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KNGF Guideline

Cardiac rehabilitation

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In the context of international collaboration in guideline development, the Royal Dutch Society for Physical Therapy (Koninklijk Nederlands Genootschap voor Fysiotherapie, KNGF) has decided to translate its Clinical Practice Guidelines into English, to make the guidelines accessible to an international audience. International accessibility of clinical practice guidelines in physical therapy makes it possible for therapists to use such guidelines as a reference when treating their patients. In addition, it stimulates international collaboration in the process of developing and updating guidelines. At a national level, countries could endorse guidelines and adjust them to their local situation if necessary.

KNGF's objective is to create the right conditions to ensure that high quality physical therapy care is accessible to the whole of the Dutch population, and to promote recognition of the professional expertise of physical therapists. KNGF represents the professional, social, and economic interests of over 20,000 members. The guideline is summarized on a flowchart; the Practice Guidelines as well as the flowchart can be downloaded from www.fysionet.nl.

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Preface

This 2011 Guideline on Cardiac Rehabilitation by the Royal Dutch Society for Physical Therapy (KNGF) can be regarded as a specific supplement for physical therapists to the 2011 general multidisciplinary guideline on cardiac rehabilitation (*Multidisciplinaire Richtlijn Hartrevalidatie 2011*) published by the Netherlands Society of Cardiology (*Nederlandse Vereniging voor Cardiologie*, NVVC).

The Guideline offers a manual for physical therapy interventions for patients who are eligible for cardiac rehabilitation on an inpatient or outpatient basis. This Guideline replaces the 2001 KNGF Guideline on Physical Therapy in Cardiac Rehabilitation, which was revised in 2003 on the basis of the AGREE instrument and was reissued in 2005.

The first part (A) of the Guideline focuses on physical therapy care for patients with coronary heart disease (in accordance with the 2005 KNGF Guideline on Physical Therapy in Cardiac Rehabilitation), while part B describes the physical therapy care for patients with chronic heart failure.

The KNGF Guideline on Cardiac Rehabilitation consists of a set of Clinical Practice Guidelines, a separate document called *Verantwoording en Toelichting* (review of the evidence, in Dutch) which presents the scientific evidence for the physical therapy interventions, and a summary in the form of a flowchart.

All parts of the Guideline can be read individually.

Practice Guideline

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Introduction

The 2011 Guideline on Cardiac rehabilitation by the Royal Dutch Society for Physical Therapy (KNGF) offers a guide to physical therapy interventions for patients eligible for cardiac rehabilitation on an inpatient or outpatient basis. This Guideline updates the 2001 KNGF Guideline on Cardiac Rehabilitation, which was revised in 2003 on the basis of the AGREE instrument and was reissued in 2005. The Guideline is in line with the 2011 general multidisciplinary guideline on cardiac rehabilitation (*Multidisciplinaire Richtlijn Hartrevalidatie 2011*) published by the Netherlands Society of Cardiology (*Nederlandse Vereniging voor Cardiologie* NVVC), as well as with various national and international guidelines and position statements.
The Guideline is based on the most recent scientific insights. The Guideline offers physical therapists the opportunity to design a tailored treatment program.
Cardiac rehabilitation is a multidisciplinary treatment that aims to optimize the patients' physical, psychological and social functioning. Cardiac rehabilitation is intended to reduce a heart patient's unhealthy behavior and risk factors (in other words to improve their lifestyle; this is also known as 'cardiovascular risk management' or 'secondary prevention'), in order to prevent recurrence of cardiac events or further progression of an existing cardiac disorder or impairments due to such a disorder. Cardiac rehabilitation is offered by almost all Dutch hospitals, and is successful in over 98% of heart patients.
Physical therapy is part of the multidisciplinary cardiac rehabilitation program. Physical therapy after a cardiac event, after medical treatment or for a chronic cardiovascular disease primarily aims to optimize the restoration of everyday physical functioning in relation to individual physical activity limitations and participation restrictions. Physical therapy interventions should induce inactive patients to develop and maintain an active lifestyle.

The following phases are distinguished in the care program for heart patients:

1. Preoperative phase. This phase preferably starts 4 weeks before cardiac surgery. Patients who have to undergo an open heart operation (coronary artery bypass grafting [CABG] and/or valve replacement) and are at increased risk of developing postoperative pulmonary complications are offered preoperative physical therapy.
2. Phase I or clinical phase (hospital admission). This phase starts immediately after an acute cardiac event such as an acute coronary syndrome (ACS), heart failure or acute hospital admission for another cardiac disorder. In the acute phase, relative rest is indicated, supplemented with pulmonary physical therapy if necessary. This is followed by the mobilization phase on the ward. Physical therapy in the mobilization phase starts with dynamic mobilization exercises at the earliest possible opportunity. These are then gradually expanded to include the intended general activities of daily life such as walking and stair climbing.
3. Phase II or rehabilitation phase. This phase succeeds the clinical phase and starts after the patient is discharged from the hospital. It is nearly always implemented on an outpatient basis. Only in exceptional cases can this phase be implemented during the patient's clinical admission to a rehabilitation center for complex cardiac rehabilitation. The physical therapy program involves informing and advising the patients, designing and supervising a tailored exercise program[a] and offering a relaxation program (in consultation with a social worker and/or psychologist).
4. Phase II or postrehabilitation phase. This phase succeeds the rehabilitation phase, but is carried out outside institutional healthcare. This phase focuses on maintaining the active lifestyle initiated in phase II. Patients may be advised to join an exercise program in primary care.

a *An exercise program is indicated for coronary heart disease, while a training program is used for heart failure.*

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The KNGF Guideline on Cardiac Rehabilitation consists of a set of Clinical Practice Guidelines, a separate document called *Verantwoording en toelichting* (review of the evidence, in Dutch) which presents the scientific evidence for the physical therapy interventions, and a summary in the form of a flowchart. All parts of the Guideline can be read individually.

