty, closing the artery. NCC developed in 39 patients and were defined as infections and hyperthyroidism.

Statistical analysis

Continuous variables were presented using median with interquartile range (Q1 and Q3). For the lack of normal distribution of data, the Mann-Whitney U test were used. The level of statistical significance was set at < 0.05. Categorical variables were presented as raw data and as percentages. The Chi^2 test and correction of Freeman-Halton were used for comparing categorical variables. To evaluate the clinical factors (demographic factors, laboratory and imaging studies) that independently influenced the length of hospital stay Spearman R correlations were performed. A linear regression model was used included variables with $p < 0.15$ in univariate models to perform multivariate analysis of factors influencing hospital duration, CC and NCC occurrence. All analyses were performed with Statistica v. 12 (TIBCO Software Inc., USA, and Tulsa).

Results

Most patients were male (72%) and had STEMI (64%). The median age was 62 (Q1: 55, Q3: 69). The median length of hospitalization was 6 days (Q1: 5; Q3: 7). The group of early discharge amounted 44 patients. Prolonged hospitalization was associated with older age ($p < 0.0007$), fasting blood glucose (FBG) ($p < 0.0027$), STEMI ($p < 0.0166$), anterior myocardial infarction (aMI) ($p < 0.0136$) and LVEF ($p < 0.0399$). Patients' baseline characteristics are presented in Table 1.

CC occurred in 40 patients. The most common CC was supraventricular arrhythmia (N = 11). NCC developed in 39 patients and were presented mainly as infections (N = 31). Mean length of stay was increased in patients who suffer from CC (7,5 days Q1: 7, Q3: 10 days, $p = 0.000$) than NCC (7 days, Q1: 6, Q3: 9, $p = 0.0001$). Both CC and NCC importantly prolonged time of hospitalisation (Table 1).

Table 2 presents the subgroup of patients with CC. These patients were older (68 years, $p < 0.01$), had lower estimated glomerular filtration rate (eGFR 72.5 mL/min/1.73 m^2, $p < 0.001$) and lower LVEF (45.0%, $p < 0.001$). Patients were also divided depending on the presence of NCC and presented in Table 3. Those with NCCs were older (67 years, $p < 0.05$) as well, had hyperglycaemia (HG) in the first day of stay (6.9 mmol/L, $p < 0.04$), higher troponin level (2742.0 ng/L, $p < 0.01$) and lower LVEF (45%, $p < 0.0001$).

Older age, admission blood glucose (ABG), FBG, oral glucose tolerance test (OGTT) at discharge, first 24-hour glucose mean average, eGFR, troponin level and LVEF were correlated with prolonged hospitalisation (Table 4). Bleeding larger than typical in 45 patients (34.35%) importantly prolonged hospitalization ≥ 6 days ($p = 0.01$). In multivariate analysis the factors which were associated significantly with longer hospitalization were: OGTT at discharge, age and LVEF (Table 5, Figure 1A, adjusted $R^2 = 0.32$).

In a multivariate analysis independent predictors of CC were eGFR [odds ratio (OR) 0.97 (95% CI 0.95–0.99); $p = 0.009$], LVEF [OR 0.93 (0.88–0.97); $p = 0.003$] with

Table 1. Baseline characteristic of patients according to the length of hospitalisation*

Variable	N	< 6 days (N = 44)	≥ 6 days (N = 87)	p value
Age, years	131	58.5 (Q1: 54, Q3: 63)	65.0 (Q1: 59, Q3: 71)	0.0007
Female	37	8 (21.6)	29 (78.4)	0.0689
Hypertension	84	27 (32.1)	57 (67.9)	0.6300
Hyperlipidaemia	99	34 (34.3)	65 (65.7)	0.7400
History of MI	19	9 (47.4)	10 (52.6)	0.1600
STEMI	84	22 (26.2)	62 (73.8)	0.0166
Anterior MI	39	7 (17.9)	32 (82.1)	0.0136
BMI [kg/m^2]	131	27.1 (Q1: 25, Q3: 30)	26.7 (Q1: 25, Q3: 30)	0.8150
Admission blood glucose [mmol/L]	131	6.7 (Q1: 6, Q3: 8)	7.3 (Q1: 6, Q3: 9)	0.0612
Fasting blood glucose [mmol/L]	131	5.6 (Q1: 5, Q3: 6)	6.0 (Q1: 5, Q3: 7)	0.0027
HbA_{1c} [%]	131	5.8 (Q1: 5, Q3: 6)	5.8 (Q1: 5, Q3: 6)	0.9279
eGFR [mL/min/1.73 m^2]	131	83.5 (Q1: 74, Q3: 101)	79 (Q1: 69, Q3: 92)	0.1188
Troponin max [ng/L]	131	1761.5 (Q1: 468, Q3: 3843)	2238 (Q1: 934, Q3: 5272)	0.0621
Total cholesterol [mmol/L]	131	5.5 (Q1: 5, Q3: 7)	5.4 (Q1: 5, Q3: 6)	0.5851
LDL-cholesterol [mmol/L]	131	3.5 (Q1: 3, Q3: 5)	3.4 (Q1: 3, Q3: 4)	0.9650
HDL cholesterol [mmol/L]	131	1.2 (Q1: 1.1, Q3: 1.4)	1.3 (Q1: 1.0, Q3: 1.5)	0.9572
Triglycerides [mmol/L]	131	1.5 (Q1: 1, Q3: 2)	1.5 (Q1: 1, Q3: 2)	0.8646
LVEF [%]	131	51.0 (Q1: 48, Q3: 57)	48 (Q1: 42, Q3: 55)	0.0399
Cardiac complications, N [%]	40	5 (12.5)	35 (87.5)	0.0007
Non-cardiac complications, N [%]	39	5 (12.8)	34 (87.2)	0.0001

