HOW TO DO

Cardiac rehabilitation following myocardial infarction

Ryszard Piotrowicz, Jadwiga Wolszakiewicz

Department of Cardiac Rehabilitation and Noninvasive Electrocardiology,
Institute of Cardiology, Warsaw, Poland

Abstract

This article provides an overview of current recommendations regarding cardiac rehabilitation (CR) after myocardial infarction and its clinical application. Evidence shows that exercise-based CR after cardiac events positively affects the extent of disability and level of quality of life, and has also important beneficial role in modifying morbidity and mortality. Cardiac rehabilitation is an integral component of the care for patients who have undergone acute myocardial infarction, after invasive coronary procedures and those with chronic stable angina. Although in the last four decades physical training has assumed a major role in health care of coronary artery disease patients, cardiac rehabilitation does not consist exclusively of regular exercising. Comprehensive cardiac rehabilitation should include the following components: clinical evaluation, optimization of pharmacotherapy, physical training, psychological rehabilitation, evaluation and reduction of coronary disease risk factors, life style modification, and patient education. Comprehensive cardiac rehabilitation should be addressed by the designated team (physician, physiotherapist, nurse, psychologist, dietician, social worker) immediately after acute phase of myocardial infarction and should contain individualized programs designed to optimize physical, psychological, social and emotional status. Modern model of comprehensive cardiac rehabilitation should be initiated as early as possible, continued for required time, properly staged, and individualized depending on clinical status of the patients.
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Key words: comprehensive cardiac rehabilitation, physical activity, myocardial infarction

Introduction

According to the 1964 World Health Organization definition, cardiac rehabilitation includes all actions undertaken to provide optimal physical, mental and social environment for the cardiac patient to let him or her regain maximal functional capacity in the society [1]. Thus, cardiac rehabilitation should be multifaceted and comprehensive. It should be initiated with first symptoms of cardiac disease, immediately following the life-threatening phase of an acute coronary event, or in the early period following invasive treatment. No temporal limits should be imposed on cardiac rehabilitation.

Modern cardiac rehabilitation should be [2]:
— comprehensive;
— initiated as early as possible;
— continuous;
— staged;
— individualized depending on the clinical state;
— acceptable for the patient.

Address for correspondence: Ryszard Piotrowicz, MD, PhD, Department of Cardiac Rehabilitation and Noninvasive Electrocardiology, Institute of Cardiology, Alpejska 42, 04–628 Warszawa, Poland, tel: + 48 22 343 44 09, fax: +48 22 343 45 19, e-mail: rpiotrowicz@ikard.pl; jwolszakiewicz@ikard.pl

In addition, comprehensive cardiac rehabilitation should include the following components: clinical evaluation, optimization of pharmacotherapy, physical training, psychosocial rehabilitation, evaluation and reduction of coronary disease risk factors, lifestyle modification, and patient and family education [2].

These comprehensive goals require involvement of a multidisciplinary team that includes not only physician but also physiotherapist, psychologist, sociologist, and dietetician. The primary goal of the therapeutic team is to develop an individualized therapeutic plan with the aim of regaining and maintaining optimal clinical status, as well as physical, mental, and social capacity of the patient [2].

Physical rehabilitation is a major component of the comprehensive cardiac rehabilitation. During the last 30 years, a major breakthrough occurred in our thinking regarding the role of physical activity in patients with cardiovascular disease. Until 1960s, bed rest or major limitation of exercise were considered beneficial for the majority of patients. In contrast, moderate or even intense exercise training is currently used not only in the prevention of coronary heart disease, but also as a therapeutic measure following myocardial infarction, percutaneous coronary intervention (PCI), cardiac surgery, and permanent pacemaker or cardioverter-defibrillator implantations. For some years now, physical rehabilitation is also undertaken in patients with heart failure regardless of its etiology [3–5].

Stages of cardiac rehabilitation

Comprehensive cardiac rehabilitation consists of an early phase (stages I and II) and a late phase (stage III) (Fig. 1) [2].

Early cardiac rehabilitation includes two stages and is undertaken in all patients following an acute coronary syndrome or exacerbation of chronic angina pectoris regardless of the treatment strategy (conservative or invasive).

Stage I

Stage I rehabilitation (early in-hospital rehabilitation) is initiated immediately following an acute, life-threatening period of the cardiac disease.