Objective and target group
The objective of this Guideline is to describe the best possible physical therapy, in terms of efficacy, efficiency and tailored care, for patients who are eligible for cardiac rehabilitation.
In addition, the KNGF Guideline on Cardiac Rehabilitation explicitly aims to:
- contribute to evidence-based physical therapy care and help improve the quality and uniformity of the interventions / treatments;
- define and clarify the tasks and responsibilities of physical therapists, and encourage collaboration with the other disciplines involved;
- assist physical therapists in implementing the diagnostic process and facilitate the use of therapeutic interventions.

Most of the patients who are referred to multidisciplinary outpatient cardiac rehabilitation are suffering from coronary heart disease. In view of its proven effectiveness, there is an absolute indication for multidisciplinary cardiac rehabilitation for this diagnostic group.
The diagnostic groups referred to cardiac rehabilitation for coronary heart disease include:
- patients with an acute coronary syndrome (ACS), including acute myocardial infarction (AMI) and unstable angina pectoris (UAP);
- patients with angina pectoris (AP);
- patients who have undergone an acute or elective percutaneous coronary intervention (PCI);
- patients who have undergone a coronary artery bypass grafting (CAPG) or valve replacement[b].

In addition, there is a relative indication for cardiac rehabilitation for the following diagnostic groups: patients with heart failure, patients with congenital cardiac abnormalities, patients who have undergone a heart transplant, patients who have received an implantable cardioverter defibrillator (ICD) or a pacemaker, patients being treated for cardiac arrhythmias, patients with atypical thoracic pain complaints, patients who have been resuscitated and patients who have undergone other cardiothoracic surgical interventions.
The evidence for the value of cardiac rehabilitation is stronger for patients with chronic heart failure than for other diagnostic groups with a relative indication for cardiac rehabilitation. Providing multidisciplinary cardiac rehabilitation to patients with chronic heart failure (New York Heart Association [NYHA] class II-III) results in better perceived quality of life, reduction of the number of admissions or readmissions, and shorter hospital stay after new admissions. In addition, the incidence and prevalence of chronic heart failure are relatively high (associated with the current increase in life expectancy).
However, the pathophysiology of chronic heart failure differs from that of coronary heart disease, so patients with chronic heart failure cannot be treated in the same way as those with coronary heart disease. Hence, the present Guideline consists of two parts: guidelines for the physical therapy care of patients with coronary heart disease and guidelines for the physical therapy care for patients with chronic heart failure.
If a therapist is in doubt about the effectiveness of cardiac rehabilitation in other groups of patients, a screening procedure and an intake interview can be used to assess whether there is an indication for physical therapy interventions.

b *Although heart valve disease is not a form of coronary disease, the rehabilitation process for this disease largely corresponds to that in coronary disease.*

A Coronary heart disease

The physical therapist must satisfy the following professional requirements to be able to act in accordance with the present Guideline.

Treating patients with coronary heart disease
A physical therapist who treats heart patients must be familiar with the 2011 Dutch multidisciplinary guideline on cardiac rehabilitation (*Multidisciplinaire Richtlijn Hartrevalidatie 2011*), must have completed and passed the 'Cardiac rehabilitation' course and must have been trained in Basic Life Support and the use of an automated external defibrillator (AED). A doctor must be available on call during the exercise program.

Introduction
The term coronary heart disease covers disorders caused by narrowing of the coronary arteries as a result of atherosclerosis. A distinction is made between disease involving one, two or three coronary artery branches.

Diagnostic groups in coronary artery disease

The recommendations are relevant for:
- patients with an acute coronary syndrome (ACS), including acute myocardial infarction (AMI) and unstable angina pectoris (UAP);
- patients with angina pectoris (AP);
- patients who have undergone an acute or elective percutaneous coronary intervention (PCI);
- patients who have undergone a coronary artery bypass grafting (CAPG) or valve replacement.

The cardiac rehabilitation process is divided into the following phases:
- the preoperative phase (if applicable), i.e. activities preceding open heart surgery;
- the clinical phase (Phase I), i.e. activities during the hospital stay;
- the rehabilitation phase (Phase II), i.e. activities on an outpatient basis (after clinical admission) or in the case of complex cardiac rehabilitation, activities during clinical admission to a rehabilitation center;

- the post-rehabilitation or aftercare phase (Phase III), i.e. activities after the cardiac rehabilitation has ended.

This chapter of the guideline discusses the rehabilitation activities for this group of patients for each phase of the cardiac rehabilitation process.

Risk factors
Nearly all coronary heart diseases are caused by atherosclerosis. The progression of the atherosclerotic process, and hence the extent of damage to the coronary arteries, is related to the presence of cardiovascular risk factors, which may or may not be modifiable.

Cardiovascular risk factors

Modifiable factors:
- smoking
- unhealthy dietary pattern
- (systolic) hypertension
- body-mass index (BMI) > 30 kg/m2 or waist circumference > 102 cm in men or > 88 cm in women
- abnormal blood lipids composition (hypercholesterolemia and hyperlipidemia)
- type 2 diabetes mellitus
- excessive alcohol use
- lack of physical activity
- lack of social support
- psychological factors like stress, depression and anxiety

Non-modifiable factors:
- genetic predisposition
- male sex
- age

Prognostic factors
Prognostic factors that may influence the recovery process include the severity of the cardiac disease, the remaining left ventricular function, comorbidities (like osteoarthritis or chronic obstructive pulmonary disease [COPD]), peripheral vascular disease, obesity, cancer, diabetes mellitus, cerebrovascular accident (CVA), psychological factors (depression and anxiety) and lack of social support.

Prevention
Secondary and tertiary prevention include all measures to induce patients to change their behavior and modify their modifiable risk factors, in order to prevent progression of existing heart disease or the development of impairments due to the disease.

A.1 Preoperative phase in coronary artery disease

Preoperative physical therapy for patients at increased risk of developing postoperative pulmonary complications (PPCs) reduces mortality rates, morbidity (fewer airways infections), duration of ventilation and length of hospital stay.
Patients are referred to a physical therapist by their cardiologist, and the physical therapist receives information from the cardiologist about the diagnosis and any comorbidities, the diagnostic data considered relevant by the cardiologist, information about the type of surgery the patient will undergo and, if already known, the hospital admission date and the planned date of the operation. The physical therapist screens the risk of developing a PPC using a scoring system (Table 1). If the total score is < 1, this implies a low risk, while a total score ≥ 2 means a high risk. The preoperative phase should preferably start 4 weeks before the surgery, and is concluded on the day before the open heart operation.

