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EARLY CARDIAC REHABILITATION IN ACUTE MYOCARDIAL INFARCTION PATIENTS AND ITS FEATURES

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Patients that have undergone myocardial infarction require inclusion in the treatment program of cardiac rehabilitation as a component of secondary prevention. Rehabilitation potential in patients with myocardial infarction was investigated according to a mathematical model that included indicators of hospital mortality, myocardial reperfusion, anxiety and depression, myocardial contractility, comorbidity and prehospital physical activity. The individual rehabilitation program according to the level of rehabilitation potential contributed to the early expansion of the physical exercise mode to the ward mode in patients of the experimental group for 2.83±0.13 days compared with 3.57±0.14 days in the control group, the baseline heart rate was 73.2±1.72 beats per minute, and 78.4±1.13 beats per minute, respectively. According to the results of submaximal testing, the distance in the experimental group was 694.7±38.4 m, in the control group – 584.2±40.7 m ($p<0.05$). Assessment of rehabilitation potential provides determination of optimal terms and methods of cardiac rehabilitation.

Key words: acute myocardial infarction, cardiac rehabilitation, rehabilitation potential, immobilization syndrome, acute coronary syndrome.

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ОСОБЛИВОСТІ РАННЬОЇ РЕАБІЛІТАЦІЇ ПАЦІЄНТІВ З ГОСТРИМ ІНФАРКТОМ МІОКАРДУ

Перенесений інфаркт міокарда, потребує включення в програму лікування кардіологічної реабілітації, як складової вторинної профілактики. Досліджували реабілітаційний потенціал у хворих на інфаркт міокарда за математичною моделлю що включала показники госпітальної летальності, реперфузії міокарду, тривоги та депресії, скоротливості міокарда, коморбідності та догоспітальної фізичної активності. Індивідуальна програма реабілітації за рівнем реабілітаційного потенціалу сприяла ранньому розширенню рухового режиму до палатного у хворих дослідної групи за 2,83±0,13 дні у порівнянні з 3,57±0,14 дні в групі контролю, показник базової ЧСС склав 73,2±1,72 уд./хвилину, та 78,4±1,13 уд./хвилину відповідно. За результатами субмаксимального тестування освоєна відстань в дослідній групі 694,7±38,4 м, в контрольній групі – 584,2±40,7 м. ($p<0,05$). Оцінка реабілітаційного потенціалу забезпечує визначення оптимальних термінів та методів кардіологічної реабілітації.

Ключові слова: інфаркт міокарда, кардіологічна реабілітація, реабілітаційний потенціал, іммобілізаційний синдром, гострий коронарний синдром.

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Acute myocardial infarction (AMI) is a leading disease in morbidity, mortality and disability worldwide. Despite the significant economic costs of AMI treatment, the annual incidence in the world reaches seven million people, and mortality is 10 %, correlating with individual patient characteristics.

Cardiac rehabilitation (CR) as a component of secondary prevention of cardiovascular events is represented by multifactorial intervention and is included in the international guideline for the treatment of patients with coronary heart disease (CHD), AMI. The "consequences" of the CR implementation are the reduction of mortality, re-hospitalizations, costs, as well as improving exercise tolerance, quality of life and psychological well-being [8]. An important aspect of successful CR is the initial, stationary stage of CR in patients with AMI - the first phase of CR.

The acute period of myocardial infarction is characterized by the patient's stay in a "bed – rest" (bed) regime, which is a way of positioning the patient during the stay in the intensive care unit [1]. The doctrine of a "bed–rest" regime in patients with AMI undoubtedly has a number of positive effects, such as reducing pain, reducing coronary stress and ischemia, maintaining the patient's hypometabolic status, which is a necessary component of perfusion – metabolic balance [1]. However, staying in a "bed–rest" for more than 48 hours increases the risk of developing multi-organ disorders associated with non-physiological (Learned Non-use phenomenon) limitation of motor and cognitive activity, called immobilization syndrome (IS) [1].

