Clin Res Cardiol 96:383–388 (2007)
DOI 10.1007/s00392-007-0517-9

ORIGINAL PAPER

M. Unverdorben
S. Unverdorben
K. Edel
R. Degenhardt
O. A. Brusis
C. Vallbracht

Risk predictors and frequency of cardiovascular symptoms occurring during cardiac rehabilitation programs in phase III-WHO

Received: 31 July 2006
Accepted: 12 February 2007
Published online: 22 May 2007

Martin Unverdorben
Susanne Unverdorben
Ralf Degenhardt (✉)
Clinical Research Institute
Center for Cardiovascular Diseases
Heinz-Meise-Straße 100
36199 Rotenburg an der Fulda, Germany
Tel.: +49-6623/88-5991
Fax: +49-6623/88-5976
E-Mail: r.degenhardt@hkz-rotenburg.de

Klaus Edel
Heart and Diabetes Clinic
33014 Bad Hermannsborn, Germany

Otto A. Brusis
Albert Schweitzer Clinic
78126 Königsfeld, Germany

Christian Vallbracht
Cardiologic Clinic
Center for Cardiovascular Diseases
36199 Rotenburg an der Fulda, Germany

Abstract *Introduction* Rehabilitation in ambulatory heart groups has become a well established part of comprehensive cardiac treatment in Germany. Identifying patients at risk for cardiovascular symptoms is important for the efficiency and safety of the program. *Methods* Questionnaires were mailed to ambulatory heart groups in the state of Hessen, Germany, and returned by 1935/13174 (15%) patients, age 65.9 ± 7.6 years, 1504/1935 (77.7%) males, comprising ≈674000 patient exercise hours. *Results* 828 symptoms were reported by 538 patients, comprising dyspnea in 330/538 (61.3%), angina pectoris in 80/538 (14.9%), palpitation in 145/538 (27%), tachycardia in 59/538 (11%), dizziness in 152/538 (28.3%), fainting in 6/538 (1.1%), and others in 47/538 (8.7%). Cardiovascular symptoms occurred more frequently in patients presenting with overexertion (43/68 (63.2%), $p < 0.0001$, RR 4.77 [95% CI 3.01–7.56]), chronic heart failure (115/291 (39.5%) vs 419/1624 (25.8%), $p < 0.0001$, RR 1.88 [95% CI 1.45–2.43]), lower exercise capacity (1.49 ± 0.4 vs 1.59 ± 0.5 W/kg body weight, p=0.0002, mean difference –0.096 [95% CI (–0.146) –(–0.046)]), hypertension (269/854 (31.5%) vs 266/1068 (24.9%), $p = 0.001$, RR 1.39 [95% CI 1.14–1.69]), and hyperlipidemia (280/907 (30.9%) vs 255/1015 (25.1%), $p = 0.005$, RR 1.33 [95% CI 1.09–1.63]). Cardiovascular symptoms were more frequent in women (141/431(32.7%) vs 397/1503 (26.4%), $p = 0.01$, RR 1.35 [95% CI 1.08–1.71]). Overexertion ($p < 0.0001$), heart failure ($p = 0.003$), and hypertension ($p = 0.05$) are significant independent predictors of cardiovascular symptoms, while female gender ($p = 0.06$), and hyperlipidemia ($p = 0.07$) are not as significant. Previous myocardial infarction and diabetes had no statistical significant impact on cardiovascular symptoms. *Conclusion* Patients likely to experience cardiovascular symptoms in ambulatory rehabilitation can be identified by their medical history and perceived exertion.

Key words
cardiac rehabilitation – ambulatory heart groups – cardiovascular risk

Introduction

Ambulatory rehabilitation programs for cardiovascular patients have emerged as an integrated part in comprehensive cardiac care during recent decades with a proven reduction of fatal myocardial infarction, cardiovascular deaths, and all-cause mortality on the order of 25% when the rehab activities were not limited to an 8–12 week period of time [1, 9]. There is widespread consensus that regular physical exercise favorably influences cardiovascular risk factors such as hyperlipidemia, obesity, hypertension, and diabetes mellitus depending on the relative work-load of an individual versus his or her maximum exercise capacity [5]. Therefore, a particular load is most likely to be of different benefit to a particular participant contingent upon his or her physical fitness, which is partly dependent on the type and the stage of the disease. Although the overall acute cardiovascular hazards of cardiac rehabilitation programs have been reported to be relatively small [3, 6, 11–14], prevention of the participant's apprehension of overexertion will likely improve the quality of the programs.

Therefore, the purpose of this study was to identify patients at elevated risk for experiencing cardiovascular symptoms while participating in ambulatory cardiac rehabilitation programs.