*Table 1. Risk of pulmonary complications after open heart surgery (postoperative pulmonary complications, PPCs).**

parameters	score
age > 70 years	1
productive cough	1
diabetes mellitus	1
smoking	1
COPD: FEV_1 < 75%$_{predicted}$ or requiring medication	1
BMI > 27.0 kg/m²	
lung function: FEV_1 < 80%$_{predicted}$ and FEV_1/FVC < 70%$_{predicted}$	2

** The risk is low at a total score ≤ 1, high at a total score ≥ 2. PPC = postoperative pulmonary complication; COPD = chronic obstructive pulmonary disease; FEV1 = forced expiratory volume in 1 second; FVC = forced vital capacity.*

The treatment consists of:
- inspiratory muscle training (IMT) using a threshold device:
  - resistance: 30% of Pi_{max}, adding 5% each week if the Borg score (1-10) < 5;
  - frequency: 7 days a week;
  - duration: 20 minutes per session for at least 2 weeks, if possible 4 weeks before surgery;
- breathing exercises;
- airway clearance techniques.

The physical therapist evaluates the treatment.
The intended outcome is:
- An increased Pi_{max} (and inspiratory endurance time) – measured using a Pi_{max} meter;
- No detectable pulmonary problems (patient is functionally able to cough up sputum).

A.2 Clinical phase (Phase II) in coronary artery disease

The cardiologist provides the physical therapist with the following medical referral information: reason for referral, date of hospital admission, diagnosis, date of the event or treatment, medication use (type and dosage regime), any complications or comorbidities, and any further diagnostic information deemed relevant by the cardiologist.
Relative rest is indicated during the patient's stay at the coronary care unit (CCU) after an acute cardiac incident or after their stay at the intensive care unit (ICU) following open-heart surgery. In addition, pulmonary physical therapy may be required in the case of pulmonary and/or respiratory problems. Pulmonary physical therapy consists of teaching patients techniques aimed at improving ventilation and mobilizing and coughing up sputum (breathing, huffing and coughing techniques).
As soon as the patient has become stable, they enter the mobilization phase on the ward. In the mobilization phase, the patient

should start dynamic mobilization exercises of the large muscle groups as soon as possible; the exercises are gradually extended to include walking and stair climbing, while the physical therapist watches out for signs of excessive strain.

Signs of strain upon exertion

- angina
- impaired pump function:
  - shortness of breath disproportionate to exertion
  - fatigue: abnormal fatigue disproportionate to exertion
  - increased peripheral / central edema
- arrhythmias:
  - high heart rate not in proportion to exertion
  - irregular heartbeat, changes in known arrhythmias
- abnormal increase or decrease of blood pressure
- fainting
- dizziness
- vegetative reactions (e.g. excessive perspiring, pallor)

The physical therapist explains the nature of the patient's heart disease and/or the operation, the further course of the rehabilitation program, ways of coping with cardiac and other complaints and the disease itself, ways to recognize signs of excessive strain and the way the intensity of activities at home can be gradually increased.
Final outcome criteria for the physical therapy in this phase are:

- The patient is able to function at the intended ADL level (including e.g. walking, climbing stairs and self-care, with assistance if necessary). Moderate exertion is possible (≥ 3-4 METs).
- The patient has at least some knowledge of their heart disease.
- The patient knows how to cope with their symptoms and is able to intensify and expand their ADL activities.

In some exceptional cases, patients may not have met these goals at the time of discharge from hospital, due to psychosomatic, social or severe physical problems. Such patients may be referred for clinical admission to a rehabilitation center for cardiac rehabilitation (Phase II), where they can continue to work towards meeting the goals.

A.3 Rehabilitation phase (Phase II) in coronary heart disease

At discharge from the hospital, all patients with coronary heart disease are referred by their cardiologist to a multidisciplinary cardiac rehabilitation team for cardiac rehabilitation.
Relevant referral information includes:

- (medical) diagnosis;
- any diagnostic cardiologic information deemed relevant by the physician:
  - details of hemodynamic stability during and after the treatment of the event, size and location of the infarct and/or left ventricular dysfunction, any remaining ischemia and status of the (untreated) coronary arteries;
  - arrhythmias and conduction defects;
  - PCIs: number and location(s); whether fitted with a stent;
  - surgical details if applicable (CABG / valve replacement);
  - presence / absence of implantable cardioverter defibrillator (ICD) or pacemaker;
- data from the maximum or symptom-limited exercise test (see treatment plan);
- any relevant comorbidity;
- prior history (cardiac or non-cardiac);
- medication (type and dosage).

All patients are eligible for a screening procedure and intake interview, carried out by a member of the rehabilitation team, in many cases the cardiac rehabilitation coordinator.
Screening takes place on the basis of a set of screening questions.

Screening questions to assess indications for cardiac rehabilitation

1. Is the patient's physical functioning affected or threatened?
1a. Is the patient's exercise capacity objectively reduced in relation to future functioning?
1b. Is the patient able to realistically estimate their own current exercise capacity?

2. Is the patient's psychological functioning affected or threatened?
2a. Is the patient's emotional functioning affected (including anxiety and/or depression)?

3. Is the patient's social functioning affected or threatened?
3a. Is the patient's social functioning affected and/or is there a lack of social support?
3b. Does the patient have a caregiver (life partner, relative, good friend) they can rely on?
3c. Are there problems to be expected regarding the patient's return to work?

4. What is the patient's cardiovascular risk profile?
4a. Is the patient overweight or obese?
4b. Does the patient have high blood pressure?
4c. Does the patient have diabetes mellitus?
4d. Does the patient have an elevated blood cholesterol level?

5. Does the patient engage in unhealthy behavior?
5a. Was the patient a smoker before they were admitted to hospital?
5b. Did the patient meet the Dutch recommendations for healthy physical activity?
5c. Does the patient drink excessive amounts of alcohol or is there a risk of alcohol abuse / dependence?

