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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

Effect of different models of cardiac rehabilitation on heart rate recovery

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Abstract

Background and aim: The aim of this study was to assess the effect of different models of the second stage of cardiac rehabilitation on heart rate recovery (HRR). We also evaluated the effect of selected cardiovascular risk factors on HRR.

Methods: The study included 103 patients (80 men and 23 women) aged 60.9 ± 10.7 years with a recent acute coronary syndrome undergoing the second stage of a comprehensive cardiac rehabilitation. An exercise test (ExT) was performed before and after rehabilitation.

Results: HRR improved significantly only in women (26.5 bpm in ExT before rehabilitation vs. 32.8 bpm in ExT after rehabilitation, $p < 0.05$). The highest HRR was obtained in the subgroup rehabilitated according to the model A, and the lowest in subgroup C (31 vs. 22.1 bpm, $p < 0.05$). The highest increase in HRR was observed in the most seriously ill patients in subgroup C (18 bpm before rehabilitation vs. 22.1 bpm after rehabilitation).

Conclusions: The most significant improvement in HRR was observed in the most seriously ill patients.

Key words: cardiac rehabilitation, rehabilitation models, heart rate response

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INTRODUCTION

Research on cardiac rehabilitation performed in the last two decades resulted in introduction of new, safe rehabilitation methods and showed additional benefits of exercise training, including the effect of rehabilitation on gene expression [1].

One of increasingly used forms of cardiac rehabilitation is strength training. It was introduced into standards of comprehensive cardiac rehabilitation (CCR) many years ago, but studies of the recent years proved it was safe also in patients with average exercise tolerance ≥ 5 metabolic equivalents of task (MET). Resistance training should be performed according to the established recommendations which include patient selection and safety measures [2]. An example of new form of rehabilitation in patients with cardiovascular (CV) disease is isokinetic training. With workload adjusted to the perceived exertion, it is a safe (lower trauma risk, precise exercise dosing) and effective rehabilitation method [3].

Cardiac rehabilitation benefits from development of new forms of training and optimalisation of exercise load in various conditions. It is also important, however, that rehabilitation result in most optimal patient outcomes when performed according to the currently established rules. One of the parameters that may be used to evaluate efficacy of rehabilitation is heart rate recovery (HRR), defined as the difference between the maximum heart rate during exercise and the heart rate at 1 min after termination of exercise. HRR ≤ 12 bpm has been considered abnormal by most authors [4]. Reduced HRR may indicate parasympathetic nervous system dysfunction [5]. Studies on the effect of rehabilitation on this variable showed an increase in HRR in patients with

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heart failure, previous myocardial infarction, or coronary artery disease undergoing CCR [6–8]. Most authors consider post-exercise HRR an indicator of effective CCR [9–11]. Not all agree, however, whether this parameter may be used to evaluate effects of rehabilitation [12].

The aim of the study was to evaluate effect of various models of cardiac rehabilitation (A, B, and C) on HRR. A secondary goal was to evaluate the effect of selected CV risk factors on HRR.

METHODS

The study was performed in a group of 103 patients admitted due to an acute coronary syndrome (ACS) and referred for stage II cardiac rehabilitation. Required sample size as estimated by a statistician was 100. Detailed information regarding demographic data, laboratory test results and medical history are shown in Tables 1–3. All patients were in sinus rhythm and free of arrhythmia. Before and after rehabilitation, a submaximal stress test was performed on a Marquette Electronics treadmill according to the modified Bruce protocol. HRR was measured after the exercise test in standing position. The delay from the ACS to an initial exercise test ranged from 1 to 3 weeks. Based on the results of the initial exercise test and estimated risk of CV complications, patients were referred for various models of cardiac rehabilitation (A, B or C). Depending on the rehabilitation model, patients exercised in a gym and a swimming pool (subgroups A and B) and on a cycloergometre (subgroups A, B, and C). Patients rehabilitated using the model A exercised at 40 Watts, those rehabilitated using the model B exercised at 30 Watts, and those rehabilitated using the model C exercised at 20 Watts. The rehabilitation program consisted of 24 sessions of interval training. Each training session lasted for 36 min and included 6-min cycles (4 min of exercise with load, 2 min of exercise without load). Rehabilitation in a gym included a 10-min warm-up, 30-min training, and 10-min cool-down. The warm-up period included dynamic exercises of small and moderate muscle groups. The actual training included dynamic exercises of large muscle groups, respiratory exercises, and exercises against a small resistance. The cool-down period included respiratory exercises and autogenic training according to Schultz. Training in a swimming pool consisted of a 5-min warm-up including active exercises of small muscle groups, an actual 20-min training including dynamic exercises of large muscle groups, both active and against a resistance (using water exercise equipment), and a 5-min cool-down period (free swimming).

