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Features of Glycaemia in Patients with Myocardial Infarction Complicated by Acute Heart Failure

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Abstract The aim was to determine the features of in-hospital period in patients with myocardial infarction with ST segment elevation depending on the level of glycaemia in admission. There have been examined 319 patients with acute myocardial infarction (190 men and 129 women) aged 59-69 years, who were divided by the level of glycaemia in admission into 3 groups: group 1: 110 persons with the concentration of glucose ≤ of 7,1 mmol/l, 2-I – 138 patients with glucose 7,1-11,1 mmol/l, 3-I – 71 patient with the concentration of glucose ≥11.1 mmol/l. The level of glucose in the 3rd group was higher than in the 1-st and 2-nd groups (2,7 times and 1,8 times respectively, p1-3=0,0001, p2-3=0,0008). There has been identified the association of glycaemia with traditional factors of cardiovascular risk and the level of troponin T. The blood glucose level can be considered as a universal marker, indicating the presence of disorders of carbohydrate metabolism, and reflecting the stress response to ischemic myocardial damage. Hyperglycaemia revealed in admission to the hospital in patients with MI is associated with adverse course of in-hospital period, including the development of lethal outcomes.

Keywords Hyperglycaemia in admission, Myocardial infarction, Diabetes mellitus type 2

1. Introduction

Despite ongoing prevention and Changes in cardiovascular treatment diseases (CVD), in world, death from acute myocardial infarction (AMI) remains high [6]. One of the important factors ditch risk of developing AMI is diabetes mellitus (DM) Type 2, which leads to an increase in the frequency of myocardial infarction in 5 times for women and 3 times for men [1, 3]. Shown, that the proportion of patients with previously and newly diagnosed diabetes among patients with acute coronary syndrome (ACS) may reach 45-53%, and with impaired tolerance to glucose (ITG)-20-36% [10].

In recent years, the role of high blood glucose levels as a marker for the development of complications of AMI with acute heart failure (AHF), has been actively discussed [5]. It is known that in AMI, the level of glycaemia increases in proportion to the volume of myocardial damage, the class of AHF and correlates with the activity of cardiospecific enzymes, such as creatine phosphokinase- MB (CPK-MB), regardless of the presence of carbohydrate metabolism disorders exchange [9].

Despite the available data on the significance of hyperglycaemia in patients with ACS, simplicity and accessibility the definition of this parameter in the earliest terms disease development in the most common modern medical practice scales stratify risk assessment in AMI (TIMI, CADILLAC, FRISK, etc.) it not counted. In addition, today there is no consensus regarding the role of hyperglycaemia in implementation of adverse outcomes in hospital period of AMI, therefore, it is necessary to further study of.

2. Objective

Aim of the study is to determine the features of the in the patients with myocardial infarction with the rise of the segment ST depending on glycaemia level at admission.

3. Materials and Methods

319 patients with AMI were examined (190 men and 129 women) aged 59-69 years. The diagnosis is established based on clinical, electrocardiographic (ECG), echocardiography and biochemical characteristics the characteristics of this disease [7]. The research is done but based on the Republican Research Center of Emergency

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Medicine. Criteria inclusion in the study were the presence of pain thorax syndrome angina, not inhibited by taking nitroglycerin; signs subepicardial damage to the myocardium ST segment on ECG; increasing the content of biomarkers: CPK-MB, troponin T, voluntary patient informed consent to participation in the study.

Criteria for excluding patients from the study: age over 75 years; the presence of a clinically significant pathology (autoimmune diseases, diseases of the thyroid gland, adrenal glands); ACS, which emerged as a complication of percutaneous interventions (PCI) or coronary shunting (CSH).

General clinical trials included collecting history and complaints, determination of body weight (kg), height (m), calculation of body mass index (BMI) (kg / m^2), measured arterial blood pressure (ABP). The initial clinical and anamnestic characteristics the characteristics of the patients included in the study put in table 1. The average glucose level at Hospitalization was 9,56 ± 0,27 mmol/l. DM history was observed in 77 (24,1%) patients, for the first time revealed diabetes was diagnosed in 9 (2,8%) patients taking into account the data re-determine the level of missions.