*Median (IQ range) and N (%) are reported for continuous and categorical variables, respectively; MI — myocardial infarction; STEMI — ST-segment elevation myocardial infarction; BMI — body mass index; HbA_{1c} — glycated haemoglobin; eGFR — estimated glomerular filtration rate; LDL — low-density lipoprotein; HDL — high-density lipoprotein; LVEF — left ventricular ejection fraction

Table 2. Baseline characteristic of patients with cardiac complications*

Variable	N	Cardiac complications (N = 40)	Without cardiac complications (N = 91)	p value
Age [years]	131	68 (Q1: 57, Q3: 75)	61 (Q1: 55, Q3: 67)	0.0088
Female	37	14 (37.8)	23 (62.2)	0.2500
MI history	19	7 (36.8)	12 (63.2)	0.5100
BMI [kg/m^2]	131	26.4 (Q1: 24, Q3: 29)	27.3 (Q1: 24, Q3: 29)	0.0777
Waist [cm]	131	96.5 (Q1: 87, Q3: 102)	97.0 (Q1: 88, Q3: 103)	0.7986
Hips [cm]	131	97.0 (Q1: 94, Q3: 103)	98.0 (Q1: 93, Q3: 102)	0.8004
Admission blood glucose [mmol/L]	131	7.5 (Q1: 6, Q3: 8)	6.9 (Q1: 6, Q3: 8)	0.1678
Fasting blood glucose [mmol/L]	131	6.1 (Q1: 5, Q3: 7)	5.8 (Q1: 5, Q3: 6)	0.5688
HbA_{1c} [%]	131	5.9 (Q1: 5, Q3: 6)	5.8 (Q1: 5, Q3: 6)	0.9719
Oral glucose tolerance test at discharge [mmol/L]	131	9.7 (Q1: 7, Q3: 12)	9.0 (Q1: 6, Q3: 11)	0.1397
eGFR [mL/min/1.73 m^2]	131	72.5 (Q1: 61, Q3: 84)	86.0 (Q1: 74, Q3: 95)	0.0006
Troponin max [ng/L]	131	2509 (Q1: 991, Q3: 9013)	1974 (Q1: 670, Q3: 3994)	0.1722
Total cholesterol [mmol/L]	131	5.4 (Q1: 4, Q3: 6)	5.4 (Q1: 4, Q3: 6)	0.5554
LDL-cholesterol [mmol/L]	131	3.4 (Q1: 2, Q3: 4)	3.4 (Q1: 2, Q3: 4)	0.6746
HDL-cholesterol [mmol/L]	131	1.2 (Q1: 0.9, Q3: 1.4)	1.2 (Q1: 1.0, Q3: 1.4)	0.7528
Triglycerides [mmol/L]	131	1.3 (Q1: 1, Q3: 2)	1.5 (Q1: 1, Q3: 2)	0.8337
STEMI	84	26 (30.9)	58 (69.1)	0.8800
LVEF [%]	131	45.0 (Q1: 38, Q3: 53)	50.0 (Q1: 47, Q3: 57)	0.0009

*Median (IQ range) and N (%) are reported for continuous and categorical variables, respectively; MI — myocardial infarction; BMI — body mass index; HbA_{1c} — glycated haemoglobin; eGFR — estimated glomerular filtration rate; LDL — low-density lipoprotein; HDL — high-density lipoprotein; STEMI — ST-segment elevation myocardial infarction; LVEF — left ventricular ejection fraction