In this context, the early mobilization of patients with AMI under the control of the safety of motor expansion is especially important in the structure of the CR.

The standard classification of patients with AMI by ability to physical rehabilitation in the inpatient phase includes taking into account the depth, expansion of myocardial damage, and the presence of complications, according to which there are 4 functional classes (FC) [6]. Such distribution cannot fully reflect the patient's rehabilitation potential (RP) and permit the necessary rehabilitation measures to be implemented.

Determining the level of RP in patients with AMI at the initial stage of treatment will optimize existing classifications of FC severity and develop individual CR programs with early motor expansion, prevent the development of IS, reduce hospital stays, improve rehabilitation and recovery.

The purpose of the study was to develop a methodology for determining the rehabilitation potential in patients with acute coronary syndrome and efficacy assessment of early rehabilitation in patients with acute myocardial infarction at the initial stage of cardiac rehabilitation.

Materials and methods. The study involved 30 patients (18 men and 12 women, mean age 59.13±1.20 years), with ST-segment elevation corticosteroids (STEMI) and ST-segment-free corticosteroids (NSTEMI), with a clinical diagnosis of AMI and FC II severity degree according to D.M. Aronov. Exclusion criteria: refusal of primary coronary intervention; age over 70 years. The mathematical model for the assessment of RP in patients of the experimental group (EG) included: 1) the risk of hospital mortality by the GRACE scale [7]; 2) the rate of coronary circulation restoration and myocardial reperfusion by the TIMI and MBG scale; 3) completeness of the intervention; 4) the level of anxiety and depression by the HADS scale; 6) myocardial contractility; 7) comorbidity index by the Charleson scale; 8) index of pre-hospital physical activity by the DASI scale.

The control group (CG) consisted of 30 patients of I, II FC severity of AMI, who underwent rehabilitation measures according to the generally accepted method [5]. The mean age of patients with CG was 58.31±1.17. Among the patients with CG were 16 men and 14 women.

Assessment of the intervention completeness in patients with EG, permitted to identify the following variants of the course, which were taken into account in the calculation of RP: patients with PCI of infarct-dependent artery only without additional lesions; patients with multivascular lesions and PCI of infarct-dependent artery only and the presence of significant subocclusions (>70 %) of other localizations; patients with multivascular lesions and PCI of infarct-dependent artery only and the need for coronary artery bypass grafting (patients at risk of PCI complications of 23–32 points by the SYNTAX scale).

According to the scale of anxiety and depression HADS, among the patients of HF were distinguished: patients without anxiety/depression (0–7 points); patients with subclinical severe anxiety/depression (8–10 points); patients with clinically severe anxiety/depression (≥11 points).

To assess myocardial contractility, echocardiography (Echocardiography) was performed on all patients in the first 24 hours after hospitalization on a Vivid S60N scanner (United States) as recommended by the American Echocardiography Society and the European Association of Cardiovascular Imaging Specialists. To assess RP, the following were considered: left ventricular ejection fraction (LV) by the Simpson method and the segmental contractility assessment of the left ventricle based on the calculation of the wall motion score index (WMSI) with a semi-qualitative estimation.

A 16-segment model of the heart was used [12]. The movement of each segment was assessed by the following criteria: normokinesia (1 point); hypokinesia (2 points), akinesia (3 points); “aneurysmal” movement of the wall, dyskinesia (4 points). WMSI was calculated by the formula: total score/number of myocardial segments. The following WMSI ranges were considered to assess RP in patients: 1.0 to 1.49; from 1.5 to 1.99; from 2.0 to 2.49; from 2.5 to 2.99 and ≤3.0.

Mathematical processing of the results was performed using the software “Statistica 8.0” (StatSoft Inc, USA). Mean (M), variance, standard deviation and median (m), as well as probability and significance level (p) were calculated. Differences were considered statistically significant at $p<0.05$.