The management goals in this stage include [2]:
— optimization of pharmacotherapy of the underlying cardiac disease;
— prevention of the sequelae of immobilization;
— improvement in exercise capacity;
— evaluation of the mental state of the patients, anxiety reduction, and mental support;
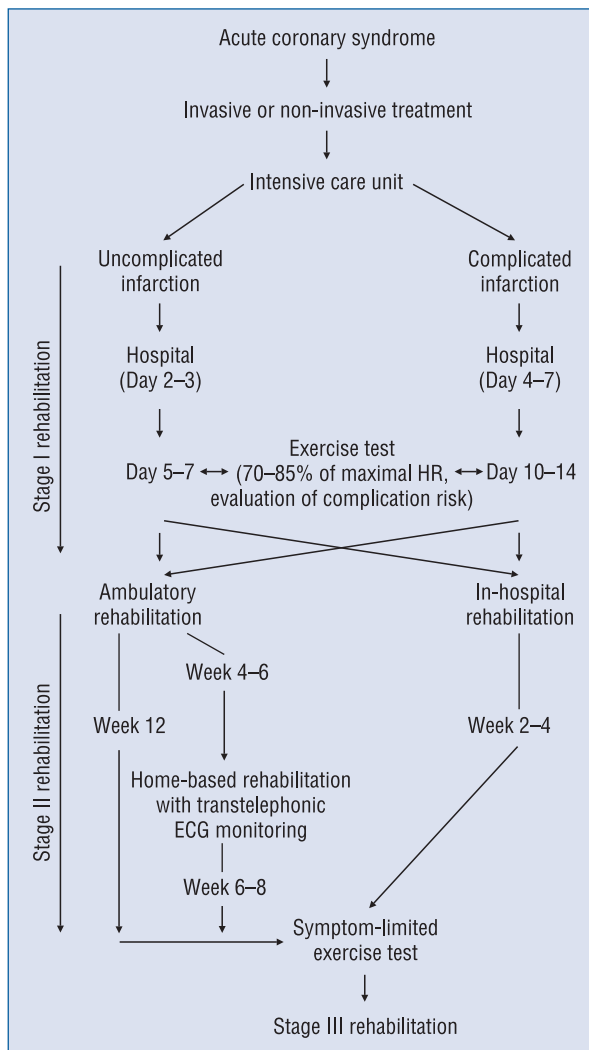

Figure 1. Schematic overview of cardiac rehabilitation following myocardial infarction; ECG — elecrocardiographic; HR — heart rate.

— patient education, including:
  — basic information regarding the disease itself, treatment modalities, and organization of care;
  — information regarding coronary heart disease risk factors and the possible strategies to reduce them;
— evaluation of the clinical status of the patient (see risk groups as shown in Table 1) and assigning appropriate stage II rehabilitation schedule.

Active physical rehabilitation, depending on the severity of the infarction (complicated versus uncomplicated) and possible contraindications (Table 2), is initiated after 12–48 hours of bed rest. After the clinical condition of the patient is stabilized (usually within 2–3 days in case of uncomplicated infarction), exercise of gradually increased intensity is initiated under physiotherapist supervision:

Table 1. Exercise-induced cardiac event risk stratification model [6].

Risk factor	Risk		
	Low	**Moderate**	**High**
Left ventricular systolic function	No significant dysfunction EF > 50%	Moderate dysfunction EF = 40–49%	Significant dysfunction EF < 40%
Complex ventricular arrhythmia	Absent at rest and during exercise		Resting and exercise--induced
Exercise-induced cardiac ischemia	No	Yes	Yes
Exercise capacity	≥ 7 METs	5–6.9 METs	< 5 METs
Hemodynamic response to exercise	Normal		No increase or decrease in SBP or HR with increasing load
Clinical data	Uncomplicated infarction/CABG/PTCA NYHA class I	NYHA class II	Infarction or invasive procedure complicated by cardiogenic shock and/or pulmonary edema. Persistent ischemia following invasive treatment. NYHA class III–IV

Categorization to low risk group requires all low-risk features to be present. Categorization to high risk group requires only one high-risk feature to be present. Risk can be categorized as moderate if a given parameter indicates neither high nor low risk or can be explicitly assigned moderate risk category. CABG — coronary artery bypass grafting; EF — ejection fraction; HR — heart rate; MET — metabolic equivalent; NYHA — New York Heart Association; PTCA — percutaneous transluminal coronary angioplasty; SBP — systolic blood pressure

Table 2. Absolute contraindications to initiation of physical training in patients after a myocardial infarction.