Table 3. Baseline characteristic of patients with non-cardiac complications*

Variable	N	Non-cardiac complications (N = 39)	Without non-cardiac complications (N = 92)	p value
Age [years]	131	67 (Q1: 57, Q3: 76)	61 (Q1: 55, Q3: 68)	0.0422
Female	37	13 (35.1)	24 (64.8)	0.3900
MI history	19	4 (21.1)	15 (78.9)	0.3600
BMI [kg/m^2]	131	26.5 (Q1: 24, Q3: 28)	27.7 (Q1: 25, Q3: 30)	0.0554
Waist [cm]	131	97.0 (Q1: 88, Q3: 100)	97.0 (Q1: 88, Q3: 104)	0.3917
Hips [cm]	131	96.0 (Q1: 93, Q3: 100)	98.0 (Q1: 93, Q3: 103)	0.1265
Admission blood glucose [mmol/L]	131	7.6 (Q1: 6, Q3: 11)	6.9 (Q1: 6, Q3: 8)	0.1678
Fasting blood glucose [mmol/L]	131	6.2 (Q1: 5, Q3: 7)	5.7 (Q1: 5, Q3: 6)	0.1564
HbA_{1c} [%]	131	5.9 (Q1: 5, Q3: 6)	5.8 (Q1: 5, Q3: 6)	0.6169
Glucose tolerance test at discharge [mmol/L]	131	9.7 (Q1: 7, Q3: 13)	9.0 (Q1: 6, Q3: 11)	0.1362
First 24-hour glucose Mean average [mmol/L]	131	6.9 (Q1: 6, Q3: 8)	6.4 (Q1: 5, Q3: 7)	0.0306
eGFR [mL/min/1.73 m^2]	131	75.0 (Q1: 60, Q3: 100)	82.5 (Q1: 72, Q3: 92)	0.2397
Troponin max [ng/L]	131	2742.0 (Q1: 1631, Q3: 6471)	1752 (Q1: 623, Q3: 3966)	0.0088
Total cholesterol [mmol/L]	131	5.0 (Q1: 4, Q3: 6)	5.5 (Q1: 4, Q3: 6)	0.0731
LDL-cholesterol [mmol/L]	131	3.1 (Q1: 2, Q3: 4)	3.6 (Q1: 2, Q3: 4)	0.2542
HDL-cholesterol [mmol/L]	131	1.1 (Q1: 1.0, Q3: 1.4)	1.2 (Q1: 1.0, Q3: 1.4)	0.3948
Triglycerides [mmol/L]	131	1.1 (Q1: 0.7, Q3: 1.9)	1.5 (Q1: 1, Q3: 2)	0.0422
STEMI	84	28 (33.3)	56 (66.7)	0.2300
LVEF [%]	131	45.0 (Q1: 40, Q3: 50)	52.0 (Q1: 47, Q3: 57)	0.0000

*Median (IQ range) and N (%) are reported for continuous and categorical variables, respectively; MI — myocardial infarction; BMI — body mass index; HbA_{1c} — glycated haemoglobin; eGFR — estimated glomerular filtration rate; LDL — low-density lipoprotein; HDL — high-density lipoprotein; STEMI — ST-segment elevation myocardial infarction; LVEF — left ventricular ejection fraction

Table 4. Non-parametric correlations of variables influencing the time of hospitalisation

Variables	Spearman R	p value
Age [years]	0.471	0.000
BMI [kg/m^2]	–0.085	0.332
Waist [cm]	0.016	0.852
Hips [cm]	0.051	0.565
Admission blood glucose [mmol/L]	0.232	0.008
Fasting blood glucose [mmol/L]	0.245	0.005
Oral glucose tolerance test at discharge [mmol/L]	0.232	0.008
First 24 hour glucose mean average	0.284	0.001
eGFR [ml/min/1.73 m^2]	–0.270	0.002
LVEF [%]	–0.362	0.000
Troponin max [ng/L]	0.241	0.006
TC (ref.: 3.0–5.0) [mmol/L]	–0.056	0.527
LDL (counted) [mmol/L]	0.009	0.918
HDL [mmol/L]	0.026	0.772
TG [mmol/L]	–0.124	0.160
HbA_{1c} [%]	0.063	0.473

MI — myocardial infarction; eGFR — estimated glomerular filtration rate; LVEF — left ventricular ejection fraction; TC — total cholesterol; LDL — low-density lipoprotein; HDL — high-density lipoprotein; TG — triglycerides; HbA_{1c} — glycated haemoglobin

Table 5. A multivariate model predicting the length of hospitalizations (adjusted $R^2 = 0.32$)

Parameter	Regression coefficient	Standardized regression coefficient (β)	S
Intercept	5.9229		
Oral glucose tolerance test at discharge [mmol/l]	0.0983	0.0423	0.1561
LVEF [%]	–0.0955	< 0.0001	–0.3225
Age [years]	0.0711	< 0.0001	0.3210

LVEF — left ventricular ejection fraction

AUC 0.735 (95% CI 0.64–0.82) with specificity 76%, sensitivity 60%, negative predictive value (NPV) 81% and positive predictive value (PPV) 52% (Figure 1B). More patients with multivascular disease (MVD) didn't have CC in comparison with patients without MVD (p = 0.03). Both non-critical stenosis in the coronary arteries and two vessel coronary disease didn't have important influence on CC development (p = 0.008; p = 0.008). Critical stenosis in non-intervention vessel (p = 0.07), single-vessel disease (p = 0.95), qualification to second percutaneous angioplasty during next hospitalization (p = 0.77), completeness of