Results of the study and their discussion. The program of CR at the initial inpatient phase was started in all patients 12 hours after the elimination of the pain attack and provided stable hemodynamics and no contraindications. Rehabilitation measures included physiotherapy classes, breathing exercises and gradual expansion of the motor regime.

The calculated level of RP in accordance with the listed key criteria permitted to identify among patients with HF (n = 30) groups of low, medium and high RP. Thus, among patients with HF in 8 patients (27 %) the assessment of RP was high; in 18 patients (60 %) the moderate rate of RP and in 4 patients (13 %) the level of RP was defined as low.

Expansion of motor regime in patients with HF occurred at the level of RP, which permitted to carry out controlled orthostatic tests and dosed exercise tests (especially in patients with moderate and high RP) earlier than in patients with CG, where motor mode expansion was standardized according to FC AMI

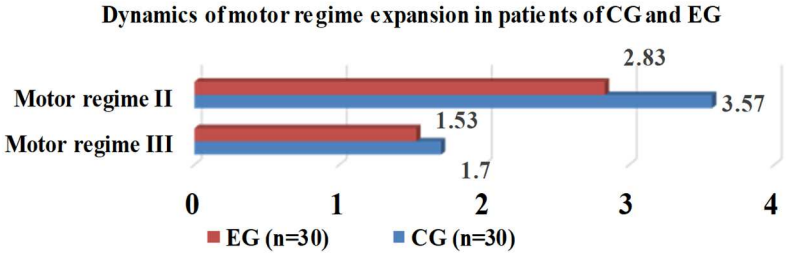

Fig. 1. Dynamics of achievement by patients of CG (n = 30) and EG (n = 30) of the II and III motor regime (p<0.05) at value of t - Student's coefficient 4.3979)

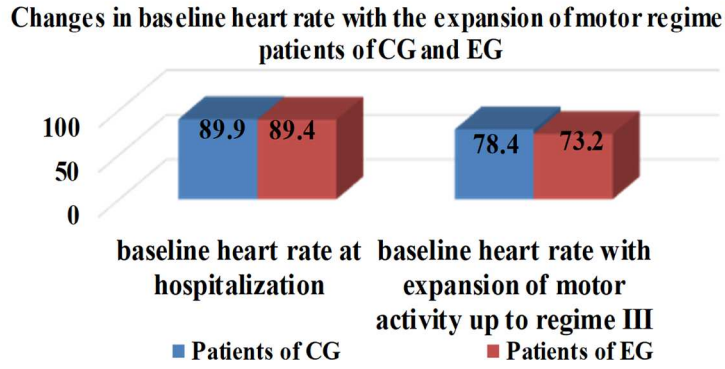

Fig. 2. Changes in baseline heart rate with the expansion of motor regime in patients of CG (n=30) and EG (n=30) when reaching the third motor regime (p<0.05 at the value of t – Student's coefficient 2.3247)

severity. Thus, the mean length of stay in patients at the inpatient stage to the level of expansion of the motor regime III (ward regime) in patients with CG was 3.57±0.14 days, and in patients with DG 2.83±0.13 days (fig. 1).

Monitoring of the CR program efficacy in accordance with the patient's RP included assessment of the baseline heart rate dynamics (HR). Thus, the mean baseline heart rate in patients of CG was 89.9±1.18 beats/minute at hospital, and in patients with HF 89.4±1.37 beats/minute (there was no statistically significant difference in the samples: p>0.05 at a value of t – Student's coefficient of 0.2765).

The mean baseline heart rate in the extension of motor regime to III in patients of CG was 78.4±1.13 beats/minute. The baseline heart rate in EG patients when reaching the third motor regime was 73.2±1.72 beats/minute (with a value of t – Student's coefficient of 0.2765, the difference was statistically significant, p<0.05) (fig. 2).

