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THE IMPACT OF PROFESSIONAL STATUS ON THE EFFECTS OF AND ADHERENCE TO THE OUTPATIENT FOLLOWED BY HOME-BASED TELEMONITORED CARDIAC REHABILITATION IN PATIENTS REFERRED BY A SOCIAL INSURANCE INSTITUTION

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Abstract

Objectives: Legislators and policymakers have expressed strong interest in intervention programs to reduce dependence on social disability benefits. Hybrid: ambulatory followed by home-based cardiac telerehabilitation – hybrid cardiac rehabilitation (HCR) seems to be a novel alternative for standard cardiac rehabilitation for patients with cardiovascular diseases (CVD) as a form of pension prevention paid by the Social Insurance Institution (SII). The kind of professional status may bias the motivation to return to work after HCR. The aim of our study was to evaluate whether the professional status can affect the effects of HCR. **Material and Methods:** One hundred fifty-two patients with CVD referred by the SII for a 5-week HCR were qualified for the study. Patients (87.7% males), aged 57.31±5.61 years, were divided into 2 subgroups: W) white-collar employees (N = 22) and B) blue-collar employees (N = 130). To evaluate functional capacity, an exercise test on a treadmill was used. **Results:** The number of days of absence in the cardiac rehabilitation program did not differ between the groups (mean ± standard deviation – B: 1.09±3.10 days, W: 1.95±3.64 days). There were significant improvements ($p < 0.05$) in measured variables after HCR in both (W and B) groups (max workload: 8.21±2.88 METs (measured in metabolic equivalents) vs. 9.6±2.49 METs, 7.76±2.51 METs vs. 8.73±2.7 METs, resting heart rate (RHR): 77±16.22 bpm vs. 69.94±12.93 bpm, 79.59±14 bpm vs. 75.24±11.87 bpm; double product, i.e., product of heart rate and systolic BP (DP rest) 10 815.22±2968.24 vs. 9242.94±1923.08, 10 927.62±2508.47 vs. 9929.7±2304.94). In group B, a decrease in systolic blood pressure (BP syst. – 137.03±17.14 mm Hg vs. 131.82±21.13 mm Hg), heart rate recovery in the 1st minute after the end of peak exercise (HRR_1) (99.38±19.25 vs. 93.9±19.48) and New York Heart Association (NYHA) class (1.22±0.53 vs. 1.11±0.36) was observed. In group W, a decrease in diastolic blood pressure (BP diast.) at rest was observed (88.28±9.79 mm Hg vs. 83.39±8.95 mm Hg). The decrease in resting HR was significantly greater in group W (69.94±12.93 vs. 75.24±11.87, $p = 0.034$). **Conclusions:** Hybrid cardiac rehabilitation is feasible and safe with high adherence to the program regardless of the patient's professional status. Professional status did not influence the beneficial effect of HCR on exercise tolerance.

Key words:
Rehabilitation, Coronary artery disease, Telemedicine, Cardiac rehabilitation, Social benefit, Occupational status

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INTRODUCTION

Legislators and policymakers have expressed strong interest in early intervention programs to reduce dependence on social disability benefits. The continuing rise in the number of individuals enrolled in the Polish Social Insurance Institution (SII) and growing expenditures paid out to beneficiaries have prompted the need to identify strategies that will limit the growth of future outlays. Since 2008, an increase in the nominal benefit payments expenditure has been observed.

Expenditure in the area served by the SII includes expenditure on disability payments for incapacity for work including care allowances; expenditure on social pensions, paid from the state budget; expenditure on sickness absence, meaning temporary inability to work due to sickness itself (sick leave); sickness benefits; expenditure on social rehabilitation benefits; and expenditure on medical rehabilitation under the SII pension prevention policy. The amount of these expenses during 2012 accounted for 1.9% of Poland's gross domestic product (GDP). The highest percentage of expenditure on benefits associated with the inability to work was spent on pensions for incapacity for work. In the structure of total expenditure on benefits for incapacity for work in 2012, cardiovascular diseases were in 2nd place in terms of generating costs and accounted for 15.1% of total costs [1].