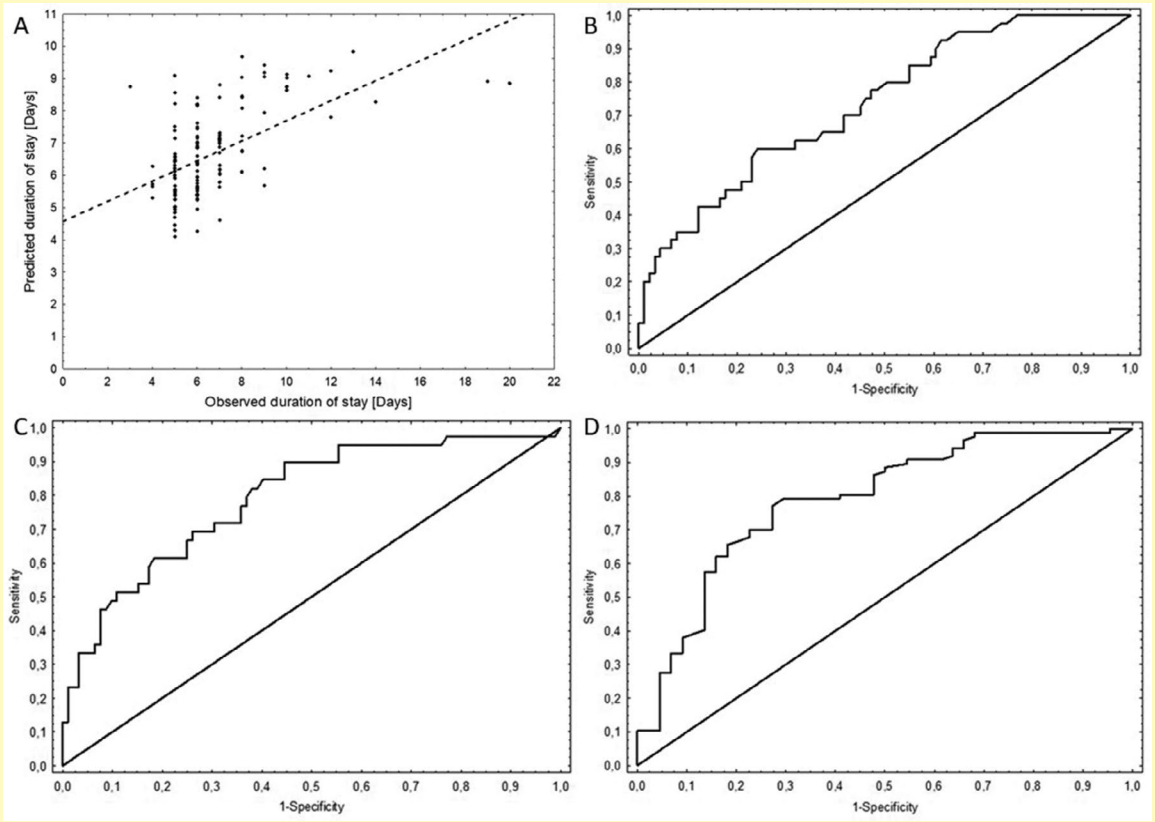

Figure 1. Multivariate models: **A.** Prediction of hospital stay duration; **B.** Receiver operating characteristic (ROC) curve for CC. The area under the curve (AUC) 0.735 — 95% confidence interval (CI) (0.645–0.82). The cut-off point is the probability assessed as 31% and higher; **C.** ROC curve for on-cardiac. The area under the curve (AUC) 0.792 — 95% CI (0.712–0.872). The cut-off point is the probability assessed as 18% and higher; **D.** ROC curve for a hospital stay at least 6 days. The area under the curve (AUC) 0.79 — 95% CI (0.71–0.87). The cut-off point is the probability assessed as 60% and higher

revascularization (p = 0.28) remained without influence on CC occurence in statistical analysis.

Factors influencing occurrence of NCC were hyperlipidaemia [OR 0.33 (95% CI 0.13–0.84); p = 0.021], and LVEF [OR 0.93 (95% CI 0.88–0.98); p = 0.004] with AUC 0.792 (95% CI 0.71–0.87) with specificity 55% and sensitivity 90%, NPV 92.7% and PPV 46%. Figure 1C presents ROC curves for model predicting NCC.

Non-critical stenosis in coronary arteries (p = 0.15), single vessel disease (p = 0.57), two vessel disease (p = 0.15), multivascular disease (p = 0.84), critical disease in non-intervention vessel (p = 0.55), qualification to coronary artery bypass surgery (CABG) (p = 0.38), qualification to second pPCI (p = 0.18), completeness of revascularization (p = 0.93) didn't have statistical influence in NCC.

The factors influencing hospital stay at least 6 days long were: age [OR 1.09 (95% CI 1.04–1.14); p = 0.000], and hip circumference [OR 1.09 (95% CI 1.02–1.17); p = 0.014] with AUC 0.792 (95% CI 0.71–0.87) with specificity 71% and sensitivity 79%, NPV of 63% and PPV of 84%. Figure 1D present ROC curves for the model predicting hospitalisation of at least 6 days.