The level of anxiety – depressive disorders, calculated according to the HADS scale, indicates a decrease in anxiety in patients in a clear correlation with the timing of the motor regime expansion. Thus, there was a decrease in the mean value of anxiety by the HADS scale in patients with HF from 10.88±0.34 points to 6.44±0.48 points when reaching the third motor regime, which is comparable to the same figure in patients with CG, where it was 10.83±0.26 at hospitalization and 8.18±0.37 at the achievement of III motor regime, had a statistically significant difference (p<0.01). Dynamic changes in the level of anxiety and depressive disorders by the HADS scale are shown in fig. 3.

In order to determine the efficacy of early controlled expansion of motor regime in patients with CG (n=30) and EG (n=30) to level IV (expanded ward), but not earlier than the 5th day after AMI, in the absence of complications and contraindications, patients underwent submaximal test with assessment of exercise tolerance (TFL) with an increase in heart rate to 20/min., but not more than 100/min.

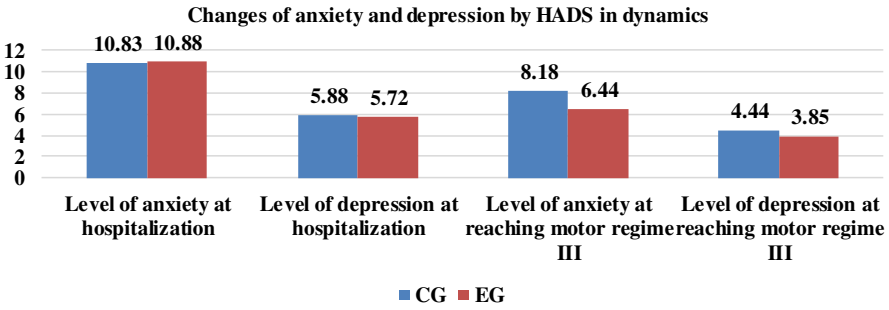

Fig. 3. Changes of anxiety and depression HADS by the hospital scale in the dynamics of CG (n = 30) and EG (n = 30) patients with expansion of motor regime

The submaximal test was performed with a treadmill ergometer under the control of clinical status, blood pressure, ECG according to a continuous protocol with a speed of 2.5 km/h and a track angle of 0 %. The criteria for the test were: increase in heart rate to 20/min. (but not more than 100/min.), distance traveled 1000 m. Criteria for termination of the sample were: negative ECG dynamics, heart rate increase> 20/min., increase in systolic arterial pressure (SAP) >20 mm.Hg. or reduction>15 mm. Hg; increase in diastolic blood pressure (DAP)>10 mm. or reduction of DAP>5 mm Hg, increase in the intensity assessment of physical activity during the test to 13 points by a 20 - point scale for assessing the severity of physical activity according to Borg.

According to the results of the test (submaximal testing) in EG patients exercise tolerance (ET) was recorded significantly higher. Thus, the mean distance traveled in the EG was 694.7±38.4 m compared to patients with CG, where the similar figure was 584.2±40.7 m (p<0.05).

Also, it is noteworthy that among EG patients in 9 patients (30 %) the test was stopped when reaching 1000 m distance, and among patients with CG only 5 patients (16.6 %) completed the test, reaching 1000 m distance. Accordingly, the duration of patients' stay in the hospital (before discharge) was 6.7±0.24 days compared to patients of CG, where this figure was 8.3±0.43 days ($p<0.01$).

The method of RP assessment is developed, which takes into account morphological features of AMI, psychosomatic status of the patient, risk group according to the GRACE scale, which permits to identify 12 clinical rehabilitation scenarios.