Exercise intensity during rehabilitation was guided by estimated target training heart rate (calculated as resting heart rate + 40–80% of heart rate reserve). Patients rehabilitated in a gym and in swimming pool had blood pressure and heart rate measured before and after the training. During exercise, patients estimated perceived exertion using the Borg scale. Before initiation of the rehabilitation program, patients received instructions regarding target perceived exercise intensity (11–14 points in the Borg scale). Rehabilitation was performed according to the CCR recommendations described in a statement by the Committee to Develop Cardiac Rehabilitation Standards of the Polish Cardiac Society [13]. Upon completion of the cardiac rehabilitation program, a repeated exercise test was performed.

Table 1. Study sample size (overall and in subgroups for both genders)

	No. of patients	Women	Men
Overall	N = 103	23 (22%)	80 (78%)
Subgroup A	N = 39	6 (15%)	33 (85%)
Subgroup B	N = 54	13 (24%)	41 (76%)
Subgroup C	N = 10	4 (40%)	6 (60%)

Numbers (percentages) of patients are given.

Table 2. Demographic and laboratory characteristics of the study group (overall and in subgroups A, B, C)

Variable	Mean			Minimum			Maximum			Median		
	A	B	C	A	B	C	A	B	C	A	B	C
Age [years]	57.6	61	73	36	35	65	78	80	85	56	59.5	72.5
Body mass [kg]	81.6	84.1	80.3	47	60	61	109	125	115	83	84	78
Height [cm]	171.2	171.8	169.4	148	15	152	183	186	183	175	172.5	172
BMI [kg/m^2]	27.8	28.4	28	20.3	20.1	24.4	39.5	41.5	39.8	28	27.6	27.1
TC [mg/dL]	173.5	171.5	156.8	87	105	115	274	254	207	168	169.5	156
TG [mg/dL]	122.4	126.8	109.2	35	38	67	333	277	173	114	114.5	107
HDL-C [mg/dL]	40.7	45.8	46.9	12	22	29	80	121	111	38	47	39
LDL-C [mg/dL]	108.2	100.5	90	39	10	42	204	184	149	112	100	95

BMI — body mass index; HDL-C — high density lipoprotein cholesterol; LDL-C — low density lipoprotein cholesterol; TC — total cholesterol; TG — triglycerides

Table 3. Clinical characteristics (medical history data) of the study group (overall and in subgroups A, B, C)

Variable	Subgroup		
	A	B	C
ST elevation MI (currently)	22 (56.4%)	31 (57.5%)	5 (50%)
Non-ST elevation MI (currently)	16 (41%)	20 (37%)	4 (40%)
Unstable angina (currently)	1 (2.6%)	3 (5.5%)	1 (10%)
History of MI	5 (12.8%)	19 (35.2%)	3 (30%)
History of UA	4 (10.2%)	1 (1.8%)	0 (0%)
PCI (currently)	33 (84.6%)	37 (68.5%)	7 (70%)
CABG (currently)	0 (0%)	1 (1.8%)	0 (0%)
Fibrinolysis (currently)	0 (0%)	0 (0%)	0 (0%)
History of PCI	4 (10.2%)	16 (29.6%)	1 (10%)
History of CABG	2 (5.1%)	5 (9.2%)	3 (30%)
History of fibrinolysis	0 (0%)	1 (1.8%)	1 (10%)
Obesity/overweight	29 (74.3%)	38 (70.4%)	9 (90%)
Hypertension	25 (64.1%)	40 (74.1%)	6 (60%)
Diabetes	7 (17.9%)	15 (27.8%)	3 (30%)
Smoking	13 (33.3%)	16 (29.6%)	0 (0%)
Any dyslipidaemia	33 (84.6%)	45 (83.3%)	7 (70%)
Elevated TC (> 175 mg/dL)	16 (41%)	24 (44.4%)	3 (30%)
Elevated LDL-C (> 100 mg/dL)	23 (59%)	26 (48.1%)	4 (40%)
Elevated TG (> 150 mg/dL)	9 (23.1%)	14 (25.9%)	1 (10%)
Decreased HDL-C (men < 40 mg/dL. women < 50 mg/dL)	22 (56.4%)	24 (44.4%)	6 (60%)