Non-critical stenosis in coronary arteries (p = 0.57), single-vessel disease (p = 0.06), two-vessel disease (p = 0.58), multivascular disease (p = 0.75), critical disease in non-intervention vessel (p = 0.15) didn't prolong time of hospitalization ≥ 6 days. However, in the multifactorial analysis by step method multivascular disease appeared to be an essential factor prolonging hospitalization ≥ 6 days (p = 0.01). Moreover, patients, who didn't have completed revascularization stayed at hospital ≥ 6 days (p = 0.01). 60.31% of patients who haven't been qualified to second angioplasty required prolonged hospitalization ≥ 6 days (p = 0.0015). Only 16.79% of patients needed second angioplasty which was undergone on the second admission to the Unit. 6.11% of them (8 patients) needed prolonged hospitalization ≥ 6 days. More patients — 14 (10.68%) — were discharged before 6 days, but the

time reduction was about 1 day (median 5 days vs. 6 days; p = 0.028).

Bleeding larger than typical in 45 patients (34.35%) importantly prolonged time of hospitalization ≥ 6 days (p = 0.01).

Discussion

The authors' data showed that factors: age, STEMI, aMI and LVEF are those, which cause longer hospitalization with at least 6 days of stay. Those factors present themselves as predictors of longer hospitalisation in other publications as well but in different constellations. Also, the definition of longer hospitalisation differs from the one presented by the authors. One of the manuscripts was written by Vavalle et al. [3], who presented that older age, in patients with NSTEMI, was strongly associated with length of stay over 4 days. Another manuscript written by Farhana Ahmed, who observed that aMI had significant influence in major adverse cardiac outcomes after primary PCI [4]. Wegiel et al. [2] similarly to the findings of this study, revealed that patients age, LVEF, STEMI and multivascular disease were independent predictors of longer hospital stay but the threshold was at least 8 days.

Apart from already mentioned features, one of particularly worth attention is HG, measured in different time points. This factor also had an impact on hospitalization time in this study, predominantly: ABG, FBG and OGTT at discharge. There is no consensus about the definition of acute HG for patients with acute myocardial infarction. In most recent studies, levels of blood glucose from 180–198 mg/dL have been used to define acute HG [5]. Little is known about the influence of HG on prolonged hospitalization time in patients with myocardial infarction. Available data which presented levels of ABG as a predictor for only long term prognosis does not refer to the hospitalisation time [6]. Moustafa et al. [7] showed that higher levels of ABG were associated with earlier short-term mortality and more severe multi-vessel coronary lesion in non-diabetic patients with STEMI. The mechanism of shorter survival in abovementioned studies including deviations in HG, measured in different time points is unknown. One of the hypothesis is the acute stress HG development or long-term metabolic control before the event [7]. It was also discovered that acute HG in patients without known diabetes mellitus was independently associated with larger infarct size [7]. Zhen-Xuan Hao meta-analysis also demonstrated that impaired ABG may be an effective prognostic marker for significantly increased risk of early death in non-diabetic patients with STEMI [8]. Furthermore, Foo et al. presented a near-linear relationship between higher ABG levels and higher rates of left ventricular failure [9].

Not only ABG in patients without diabetes in MI predict mortality, but also fasting blood glucose (FBG) does as well. Aronson et al. [10] revealed FBG is a simple tool for predicting long term mortality in the subjects. Verges et al. [11] demonstrated that impaired FBG levels (between 110–126 mg/dL) were an important predictor for the onset of severe congestive heart failure after MI and cardiovascular mortality in 30 days.

Moreover, the GAMI trial (Ryden L.) proved that in patients with acute MI and abnormal oral glucose tolerance test (OGTT) compared with normal OGTT at discharge, the composite of death, reinfarction, stroke and severe heart failure at 2.8 years were higher [12]. Bartnik et al. [13] the same as Ryden L. evaluated that abnormal OGTT was associated with four times higher risk for the composite of cardiovascular death, re-infarction or severe heart failure during a median follow-up time of 34 months.

In most studies assessing CC in their group in terms of predictors of longer hospital stay describe them as cardiogenic shock, arrhythmias and conduction disorders, pericarditis, mechanical complications: left ventricular free wall rupture, ventricular septal rupture, papillary muscle rupture [14]. In contrast with abovementioned description, Cosby et al. [15] in 1976 presented a different characterisation of CC as major CC (abnormalities of wall movement and pump failure, dysrhythmias, congestive heart failure, angina pectoris) and minor CC (post-myocardial infarction pain, shoulder-hand syndrome and functional states like depression, anxiety) of MI. A great number of publications concern the mechanical complication of the heart [16]. Little is known about other types of CC and its influence on the time of hospitalization.