Source: NVVC-CCPH – Commissie Cardiovasculaire Preventie en Hartrevalidatie, LMDO-H – Landelijk Multidisciplinair Overleg Hartrevalidatie. Beslisboom Poliklinische Indicatiestelling Hartrevalidatie 2010. Utrecht: NVVC, 2010.

Based on the results of the screening questionnaire, the cardiac rehabilitation coordinator, in consultation with the patient, decides what type of care or what interventions is/are indicated.

The resulting indication is then discussed at a multidisciplinary meeting, after which the patient is referred to one or more of the following programs offered by the various disciplines:

- information program:
  - the patient (and their partner, if any) is offered information about their disease and ways of coping with it, as well as about the way cardiac rehabilitation can facilitate physical, psychological and social recovery;
  - the patient is offered information about legal and other regulations relevant to regaining social participation;
- exercise program (in the relevant multidisciplinary setting);
- relaxation program;
- assisting behavior change (lifestyle program, behavior modification program);
- psychological programs;
  - psycho-education (educating patients about cardiac problems and how to deal with them);
  - program to treat psychological symptoms (various programs): e.g. stress management, cognitive behavioral therapy.

The patient then goes through specific intake procedures for each of the relevant disciplines, after which they start one or more cardiac rehabilitation programs. If outpatient cardiac rehabilitation is contra-indicated, the patient may be referred to a clinical setting for cardiac rehabilitation, such as a specialized rehabilitation center.

A.3.1 Diagnostic process for coronary heart disease in Phase II

The aim of the diagnostic process in physical therapy is to assess the nature and severity of the patient's health problem in relation to their physical functioning and to assess the extent to which it can be modified. The assessment is based on the patient's presenting problem and the physical improvement that can be expected.
The physical therapist assesses the patient's health status, starting from the main symptoms, identifies the target situation, checks for the presence of favorable and unfavorable factors and assesses the patient's need for information. Based on the findings, the physical therapist determines the rehabilitation goals.
The diagnostic process involves history-taking, physical examination, analysis and designing a treatment plan.

History-taking

The details of the patient's history are partly obtained from the rehabilitation team (including the referral information provided by the cardiologist) and partly from the patient.
Focal points in history-taking include:

- identifying the patient's presenting problem or the target activity level (preferably using the patient-specific complaints [PSC] instrument);
- identifying the patient's activity level before the current health status arose;
- exploring the patient's health status:
  - nature and severity of complaints (in terms of body functions, activities and participation);
  - start, duration and course of the coronary heart disease;
  - prognosis and risk factors (risk factor checklist);
  - comorbidities;
  - physical activity behavior;
- assessing the patient's current status:
  - functional impairments, activity limitations (preferably assessed using the PSC instrument) and restrictions of participation associated with the coronary heart disease;
  - current general health status (in terms of body functions, activities and participation);
  - internal and external factors that may affect the recovery process;
  - current treatment: medication / additional treatment;
- other information:
  - personal details:
    - social details (occupational, family);
    - demands made on the patient by their environment;
  - motivation;
  - the patient's information requirements.

Physical examination

The examination focuses on identifying impairments of body functions, limitations of activities, restrictions of participation and health problems that may influence the choice of exercise activities to be included in the rehabilitation program. Limitations of activities may regard their nature, duration and / or quality.
The physical therapist analyses the performance of problematic activities that were identified using the PSC instrument. The physical therapist assesses the quality of the patient's basic motor skills (including endurance, strength, speed, agility and coordination) and the degree to which the patient is able to use them.
The performance of the problematic activities can be scored in terms of duration and intensity, perceived fatigue (Borg Rating of Perceived Exertion (RPE) scale 6-20) and possibly in terms of anxiety, chest pain and dyspnea (on the Anxiety, Angina and / or Dyspnea scales). If requested by the patient's physician, the therapist can monitor the patient's heart rate and blood pressure during these activities. The Shuttle walk test (SWT) or the 6-minute walk test (6MWT) is used to determine the patient's functional exercise capacity. The MET method and/or the Specific Activity Scale (SAS) can be used to estimate whether any discrepancy between the actual performance level and the target level can be eliminated with a suitable exercise program.
Part of the examination involves the physical therapist observing how the patient copes with their health problem, for instance if they show fear of exercise. As regards the patient's psychosocial functioning, the role of the physical therapist is to signal and report any problems.

Analysis

The analysis of the patient's health problems focuses on the following questions:

1 What is the patient's current health status in terms of body functions and structures (impairments), activities (limitations) and participation (restrictions) and what is the patient's current physical condition in terms of:
  - basic motor skills (endurance, strength, speed, agility and coordination while performing activities, assessed by means of the PSC instrument);
  - functional exercise capacity (SWT or 6MWT, possibly supplemented by the MET method or the SAS).

2 Are there any physical factors that may hamper efforts to improve the patient's physical condition, such as:
   - limited cardiac performance (check referral information provided by cardiologist);
   - other diseases (comorbidities) or disorders (e.g. musculoskeletal problems, osteoarthritis, COPD, peripheral vascular disease, obesity, cancer, type 2 diabetes mellitus or CVA)?
3 Are there any other (internal or external) factors that could affect the patient's natural ability to improve their physical condition, such as:
   - psychological impediments: anxiety, depression, emotional instability, stress, perceived disability, sleeping problems;
   - dyspnea and fatigue;
   - lifestyle: smoking, lack of physical activity, dietary habits, alcohol use;
   - use of medication;
   - social network and social functioning?
4 What is the patient's target status in terms of ability to perform activities of daily living, leisure activities, work and hobbies (patient's presenting problem and goals)?
5 Is the target status feasible in view of the conclusions drawn at points 2 and 3; in other words, can the impediments be reduced?
   - If not: what approach can be used to optimize the situation / degree of acceptance?
   - If yes: what approach can be used to reduce or eliminate the impediments and to improve the patient's physical condition?
6 In view of the above, what options does physical therapy offer to alleviate the patient's health problem, that is, to improve the patient's body functions, activities and participation?