Unstable angina

Decompensated heart failure

Resting systolic blood pressure > 200 mm Hg, diastolic blood pressure > 100 mm Hg

Severe symptomatic valvular heart disease

Complex ventricular arrhythmia

Resting paroxysmal supraventricular tachycardia

Complex arrhythmia induced by exercise

III degree atrioventricular block in a patient without permanent pacemaker

Endocarditis

Pericarditis

Arterial embolism

Thrombophlebitis

Other disease that might worsen due to physical exercise

— initial phase — breathing exercise, relaxation exercise, dynamic exercise involving small muscle groups;
— continuation phase — dynamic exercise involving large muscle groups, sitting and standing up, walking;
— at 4–6 days, the patient assisted by the physiotherapist is allowed to try climbing stairs.

Dynamic exercise is recommended throughout stage I rehabilitation. In contrast, exercise resulting in Valsalva maneuver-like conditions is not advised.

During first days following infarction, rehabilitation should be performed under electrocardiographic (ECG) monitoring. Heart rate and blood pressure are measured before exercise, during peak exercise, and after exercise. Exercise should be immediately terminated in case of the following: coronary chest pain, dyspnea, heart rate increase by more than 20 beats//min or decrease by more than 10 beats/min, significant cardiac arrhythmia provoked by exercise, decrease in blood pressure by more than 10–15 mm Hg, or excessive increase in blood pressure (systolic above 200 mm Hg, diastolic above 110 mm Hg).

Evaluation of the clinical status of the patient and assigning appropriate stage II rehabilitation schedule is a critical component of cardiac rehabilitation (Table 1, Fig. 1) [4, 5]. Performing an exercise test to determine prognosis (with continued use of current medications) plays a major role in this process. In our center, this is planned as a submaximal exercise test but in practice it is usually symptom-limited one because most patients are treated with beta-blockers and are often unable to perform submaximal exercise (Table 3). The exercise test is usually performed at 5–7 days in patients with uncomplicated infarction treated with PCI, at 10––14 days in patients with uncomplicated infarction

Table 3. Diagnostic exercise test following a myocardial infarction.

Type of exercise test	Termination criteria
Submaximal test	Heart rate 120/min
	70% of the maximal heart rate
	Workload 5 METs
Symptom-limited test	Chest pain
	Increasing dyspnea or cyanosis
	Blood pressure fall by > 10 mm Hg
	Systolic blood pressure increase to > 250 mm Hg
	Diastolic blood pressure increase to > 115 mm Hg
	Dizziness, near fainting
	Significant exercise-induced arrhythmia
	ST segment elevation by ≥ 1 mm in leads without pathologic Q
	Patients request

Table 4. Practical advice for patients who have suffered a myocardial infarction.

Activities that shoud not be undertaken
Avoid STATIC EXERCISE WITH TEMPORARY BREATHHOLD
Lifting heavy weights
Pushing a wheelbarrow, car etc.
Changing wheel in a car
Shoveling snow
Opening windows in a train car and other similar efforts requiring pulling
Hanging curtains and other similar efforts
Digging
Acceptable forms of activity
The most available and simple form of exercise is WALKING varying distances at varying pace
Bicycle riding
Recreacional games: badminton, volleyball, table tennis
Swimming in a swimming-pool (water temperature 27–30°C)
Gardening (cutting grass using light lawnmower, raking, weeding)
Fishing

treated conservatively, and with a longer delay depending on the clinical situation in patients with complicated infarction.

Stage II — recovery

Stage II rehabilitation may be performed in hospitalized or ambulatory patients [2, 5]. In patients at low risk of exercise-related complications, we introduced home cardiac rehabilitation monitored using transtelephonic ECG and with regular supervision by a physician and physiotherapist from our ambulatory cardiac rehabilitation unit. Stage II cardiac rehabilitation should be initiated as soon as possible after stage I, optimally at 2–3 weeks following infarction. Duration of stage II rehabilitation depends on the clinical condition of the patient and the form of rehabilitation (in-hospital: 2––4 weeks; ambulatory: 4–12 weeks; home rehabilitation monitored using transtelephonic ECG: up to 12 weeks).