The aim of this study was also to examine what features have an impact on CC and how CC prolong the time of hospitalization. In the presented study, the authors discovered that CC more often appeared in older patients. The subjects had also reduced eGFR and lower LVEF. On the other hand, the authors have included in the study patients who presented NCC (infections, hyperthyroidism) as well. Those patients were in more advanced age, but similarly to these with CC, they had HG manifested by the elevated level of first 24 hours mean average glycaemia, increased level of troponin and reduced LVEF. Additionally, this study revealed that lower eGFR and LVEF predict CC in MI. For NCC it was lower LVEF and hyperlipidaemia. Further studies are necessary to confirm these findings.

In this research, it was also found that older age, greater hip size, aMI and glycoprotein IIb/IIIa inhibitors administration were independent determinants of at least 6 days in-hospital stay. In the multivariate analysis performed by step method also multivascular disease appeared to be an essential factor prolonged hospitalization ≥ 6 days.

Wegiel et al. [2] presented different NCC and CC factors prolonging hospital stay than in this study. He revealed in a logistic regression analysis that patients' age, LVEF, STEMI and the presence of multivascular disease (similar to the presented findings) were independent predictors of longer hospital stay of at least 8 days [2]. In this study patients who were not qualified to second percutaneous angioplasty required to prolong hospitalization. Next angioplasty was undergone at the second hospitalization after at least 14 days, thus it did not prolong second hospital stay. Such a procedure was driven by the financial statement. Unique situations provoke earlier angioplasty. These were permanent chest pain after pPCI, persistent atrioventricular block or ventricular arrhythmia. Patients without symptoms were qualified to second treatment during the next hospitalization.

Length of hospital stay following acute MI has steadily decreased both due to improve treatments and cost considerations [17]. Longer hospitalization is associated with higher cost burden [18]. Identifying patients with low-risk STEMI using PAMI II scale is challenging [18] but may reduce final expenses. There are a few different risk scores that indicate whether early discharge following STEMI is possible and safe. One of them is Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complication (CADILLAC) risk score [19] or Zwolle risk score [20]. Both proved that lower-risk patients can be safely discharged within 72 hours of admission [19, 20].

The PAMI investigators also assessed that low–risk group of patients with STEMI who underwent a successful pPCI (< 3 high-risk clinical features) could be safely discharged within 72 hours [21]. However, patients with angiographic failure or over 2 high-risk clinical features had a higher possibility of major adverse cardiac events and might demand longer hospitalization [21]. Over the years the median length of hospital stay (LOS) became shorter. In 1985, 1990, 1995, 2001 LOS ranged from 9, 8, 6, 4 days, respectively [17]. But in this study, despite recommendations, only 44/131 patients have been discharged before 6 days. Probably one of the reasons were lack of early access to cardiac rehabilitation (CR) in the authors' hospital. Patients had to wait a long time to start the training rehabilitation program in different Unit, regardless of stationary or ambulatory CR. In this situation there was too much risk, caused by stress connected with lack of further control, to think of early discharge. On the other hand, longer hospitalization was associated with better spot and care of patients and was oriented toward preventing and quick diagnosing early complications. To compare, Quinn et al. claimed current median time from hospital discharge to enrolment in outpatient cardiac rehabilitation was 35 days (10 days — early, 35 days — standard) [22]. There is no data about the time of enrolment in CR in the study's subjects as well as the number of patients attended cardiac CR.

Currently, the authors have coordinated specialist care (KOS) program and thanks to this, patients have easier access to visit a cardiologist by cardiology clinic or participate in CR. During the study, such a program hasn't existed. Possibly, thus only 44 patients were discharged before 6 days of hospitalization. Further study is necessary to examine if the length of hospitalization becomes shorter after the appearance of KOS programme.

So far, data have presented that only a small group of patients in the low–risk were early discharged within 72 hours [23]. In a study by Kotowycz et al. [24], this was 28% for low–risk patients. It is expected to follow the recommendations in connection with early CR which reduces overall and cardiovascular mortality [25].

Conclusions

In practice, the real-time of hospitalisation patients admitted due to MI is longer than presented in guidelines. The factors that are associated with are not only patient's age, LVEF, multivascular disease, but also events like the elevated level of HG on admission and its fasting levels. Monitoring those factors may help select high-risk mortality patients but still, other factors may be of importance as constructed models predict only 32% of outcomes. To reduce stress and anxiety connected with early discharge after MI it is worth to arrange an early appointment on CR to ensure safety.

Acknowledgements

Data from these studies have not been presented yet in the scientific meeting.

Funding

This research was supported by Financial Resources For Statutory Activity of the Medical University of Lodz, Poland no. 502-03/1-005-05/502-14-187.

Conflict of interest

The authors declare no conflict of interest.

Streszczenie

Wstęp. Przedłużony czas hospitalizacji po zawale serca (MI) skutkuje dodatkowymi kosztami. W opisanym badaniu oceniono czynniki wydłużające czas hospitalizacji po przyjęciu do szpitala z powodu MI. Do powikłań, które także wpływają na dłuższy okres hospitalizacji, należą zarówno kardiologiczne (CC), jak i niekardiologiczne (NCC); poddano je analizie.