Numbers (percentages) of patients are given. CABG — coronary artery bypass grafting; HDL — high density lipoprotein cholesterol; LDL-C — low density lipoprotein cholesterol; MI — myocardial infarction; PCI — percutaneous coronary intervention; TC — total cholesterol; TG — triglycerides; UA — unstable angina

Statistical analysis

We analysed data from medical histories and parameters from both exercise tests. Due to non-normal distribution of the evaluated variables, non-parametric tests were used to evaluate differences between groups and relations between variables. Differences in numeric and ordinal parameters between groups were tested using the non-parametric Mann-Whitney U test. To evaluate significance of time-related changes of a given numeric parameter in various groups (i.e., after training vs. before training), the non-parametric Wilcoxon signed-rank test was used. Calculations were performed using a Statistica package (version 10 PL) licensed to the Medical University of Warsaw.

RESULTS

In the exercise test performed after cardiac rehabilitation, HRR was significantly higher in women than in men (32.8 vs. 27 bpm, $p < 0.05$), while the opposite was true in the exercise test performed before cardiac rehabilitation (26.5 vs. 28 bpm), although the latter difference was not significant. In the exercise test performed after cardiac rehabilitation, HRR decreased in men and increased in women compared to the exercise test performed before cardiac rehabilitation. Detailed results are shown in Table 4.

Both before and after cardiac rehabilitation, HRR was highest in subgroup A and lowest in subgroup C, but the difference between these subgroups was much smaller after cardiac rehabilitation compared to before cardiac rehabilitation. Significant differences were shown between all subgroups before cardiac rehabilitation and between subgroups A and C after cardiac rehabilitation. Detailed results are shown in Table 5.

In the exercise test before cardiac rehabilitation, a desirable HRR (> 12 bpm) was noted in more than 90% of patients in subgroups A and B and in a much smaller proportion of patients in subgroup C. In the exercise test after cardiac rehabilitation, an insignificant improvement was noted in all subgroups but it was smaller among men in subgroup C compared to the other subgroups. In all subgroup, this improvement was higher in women than in men. Detailed results are shown in Table 6.

Table 4. Comparison of heart rate reserve (HRR) during exercise test before (ExT before) and after (ExT after) cardiac rehabilitation in the overall study group and in both genders

Variable	Overall study group											
	Overall				Women				Men			
	ExT before	ExT after	Δ	P	ExT before	ExT after	Δ	P	ExT before	ExT after	Δ	P
HRR	27.6	28.3	+0.7	NS	26.5	32.8	+6.3	< 0.05	28	27	–1	NS

Δ — difference between exercise tests before and after rehabilitation

Table 5. Comparison of heart rate reserve (HRR) during exercise test before (ExT before) and after (ExT after) cardiac rehabilitation in subgroups A, B, C

Variable	Group A vs. B			Group A vs. C			Group B vs. C		
	A	B	P	A	C	P	B	C	P
HRR (ExT before)	31.9	26.4	< 0.01	31.9	18	< 0.0005	26.4	18	< 0.05
HRR (ExT after)	31	27.6	NS	31	22.1	< 0.05	27.6	22.1	NS

Table 6. Characteristics of the study group — heart rate reserve (HRR) during exercise test before (ExT before) and after (ExT after) cardiac rehabilitation

	HRR (ExT before)		HRR (ExT after)	
	> 12 bpm (% group/subgroup)	≤ 12 bpm (% group/subgroup)	> 12 bpm (% group/subgroup)	≤ 12 bpm (% group/subgroup)
Overall	91.3	8.7	97.1	2.9
Women	95.6	4.4	100	0
Men	90	10	96.2	3.8
Subgroup A	92.3	7.7	92.3	7.7
Women	100	0	100	0
Men	90	10	90	10
Subgroup B	96.3	3.7	100	0
Women	100	0	100	0
Men	95.1	4.9	100	0
Subgroup C	60	40	80	20
Women	75	25	100	0
Men	50	50	66.7	33.3

Among CV risk factors, only high HDL cholesterol level in men (> 40 mg/dL) was associated with a significant improvement of the maximal workload ($p < 0.05$). HRR increased significantly in women ($p < 0.05$).