Home-based rehabilitation is a novel and less expensive alternative for patients with cardiovascular diseases, and in Poland has also been used in the rehabilitation of people with musculoskeletal diseases and in patients with hearing and speech disorders [2]. Cardiac telerehabilitation is based on physical exercise performed at home under the supervision of a specialist center. For the first time, the SII implemented a home-based program of cardiac telerehabilitation in 2009, initially as a pilot program.

Introducing hybrid: ambulatory followed by home-based cardiac telerehabilitation (hybrid cardiac rehabilitation – HCR) may eliminate most of the factors that result in the currently low number of patients undergoing outpatient-based rehabilitation programs and may be more attractive for vocationally active patients [3–4]. To date, only a few studies have demonstrated favorable effects of telemonitored cardiac rehabilitation (CR) in patients with stable heart diseases in phase III of CR, the main goal of which is to strive for sustainable, beneficial lifestyle changes that patients will continue after completion of the program, education and assistance in quitting addictions. The population assessed in this study is unique because it comprises only patients suffering from cardiovascular diseases who do not work due to disability payment, social rehabilitation benefit and sick leave. The aim of the study was to evaluate whether professional status can affect the effects of the hybrid (ambulatory followed by home-based cardiac) telerehabilitation in patients referred by a social insurance institution.

The secondary end point was the assessment of the adherence to this kind of treatment.

MATERIAL AND METHODS

This was a retrospective 1-institutional cohort study that comprised patients referred for home-based cardiac telerehabilitation by the Polish Social Insurance Institution (SII).

Patient population

A total of 155 patients were referred by the SII for outpatient followed by home-based telemonitored cardiac rehabilitation, phase III CR, from January 2010 to December 2013. From this group, 3 patients who did not begin training for the following reasons – deep vein thrombosis, lumbar sciatica and back pain due to discopathy – were excluded from the analysis. Finally, 152 patients with documented cardiovascular diseases (CVD) referred by the SII for a 5-week HCR were qualified for the study.

Patients (87.7% males), aged 57.31±5.61 years (mean ± standard deviation), were divided into 2 subgroups: group

W – white-collar employees (N = 22), and group B – blue-collar employees (N = 130). White-collar employees were defined as people who performed professional, managerial or administrative work, and worked in an office or cubicle, while blue-collar workers were defined as people whose job required manual labor. Cardiac rehabilitation began no sooner than 12 weeks following the cardiovascular event.

Study protocol

The study was designed as a retrospective non-randomized trial. The patients underwent the following assessments at entry and after completing HCR – a physical examination, an exercise treadmill test according to the Bruce protocol and additional laboratory tests when it was necessary to assess their clinical state. Adherence was reported as the number of dropouts during the whole HCR program.

Exercise test

All patients underwent a symptom-limited exercise test (ET) performed according to the Bruce protocol [5] on a Woodway treadmill, using a computerized electrocardiography (ECG) Sun Tech Tango system. Twelve standard electrocardiographic leads were continuously recorded before, during and for 10 min after the test. Patients were encouraged to exercise to their maximum.

The test was discontinued in the case of reported anginal chest pain, maximal fatigue, arterial blood pressure increase over 230/120 mm Hg, ST segment depression by at least 2 mm in ECG, or severe arrhythmia. The following parameters were analyzed: max workload (measured in metabolic equivalents – METs), heart rate in beats per min (HR, bpm) at rest and at peak effort, blood pressure (BP, mm Hg) at rest and at peak effort, and double product (DP, mm Hg/min×100), e.g., the product of HR and systolic BP at rest and at peak effort [6]. Heart rate recovery in the 1st minute after the end of peak exercise (HRR_1) was measured as the method to assess the reactivation of the parasympathetic nervous system.

Hybrid cardiac telerehabilitation

Hybrid cardiac rehabilitation prescription followed the guidelines of cardiac rehabilitation and comprised all core components: medical evaluation, exercise training, relaxation sessions, educational, counselling, and behavioral interventions and other secondary prevention strategies for risk factor reduction [7]. All patients received remote-controlled equipment for tele-ECG monitoring and supervised exercise training (Pro Plus Company, Poland). The device enabled ECG data to be recorded using 3 precordial leads and transmitted via a mobile phone network to the monitoring center, which was located in the department of rehabilitation. Hybrid cardiac rehabilitation consisted of 2 phases: an ambulatory phase, conducted within an outpatient rehabilitation center (8–10 days), and a home-based phase, conducted at home (11–12 days).

