The Beneficial Effects of Cardiac Rehabilitation

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Abstract

Cardiac rehabilitation (CR) is a combined range of measures aimed at providing patients with cardiovascular disease with the optimum psychological and physical conditions so that they themselves can prevent their disease from progressing or potentially reversing its course. The following measures are the three main parts of CR: exercise training, lifestyle modification, and psychological intervention. The course of cardiac rehabilitation generally takes 3–4 weeks.

Keywords: After care, Atrial fibrillation, Cardiac rehabilitation, Cardiology, Exercise training, Lifestyle modification, Myocardial infarction, Psychological intervention

Key Summary Points

Why carry out this study?
Cardiac rehabilitation (CR) is a cost-effective, class 1a recommended part of cardiac care for patients with cardiovascular disease that generally takes 3–4 weeks to complete.
CR has shown to improve various important patient outcomes, including exercise capacity, control of cardiovascular risk factors, quality of life, hospital readmission rates, and mortality rates.
This review gives an overview of the current advances in CR and summarizes its benefits.
What was learned from the study?

The efficacy of multimodal rehabilitative interventions has been shown in several studies.
The reduction of risk factors such as physical exercise, nicotine abstinence, weight loss, and cholesterol lowering by CR can improve quality of life and reduce mortality.
Intensified follow-up programs improve the clinical outcome of patients with cardiac disease and should be offered whenever possible.

Introduction

Cardiac rehabilitation (CR) is a cost-effective, class 1a recommended part of cardiac care for patients with cardiovascular disease that generally takes 3–4 weeks to complete [1, 2]. Benefits of CR have been demonstrated for patients with various cardiac diseases, such as for patients after myocardial infarction (MI), coronary artery bypass surgery, heart valve repair, percutaneous coronary interventions, stable angina, stable chronic heart failure, heart transplantation, cardiac arrhythmias, or severe arterial hypertension [2]. The goals of CR include improvement in exercise tolerance and optimization of coronary risk factors, including improvement in lipid and lipoprotein profiles, body weight, blood glucose levels, blood pressure levels, and smoking cessation. Additional attention is devoted to stress and anxiety and lessening of depression [2–4]. The most important targets are presented in Table 1. CR has been shown to improve various important patient outcomes, including exercise capacity, control of cardiovascular risk factors, quality of life, hospital readmission rates, and mortality rates [3–5].

Table 1

Risk factor goals and target levels for important cardiovascular risk factors based on the European Guidelines 2016 on cardiovascular disease prevention in clinical practice [18]

Smoking	**No exposure to tobacco in any form**
	Low in saturated fats with a focus on whole-grain products,

Diet	vegetables, fruit, and fish
Physical activity	At least 150 min a week of moderate aerobic physical activity (30 min for 5 days/week) or 75 min a week of vigorous aerobic physical activity (15 min for 5 days/week) or a combination thereof
Body weight	BMI 20–25 kg/m^2. Waist circumference < 94 cm (men) or < 80 cm (women)
Blood pressure	< 140/90 mmHg is the general target. The target can be higher in frail elderly, or lower in most patients with diabetes mellitus and in some (very) high-risk patients without diabetes mellitus
Lipids LDL is the primary target HDL-C Triglycerides	Very high-risk: < 70 mg/dl, or a reduction of at least 50% if the baseline is between 70 and 135 mg/day High-risk: < 100 mg/dl, or a reduction of at least 50% if the baseline is between 100 and 200 mg/dl Low to moderate risk: < 115 mg/dl No target but > 40 mg/dl in men and > 45 mg/dl in women indicate lower risk No target but < 150 mg/dl indicates lower risk and higher levels indicate a need to look for other risk factors
Diabetes	HbA1c < 7%

About 10% of the statutory pension insurance budget is spent on patients with cardiovascular diseases. Most of these patients suffer from coronary heart disease (CHD) with or without myocardial infarction [6]. Older patients are more likely to suffer from acute coronary syndrome (ACS). In European registries, 27–34% of the elderly are affected by ACS [7, 8]. Coronary artery disease is closely linked to cardiovascular risk factors such as arterial hypertension, smoking, eating habits, elevated serum cholesterol, obesity, and sedentary lifestyle [9]. Besides CHD, cardiac arrhythmias such as atrial fibrillation (AF), the most prevalent cardiac arrhythmia in the world today [9, 10] with about nine million patients in Europe [9], can affect a person's capacity to work and the self-sufficiency of patients [11]. All of this also has an economic impact and CR has been shown to reduce the burden of cardiovascular disease on health care.