In-hospital stage II cardiac rehabilitation is indicated following stage I rehabilitation in case of:
— clinical condition of the patient that precludes ambulatory stage II rehabilitation;
— social and environmental barriers hindering ambulatory stage II rehabilitation (e.g. patients living in bad social conditions or in a remote place that is located far away from an ambulatory cardiac rehabilitation center).

In-hospital stage II cardiac rehabilitation is particularly indicated in the elderly and patients with coexisting diseases.

Management at this stage is directed at full accomplishment of all major goals of comprehensive cardiac rehabilitation as described above.

Acceptable exercise intensity and rules of loading during training should be defined at this stage, along with information on acceptable and undesirable forms of physical activity during daily life (Table 4), including sexual activity [4, 5].

Appropriate stage II rehabilitation should be planned based on the risk of complications related to exercise training (Table 1). Patients at low risk of such complications may be referred for ambulatory rehabilitation, and after they learn (usually within 6–12 training sessions) how to monitor themselves by measuring heart rate and blood pressure and estimating exercise load during training, they may proceed to further home rehabilitation [5]. It would be ideal to monitor the latter using transtelephonic ECG. Patients at moderate risk of complications related to exercise training may undergo conventional ambulatory rehabilitation or in some cases are even referred for in-hospital rehabilitation. Patients at high risk of exercise-related complications should undergo in-hospital rehabilitation and only exceptionally they may be allowed ambulatory

cardiac rehabilitation. Physical activity in patients at moderate or high risk of exercise-related complications should be individualized. Close medical supervision as well as ECG and blood pressure monitoring are essential. Patients at moderate risk of complications related to exercise training may proceed to further home rehabilitation after an initial course of training sessions (2 months) if they tolerate exercise well and are able to monitor themselves [5].

In-hospital and ambulatory stage II cardiac rehabilitation includes [2, 4]:

— general fitness training (breathing gymnastics, stretching and relaxation exercise, water-based exercise – considered more attractive by the patients than other forms of rehabilitation, safe and resulting in similar improvement in fitness compared to bicycle ergometer training [7]);
— endurance training:
   — interval training using bicycle ergometer or treadmill, lasting for 15–30 min with 3 min load periods alternating with 2–3 min periods of rest;
   — continuous training lasting for 15–30 min (bicycle ergometer or walking).
— resistance exercise performed as part of stationary training (e.g. interval training using bicycle ergometer exercise alternating with rowing, stepping, and treadmill exercise) to supplement uniform bicycle ergometer exercise.

Similarly to stage I rehabilitation, stage II and III exercise should be terminated or modified if the following occur: coronary chest pain, dyspnea, heart rate increase to values exceeding maximum heart rate or decrease by more than 10 beats/min despite increasing load, significant cardiac arrhythmia provoked by exercise, decrease in blood pressure by more than 10–15 mm Hg, or excessive increase in blood pressure (systolic above 200 mm Hg, diastolic above 110 mm Hg) [2].

Stage III — secondary prevention and healthy lifestyle

Stage III cardiac rehabilitation may be performed on an outpatient basis in patients living in their homes or takes place in specialized rehabilitation facilities. This may be either individual or group activity that is periodically supervised by primary care physicians and/or physicians and physiotherapists based at cardiac rehabilitation units [8].

The goals of stage III rehabilitation include:
— control of pharmacotherapy;
— maintaining optimal mental and physical condition of the patient;
— reduction of coronary artery disease risk factors;
— promotion of healthy lifestyle.

Stage III cardiac rehabilitation usually begins at 2–4 months after the onset of disease and is continued lifelong. Patients usually do not require constant medical supervision and monitoring of exercise training [3–5].

In some patients, high risk of physical training-related complications may continue for years. These patients would be candidates for ambulatory rehabilitation but due to logistic, financial and personal problems home-based rehabilitation often remains the only feasible option. Appropriate patient education is critical in this group, and attention should be given to such issues as prescribing appropriately intense exercise, the ability of the patient to identify worrisome symptoms, and patient self-monitoring during the training. In addition, easy telephone contact with the physician is extremely important, in particular if transtelephonic ECG monitoring is also possible [5].

Stage III cardiac rehabilitation may include various forms of physical activity (Table 4). Exercise intensity should be individualized. Recommended activity includes walking, cycling, general fitness training, and team games (without competitive sports). Training sessions should be performed at least twice a week and last 45–60 min.