The goals of the 1st stage were: a baseline clinical examination, optimization of pharmacological treatment, education in the prevention of cardiovascular risk factors and coping with stress, individual planning of exercise training, psychological assessment and relaxation sessions. The home-based stage comprised the training consent procedure, which included a telephone conversation with a physician during which the patient answered questions about her/his present clinical condition, symptoms and medications taken and was asked to send resting and the training session ECG data.

The telemonitoring system had details of the training sessions and times of automatic ECG recording preprogrammed for each patient. If the training session was completed uneventfully, the patient transmitted the ECG recording *via* the mobile phone to the monitoring center at the end of the session. Exercise training was planned individually for each patient according to the published guidelines [7]. The training HR was calculated using the HR

reserve method (Karvonen's method), based on data obtained in the exercise test. This method uses the heart rate reserve to calculate training zones based on both maximum and resting heart rate [8].

The target training HR was 60–80% of the HR reserve. Each training session consisted of 3 parts: 1st, warming up lasting 5–10 min, comprising breathing exercises, light resistance and systemic exercises; 2nd, aerobic endurance training based on different forms, i.e., either walking or Nordic walking or cycloergometer training for 30 min each; and finally a 5–10 min cooling down period. Patients were trained 5 times a week. The technical details of the telemonitoring system were presented previously by Piotrowicz et al. [3].

ETHICS

The procedures followed were in accordance with the ethical standards of a responsible institutional committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 1983 [9]. Each patient gave a written, institutional informed consent for participation in the program.

STATISTICS

The collected data were analyzed using IBM SPSS version 21. To compare the baseline characteristics of group W and group B, the Fisher test was used because of the small size of the groups. Student's t-tests were performed to test the independent and dependent samples for normally distributed variables, and the Wilcoxon and Mann-Whitney tests for variables not distributed normally in the analysis of the effects of cardiac rehabilitation. $P < 0.05$ was considered significant.

RESULTS

Baseline characteristics

One hundred and thirty patients (114 men, 16 women) with a mean age of 57.16±5.69 years from group B and 22 patients (19 men, 3 women) with a mean age of 58.23±4.97 years from group W were qualified for analysis. To compare sex, age and the mean number of absences in the HCR program, the Mann-Whitney test was used due to the large differences in group size. No statistical differences were found. To compare the distribution of other variables, the exact Fisher test was used because of the small size of the groups.

The most frequent kinds of disability benefit were social rehabilitation benefit and disability payment in both groups ($p = 0.157$). Blue-collar employees were current smokers ($p = 0.09$) or had a smoking history ($p = 0.01$) more frequently than white-collar workers. Hyperlipidemia also occurred in blue-collar workers more frequently ($p = 0.035$). The baseline clinical and demographic characteristics of the patients are summarized in Table 1.

Adherence

The number of days of absence in the cardiac rehabilitation program did not differ between the groups. The mean number of days of absence was 1.09±3.1 days in group B and 1.95±3.64 days in group W.

No tested subjects were excluded from home-based training or finished the training earlier for major adverse cardiac events (MACE) or other cardiovascular reasons.

Effects of HCR in white-collar workers and in blue-collar workers

There were some significant improvements ($p < 0.001$) in variables measured in the exercise test on a treadmill after HCR. Maximal workload measured in metabolic equivalents (METs) improved significantly ($p < 0.05$), while resting heart rate and double product decreased significantly in both groups. The effectiveness of HCR in terms of lowering systolic BP at rest (137.03±17.14 mm Hg before HCR vs. 131.82±21.13 mm Hg after HCR, $p = 0.04$), lowering HRR_1 (99.38±19.25 bpm before HCR vs. 93.90±19.48 bpm after HCR, $p = 0.001$) and NYHA class (1.22±0.53 vs. 1.11±0.36, $p < 0.01$) was

Table 1. Baseline clinical and demographic characteristics of study group – blue-collar (B) and white-collar (W) workers