Methods and materials

Questionnaires

From July 2003 through March 2004, 13 000 questionnaires were mailed to the administration officers of the ambulatory cardiac rehabilitation groups registered in the Hessischer Behinderten- und Rehabilitations-Sportverband (Hessian Association for the Disabled and Rehabilitation Sports = HBRS) Germany. Separate explanatory sheets about the purpose of the study were included for association officers, physicians, and rehab instructors.

The association officers were requested to distribute the questionnaires to all of the patients in their rehab groups. Questions focused on the patient's demographic data (5 items), their sports (3 items) and medical history (25 items) encompassing information like the diagnosis and the current and previous medical treatment, the frequency of participation (3 items) as well as the type of exercise programs (3 items), and personal or medical consequences ensuing from the cardiovascular symptoms (3 items). Physicians and rehab instructors reported on the patients' major cardiovascular complications. The association officers were asked to provide information such as the date of foundation of the group, the number of members, and the major cardiovascular complications.

The anonymized patient questionnaires were returned to the data evaluation center together with written informed consent for data analysis submitted on a separate sheet. Therefore, no reminders could be sent out.

The programs start with warming-up, stretching, and gymnastics, before continuing with endurance type exercise. One or several ball games like volleyball are the core activities followed by the cooling-down period to conclude the session. The pulse rate as given in the prescription for each participant serves to control for exercise intensity.

Statistical analyses

The Kolmogorov-Smirnov test was used to prove Gaussian distribution allowing for calculation of the mean, standard deviation, and application of the Student's two-tailed t-test. Non-Gaussian samples were described by median and range and significance was analyzed with the Wilcoxon-Mann-Whitney U-rank test. The exact Fisher's test was used for categorical variables. The relative risk (RR) and its 95% confidence interval (C.I.) were computed by logistic regression analysis for outcome data. For all tests, the significance level α was 0.05.

Results

A total of 1935 of 13 174 (15%) patients of 133 rehabilitation groups registered in the HBRS returned the questionnaires to the data evaluation center along with 327 physician and 255 rehab instructor questionnaires, covering approximately 674 000 patient exercise hours. In the questionnaires returned, the patients answered 97.4% of the test items while the response rates were 97.9% for the physicians, 98.0% for the rehab-instructors, and 96.7% for the association officers.

The baseline characteristics and medication of the patients are given in Table 1 and Fig. 1.

532 of the 935 respondents (56.9%) reported 828 cardiovascular symptoms during the 674 000 patient exercise hours translating into an incidence of one symptom per 800 hours (Fig. 2). Two hundred and thirteen participants (40.1%) experienced repetitive complaints.

These symptoms were significantly more frequent in patients who felt overexerted (43/68 (63.2%))

Table 1 Baseline characteristics of patients

Patients	
N	1935
Men	1504/1935 (77.7%)
Women	431/1935 (22.3%)
Age	65.9 ± 7.7 years * (27–85 years)
Body mass index	26.8 ± 3.1 (kg/m^2) *
Working capacity	1.6 ± 0.5 W/kg BW ** 5.4 ± 1.7 METs ***
Diagnoses	
Coronary heart disease	1920/1935 (99.2%)
– Previous myocardial infarction	1108/1920 (57.7%)
– Previous coronary artery bypass grafting (CABG)	921/1920 (47.9%)
– Previous percutaneous coronary interventions (PCI)	527/1920 (27.4%)
Valvular heart disease	221/1935 (11.5%)
Dilative cardiomyopathy	3/1935 (0.16%)
Post myocarditis	0/1935 (0%)
Heart transplantation	0/1935 (0%)
Heart failure (NYHA**** II/III)	291/1935 (15.0%)
Previous stroke	153/1935 (7.9%)
Peripheral arterial occlusive disease	101/1935 (5.3%)
Risk factors for atherosclerotic disease	
Smoking status	
– never	787/1935 (41.1%)
– current	55/1935 (2.9%)
– former	1073/1935 (55.9%)
Hyperlipidemia [a]	907/1935 (47.2%)
Diabetes mellitus [b]	300/1935 (15.6%)
Hypertension [c]	854/1935 (44.5%)
Overweight [d]	1035/1935 (53.9%)
Obesity [e]	279/1935 (14.5%)
Family history of cardiovascular disease [f]	196/1935 (10.2%)

* Mean ± standard deviation, ** W/kg BW = Watts per kilogram of body weight, *** MET = metabolic equivalent, **** NYHA = New York Heart Association