Materiał i metody. Prospektywnie zakwalifikowano 131 pacjentów z MI leczonych pierwotną przezskórną angioplastyką. Zebrano następujące dane: demograficzne, antropomorficzne, rodzaj zawału, 12-odprowadzeniowe badanie elektrokardiograficzne, echokardiograficzne, standardowe badania laboratoryjne, włączając oznaczenie glukozy przy przyjęciu, glukozę na czczo, doustny test tolerancji glukozy (OGTT) przy wypisaniu, a także filtrację kłębuszkową oraz parametry lipidowe. Czas hospitalizacji wynosił poniżej 6 dni lub dłużej, natomiast analizie poddano powikłania zarówno CC, jak i NCC.

Wyniki. Średni wiek pacjentów wynosił 62 ± 10,9 roku, 71,8% stanowili mężczyźni. Do czynników, które znacząco korelowały z dłuższym czasem hospitalizacji, zaliczono: starszy wiek (R = 0,47; p = 0,001), wyższe stężenie glukozy na czczo (R = 0,25; p = 0,027), obniżoną frakcję wyrzutową lewej komory (LVEF) (R = –0,36; p = 0,04), występowanie zawału serca z uniesieniem odcinka ST (p = 0,0166), obecność powikłań CC (p = 0,0007) i NCC (p = 0,0001). Wiek, wysokie stężenie glukozy w OGTT przy wypisaniu oraz LVEF pozostawały znaczące w wieloczynnikowym modelu służącym przewidywaniu czasu hospitalizacji (R^2 = 0,32). Do czynników służących przewidywaniu czasu hospitalizacji ponad 6 dni w modelu wieloczynnikowym należały: starszy wiek (p = 0,000), obwód w biodrach (p = 0,014), przednia ściana MI (p = 0,026), zastosowanie inhibitora glikoprotein IIb/IIIa (p = 0,022) z polem powierzchni pod krzywą (ROC): 0,792 (95-proc. przedział ufności [CI] 0,71–0,87) ze specyficznością 71% i czułością 79%. Czynnikami wpływającymi na występowanie powikłań CC w wieloczynnikowym modelu były szacowany współczynnik filtracji kłębuszkowej (eGFR) (p = 0,009), LVEF (p = 0,003) z ROC 0,735 (95% CI 0,65–0,82) ze specyficznością 76% i czułością 60%. Do czynników wpływających na wystąpienie NCC należały: hiperlipidemia (p = 0,021) i LVEF (p = 0,004) z ROC 0,792 (95% CI 0,71–0,87) ze specyficznością 55% i czułością 90%.

Wnioski. Wartość LVEF, wiek oraz stężenie glukozy znacząco przedłużają czas hospitalizacji. Głównym czynnikiem związanym ze zwiększonym ryzykiem wystąpienia zarówno CC, jak i NCC była LVEF.

Słowa kluczowe: zawał serca (MI), czas hospitalizacji, powikłania

Folia Cardiologica 2020; 15, 6: 398–406

References

1. Ibanez B, James S, Agewall S, et al. ESC Scientific Document Group. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018; 39(2): 119–177, doi: 10.1093/eurheartj/ehx393, indexed in Pubmed: 28886621.
2. Węgiel M, Dziewierz A, Wojtasik-Bakalarz J, et al. Hospitalization length after myocardial infarction: risk-assessment-based time of hospital discharge vs. real life practice. J Clin Med. 2018; 7(12), doi: 10.3390/jcm7120564, indexed in Pubmed: 30567307.
3. Vavalle JP, Lopes RD, Chen AY, et al. Hospital length of stay in patients with non-ST-segment elevation myocardial infarction. Am J Med. 2012; 125(11): 1085–1094, doi: 10.1016/j.amjmed.2012.04.038, indexed in Pubmed: 22921886.
4. Ahmed F, Rahman A, Rahman M, et al. Predictors of short term outcomes of primary percutaneous coronary intervention. Bangladesh Heart J. 2018; 33(2): 112–120, doi: 10.3329/bhj.v33i2.39307.
5. Hirsch IB, O'Brien KD. How to best manage glycemia and non-glycemia during the time of acute myocardial infarction. Diabetes Technol Ther. 2012; 14 Suppl 1: S22–S32, doi: 10.1089/dia.2012.0095, indexed in Pubmed: 22650221.
6. Macín SM, Perna E, Coronel M, et al. Influence of admission glucose level on long-term prognosis in patients with acute coronary syndrome [Article in Spanish] . Rev Esp Cardiol. 2006; 59(12): 1268–1275, indexed in Pubmed: 17194422.
7. Moustafa TM. Utility of admission blood glucose level in prediction of short-term course and extent of coronary artery occlusion in non-diabetic patients with ST segment elevation myocardial infarction. IJC Metab Endocr. 2017; 14: 16–20, doi: 10.1016/j.ijcme.2016.11.004.
8. Zhao Cj, Hao Zx, Liu R, et al. Admission glucose and risk of early death in non-diabetic patients with ST-segment elevation myocardial infarction: a meta-analysis. Med Sci Monit. 2015; 21: 1387–1394, doi: 10.12659/MSM.894249, indexed in Pubmed: 25982366.
9. Foo K, Cooper J, Deaner A, et al. A single serum glucose measurement predicts adverse outcomes across the whole range of acute coronary syndromes. Heart. 2003; 89(5): 512–516, doi: 10.1136/heart.89.5.512, indexed in Pubmed: 12695455.
10. Aronson D, Hammerman H, Kapeliovich MR, et al. Fasting glucose in acute myocardial infarction: incremental value for long-term mortality and relationship with left ventricular systolic function. Diabetes Care. 2007; 30(4): 960–966, doi: 10.2337/dc06-1735, indexed in Pubmed: 17392556.