Several efforts have been made within the field of CR in the past years. This review gives an overview of the current advances in CR and summarize its benefits. The article was written in accordance with the ethical standards given in the 1964 Declaration of Helsinki and its later amendments. This article is based on previously conducted studies and does not contain any studies with human participants or animals performed by any of the authors.

Effectiveness

CR is a combined range of measures aimed at providing patients with chronic cardiovascular disease or following an acute incident with the optimum psychological and physical support in order that they themselves can prevent their disease from progressing or even to potentially reverse its course. The following three measures are the main part of CR: Exercise training, lifestyle modification, and psychological intervention (Fig. 1). Current data are sufficiently robust to promote strategies to improve referral to and participation in CR [12, 13]. Heran et al. analyzed 47 studies randomizing 10,794 patients to exercise-based CR or usual care. They found that exercise-based CR reduced overall and cardiovascular mortality [RR 0.87 (95% CI 0.75, 0.99) and 0.74 (95% CI 0.63, 0.87), respectively], as well as hospital admission rates [RR 0.69 (95% CI 0.51, 0.93)] [1]. Home- and clinic-based forms of CR seem to be similarly effective in regards to clinical and health-related quality of life outcomes in patients after MI, revascularization, or with heart failure [14]. Therefore, CR programs are recommended as a standard of care by major clinical guidelines [1, 2, 15].

Fig. 1

Main components of cardiac rehabilitation—exercise training, lifestyle modification, and psychological intervention

Exercise Training

Exercise training is an important aspect during CR in patients with cardiac

disease. Pollock et al. published the first recommendations for resistance exercise in CR in the year 2000 [16]. Resistance training is a form of exercise that improves muscular strength and endurance. Pollock and his team recommended that stretching or flexibility activities can begin as early as 24 h after bypass operation or 2 days after acute MI. Current guidelines recommend the careful implementation of dynamic resistance exercise, beginning with training at a low intensity (<30%) and then an individualized progression up to 60% and sometimes up to 80% in select patients [17]. The beneficial effects of exercise training in patients with heart disease and normal left ventricular systolic function are now well known [18]. However, it has remained unclear whether this also applies to patients with heart failure (HF). Taylor et al. analyzed 44 trials with 5783 HF patients who underwent exercise CR compared with control subjects without exercise CR. Exercise CR did reduce all-cause hospitalization (RR: 0.70; 95% CI 0.60 to 0.83; TSA-adjusted CI 0.54 to 0.92) and HF-specific hospitalization (RR: 0.59; 95% CI 0.42 to 0.84; TSA-adjusted CI 0.14 for 2.46). Furthermore, patients reported improved Minnesota Living with Heart Failure questionnaire overall scores (mean difference: – 7.1; 95% CI – 10.5 to – 3.7; TSA-adjusted CI – 13.2 to – 1.0) [19]. However, further studies are needed.

In addition, in patients with AF, regular and moderate exercise training has shown positive effects [20]. CR has been proven to reduce the time in arrhythmia of patients with paroxysmal and persistent AF. In permanent AF, CR may decrease the resting ventricular response rate in patients and therefore improve symptoms related to arrhythmia. Therefore, CR seems to be a safe and manageable option for AF patients [20].

In addition to the well-established training programs, there are several new approaches. For example, Segev et al. reported on the positive effect of a stability and coordination training program for balance in the elderly with cardiovascular disease. Twenty-six patients with cardiovascular diseases (age 74 ± 8 years) were divided randomly into intervention and control groups. The intervention group received 20 min of stability and coordination exercises as part of their 80-min CR program while the

control group performed the traditional CR program twice a week for 12 weeks. Balance assessment was based on three tests: the Timed Up and Go test, Functional Reach test, and Balance Error Scoring System test. In the intervention group, 70% of patients adhered to the program, with significant improvement post-intervention in the Timed Up and Go ($p < 0.01$) and the Balance Error Scoring System ($p < 0.05$) tests. In the control group, no changes were made. The authors recommended that CR centers should consider including this training alongside the routine CR program [21].