No significant associations were seen in patient subgroups. Also, no significant effect was noted of the 5 major CV risk factors (hypertension, diabetes, smoking, dyslipidaemia, increased body mass index) on HRR in patients of either gender or in any of the subgroups.

DISCUSSION

CCR is an important component of the management of patients with CV disease. It exerts a beneficial effect on CV risk factors and the quality of life [14]. In a metaanalysis of 34 cardiac rehabilitation programs by Lawler et al. [15], participation in these programs was associated with reduced CV mortality (odds ratio [OR] 0.64; 95% confidence interval [CI] 0.46–0.88) and overall mortality (OR 0.64; 95% CI 0.46–0.88). In the current era of rapid advances in medicine, it seems important to develop methods to evaluate effects of rehabilitation. In addition to established parameters such as effort tolerance in METs and exercise duration, HRR may also be used to evaluate efficacy of rehabilitation. This parameter was shown to predict morbidity and mortality, e.g., in patients with chronic heart failure [16]. Measurement of HRR may be an easy, inexpensive, and reproducible tool to evaluate effects of cardiac rehabilitation [17–24]. In our study, highest baseline HRR values were noted in men. After cardiac rehabilitation, HRR increased significantly only in women (from 26.5 to 32 bpm) but it did not increase in men. These observations are in agreement with those reported by Caminiti et al. [25] who showed correlations between lower HRR, metabolic syndrome, and previous ACS only in women but not in men.

The highest HRR values in the exercise test before rehabilitation were noted in subgroup A, i.e., the most fit patients, and the lowest values were noted in subgroup C. The highest improvement in HRR after rehabilitation was observed in subgroup C.

In our study, HRR in most patients was > 12 bpm which has been considered an indicator of effective rehabilitation by most authors [26–28]. In subgroups A and B, HRR before rehabilitation was > 12 bpm in 91.3–100% of patients, compared to 50–75% patients in subgroup C. After cardiac rehabilitation, HRR increased in nearly all subgroups but these differences were not significant. This might have been related to small sample sizes, but also to mostly normal HRR values

seen already in the exercise test before cardiac rehabilitation and thus a relatively small potential for improvement of this parameter after rehabilitation.

We also evaluated the relationship between HRR and selected CV risk factors. Kizilbash et al. [29] showed a correlation between low HRR and the severity of atherosclerotic lesions, and Samad et al. [30] showed an association between HRR and smoking. In our study group, we found a positive correlation between female gender and HRR. Such an association was not observed in men.

We also evaluated a combination of 5 major risk factors in relation to those patients in whom at least 1 risk factor was absent. No significant results were obtained but these groups were much unbalanced, as only 2.5–5% of patients in different subgroups had all 5 risk factors which undoubtedly affected the results. The relation between a combination of CV risk factors and HRR has not been evaluated in the available literature.

Heart rate reserve is an interesting research topic, and discrepant results of the published peer-reviewed studies indicate a need for further studies on this parameter.

Limitations of the study

Our study had some methodological limitations. Patient subgroups differed in regard to their size, patient age, and gender proportions. We attempted to include consecutive patients after a recent ACS to avoid selection bias. The 3 subgroups based on different cardiac rehabilitation models were inherently needed based on the premises of our research but resulted in relatively small sample sizes in each subgroup.

CONCLUSIONS

Both before and after rehabilitation, HRR was highest in subgroup A and lowest in subgroup C. Differences in HRR between these subgroups were much lower in the exercise test after rehabilitation compared to that before rehabilitation. The highest improvement in HRR was observed in subgroup C.