11. Vergès B, Zeller M, Dentan G, et al. Impact of fasting glycemia on short-term prognosis after acute myocardial infarction. J Clin Endocrinol Metab. 2007; 92(6): 2136–2140, doi: 10.1210/jc.2006-2584, indexed in Pubmed: 17426093.
12. Glucose abnormalities in patients with myocardial infarction: prevalence, diagnosis, and prognostic implications — GAMI. https://www.acc.org/Latest-in-Cardiology/Clinical-Trials/2010/02/23/19/06//GAMI (8 November, 2004).
13. Bartnik M, Malmberg K, Norhammar A, et al. Newly detected abnormal glucose tolerance: an important predictor of long-term outcome after myocardial infarction. Eur Heart J. 2004; 25(22): 1990–1997, doi: 10.1016/j.ehj.2004.09.021, indexed in Pubmed: 15541834.
14. Ponikowski P, Hoffman P, Witkowski A. ed. Kardiologia. Podręcznik Polskiego Towarzystwa Kardiologicznego. Via Medica, Gdańsk 2019: 212.
15. Cosby RS. Late complications of myocardial infarction. JAMA. 1976; 236(15): 1717–1720, doi: 10.1001/jama.1976.03270160039027.
16. Kutty RS, Jones N, Moorjani N. Mechanical complications of acute myocardial infarction. Cardiol Clin. 2013; 31(4): 519–31, vii, doi: 10.1016/j.ccl.2013.07.004, indexed in Pubmed: 24188218.
17. Berger AK, Duval S, Jacobs DR, et al. Relation of length of hospital stay in acute myocardial infarction to postdischarge mortality. Am J Cardiol. 2008; 101(4): 428–434, doi: 10.1016/j.amjcard.2007.09.090, indexed in Pubmed: 18312752.
18. Isik T, Ayhan E, Uluganyan M, et al. Predictors of prolonged in-hospital stay after primary percutaneous coronary intervention for ST-elevation myocardial infarction. Angiology. 2016; 67(8): 756–761, doi: 10.1177/0003319715617075.
19. Sharkawi MA, Filippaios A, Dani SS, et al. Identifying patients for safe early hospital discharge following st elevation myocardial infarction. Catheter Cardiovasc Interv. 2017; 89(7): 1141–1146, doi: 10.1002//ccd.26873, indexed in Pubmed: 27896906.
20. Tralhão A, Ferreira AM, Madeira S, et al. Applicability of the Zwolle risk score for safe early discharge after primary percutaneous coronary intervention in ST-segment elevation myocardial infarction. Rev Port Cardiol. 2015; 34(9): 535–541, doi: 10.1016/j.repc.2015.04.006, indexed in Pubmed: 26297630.
21. Grines CL, Marsalese DL, Brodie B, et al. Safety and cost-effectiveness of early discharge after primary angioplasty in low risk patients with acute myocardial infarction. J Am Coll Cardiol. 1998; 31(5): 967–972, indexed in Pubmed: 10.1016/S0735-1097(98)00031-X.
22. Pack QR, Mansour M, Barboza JS, et al. An early appointment to outpatient cardiac rehabilitation at hospital discharge improves attendance at orientation: a randomized, single-blind, controlled trial. Circulation. 2013; 127(3): 349–355, doi: 10.1161/CIRCULATIONAHA.112.121996, indexed in Pubmed: 23250992.
23. Laurencet ME, Girardin F, Rigamonti F, et al. Early discharge in low-risk patients hospitalized for acute coronary syndromes: feasibility, safety and reasons for prolonged length of stay. PLoS One. 2016; 11(8): e0161493, doi: 10.1371/journal.pone.0161493, indexed in Pubmed: 27551861.
24. Kotowycz MA, Syal RP, Afzal R, et al. Can we improve length of hospitalization in ST elevation myocardial infarction patients treated with primary percutaneous coronary intervention? Can J Cardiol. 2009; 25(10): 585–588, doi: 10.1016/s0828-282x(09)70717-2.
25. Heran BS, Chen JMh, Ebrahim S, et al. Exercise-based cardiac rehabilitation for coronary heart disease. Cochrane Database Syst Rev. 2011(7): CD001800, doi: 10.1002/14651858.CD001800.pub2, indexed in Pubmed: 21735386.