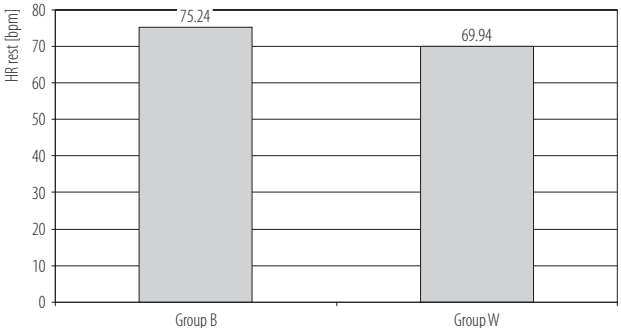
Variable	Group B (N = 130)	Group W (N = 22)	p
Males [n (%)]	114 (87.7)	19 (86.4)	0.740
Age [years] (M±SD)	57.16±5.69	58.23±4.97	0.450
Kind of disability benefit [n (%)]			0.157
unemployed	1 (0.8)	0 (0.0)	
disability payment	39 (30.0)	9 (40.9)	
social rehabilitation benefit	77 (59.2)	8 (36.4)	
sick leave	13 (10.0)	5 (22.7)	
Body mass index (M±SD)	28.81±4.40	29.62±4.76	0.214
Days of absence in the cardiac rehabilitation program [n] (M±SD)	1.09±3.10	1.95±3.64	0.200
Current smoker [n (%)]	31 (25.6)	0 (0.0)	0.009
Smoking history [n (%)]	99 (83.2)	10 (50.0)	0.001
Coronary artery disease [n (%)]	106 (81.5)	17 (77.3)	0.640
Myocardial infarction [n (%)]	76 (58.5)	12 (54.5)	0.730
Heart failure [n (%)]	16 (12.3)	3 (13.6)	0.740
Percutaneous coronary intervention [n (%)]	76 (58.5)	11 (50)	0.171
Coronary artery bypass grafting [n (%)]	20 (15.4)	6 (27.3)	0.111
Arterial hypertension [n (%)]	110 (84.6)	18 (81.8)	0.750
Atrial fibrillation chronic or persistent [n (%)]	7 (5.4)	1 (4.5)	1.000
Chronic obstructive pulmonary disease [n (%)]	6 (4.6)	0 (0.0)	0.304
Hyperlipidemia [n (%)]	63 (48.5)	5 (22.7)	0.035
Obesity [n (%)]	58 (45.0)	8 (36.4)	0.450
Overweight [n (%)]	58 (45.0)	10 (45.5)	0.966
Ca-blocker [n (%)]	30 (23.8)	7 (33.3)	0.350
Beta-blocker [n (%)]	115 (92.0)	17 (81.0)	0.112
Angiotensin converting enzyme inhibitors [n (%)]	86 (68.8)	12 (57.1)	0.293
Clopidogrel / Dabigatran [n (%)]	51 (40.8)	5 (23.8)	0.138
Inhibitor PP [n (%)]	49 (39.5)	4 (19.0)	0.072
Aspirin [n (%)]	99 (79.2)	14 (66.7)	0.258
Statins [n (%)]	108 (87.1)	16 (76.2)	0.191
Loop diuretics [n (%)]	10 (8.0)	2 (9.5)	0.684
Oral anticoagulants [n (%)]	12 (9.6)	5 (23.8)	0.073
Insulin therapy [n (%)]	7 (5.6)	1 (4.8)	1.000
Oral glucose-lowering agents [n (%)]	25 (20.0)	8 (38.1)	0.089

M – mean; SD – standard deviation; PP – proton pump.

significant in group B. Diastolic BP at rest decreased significantly only in group W (88.28±9.79 mm Hg before vs. 83.39±8.95 mm Hg after HCR). The results of the exercise stress test are summarized in Table 2.

Comparison of exercise test results between white-collar and blue-collar workers

Baseline heart rate decreased significantly after HCR in white-collar patients in comparison with blue-collar patients (Figure 1) and HRR_1 had a tendency ($p = 0.062$) to be lower in this group. Other results of exercise test did not differ between groups. Comparison of exercise test results between white-collar employees (group W) and blue-collar employees (group B) before and after HCR is shown in Table 3.



HR – heart rate.
p = 0.034.