[a] Hyperlipidemia was diagnosed in patients who reported hyperlipidemia; [b] Diabetes mellitus was diagnosed in patients with any form of antidiabetic treatment; [c] Hypertension was diagnosed in patients who reported hypertension; [d] Overweight was diagnosed in patients with a body mass index of ≥25 kg/m^2 and <30 kg/m^2; [e] Obesity was diagnosed in patients with a body mass index of 30 kg/m^2 and beyond; [f] Family history of cardiovascular disease was diagnosed if a positive history of myocardial infarction was reported either in a first-degree relative male below the age of 55 years or in a first-degree female relative below the age of 65 years

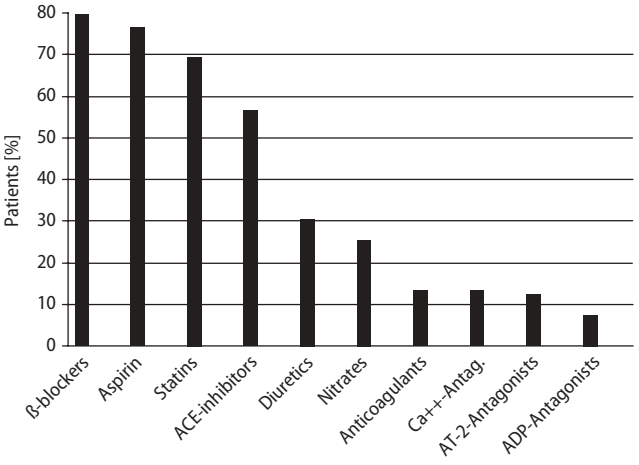

Fig. 1 Medication of patients

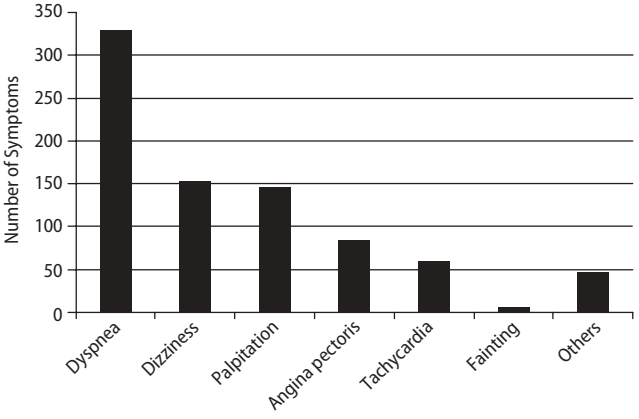

Fig. 2 Number of cardiovascular symptoms reported

Table 2 Incidence of cardiovascular symptoms in the various patient subgroups

Patient subgroup	Incidence
Exercise level perceived as too high	43/68 (63.2%)
Exercise level perceived as adequate exercise level	445/1640 (27.1%)
Exercise level perceived as too low	44/178 (22.5%)
Chronic heart failure	115/291 (39.5%)
Hypertension	269/854 (31.5%)
Hyperlipidemia	280/907 (30.9%)
Women	141/431 (32.7%)
Men	397/1503 (26.4%)

compared to those who judged the training workload as adequate (445/1640 (27.1%)) or who considered the exercise level as too low (44/178 (22.5%), $p < 0.0001$) (Table 2). Cardiovascular complaints occurred also more frequently in chronic heart failure (115/291 (39.5%) vs 419/1624 (25.8%), $p < 0.0001$), in patients with low exercise capacity (1.49 ± 0.4 vs 1.59 ± 0.5 W/kg body weight, $p = 0.0002$), in respondents with arterial hypertension (269/854 (31.5%)) compared to non-hypertensive participants (266/1068 (24.9%), $p = 0.001$) and in participants with hyperlipidemia (280/907 (30.9%)) in relation to their normolipidemic counterparts (255/1015 (25.1%), $p = 0.005$). Women (141/431 (32.7%)) as opposed to men (397/1503 (26.4%)) also reported more ($p = 0.01$) cardiovascular symptoms (Fig. 3). Neither previous myocardial infarction nor the type of cardiac treatment such as drugs, percutaneous coronary

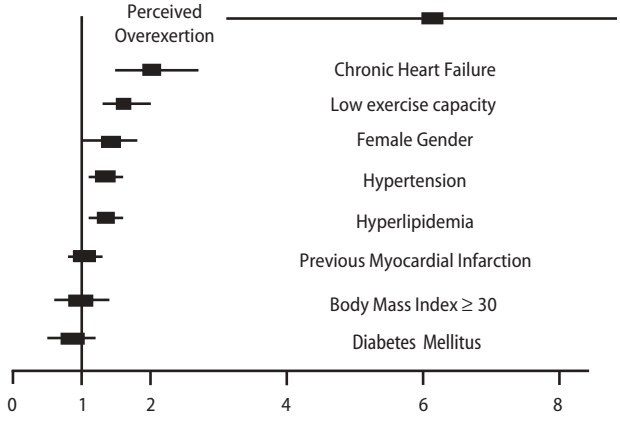

Fig. 3 Patient characteristics versus relative risk for cardiovascular symptoms

intervention, nor cardiac surgery was predictive of the occurrence of cardiovascular symptoms.