Conflict of interest: *none declared*

References

1. Ennezat PV, Malendowicz SL, Testa M. Physical training in patients with chronic heart failure enhances the expression of genes encoding antioxidative enzymes. J Am Coll Cardiol, 2001; 38: 194–198.
2. Pietras P, Wujek-Krajewska E, Kuch M et al. Trening oporowy w rehabilitacji kardiologicznej: zasady prowadzenia i efekty kliniczne. Kardioprofil, 2009; 28: 53–61.
3. Feiereisen P, Vaillant M, Eischen D et al. Isokinetic versus one-repetition maximum strength assessment in chronic heart failure. Med Science Sports Exercise, 2010; 42: 2156–2163.
4. Zdrenghea D, Sitar-Tăut A, Pop D. Comparison between heart rate variability and recovery in ischemic patients. Rom J Internal Med, 2007; 45: 171–175.
5. Myers J, Hadley D, Oswald U et al. Effects of exercise training on heart rate recovery in patients with chronic heart failure. Am Heart J, 2007; 153: 1056–1063.
6. Legramante J, Iellamo F, Massaro M et al. Effects of residential exercise training on heart rate recovery in coronary artery patients. Am J Physiology, Heart Circulatory Physiolog,y 2007; 292: 510–515.
7. Giallauria F, Lucci R, Pietrosante M et al. Exercise-based cardiac rehabilitation improves heart rate recovery in elderly patients after acute myocardial infarction. J Gerontol: Biol Scien, 2006; 61: 713–717.
8. Känel R, Saner H, Kohls S et al. Relation of heart rate recovery to psychological distress and quality of life in patients with chronic heart failure. Eur J Cardiovasc Preven Rehabil, 2009; 16: 645–650.
9. MacMillan J, Davis L, Durham C et al. Exercise and heart rate recovery. Heart Lung: J Acute Critical Care, 2006; 35: 383–390.
10. Streuber S, Amsterdam E, Stebbins C. Heart rate recovery in heart failure patients after a 12-week cardiac rehabilitation program. Am J Cardiol, 2006; 97: 694–698.
11. Kligfield P, McCormick A, Chai A et al. Effect of age and gender on heart rate recovery after submaximal exercise during cardiac rehabilitation in patients with angina pectoris, recent acute myocardial infarction, or coronary bypass surgery. Am J Cardiol, 2003; 92: 600–603.
12. Piotrowicz E, Baranowski R, Piotrowska M et al. Variable effects of physical training of heart rate variability, heart rate recovery, and heart rate turbulence in chronic heart failure. Pacing Clin Electrophysiol, 2009; 32: 113–115.
13. Dylewicz P, Jegier A, Piotrowicz R et al. Kompleksowa rehabilitacja kardiologiczna. Stanowisko Komisji ds. Opracowania Standardów Rehabilitacji Kardiologicznej PTK. Folia Cardiol, 2004; 11 (supl. A): 1–48.
14. Bromboszcz J, Dylewicz P. Trening fizyczny w rehabilitacji kardiologicznej. In: Rehabilitacja kardiologiczna: stosowanie ćwiczeń fizycznych. ELIPSA-JAIM, Kraków 2005: 109–169.
15. Lawler P, Filion K, Eisenberg M. Efficacy of exercise-based cardiac rehabilitation post-myocardial infarction: a systematic review and meta-analysis of randomized controlled trials. Am Heart J, 2011; 162: 571–584.
16. Heffernan K, Jae S, Fernhall B. Heart rate recovery after exercise is associated with resting QTc interval in young men. Clin Auton Res, 2007; 17: 356–363.
17. Chaitman B. Abnormal heart rate responses to exercise predict increased long-term mortality regardless of coronary disease extent: the question is why? J Am Coll Cardiol, 2003; 42: 839–841.
18. Nishime E, Cole C, Blackstone E et al. Heart rate recovery and treadmill exercise score as predictors of mortality in patients referred for exercise ECG. JAMA, 2000; 284: 1392–1398.
19. Vivekananthan D, Blackstone E, Pothier C et al. Heart rate recovery after exercise is a predictor of mortality, independent of the angiographic severity of coronary disease. J Am Coll Cardiol, 2003; 42: 831–838.
20. Morshedi-Meibodi A, Larson M, Levy D et al. Heart rate recovery after treadmill exercise testing and risk of cardiovascular disease events (The Framingham Heart Study). Am J Cardiol, 2002; 90: 848–852.
21. Känel R, Barth J, Kohls S et al. Heart rate recovery after exercise in chronic heart failure: Role of vital exhaustion and type D personality. Am J Cardiol, 2009; 53: 248–256.
22. Giallauria F, De Lorenzo A, Pilerci F et al. Long-term effects of cardiac rehabilitation on end-exercise heart rate recovery after myocardial infarction. Eur J Cardiovasc Preven Rehabil, 2006; 13: 544–550.
23. Sato S, Makita S, Majima M. Additional physical activity during cardiac rehabilitation leads to an improved heart rate recovery in male patients after coronary artery bypass grafting. Circulation, 2005; 69: 69–71.
24. Yamada T, Yoshitama Y, Kunihiko Makino K et al. Heart rate recovery after exercise is a predictor of silent myocardial ischemia in patients with type 2 diabetes. Diabetes Care, 2011; 34: 724–726.