Traditionally, rehabilitation measures in patients with AMI are based on taking into account only the following features of the current disease: the depth of myocardial damage, myocardial reperfusion, presence of complications. When performing myocardial revascularization, its completeness and indices of recovery of myocardial perfusion are not taken into account. To calculate the RP, we took into account the completeness of the intervention. Thus, according to current research, complete reperfusion of all hemodynamically significant atherosclerotic lesions of the CA in patients with AMI has advantages over selective stenting only infarct-dependent artery. While the presence of multiple chronic occlusions results in the development of diffuse cardiosclerosis and ischemic heart remodeling with reduced myocardial contractility and lower rehabilitation capacity of the patient. We have identified the following categories of patients according to the characteristics of reperfusion: patients with PCI of infarct-dependent artery only without lesions of other areas, patients with multivascular lesions and PCI of infarct-dependent artery only and presence of significant subocclusions of other localizations, patients with multivascular lesions and PCI of infarct-dependent artery only and the need in coronary artery bypass grafting.

Timely adequate restoration of coronary artery blood flow is able to provide the required level of myocardial perfusion, thereby leading to the return to normal life of hibernated due to ischemia, cardiomyocytes. Angiographic assessment of blood flow in the epicardial artery by the TIMI scale was performed to calculate RP: TIMI 0 – no anterograde blood flow in the artery; TIMI 1 – minimal blood flow; TIMI 2 – incomplete restoration of blood flow; TIMI 3 – complete restoration of blood flow. The calculation was performed by the number of frames illustrating the passage of contrast from the proximal segment of the artery to the landmarks in the distal segment of the artery.

Restoration of blood flow in the epicardial artery cannot fully give an idea of the perfusion adequacy in the myocardium. There is a known phenomenon of "no reflow", which indicates the absence of myocardial perfusion (MP) or its reduction, despite effective reperfusion therapy, resulting from the development of aseptic myocarditis, its necrosis, usually against the background of a long-term episode of ischemia and late reperfusion. Patients in this group have a worse prognosis, lower RP, and need changes in treatment and rehabilitation measures. Based on the above, the calculation model included the analysis of MP in the affected area after reperfusion therapy.

MP was studied by the rate of leaching of the contrast agent by the MBG scale and took into account 4 degrees: MBG 0 – no myocardial staining; MBG 1 – preservation of staining until the next image (weak contrast leaching), MBG 2 – intense myocardial staining, but slow contrast leaching and MBG 3 – intense myocardial staining and rapid contrast leaching, indicating normal myocardial perfusion.

Thus, methods of studying the efficacy of reperfusion therapy in the stratification of patients according to their rehabilitation ability are an integral part.

Equally important in the assessment of RP is the determination of myocardial fractional contraction by the Simpson method and segmental myocardial contractility. Indices of central and peripheral hemodynamics directly depend on the volume of minute blood flow, the measurement of which in patients with AMI in the presence of local contractility, a- and dyskinesia, can not be performed by the Teicholtz method (the difference between diastolic and systolic LV sizes in two-dimensional mode). Assessment of the WMSI index, after reperfusion, gives an understanding of the lesion's extent, regardless of the electrocardiographic criteria of the lesion's depth (the presence of a Q wave). Thus, RP is determined taking into account myocardial contractility, provides grounds for accelerating or slowing down rehabilitation measures and expanding motor regime in accordance with the heart's ability to provide blood flow at rest and during exercise.

The Hospital Mortality Index according to the Global Coronary Event Registry (GRACE) model includes clinical parameters and age of patients, is a rapid and affordable method of cardiovascular risk assessment that complements clinical assessment and permits stratification of ACS patients on admission [7]. According to the GRACE scale, patients with a low, moderate and high risk of hospital mortality were identified. Higher risk by the GRACE scale is usually associated with the development of clinical complications and requires caution in the implementation of rehabilitation measures.

An additional criterion for a comprehensive assessment of RP was the Charleson comorbidity index, which takes into account the severity of comorbidity and age of the patient. Charleson's comorbidity index distinguishes patients by 10-year survival rate, where 0 points indicate 99 % survival for 10 years, 1 point – 96 % survival, 2 points – 90 % survival, 3 points – 77 % survival, 4 points – 53 % survival, 5 points – 21 % survival. Patients with a high score by the Charlson scale usually have poor tolerance to exercise and need to slow down the expansion of motor regime.