Treatment of patients at the hospital stage was carried out taking into account the recommendations of ESC, for the diagnosis and treatment of patients with acute AMI with ST-segment elevation on the ECG. In the absence of contraindications during the hospital stay, all patients received combined coronaroactive, antithrombotic therapy, including acetylsalicylic acid, clopidogrel, β-adrenergic blockers, ACE inhibitors, antianginal drugs. At the same time, only 26.1% of patients took statins at the hospital stage of treatment. After discharge from the hospital, patients continued treatment using the main classes of anti-ischemic drugs and already about 90% took statins. When entering the serum was determined by the glucose content.

Methods of descriptive statistics included the calculation of mean values (M) and mean error (m). Statistical processing of the obtained results was performed using the STATISTICA 6.1 application software package. The non-parametric Kruskal-Wallis test was used to compare several independent groups. Frequency difference analysis in two independent groups was performed using Fisher's exact test with a two-sided confidence level (p is the achieved level of significance). The value of the level of $p < 0.05$ testified to statistical significance.

4. Results and Discussion

In accordance with national standards of care for patients with diabetes mellitus [2] the level of glycaemia at admission patients were divided into 3 groups: the first group consisted of 110 patients with a glucose concentration of ≤ 7,1 mmol/l (average level of the incidence was 5,94 ± 0,08 mmol/l), the second - 138 patients with a glucose level of 7,1-11,1 mmol/l (average level 8,73 ± 0,09 mmol / l), the third - 71 patients with a concentration of her glucose ≥11,1 mmol/l (average level of 13,03 ± 0,58 mmol/l). The level of glucose in persons of the 3rd group was higher than in persons of the 1st and 2nd groups (2,2 times and 1,8 times. This is official, $p_{1-2} = 0.0013$, $p_{2-3} = 0.0008$, $p_{1-3} = 0{,}0001$).

In the analysis of the initial clinical and anamnestic patient characteristics taking into account the glycaemia level admission attracts attention that hypertension and hygiene hypercholesterolemia, which are indisputable factors risk factors for cardiovascular diseases **(CVDs)**, significantly more common in patients of the 3rd group (90,0% and 70,0%, respectively), BMI in individuals of this group was also higher compared to with the 1st group. In addition, in this group more than half of the patients had a clinic of angina before the development of AMI (65,0%), AMI in the past suffered 27,5%, and acute stroke (AS) - 10,0% of patients. Diabetes was more common in patients with 3rd group. However, the percentage of smokers sick and with burdened by a family history of coronary artery disease was more among persons of the 1st group (with normoglycaemia).

Analysis of biochemical markers of myocardial necrosis, identified at admission, did not reveal differences in comparison groups by the level of total CPK and CPK-MB. The level of troponin T in patients of the 3rd group was 3 times higher compared with patients of the 1st group and 1.8 times - compared to the 2nd.

In the hospital period, AHF class II by Killip occurred mainly in patients of the 3rd group, as well as early post infarction angina (RPIA), however, relapse of myocardial infarction with a greater frequency was observed in patients of the 2nd group. Mortal outcomes in the 3rd group recorded more often than in the 1st and 2nd groups (in 5.7 times and 2.2 times, respectively).

During the hospital stay the patients of the 3rd groups with significantly higher frequency took diuretics, nitrates and insulin, which characterizes them as heavier group. Patients of the 1st group took statins more often. For other classes of drugs individuals of the analyzed groups were comparable.

Thus, in persons of the 3rd group significantly more frequency has been observed such traditional cardiovascular risk factors, like hypertension, hypercholesterolemia, obesity.

One of the urgent tasks of modern cardiology still remains the prediction of various outcomes of AMI complicated AHF with the aim of timely correction of treatment activities at the earliest stages of development diseases.

It is known that for more than half of patients with AMI complicated AHF is characterized by an increase in glucose levels blood [8]. Moreover, in 65% of patients with myocardial infarction without in the history of diabetes, there is a violation of tolerance glucose, and in 31% of patients such changes reach the level for the first time identified DM [4]. According to our results, newly diagnosed diabetes in the 3rd group was recorded 2,4 times more often than in the 2nd, in the 1st group of cases, the first high diabetes detected was not observed. Consequently, hyperglycaemia in patients with AMI complicated AHF at admission may not just a stress response, but also to testify about undiagnosed DM.