25. Caminiti G, Volterrani M, Marazzi G et al. Metabolic syndrome predicts lower functional recovery in female but not in male patients after an acute cardiac event. Int J Cardiol, 2009; 135: 296–301.
26. Hai J, Siu C, Ho H et al. Relationship between changes in heart rate recovery after cardiac rehabilitation on cardiovascular mortality in patients with myocardial infarction. Heart Rhythm, 2010; 7: 929–936.
27. Adams B, Carr J, Ozonoff A et al. Effect of exercise training in supervised cardiac rehabilitation programs on prognostic variables from the exercise tolerance test. Am J Cardiol, 2008; 15: 1403–1407.
28. Morshedi-Meibodi A, Larson MG, Levy D et al. Heart rate recovery after treadmill exercise testing and risk of cardiovascular disease events (The Framingham Heart Study). Am J Cardiol, 2002; 90: 848–852.
29. Kizilbash M, Carnethon M, Chan C et al. The temporal relationship between heart rate recovery immediately after exercise and the metabolic syndrome: the CARDIA Study. Eur Heart J, 2006; 27: 1592–1596.
30. Samad G, Babak K, Parvaneh A. Abnormal heart rate recovery after exercise predicts coronary artery disease severity. Cardiol J, 2011; 18: 47–54.

Wpływ różnych modeli rehabilitacji kardiologicznej na szybkość normalizacji tętna po wysiłku fizycznym

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Streszczenie

Wstęp: Wskaźnik szybkości normalizacji tętna po wysiłku (HRR), definiowany jako różnica między szczytowym tętnem w trakcie wysiłku a tętnem w pierwszej minucie po jego zakończeniu, może służyć do oceny funkcji układu przywspółczulnego i stopnia wytrenowania.

Cel: Celem niniejszej pracy była ocena wpływu różnych modeli II etapu rehabilitacji kardiologicznej na HRR, a celem dodatkowym — ocena wpływu wybranych czynników rozwoju chorób układu sercowo-naczyniowego na ten parametr.

Metody: W badaniu wzięło udział 103 chorych (80 mężczyzn, 23 kobiety), w wieku 60,9 ± 10,7 roku, z rozpoznanym ostrym zespołem wieńcowym (OZW), poddanych II etapowi kompleksowej rehabilitacji kardiologicznej. Przed rozpoczęciem i po zakończeniu rehabilitacji wykonano u chorych test wysiłkowy.

Wyniki: Szybkość normalizacji tętna po wysiłku uległa istotnej statystycznie poprawie jedynie w grupie kobiet (test wysiłkowy przed rozpoczęciem rehabilitacji 26,5 *vs*. po zakończeniu rehabilitacji 32,8; $p < 0,05$). Najwyższe wartości HRR osiągnęła podgrupa rehabilitowana w modelu A, wartości najniższe podgrupa rehabilitowana w modelu C (podgrupa A 31 *vs*. podgrupa C 22,1; $p < 0,05$). Najwyższy wzrost wartości HRR zaobserwowano wśród pacjentów najbardziej obciążonych — w podgrupie C (test wysiłkowy przed rozpoczęciem rehabilitacji 18 *vs*. po zakończeniu rehabilitacji 22,1).

Wnioski: Największą poprawę wartości HRR zaobserwowano w grupie chorych najbardziej obciążonych.

Słowa kluczowe: rehabilitacja kardiologiczna, modele rehabilitacji, szybkość normalizacji tętna po wysiłku

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