A patient may also experience health problems in other domains, whether or not associated with the heart disease, for which physical therapy is indicated. Where possible, these problem areas are taken into account in the rehabilitation program. If necessary, the physical therapist should consult the relevant KNGF guideline or recommendations for physical activity.

Treatment plan

The information required to design a treatment plan comes partly from the multidisciplinary team and partly from the physical therapist's own analysis.
The following information is relevant for the treatment plan:

- the (medical) diagnosis;
- the diagnostic and prognostic referral details about the patient's physical condition (i.e. what the patient can physically handle), insofar as they are deemed relevant by the referring physician;
- all individual rehabilitation goals, but especially those regarding physical exercise and possible impediments to exercise, such as anxiety, a dysfunctional coping style and comorbidities;
- if the patient has an ICD or pacemaker, the settings (e.g. the heart rate range at which the patient can safely exercise);
- the result of the maximum or symptom-limited exercise test;
- the patient's risk profile;
- all medications (type and dosage).
- the physical therapy diagnosis;
- information about the patient's occupational situation (to enable the therapist to take this into account in the rehabilitation program) and the prognosis;
- any relevant further information about the patient's family and social support.

Table 2. Goals of physical therapy treatment.

goals	description
1 exploring one's own physical limits	The patient is able to deal with their own physical limits in daily life without assistance.
2 learning to cope with physical limitations	Confronting patients with their objective and subjective limits teaches them what physical exertion is possible, i.e. what their physical limits are.
3 optimizing exercise capacity	The patient is able to cope with their physical limitations in various situations requiring movement and various types of exertion.
4 applying diagnostics	Confronting patients with their physical limitations teaches them to cope with these limitations. This goal can only be attained if the patient comes to accept their situation. The exercise load dosage is decided in consultation with the patient. Active involvement is important to translate this dosage regime into everyday activities.
5 overcoming fear of physical exertion	The patient attains the intended physical condition, or the patient's physical condition is improved to such a level that they can function at their preferred or attainable level in activities of daily life, work, sports and/or hobbies.
6 developing and maintaining a physically active lifestyle	The physical therapist is able to evaluate changes in the patient's exercise capacity over time and can determine the relation between the patient's subjective symptoms and their objectifiable defects.

Table 2 lists the personal goals that can be pursued by means of physical therapy.

Nearly all patients will have a combination of goals they want to achieve. If a complete recovery of exercise capacity is not regarded as feasible, the first two goals can at least be addressed (for which self-management is essential). If one of the goals is to improve the patient's exercise capacity, and this goal is deemed attainable, the first and/or third goals will be addressed. If the patient subjectively perceives their exercise capacity to be limited, the treatment should focus on goal 1 and/or goal 5.
In many cases, goals 1 and 5 will be the first ones to be addressed, as patients first need to overcome their fear of exercise, and have to explore their own limits, before they can be trained. A goal that is important for nearly all patients is to start developing a physically active lifestyle (goal 6). During the rehabilitation process, patients are given the advice to start exercising independently or to take up sport.
Returning to work is an important goal of cardiac rehabilitation; patients are encouraged to partially resume work while still in the rehabilitation process. The physical therapy care is aimed at removing any (physical) impairments that prevent patients from returning to work.
Before the goal of optimizing exercise capacity (goal 3) can be addressed, the therapist first needs to determine the required exercise intensity, on the basis of the results of the maximum or symptom-limited exercise test (which is done by a physician). In determining the exercise intensity, the physical therapist must take account of any physical impairments that may hamper the improvement of the patient's physical condition (item 2 in the analysis), as well as other (internal or external) factors that could impede the patient's natural ability to improve their physical condition (item 3 of the analysis) and the patient's personal exercise goals.
The following information is relevant in determining the exercise intensity:

- the patient's present physical condition, based on the maximum or symptom-limited exercise test, expressed in absolute values and / or values relative to normative data (VO_{2max}/METs/Watts);
- the protocol used;
- the referring physician's evaluation of the electrocardiogram (ECG) before, during and after exercise (criteria for cardiac ischemia, arrhythmias and the practical consequences of the findings);
- the heart rate at rest, maximum heart rate, recovery heart rate (especially during the first minute) and percentage of the maximum expected VO_{2max} or wattage;
- blood pressure changes at rest, during exercise and during the recovery phase;
- the reasons for terminating a test;
- medication use (e.g. beta blockers, including type and dosage);
- the patient's (subjective) symptoms during the test (angina/dyspnea) and preferably their Borg score (6–20);
- if spiro-ergometry was used: maximum oxygen uptake (VO_{2max}), maximum respiratory minute volume (VE), tidal volume (TV) and respiratory rate, respiratory exchange rate (RER), anaerobic or ventilatory threshold, VE/VCO_2 ratio and any other relevant parameters (e.g. VO_2 recovery and presence of respiratory oscillations).

A.3.2 Therapeutic process in Phase II for coronary heart disease
The therapeutic process consists of information/advice, a tailored exercise program and a relaxation program.
The physical therapist systematically evaluates the treatment goals, during and at the end of the treatment.

Information / advice
In the context of the physical therapy treatment, the therapist offers the patient assistance (guidance), information and advice, geared towards their personal goals.
Aims of information and advice may include:

- *Improving the patient's understanding of their disorder and of cardiac rehabilitation*. The physical therapist educates the patient about the nature and course of their heart disease, comorbidities, healthy living (e.g. a physically active lifestyle and giving up smoking), rehabilitation (goals, nature of the treatment and expected duration of treatment), risk factors and prognosis.
- *Encouraging compliance (including a physically active lifestyle)*. The learning process involves continuing the body functions, activities and behaviors the patient has learned during the treatment, and incorporating them into their daily life. The further development and maintenance of a physically active lifestyle requires a positive attitude, social support, self-efficacy and self-management. Together with the patient, the physical therapist tries to find active ADL activities and sports and games, and guides the patient towards an active lifestyle.
- *Promoting a suitable way to handle symptoms*. The patient is taught to interpret their symptoms correctly and to control them (i.e. the patient will have to learn and develop an intuition about the way to cope with their heart disease). This learning process may be based on reducing anxiety and removing barriers that may hamper exercising. The physical therapist must take care not to give the patient unclear or contradictory information. Reassuring information can have a favorable influence on patients who have too negative a view of their own cardiac condition, and thus help to prevent unnecessary disability. The patient's partner should also be involved in the information process, especially if this partner is extremely worried.
- *Promoting return to work*. The patient should be encouraged to partially resume their occupation while still in the cardiac rehabilitation process. The physical therapist informs the patient about any (physical) problems that may arise when they resume their work, and about ways to effectively deal with their symptoms at work.