Forms of physical exercise used in cardiac rehabilitation

Physical exercise used in cardiac rehabilitation include isotonic (dynamic) exercise, isometric (static) exercise, and resistance training that combines isometric and isotonic exercise [5].

Isotonic exercise result in muscle movement without increasing its tension. This leads to increased left ventricular preload. Response to exercise depends on the amount of muscle involved and exercise intensity. Isometric exercise is muscle contraction without its translocation. This leads to increased left ventricular afterload, related to faster increase in blood pressure and heart rate compared to dynamic exercise. While dynamic exercise has more beneficial effect on the control of metabolic coronary risk factors, resistance training is more beneficial for patients in terms of improving fitness during their everyday activity [5].

Regardless of the form of physical activity, stage II and III training should be preceded by a 5-min warm-up followed by the main training session, and finished with a 5-min period of cool-down exercise [2, 4].

Table 5. Subjective scale of exercise intensity. 20-grade Borg scale for subjective evaluation of exercise intensity.

6	
7	Minimal exercise
8	
9	Very light exercise
10	
11	Light exercise
12	
13	Moderately intense exercise
14	
15	Intense exercise
16	
17	Very intense exercise
18	
19	Maximal exercise
20	

Monitoring of exercise training

During all stages of cardiac rehabilitation, exercise training should be initiated according to guidelines regarding acceptable workload. Exercise intensity is set based on the results of initial stress testing [5].

The following approaches to set acceptable workload have been used in cardiac rehabilitation [5]:

Target heart rate (HR) during training is set based on the exercise test result: resting HR + + (maximum HR – resting HR) × (40–80)%.

As may be seen above, a wide range of target heart rate is acceptable (40–80% of the functional reserve) depending on the training stage and the form of exercise. Lower target heart rate values are used during initial or continuous training. Exercise may be more intense (up to 80% of the heart rate functional reserve) with good exercise tolerance in well-fit patients, and during interval training.

Target workload resulting in the achievement of target heart rate during training. Workload may be set in Watts or metabolic equivalents (METs) based on the stress test result (maximum training workload equals the workload during the exercise test that resulted in the achievement of the target training heart rate). Thus, maximum acceptable workload during ergometer or treadmill training is set and compared to the workload during everyday activities of the patient.

Exercise intensity may by measured subjectively using the Borg scale (Table 5). This is used to gauge training intensity in patients who are unable to perform an exercise test [5]. The recommended training intensity is the score of 12–13, while score of 14–16 is acceptable during short periods of training in patients at low risk of exercise-related complications who tolerate the training well.

Regardless of the approach used to evaluate and set workload during training, less intense exercise is always associated with a lower risk of complications, while more intense exercise is associated with a higher risk of complications but leads to faster improvement of the cardiorespiratory fitness. Training workload and frequency to achieve desired improvement in physical capacity and fitness should be set individually [5].

Recommended exercise training frequency

Similarly to exercise intensity, training frequency should also be set individually. In addition to initial fitness of the patient, factors that should be taken into account include physical activity related to the profession of the patient and his or her daily life activity. Epidemiologic data suggest that minimal training frequency/intensity required to obtain benefits from physical activity is 30 min three times a week, equal to the energy expenditure of 700 kcal/week, and optimal moderate physical activity is 30 min 5–7 times a week with the energy expenditure of 2000–3500 kcal/week [5, 9, 10].

Summary

Cardiac rehabilitation as outlined above is a multifaceted and comprehensive process and not just mere "some morning exercise". However, physical activity is a crucial component of cardiac rehabilitation, and the lack of physical activity is an established risk factor of atherosclerosis and cardiac death, including sudden death [10].

Low level of physical activity seen in the Polish population regardless of the age group is alarming. Reluctance to undertake regular exercise training or even recreational physical activity is common. Many patients commencing cardiac rehabilitation have never exercised regularly before, have no habit or need to engage in any physical activity, and easily become disheartened with training. Even healthcare professionals neglect the importance of physical activity in primary and secondary prevention. The responsibilities of primary care physicians should include appropriate education regarding regular physical activity, safety of the training, and reduction of cardiovascular disease risk factors. If stage II or III cardiac rehabilitation is not feasible, minimum advice for the patients should be 30 min of walking every day.

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