The prevalence of diabetes mellitus ($p = 0.36$), previous stroke ($p = 0.3$), and high body mass index ($p = 0.12$) did not show a significant relation with the occurrence of symptoms. There was also no age relationship with cardiovascular complaints.

The strongest independent predictor of cardiovascular symptoms was overexertion ($p < 0.0001$). Among the other predictors, heart failure ($p = 0.003$) and arterial hypertension ($p = 0.05$) were statistically significantly independent predictors while hyperlipidemia ($p = 0.07$) and female gender ($p = 0.06$) were borderline.

Most of the symptoms occurred during endurance type exercises (289 (53.8%)) followed by the warming-up period (123 (22.9%)), games (73 (13.6%)), and the other periods of the program (52 (9.7%)).

Cardiopulmonary arrest was reported in five patients (one per 78 255 exercise hours) with successful cardiopulmonary resuscitation in all of them.

Discussion

This study suggests that the occurrence of cardiovascular symptoms during ambulatory cardiac rehabilitation programs is about one incident per 800 (1/800) exercise hours and that cardiac arrest occurs with an incidence of about 1/78 225 patient exercise hours. This low incidence is especially remarkable in view of the fact that the indication for participation in the rehab groups was broadened during the past few decades. Although coronary artery disease is still the predominant reason (99.2%) for participation, other diagnoses such as valvular heart disease (11.5%), cerebral stroke (7.9%), and peripheral arterial disease (5.3%) have become increasingly more common. Moreover, the average participant now is older than 65 years of age presenting with an increasing number of cardiovascular risk factors. The high percentage of coronary artery disease suggests a close link to the reported symptoms. However, the high incidence of non-disease specific complaints such as dizziness, palpitations, and tachycardia versus angina pectoris suggests other causative mechanisms than myocardial ischemia.

Indeed, the exercise intensity as perceived by the patient, turned out to be the strongest independent predictor of cardiovascular symptoms followed by heart failure and hypertension while hyperlipidemia and gender being borderline.

In heart failure as opposed to the other cardiovascular disease manifestations, symptoms are more likely to occur during the exercise sessions. Hypertension has been identified as a significant independent predictor of cardiovascular symptoms, whereas hyperlipidemia was of lesser significance. Although this study was not designed to study the pathomechanisms of the complaints reported it is worth mentioning that they are all associated with increased levels of systemic inflammation and endothelial dysfunction [2, 7, 10].

Ball games, which are considered by some as problematic due to the limited control of exercise intensity, were associated with only 13.6% of the symptoms. This relatively low number is remarkable since the game phase usually accounts for approximately 50% of the entire session.

More than three quarters of the complaints occurred during the endurance type- and warm-up exercises. Endurance training, however, is the most beneficial mode of exercise with respect to improving cardiovascular and overall prognosis. These positive effects increase with exercise intensity. Tailored to the patient's risk classification, the American Heart Association recommends a target heart rate in the range 45–85% of the heart rate reserve or the maximum oxygen uptake, respectively [4]. Therefore, the challenge arises to offer a program that meets the above recommendations for each participant. In some patients the line between avoiding overexertion and exercising at a high exercise level that promotes the optimal benefit from a health perspective is very fine. This ideal goal can only be achieved by an individual exercise prescription based on a pre-enrollment state-of-the-art exercise stress test including the determination of the maximal heart rate and, possibly, of the anaerobic or ventilatory threshold [1]. In clinical practice, however, the quality of exercise stress testing is frequently limited to parameters diagnostic for diseases. Data mandatory for an individual exercise prescription and only obtainable by a symptom-limited maximal test, like maximal heart

rate and blood pressure, are only obtainable by symptom-limited (vita maxima) stress test while more sophisticated variables such as oxygen uptake and other respiratory parameters requiring spiroergometry are rarely available. Moreover, regular control of the test parameters, which would allow for adjusting the intensity of the training program, is not done on a routine basis.

Therefore, a participant's perceived exertion is suggested as a practical tool to control for exercise intensity. Unfortunately, there is no information on symptoms preceding the five cardiovascular arrests in this study. However, the incidence of cardiac arrests is, in line with previous publications, extremely rare with successful cardiopulmonary resuscitation in most of the cases [6, 12–14]. These data should be interpreted in light of the fact that even in young healthy athletes sports is associated with a small risk of fatalities [8].