Table 1. Clinical and anamnestic characteristics of patients, taking into account the distribution into groups by glycaemia level at admission

Features		All patients (n=319)	1 group (n=110)	2 group (n=138)	3 group (n=71)	Significancep differences
Anamnesis data						
Men, n (%)		190 (59,5)	68 (61,8)	77 (55,8)	45 (63,4)	p=0,63
Age, years, M±m		62±1,43	57,4±1,32	62,7±1,32	66,6±1,46	p=0,72
Arterial Hypertension in the anamnesis, n (%)		237 (74,4)	76 (69,4)	97 (70,5)	64 (90,0)	p1-3=0,035 p2-3=0,033
Smoking, n (%)		110 (34,4)	46 (41,8)	42 (30,4)	23 (32,4)	p1-2=0,044 p1-3=0,045
BMI, M±m		29,48±0,38	28,26±0,61	29,46±0,65	29,95±0,7	p1-3=0,026
Burdened family anamnestic ischemic heart disease, n (%)		122 (38,3)	46 (41,9)	53 (38,5)	23 (32,5)	p1-3=0,045
Hypercholesterolemia, n (%)		179 (56,1)	48 (43,5)	81 (59,0)	50 (70,0)	p1-3=0,004 p2-3=0,039
Clinic of angina before the development of myocardial infarction, n (%)		177 (55,6)	53 (48,4)	78 (56,4)	46 (65,0)	p1-3=0,048
AMI in history, n (%)		66 (20,6)	12 (11,3)	34 (24,4)	20 (27,5)	p1-2=0,045 p1-3=0,041
Stroke in history, n (%)		27 (8,3)	7 (6,5)	12 (9,0)	7 (10,0)	p=0,67
Diabetes in history, n (%)		77 (24,1)	15 (13,6)	24 (17,4)	38 (53,5)	p1-3=0,0001 p2-3=0,0019
Newly identified diabetes, n (%)		9 (2,8)	0	4 (2,9)	5 (7,0)	
Concomitant pathology						
Chronic bronchitis, n (%)		6 (1,9)	2 (1,8)	3 (2,2)	1 (1,4)	p=0,078
Bronchial asthma, n (%)		3 (0,9)	1 (0,9)	2 (1,4)	0	
Peptic ulcer and duodenal ulcer in remission, n (%)		21 (6,6)	7 (6,4)	12 (8,7)	2 (2,8)	p=0,073
Gout, n (%)		1 (0,3)	0	1 (0,7)	0	
Chronic renal failure, n (%)		7 (2,2)	2 (1,8)	2 (1,4)	3 (4,2)	p2-3=0,025
IM characteristics						
Depth of damage:	Q-forming, n (%)	271 (85,0)	89 (80,6)	124 (89,7)	59 (82,5)	p=0,87
	Q-not forming n (%)	48 (15,0)	21 (19,4)	14 (10,3)	12 (17,5)	p=0,074
Localization of AMI:	Posterior, n (%);	135 (42,2)	46 (41,9)	55 (39,7)	34 (47,5)	p=0,68
	Posterio-inferior n (%);	11 (3,3)	4 (3,2)	5 (3,8)	2 (2,5)	p=0,75
	Front, n (%);	151 (47,2)	53 (48,4)	65 (47,4)	32 (45,0)	p=0,87
	Circular, n (%)	4 (1,1)	0	2 (1,3)	2 (2,5)	
Biochemical markers of myocardial necrosis, MÍ ± m						
CFC total, u / l		527,79±46,83	607,89±90,34	483,51±67,18	499,89±94,13	p=0,29
KFK-MB, u / l		38,02±4,15	38,81±7,94	39,09±5,03	34,54±10,23	p=0,77
Troponin T, ng / ml		0,69±0,17	0,45±0,31	0,73±0,25	1,35±0,05	p1-2=0,0035 p2-3=0,048 p1-3=0,0018
Complications of AMI in the hospital period						
AHF (Killip), n (%):	I	245 (76,8)	90 (81,8)	97 (70,3)	58 (81,7)	p=0,35
	II	35 (10,9)	6 (5,5)	18 (12,8)	11 (15,5)	p1-3=0,035 p1-2=0,045
	III	6 (1,9)	2 (1,8)	3 (2,2)	1 (1,4)	p=0,26
	IV	13 (3,9)	4 (3,2	6 (4,3)	3 (4,2)	p=0,55
Disorders of heart rhythm and conduction, n (%)		183 (57,4)	65 (59,1)	73 (52,9)	45 (63,4)	p=0,072
Early postinfarction stenocardia, n (%)		16 (5)	4 (3,6)	6 (4,3)	6 (8,5)	p1-3=0,035
Relapse of myocardial infarction, n (%)		34 (10,6)	6 (5,5)	16 (11,6)	3 (4,2)	p2-3=0,045
		9 (2,8)	1 (0,9)	6 (4,3)	2 (2,8)	p=0,08
- Alveolar pulmonary edema, n (%) - Fatal, n (%)		24 (7,5)	3 (2,7)	10 (7,2)	11 (15,5)	p1-3=0,0029 p1-2=0,043 p2-3=0,048