Fig. 1. Mean resting heart rate after hybrid cardiac rehabilitation (HCR) in blue-collar (group B) and white-collar (group W) workers

DISCUSSION

The main conclusion from this study was that adherence to the HCR program in the group of patients with CVD referred by the SII was high and the effects of training were comparable regardless of the type of work. The effectiveness and safety of hybrid cardiac telerehabilitation has been proved previously; a positive opinion in terms of the ability to return to professional work has been given by as many as 93% of patients [10]. The motivation to return to work and at the same time the effects of cardiac rehabilitation may be different according to the type of work. Some authors proved that lower income may hinder the use of sick leave by blue-collar employees as these employees are most vulnerable to the loss of income [11]. This factor, but also social and sickness benefits from the illness, can bias the effects of HCR.

In this study the difference in the size of study groups was substantial: most of the participants were blue-collar workers, but this was not surprising in the light of epidemiological studies. The EUROASPIRE II (European Action on Secondary and Primary Prevention through Intervention to Reduce Events) substudy [12], for example, showed that patients with higher education, which is often associated with white-collar employment, had significantly lower global coronary risk than people with lower education. Moreover, significantly more patients with ischemia had only primary education. In this huge, multicentre survey, which comprised data for 5556 individuals (1319 women), Poland took part as one of 15 European countries. Generally, socioeconomic status (SES), a very complex phenomenon predicted by a broad range of variables mainly combining the influences of education and occupation, is believed to be associated with development of coronary artery disease (CAD) [13].

Another important issue is that among the occupational factors that influence the decision to retire early, hard physical work, high physical demands, low degree of job control and low job satisfaction are frequently mentioned [14–17]. The implementation of telerehabilitation programs in cardiology, especially in patients with CAD, is a very important alternative to traditional forms of rehabilitation whether stationary or ambulatory, and is also used to intensify medical actions targeting people temporarily unable to work.

It seems that ECG monitoring at home encourages good compliance, which was also observed in patients with

Table 2. Effects of hybrid cardiac rehabilitation (HCR) in white-collar (W) and blue-collar workers (B)

Functional capacity	Group W (M±SD)		p	Group B (M±SD)		p
	T1	T2		T1	T2	
Max workload [METs]	8.21±2.88	9.60±2.49	0.033	7.76±2.51	8.73±2.70	< 0.001
HR rest [bpm]	77.00±16.22	69.94±12.93	0.010	79.59±14.00	75.24±11.87	< 0.001
HR max [bpm]	133.50±24.83	130.78±22.04	0.655	128.38±19.99	128.32±20.45	0.964
BP syst at rest [mm Hg]	139.22±14.66	132.44±15.93	0.120	137.03±17.14	131.82±21.13	0.004
BP diast at rest [mm Hg]	88.28±9.79	83.39±8.95	0.044	84.89±12.93	84.50±11.77	0.746
BP syst max [mm Hg]	173.50±19.37	173.06±21.86	0.930	169.99±28.41	168.75±27.48	0.612
BP diast max [mm Hg]	83.33±11.02	85.17±13.30	0.556	86.82±14.97	87.71±13.69	0.565
DP at rest [mm Hg/min]	10 815.22±2 968.24	9 242.94±1 923.08	0.003	10 927.62±2 508.47	9 929.70±2 304.94	< 0.001
Max DP [mm Hg/min]	23 230.06±5 308.83	22 695.22±5 162.35	0.719	22 031.59±5 843.58	21 861.63±5 841.07	0.719
HRR_1	94.44±20.46	86.83±20.19	0.090	99.38±19.25	93.90±19.48	0.001
NYHA	1.14±0.47	1.14±0.47	1.000	1.22±0.53	1.11±0.36	< 0.001

Max – maximal; METs – metabolic equivalents; HR – heart rate; rest – resting; BP – blood pressure; syst – systolic; diast – diastolic; DP – double product, i.e., product of heart rate and systolic BP; HRR_1 – heart rate recovery in the 1st minute after ending exercise stress test; NYHA – classification of New York Heart Association.
T1 – before hybrid cardiac rehabilitation (HCR); T2 – after HCR.