One of the important indices, we included in the analysis of the patient's RP, is the level of pre-hospital physical activity of the patient, which was performed by the DASI scale (Duke Activity Status Index). Physically trained patients tolerate exercise better in the post-infarction period, have a lower baseline heart rate, shorter recovery period, are able to achieve a higher level of submaximal load even in the hospital stage of rehabilitation. According to current recommendations, adequate physical activity has a positive effect on the quality and life expectancy in patients who have undergone AMI.

Taking into account the psychological component in the assessment of RP, and early expansion of the motor regime can prevent the development of CI, anxiety – depressive disorders, psychological and social adaptation in the postinfarction period, which are independent risk factors for post-hospital mortality in patients with coronary heart disease [4, 9].

Taking into account not only FC severity of AMI, but also features of psychological, physical condition, medical indices, individual compensatory capabilities of the cardiovascular system (CVS) in combination with environmental factors and social activity of the patient based on the International Classification of Functioning forms RP in a particular patient. RP is defined as the ability of the patient to achieve the main rehabilitation goals to restore working capacity and quality of life [3].

Assessment of RP in the process of treatment at different stages of AMI provides identification of the best ways to achieve the desired results of CR and the necessary sequence of rehabilitation measures while maintaining the principles of patient routing [2]. Assessment of RP taking into account the following indices: risk of hospital mortality by the GRACE scale, degree of coronary circulation recovery and myocardial reperfusion, completeness of intervention, level of anxiety and depression by the HADS scale, myocardial contractility, comorbidity by the Charlson scale, pre-hospital physical activity by the DASI scale permitted to identify patients with AMI of low, medium and high RP, as well as to perform earlier mobilization and implement cardiorehabilitation techniques in patients with AMI of high and medium RP, than when applying the principles of traditional rehabilitation [10].

The decrease in baseline heart rate in patients with HF with the expansion of the motor regime to the target indicated an improvement in the body's adaptive capacity. Reducing the level of anxiety of EG patients calculated by the HADS scale, contributes to social adaptation after discharge from hospital and working capacity recovery [13].

The efficacy of early controlled expansion of motor regime, determined by exercise tolerance (ET) is evidence of the positive impact of early mobilization of patients with high and medium RP [11, 15]. We used an adaptive protocol to assess the patient's rehabilitation capabilities when performing exercise on a treadmill - ergometer with a given speed and inclination under ECG control until the target heart rate is reached. Patients selected for the high and medium rehabilitation potential groups showed longer distances. Also, according to the results of submaximal testing in patients with HF compared to patients of CG, the expansion of motor regime to the target level was faster, which permitted to reduce the length of patients' stay at the inpatient stage of treatment [14].

Thus, reducing the length of patients' stay with I-II motor regimes, accelerating the pace and improving methods of expanding the motor regime of patients with AMI, in accordance with the RP permitted to achieve the target intensity of physical activity at discharge and as a result reduce the inpatient treatment. Implementation of RP assessment in patients with AMI and the improvement of CR methods can have positive effects on the patient's prognosis, his psychological, physical and social adaptation in the future.

Conclusions

1. The method of RP assessment, which takes into account the FC severity of AMI, its morphological features and completeness of reperfusion, risk group according to the GRACE scale, features of psychological, physical condition and compensatory capacity of the patient provides determination of the best timing and methods.

2. Evaluation of RP at the early stage of AMI patients' treatment permits the implementation of individual programs of CR with the early expansion of the motor regime, which prevents the development of CI and improves the rehabilitation process.

3. The use of individual CR programs at the early stages of rehabilitation can improve the results of treatment of patients with AMI of high and medium RP, reduce the duration of inpatient treatment, increase ET, reduce the likelihood of anxiety-depressive disorders.

4. The introduction of CR methods at the early stage of rehabilitation in patients with AMI contributes to the restoration of the physical, emotional, psychological health and working capacity of the patient.

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