Limitations of the study are mainly the issues inherent to a retrospective design. It cannot be excluded that those patients who did not experience any cardiovascular complaints did not consider it worthwhile filling in the questionnaires. This might have resulted in an over reporting bias. On the other hand, patients might not have remembered minor symptoms. From a preventive aspect, details on the cardiac arrests with successful cardiopulmonary resuscitation are missing. A prospective registry would help to satisfy this issue.

The association officers did not distribute an unknown number of questionnaires to the patients and probably not all of those who received the forms returned them. These shortcomings limit general conclusions since it is unclear how this bias influenced the results such as the reported occurence of symptoms and the relation of minor to severe complaints. However, the absolute number of the respondents who completed well beyond 90% of the items is unprecedented to the authors' knowledge. Although the occurrence of cardiovascular symptoms in absolute numbers may vary in other regions, the underlying principles will remain the same. Therefore, the consequences should also apply for other patients participating in ambulatory rehabilitation programs elsewhere.

In summary, the data suggest that the participant's history is a strong predictor for the occurrence of cardiovascular complaints allowing for instituting measures that are likely to reduce the occurrence of cardiovascular symptoms during the exercise sessions. Therefore, the rehab-instructors should try to run programs that allow the participant to self-adjust the workload. On the other hand, the participants have to be trained to exercise in a way that keeps the workload below the level of perceived overexertion especially in chronic heart failure, hypertension, and in female participants. This approach would improve the cooperation between participants and rehab instructors and provide the patient with considerably more responsibility and know-how. This would also ease patients to exercise control of the intensity of every day activities. Lastly, the association officers should provide the necessary means to split the groups according to the patient's risk free workload.

Acknowledgments The authors are grateful to the Hessischer Behinderten- und Rehabilitations-Sportverband (Hessian Sports Association for the Disabled and Rehabilitation). The authors have no financial interests to disclose.

References

1. Benzer W, Oldridge N (2001) Current concepts in cardiac rehabilitation. J Clin Basic Cardiol 4:211–219
2. Chan JC, Cheung JC, Stehouwer CD, et al (2002) The central roles of obesity-associated dyslipidaemia, endothelial activation and cytokines in the Metabolic Syndrome – an analysis by structural equation modelling. Int J Obes Relat Metab Disord 26(7):994–1008
3. Digenio A, Sim J, Dowdeswell R, et al (1991) Exercise-related cardiac arrest in cardiac rehabilitation. S Afr Med J 79:188–191
4. Fletcher GF, Balady G, Amsterdam E, et al (2001) Exercise standards for testing and training, a statement for health care professionals from the American Heart Association. Circulation 104:1694–1670
5. Fletcher GF, Balady G, Blair SN, et al (1996) Statement on exercise: benefits and recommendations for physical activity programs for all Americans. A statement for health professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology. American Heart Association. Circulation 94(4): 857–862
6. Haskell W (1978) Cardiovascular complications during exercise training of cardiac patients. Circulation 57:920–927
7. Landmesser U, Hornig B, Drexler H (2004) Endothelial function: a critical determinant in atherosclerosis? Circulation 109(21 Suppl 1):II27
8. Maron BJ, Gohman TE, Aeppli D (1998) Prevalence of sudden cardiac death during competitive sports activities in Minnesota high school athletes. J Am Coll Cardiol 32(7):1881–1884

9. Oldridge N, Guyatt G, Fischer M, et al (1988) Cardiac rehabilitation after myocardial infarction: Combined experience of randomized clinical trials. J Am Med Assoc 260:945–950
10. Stumpf C, Lehner C, Yilmaz A, et al (2003) Decrease of serum levels of the anti-inflammatory cytokine interleukin-10 in patients with advanced chronic heart failure. Clin Sci (Lond) 105(1):45–50
11. Unverdorben M, Bosert C, Kunkel B, et al (1993) Is an all-year outdoor endurance training program possible, beneficial and safe in patients following myocardial infarction? Int Heart J 45:300
12. Unverdorben M, Vallbracht C, Gansser R, et al (1996) Kardiovaskuläre Risiken der ambulanten kardiologischen Rehabilitation. Herz/Kreisl 28: 59–62
13. Van Camp S, Peterson R (1986) Cardiovascular complications in outpatient rehabilitation programs. J Am Med Assoc 256:1160–1173
14. Vuori I, Mäkäräinen M, Jääskeläinen A (1978) Sudden death and physical activity. Cardiology 63:287–304