Table 3. Comparison of exercise test results between blue-collar (group B) and white-collar (group W) workers before and after hybrid cardiac rehabilitation (HCR)

Functional capacity	T1		p	T2		p
	group B	group W		group B	group W	
Max workload [METs]	7.61±2.57	8.16±2.82	0.309	8.72±2.70	9.60±2.49	0.108
HR rest [bpm]	79.72±13.98	77.52±15.12	0.386	75.24±11.87	69.94±12.93	0.034
HR max [bpm]	129.16±20.46	131.10±24.04	0.532	128.32±20.45	130.78±22.04	0.481
BP syst at rest [mm Hg]	137.64±17.09	138.19±15.77	0.905	131.82±21.13	132.44±15.93	0.917
BP diast at rest [mm Hg]	85.70±13.25	88.43±9.68	0.337	84.50±11.77	83.39±8.95	0.665
BP syst max [mm Hg]	170.85±27.87	169.90±22.35	0.845	168.75±27.48	173.06±21.86	0.454
BP diast max [mm Hg]	87.78±15.26	84.95±11.45	0.637	87.71±13.69	85.17±13.30	0.812
DP at rest [mm Hg/min]	11 013.82±2 490.35	10 782.76±2 778.77	0.689	9 929.70±2 304.94	9 242.94±1 923.08	0.603
Max DP [mm Hg/min]	22 274.31±5 880.00	22 369.86±5 454.12	0.463	21 861.63±5 841.07	22 659.22±5 162.35	0.170
HRR_1 (M±SD)	99.25±19.83	94.48±19.63	0.270	93.90±19.48	86.83±20.19	0.062
NYHA (M±SD)	1.22±0.53	1.14±0.47	0.412	1.11±0.36	1.14±0.47	0.899

Abbreviations as in Table 2.

cardiovascular diseases rehabilitated by a similar method and even in heart failure patients who performed Nordic walking as a form of aerobic training [4]. One of the goals of CR is to facilitate return to a social and professional life as similar as possible to that which the patients had before their cardiac events [18] and one of the aims of the SII is to help patients with cardiovascular diseases to achieve this through disability prevention programs.

In our study, patients took part in phase III of CR, which means that they had not been working for at least 6 months. Physical capacity in the meaning of the increase of maximal workload, decrease of resting heart rate and double product improved significantly regardless of the patient's professional status. The greater decrease in resting heart rate in white-collar patients than in blue-collar ones and the significant reduction of diastolic blood pressure at rest was the significant difference between the effectiveness of HCR of the 2 groups.

As adherence to the rehabilitation program was good in both groups of patients and the medical treatment was not modified during HCR, the explanation of this phenomenon may be sought in the better efficiency of educational, tailored counselling and behavioral interventions in group W. The impact of professional status on the rehabilitation outcomes in patients with CVD has been poorly investigated by other authors so far; we may only speculate that the relation mentioned above actually exists.

Hybrid cardiac rehabilitation is a comprehensive procedure that includes all core components of CR according to guidelines: exercise training, education, psychological counselling, relaxation sessions and other secondary prevention strategies for risk factor modification [7]. Certainly, greater emphasis should be placed on education in a group of blue-collar workers as they were more frequently current smokers than white-collar workers, and had a smoking history and hyperlipidemia, although other authors showed little evidence that the occupational characteristics accelerated the progression of subclinical CVD [19]. Inoue et al. found a positive association among blue-collar workers between shift work and hypertension [20].

A strong need for new, efficient and effective interventions to support the growing number of people living on social benefits and the international interest in using new technologies such as the Internet, text messaging, telephone support or remote monitoring to help patients manage long-term conditions and help in returning to work is observed by many authors. A randomized controlled prospective clinical trial which aims to evaluate the effectiveness and cost-effectiveness of a telehealth intervention to support patients with long-term health condition and another one comparing home-based training with telemonitoring guidance versus center-based training in patients with CAD in the maintenance phase are being conducted now [21,22]. The method selected by the Polish Social Insurance Institution – hybrid cardiac telerehabilitation – is a safe form of helping patients to return to work after the onset of cardiovascular disease, regardless of the professional status.

CONCLUSIONS

Hybrid cardiac rehabilitation is feasible and safe with high adherence to the program regardless of the patient's professional status.

Professional status did not influence the beneficial effect of hybrid cardiac rehabilitation on exercise tolerance.

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