Furthermore, yoga has proven beneficial effects in several studies. Partly, it is already integrated into the standard CR program [22]. Of the seven major branches of yoga, hatha yoga is likely the most common form [23]. Patil et al. found that yoga is more effective than walking in improving cardiac function in the elderly with high pulse pressure [24]. Systolic blood pressure increases and diastolic blood pressure falls with age, leading to widening of the pulse pressure. Pulse pressure is the best tool for measuring vascular aging and a good marker for cardiovascular risk in the elderly. Elderly individuals aged ≥ 60 years with pulse pressure ≥ 60 mmHg were included in the study. The yoga group (study group, $n = 30$) was assigned yoga training and the walking group (exercise group, $n = 30$) assigned walking with loosening practices for 1 h in the morning, 6 days a week, over a period of 3 months. The pulse pressure in the yoga group was significantly lower than in the walking group [24]. Amaravathi et al. reported that yoga, in addition to conventional CR, results in higher improvements in quality of life and reduction in stress levels after 5 years after cardiac heart surgery [25]. The results of other major studies, such as the Yoga-CaRe Trial—a multicenter randomized controlled trial of 4014 patients with acute MI from India [26], are pending.

Lifestyle modification

The treatment of cardiovascular risk factors, such as arterial hypertension, diabetes mellitus, and obesity as well as cessation of smoking is another important assignment of CR, as CR has beneficial effects on them. Mittag

et al. summarized findings from a CR program and reported high pre-post effects in functional capacity (ES = 0.94), and medium-sized effects in blood pressure [27]. Excess overweight as measured by BMI is associated with an increased risk of recurrent coronary events following MI, particularly among those who are obese [28]. Jayawardena et al. report on their experience of the “plate model” as a part of dietary intervention for rehabilitation following MI. The concept of the “plate model” is a practical method to overcome the prevailing dietary pattern by reducing the average portion size of staple food in main meals, which could also ensure the sufficient intake of vegetables and protein foods simultaneously. During the 12-week follow-up period, a significant higher mean weight loss (intervention group: – 1.27 ± 3.58 kg; control group: – 0.26 ± 2.42 kg) was observed among the participants of the intervention group than the control group ($P = 0.029$). In addition, the intervention group showed a non-significant reduction of blood pressure and blood lipid levels [29].

However, it seems to be more difficult for patients with diabetes mellitus to achieve the goals of CR. Wallert et al. reported in their study that patients with first-time MI and diabetes are less likely to attain two of four selected CR goals compared to those without diabetes [30]. Another issue of lifestyle modification is to maintain the positive effects after the 3–4-week CR. Only 15–50% of patients attending CR still do exercise 6 months after CR, and even less after 12 months [31, 32]. Approximately 50% of patients who are smokers prior to a coronary event still smoke 6 months after the cardiac event, and less than 50% of obese patients follow dietary recommendations [33].

For this reason, there are some approaches to get the positive effect of rehabilitation. Close follow-up makes it easier to consolidate what has been learned by the patients during CR. Intensified follow-up after the CR provided positive results in the New Credo Study, a prospective, controlled, multicenter study with four cardiological rehabilitation institutions. In the first phase of this study, patients received standard CR and standard aftercare (control group). In the second phase, patients

received CR based on the conditions of “New Credo” with the focus on increasing physical activity (intervention group). Data for evaluation were collected by questionnaires at three points in time. Participants reported high practicability and high satisfaction. Health- related outcomes showed a trend of positive effects in the intervention group. The intervention group shows clear advantage in regards to physical activity [34]. Similar results were provided by the intensified follow-up program IRENA (Intensivierte REhabilitationsNAchsorge) [35]. The follow-up program consists of a maximum of 24 appointments and includes medical training, gymnastics, nutritional advice and medical care.

In addition, apps and telemedicine have been increasingly used. There are some promising results [36, 37], but further studies are needed. The study by Lunde et al. included an experimental, pre-post single-arm trial lasting 12 weeks. All patients received access to an app aimed to guide individuals to change or maintain a healthy lifestyle. During the study period, patients received weekly, individualized monitoring via the app. All 14 patients included in the study used the app to promote preventive activities. Satisfaction with the technology was high, and patients found the technology-based follow-up intervention useful and motivational. Ceiling effect was present in more than 20% of the patients in several domains of the questionnaires evaluating quality of life (36-Item Short Form Health Survey and COOP/WONCA functional health assessments) and health status (EQ-5D) [36]. Johnston et al. reported on 174 ticagrelor-treated MI patients, which were randomized to an interactive patient support tool on their smartphones (active group) or a simplified tool also on their smartphones (control group). The drug adherence was significantly better in the intervention group compared with the control group [37].