Tailored exercise program
Contra-indications for participation in an exercise program include:

- severe cardiac ischemia during exercise (ST depression ≥ 2 mm)
- poorly controlled type 2 diabetes mellitus (in consultation with internal medicine specialist);
- fever;
- acute systemic diseases;
- recent pulmonary embolism (< 3 months ago) causing severe hemodynamic strain;
- thrombophlebitis;
- severe anemia;
- acute pericarditis or myocarditis;

- hemodynamically serious aortic stenosis or mitral valve stenosis;
- cardiac valve failure constituting an indication for surgical intervention;
- atrial fibrillation with rapid ventricular response at rest (> 100 bpm);
- serious cognitive problems (memory, attention and concentration);
- poor compliance with prescribed medication (e.g. beta blockers).

The physical therapist keeps an eye on the patient's exercise intensity, observes their individual response and the way they tolerate the exercise load, and checks whether the patient shows any signs of excessive strain (monitoring). In the early stages of the exercise program, the therapist systematically measures the patient's blood pressure and heart rate (and rhythm) before, during and after the exercise session. This supervised period is extended if any arrhythmias, ischemia, angina, blood pressure abnormalities or supraventricular or ventricular ectopy occur during exercising.
The exercise session must be terminated if any of the following signs of excessive strain occur:

- severe fatigue or dyspnea out of proportion to the level of exertion;
- angina;
- increase in breathing rate out of proportion to the level of exertion (> 40 breaths per minute);
- pulse pressure reduction (≥ 10 mmHg);
- reduction of systolic blood pressure during exercise (> 10 mmHg);
- increasing ventricular or supraventricular arrhythmias.

The following safety criteria should be observed:

- If the patient has an ICD device, the physical therapist must consult the patient's cardiologist about the safe heart rate range during the exercise program. Cardiologists impose certain restrictions on patients for the first 6–8 weeks after their ICD or pacemaker is implanted, such as 'don't lift any heavy objects' or 'be cautious about moving the arm on the side where the device was implanted', which the physical therapist must take into account when implementing the exercise program.
- Patients who have undergone a CABG (or another operation involving sternotomy) are advised not to engage in (submaximal) strength training of the upper extremities during the first 6–8 weeks, so as not to hamper the consolidation of the sternum. The guideline development team is of the opinion that symmetrical functional movements below the patient's pain threshold (with comfortable rather than forceful movements and controlled breathing) can be started within 6 weeks after surgery (which can also help to prevent the development of a frozen shoulder).
- For patients with comorbidities, the physical therapist should consult the current KNGF guidelines. The guideline development team recommends paying special attention to the safety aspects mentioned in the relevant guidelines, and emphasizes the following criteria for patients with type 2 diabetes mellitus and those with pulmonary problems.
  - The physical therapist should regularly check a patient with type 2 diabetes mellitus for wounds and sensory defects (monofilament test). In addition, the physical therapist should check the diabetic patient's blood glucose values before, during and after the exercise session. Retinopathy of grade ≥ 3 and blood glucose values ≤ 5 and ≥ 15 mmol/L are relative contra-indications for exercising.

Table 3. Goals of the exercise program in relation to the patient's personal treatment goals and the intended treatment outcome.

exercise component	goal	intended outcome
practicing skills and activities (to enable the patient to utilize their general or strength endurance in motor activities)	1, 2, 3, 5 and 6	improving skills and increasing the level of activity regarding ADL, work and hobbies.
training patient's aerobic (general) endurance	1, 2 and 3	improving the patient's aerobic (general) endurance and improving work-, ADL-, sports- and hobby-related skills; improving blood pressure and heart rate responses at submaximal exertion; reducing 0_2 requirement of myocardium and reducing risk factors.
training local and strength endurance	1, 2 and 3	increasing muscle strength and endurance; improving skills and participation regarding work, housekeeping, sports and hobbies.
practicing functions / activities	5 and 6	the patient enjoys exercise and integrates exercise activities in their everyday routines
training to reduce risk factors	6	the patient adopts an active lifestyle: greater energy expenditure (as a precondition to reduce overweight / obesity); reduced fear of exertion and less stress; improved blood pressure response and reduced hypercholesterolemia; improved insulin sensitivity in patients with type 2 diabetes mellitus.

- Patients with pulmonary problems must not be allowed to desaturate; this usually means that 02 saturation (Sa02) should remain ≥ 90% during exercising (and should not fall by ≥ 4%). The physical therapist should consult the patient's pulmonologist or cardiologist to decide on the minimum individual saturation value.

The exercise program is designed on the basis of:
- the patient's specific complaints (i.e. the activities indicated in the PSC questionnaire) and abilities;
- the patient's physical condition (as assessed by maximum or symptom-limited exercise test);
- the patient's individual goals.

These aspects determine the priorities in the exercise program, the nature and type of activities included in it and the training variables to be used.

Prioritization
The individual physical therapy goals established for the patient (Table 2) determine what exercise options have to be given priority within the exercise program. (See Table 3.)

Nature and type of exercise activities
Cardiac rehabilitation includes a wide range of exercise activities, such as practicing functional skills, ADL-oriented activities, occupational and hobby activities, fitness, sports or games activities and field exercises (such as walking, rambling and circuit training). The program may also include aerobic exercises, swimming, ergometers (such as rowing and bicycle ergometers or treadmills), water-based exercises or sports and games activities.
The exercise activities should present the most effective and specific physical stimuli to improve or optimize the patient's functioning in daily life. Important considerations in the choice of exercise activities always include getting the patient to enjoy exercising, as well as promoting their self-management, and encouraging them to develop a more physically active lifestyle.