Disorders of glucose metabolism that occur in the acute period of myocardial infarction complicated AHF, have long been considered a consequence of the stress response in response to myocardial damage, accompanied by an increased release of catecholamines and cortisol, left ventricular (LV) dysfunction and an inflammatory response. These processes were considered as an adaptive response that does not require immediate correction [8]. But at the present time, there is increasing evidence of a possible prognostic value of hyperglycaemia in patients with AHF as a marker of hospital complications and a poor prognosis regardless of the presence of diabetes [5].

It is believed that the adverse effect of hyperglycaemia leads to the development of adverse outcomes of AMI complicated AHF: a decrease in the levels of aerobic metabolism of glucose, the formation of lactate with a cytotoxic effect, activation of lipolysis with the accumulation of β-oxidation products of fatty acids, metabolic macroergic compounds and reduced antioxidant activity systems with the development of oxidative stress and impaired endothelial function, stimulation of inflammation. All these factors lead to metabolic disregulation and development of insulin resistance that causes further impairment of glucose utilization and increased hyperglycaemia, impaired functional state of cardiomyocytes. In favor of such a provisions evidenced by the identified association glycaemia with elevated levels of troponin T in patients of the 3rd group and the occurrence of hospital complications and deaths. According to the received results, in patients with blood glucose levels more ≥11,1 mmol/l was observed the favorable course of the hospital period is with other patients (more often registered AHF class II for Killip and development of early RPIA). So about once, hyperglycaemia at admission can be considered as a marker of myocardial damage, along with such a recognized cardiospecific a marker like troponin T, and a predictor of heart insufficiency, intrahospital complications and mortality outcome.

In addition, it is found that an elevated level blood glucose in a patient at the time of hospitalization associated with high mortality in hospital period, and during the first year after AMI, regardless of the presence of diabetes in history [8]. Our study in patients with hyperglycaemia at admission hospital mortality was 6 times higher compared with patients with normoglycaemia. It is under confirmed by literature data, according to which increase in glucose level by 1 mmol/l in patients AMI complicated AHF is accompanied by an increase in mortality of 4%, for patients with hyperglycaemia upon admission and toxin level of glucose higher day is characterized by an increase in mortality by 3 times [8].

Studies previously demonstrated that with hyperglycaemia more than 11 mmol/l in patient's AMI, there is a higher frequency of recurrent myocardial infarction, expansion of the infarction zone and recurrence common ischemia [8]. However, according to the results of our research, recurrence of AMI more often recorded in patients with a glucose level of 7,1–11,1 mmol/l, which is talking about the need for closer attention to this category of patients and their assignment to the group high risk because hyperglycaemia in this case indicates undetected (and, accordingly, untreated) earlier diabetes. The results agree in harmony with the literature data about the more severe AMI complicated AHF in patients with hyperglycaemia without initial diabetes [4].

In addition, hyperglycaemia can be closely linked associated with traditional cardiovascular factors history of vascular risk, as evidenced by revealed association of glycaemia with hypertension, hyper cholesterol and obesity.

Thus, despite the existing discussions about the predictive value of hyperglycaemia determined in various conditions (when posting traction, fasting, postprandial), essential has hyperglycaemia on admission because it is a universal marker reflecting non only the stress response, but also the amount of damage myocardium, the presence of diabetes or ITG, is associated with non favorable course of the hospital period of AMI complicated AHF. That is why the blood glucose level at admission must be taken into account in the risk stratification and tactical approaches to the management of patients with AMI complicated AHF.

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