Psychological intervention

Stress and anxiety are risk factors for the development of cardiac diseases [38, 39]. Past reports have shown that stress reduction and psychological intervention are associated with positive cardiac outcomes

[40]. Wurst et al. report a positive effect of psychological intervention on exercise capacity. The patients who received psychological intervention were more resilient at the end of the CR than the control group. At the 12-month follow-up, the level of physical activity in the intervention group was still 94 min higher per week than in the control group ($p < 0.001$) [41]. Albus et al. published a systematic review and meta-analysis on CR controlled trials and controlled cohort studies to evaluate the additional benefit of psychological interventions, in comparison to exercise-based CR alone, on depression and anxiety. Twenty studies with 4450 patients were analyzed; the results of this meta-analysis have shown non-significant trends for reducing depression and cardiovascular morbidity [42]. A systematic meta-analysis by Richards et al. found small to moderate improvements in anxiety, depression, and stress with additional effects on cardiovascular mortality [43] after CR. Absoli et al. observed a significant reduction of clinical psychological distress after completion of CR [44].

Gender differences

CR improves various clinical outcomes in patients with cardiovascular disease, but such programs are particularly underutilized in women [45]. In Germany, approximately 447,918 men and 211,988 women are treated in hospitals each year for coronary heart disease [46]. Approximately 67,789 men and 23,158 women were admitted to rehabilitation in 2016 with this diagnosis [47]. Härtel et al. evaluated gender differences in patients after MI during CR and thereafter in regards to their physical and mental health, the modification of cardiovascular risk factors, in health behavior, returning to work and everyday life. In this observational study, 308 male and 202 female patients after their first MI and not older than 75 years were included. The investigation included extensive medical examinations (12-channel electrogram, transthoracic echocardiography, blood sample at the beginning of CR) as well as standardized surveys (SAFE questionnaire) at different time points (beginning and end of rehabilitation, after 1.5, 3, and 10 years after being discharged home). In this study, it was shown that women, even at the beginning of CR, were

significantly more physically impaired, as compared to men of the same age [48]. This was linked to the severity of the coronary heart disease, the ergometric load capacity, the number of additional non-cardiovascular diseases—such as thyroid disorders or osteoporosis—and the classic risk factors such as arterial hypertension, increased cholesterol, and obesity. Furthermore, symptoms of depression at the beginning of CR were more pronounced in women than in men [49]. During CR, risk factors can be modified successfully in male and female patients. However, women often obtain less benefit with regards to blood pressure and cholesterol levels as well as having higher anxiety and depression scores at the end of CR as compared to men [48, 49]. According to Grande et al. women feel more mentally stressed and sometimes have different expectations or personal treatment goals than men [50]. There are also differences between men and women in regards to the satisfaction with the various therapeutic measures and the subjective reasons why longer-term aftercare programs cannot be claimed [48–51]. More studies are needed to determine the different needs for individualized rehabilitation programs in men and women.

Contraindications for CR

Patients with chronic heart failure, stage IV according to WHO (World Health Organization) or cardiac arrhythmias with hemodynamic instability are not capable of CR, but these patients with CAD and/or stable chronic heart failure, regular physical training leads to an improvement in physical performance, a reduction in symptoms and thus an improvement in quality of life [1–4, 52]. Therefore, these patients should undergo a CR promptly after inpatient hemodynamic stabilization. Inpatient CR is more suitable as an outpatient CR for patients who are difficult to stabilize [52]. A contraindication can also result from the lack of motivation of the rehabilitant in terms of diagnostics and therapy. These patients should be given detailed information and motivation so that a CR is possible.

Conclusions

The efficacy of multimodal rehabilitative interventions has been shown in several studies. The reduction of risk factors such as physical exercise, nicotine abstinence, weight loss, and cholesterol lowering by CR can improve quality of life and reduce mortality. Intensified follow-up programs improve clinical outcome of patients with cardiac disease and should be offered whenever possible. In addition, CR programs have to be designed for the different needs of female and male patients. In addition, the study results of new innovations such as yoga or new apps are eagerly awaited. It remains to be seen which aspects will be permanently integrated into the CR in the future.

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Authorship

All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published.

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Compliance with Ethics Guidelines

This article is based on previously conducted studies and does not contain any studies with human participants or animals performed by any of the authors.

Footnotes

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