The guideline development team recommends that bicycle ergometers and other exercise equipment be calibrated, in view of the large variability in loads.

Training variables and loading stimuli
The specific training variables to be used depend on the patient's physical condition and the presence of comorbidities and risk factors. Training variables for aerobic exercising include:
- exercise frequency;
- exercise duration;
- exercise intensity;
- duration of work / rest intervals;
- structure and dosage of exercises.

If the exercise program is intended to improve the objective aerobic exercise capacity, the choice of training variables should also be based on the physiological exercise principles of 'specificity', 'overload (sufficient intensity)', 'supercompensation', 'diminishing returns' and 'reversibility'.

The intensity of strength training is determined by the external resistance against muscle contraction, the speed, the number of repeats, the number of series and the recovery interval between series, and depends on the goal of the strength training (increasing maximum strength, promoting hypertrophy or increasing muscular endurance).
In the case of comorbidities, the guideline development team recommends starting the exercise program based on the exercise principles relating to the most restrictive pathology or disorder. A low-intensity start is recommended in case of doubt.

Aerobic exercise
Aerobic exercise results in a reduction of general and cardiac mortality and morbidity rates, the number of non-fatal recurrent myocardial infarctions, and risk factors, as well as in a significant increase in exercise capacity.
The results of a maximum or symptom-limited exercise test can be used to calculate the individual exercise intensity. The optimized exercise zone can be calculated using the Karvonen formula, which calculates the exercise heart rate as a percentage of the heart rate reserve (the difference between the maximum heart rate and the heart rate at rest), added to the resting heart rate.
If the patient has had a gas analysis (because of unexplained dyspnea or comorbidity [COPD]), their exercise intensity should be based on a percentage of their VO_{2max} (predicted VO_{2max}), their $VO_{2reserve}$ (the difference between the VO_{2max} and the VO_2 at rest) or the ventilatory or anaerobic threshold, converted into heart rate or wattage.
If the patient is using beta blockers, the exercises should be based on the results of the maximum or symptom-limited exercise test with beta blocker use.
If the patient's heart rate does not rise sufficiently during the maximum or symptom-limited exercise test, the exercise intensity should be based on a percentage of the maximum capacity expressed in Watt or METs, and/or a Borg score (6–20).
The patient's exercise capacity can be increased by means of aerobic endurance and interval training, preceded by warming up and followed by cooling down. The exercise training should last 20–30 minutes, and be done at least 2–3 times a week. In the course of the exercise period, the intensity should be gradually raised from 50% to 80% of the patient's VO_{2max} as measured by the maximum or symptom-limited exercise test. Patients' exercise capacity appears to show greater improvement after high-intensity interval training than after moderate-intensity endurance training. High-intensity interval training may consist of four 4-minute blocks, during which the patient exercises at an intensity of 80-90% of their VO_{2peak}, with 3 minutes of active recovery during which they exercise at an intensity of 40-50% of their VO_{2peak}. Patients should start with two weeks of exercise at 40-50% of their VO_{2max}.

Strength training
Strength training can be regarded as an adjunct to aerobic exercise. Strength training increases muscle strength and strength endurance, resulting in a reduction of activity limitations and increased participation, especially among older (and fragile) patients (after heart surgery).
The resistance level for strength training can be estimated on the basis of the repetition maximum (RM). The guideline development team recommends estimating the maximum strength on the basis

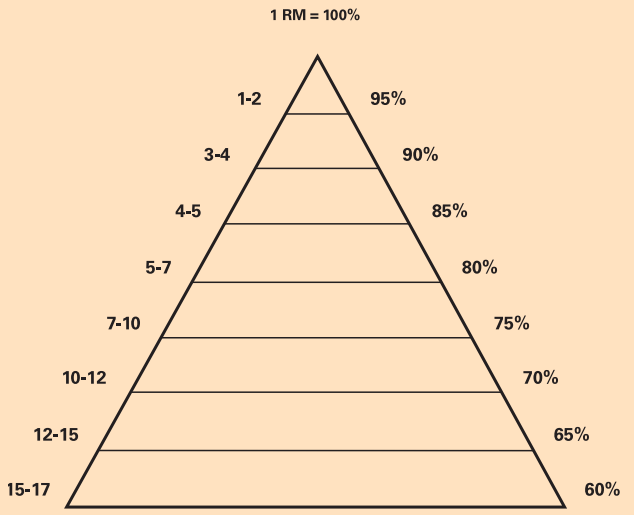

Figure 1. Number of repetitions in relation to maximum muscle strength.

of the 4–7RM. The pyramid diagram (Fig. 1) can then be used to determine the resistance level.
Muscle strength can be improved using 8–10 exercises of the large muscle groups, at a frequency of 2–3 times a week (depending on the goals) against a resistance that is gradually increased from 50% to 70–80% of the 1RM. Exercising should preferably start with 2 weeks at 30–40% of 1RM.
Table 4 shows a broad specification of the training variables for the various priorities within the exercise program.

There is a relation between relative exercise intensity and the age-adjusted absolute intensity. The relative intensity can be based on a percentage of the maximum heart rate (= HR_{max}), heart rate reserve (= $HR_{reserve}$ or HRR) or the VO_{2max} or Borg score (6–20).
Table 5 can be used to compare the load intensities, expressed in the various measures.

Relaxation program
A relaxation program is recommended for any patient who is eligible for an exercise program. A relaxation program (including breathing therapy) reduces cardiac mortality and morbidity, and has a favorable effect on physical, psychological and social parameters (including resting heart rate and fear of exercise). The heart patient should try out the program at least twice. If the patient benefits from the program, they attend 4–6 more sessions lasting 60–90 minutes each. The program addresses themes like understanding the value of rest, the balance between exertion and resting, the influence of psychological factors on physical functioning and the effects of stress, ways of dealing with anger, depression and pressure of time on the various cardiac factors. Instructions for relaxation can be given during exercising (active relaxation) or at rest (passive relaxation), partly in the context of warming up and cooling down, and partly as a separate relaxation program.

Interim and final evaluations
In addition to a 'continuous' evaluation over the entire course of the exercise program, more comprehensive interim evaluations should be carried out at least every 4 weeks, or sooner if necessary, as well as at the end of the rehabilitation program. The interim and final evaluations use the same instruments as were used in the physical therapist's diagnostic examination.

Table 4. Broad specification of training variables in the exercise program for the various priorities.

prioritized	specification of training variable
practicing skills	– content: functional training of functions / skills / activities, including getting patient to enjoy exercise. – frequency: 2–3 times a week
and developing enjoyment of exercise	– frequency: 3–5 times a week – duration: 20–60 minutes – intensity: 50–80% of VO_{2max} or heart rate reserve, or based on Borg score (11–16) – structure: warming up, aerobic training (endurance or interval endurance training), cooling down
training patient's aerobic (general) endurance.	– content: circuit training and functional exercises geared toward individual goals – frequency: 2–3 times a week – intensity: 50–80% of 1RM – warming up, strength training (1–3 series, 10–15 repetitions (with 1–2 minute intervals), 8–10 exercises), cooling down
training local and strength endurance*	– content: moderate intensity endurance training (Borg score 11–13) – frequency: preferably every day – duration: 45–60 minutes a day

** This refers to risk factors that can be modified by physical activity, such as obesity, mild to moderate hypertension and type 2 diabetes mellitus and abnormal blood lipids composition.*

Table 5. Load intensities expressed in various training load measures as reported by the American College of Sports Medicine.

training aerobic endurance relative intensity				**absolute intensity (in METs) for healthy older people (age in years)[a]**					**Strength training relative intensity[b]**
intensity:	VO_{2max} (%) or HRR (%)	HRmax (%)	Borg score (6-20)	20-39	40-64	65-79	80+	Borg score (6-20)	MVC (%)
very low	< 25	< 30	< 9	< 3,0	< 2,5	< 2,0	< 1,25	< 10	< 30
low	25-44	30-49	9-10	3,0-4,7	2,5-4,4	2,0-3,5	1,26-2,2	10-11	30-49
moderate	45-59	50-69	11-12	4,8-7,1	4,5-5,9	3,6-4,7	2,3-2,99	12-13	50-69
high	60-84	70-90	13-16	7,2-10,1	6,0-8,4	4,8-6,7	3,0-4,25	14-16	70-84
very high	≥ 85	≥ 90	> 16	≥ 10,2	≥ 8,5	≥ 5,8	≥ 4,25	17-19	> 85
maximum	100	100	20	12,0	10,0	8,0	5,0	20	100

a Maximum values are mean values achieved during training by healthy older people. The absolute intensity (in METs) was determined in men. The intensity for women is about 1–2 METs lower than that for men.

b Based on 8–12 repetitions for persons aged < 50 years and 10–15 repetitions for persons > 50 years.

*HR_{max} = maximum heart rate; VO_{2max} = maximum oxygen uptake; * $HR_{reserve}$= HR_{max}-HR_{rest};* MVC = maximum voluntary contraction; HRR= heart rate reserve; Borg score = score on the Borg Rating of Perceived Exertion scale.*

One of the following situations may prevail at the conclusion of the rehabilitation program:

- The patient has attained their goals.
- The patient has partially attained their goals, and it seems likely that they will be able to continue the rehabilitation activities independently (at home) and thus attain their goals eventually.
- The patient has partially attained their goals, but it seems likely that they will not be able to continue the rehabilitation activities independently (at home) and will thus not attain their goals. In this case, the cardiac rehabilitation program is prolonged or the patient is referred to a primary care physical therapy practice (see Phase III).
- The patient has not attained their goals and it seems likely that they have attained their maximum achievable level. In this case, the patient is referred back to the cardiac rehabilitation team and is treated, if possible, by other disciplines, or is referred for clinical rehabilitation.

Table 6 lists the intended outcome for each physical therapy goal, with recommendations to measure and evaluate the outcome. The physical therapist also evaluates whether the patient has acquired sufficient knowledge about secondary prevention, and evaluates the goals of the relaxation program.

A.4 Post-rehabilitation phase (Phase III) in coronary heart disease

In the course of the cardiac rehabilitation process, the patient should be educated about the necessity of continuing independent exercise. During and after the end of the rehabilitation period, they should be encouraged to keep up a physically active lifestyle after the cardiac rehabilitation program.

Patients should find an activity that appeals to them and that they will be able to keep up in the long term.

The following patient categories are distinguished:

1. Patients who are able to keep up a physically active lifestyle and have attained all their physical therapy goals.
   These patients are advised to remain physically active, for instance by walking or cycling, exercising at a certified exercise facility (i.e. one registered with the Dutch *Hart- en Vaatgroep* patient association) or making use of regular sports facilities.
2. Patients who are not, or not yet, able to keep up a physically active lifestyle, or who have not attained all their physical therapy goals during the outpatient phase, but who are deemed to have the ability to do so later.
   These patients are advised to join an exercise program in primary care, which is carried out in accordance with the KNGF guidelines for exercise interventions in coronary heart disease (*KNGF-Standaard Beweeginterventie coronaire hartziekten*) and is supervised by a physical therapist who has completed a KNGF-accredited special training course.

Table 6. Evaluation and screening instruments for each goal in physical therapy for coronary heart disease.

goal	final outcome	evaluation instrument	when
1. exploring one's own physical limits	Patient is aware of their own physical limits, i.e. they know what level of exertion is possible.	• ask for 5 most problematic activities (PSC) • ask patient to carry out problematic activities and score for duration and quality, and possibly on the Anxiety and/or Angina and/or Dyspnea scales • score using Borg RPE scale (6–20) for fatigue and dyspnea • monitor heart rate and blood pressure if indicated by physician	at start and end of rehabilitation and / or exercise program monitoring heart rate, measuring blood pressure and scoring on Borg RPE scale before, during and after each session
2. learning to cope with physical limitations	Patient can cope with physical limitations.		
3. optimizing exercise capacity	Exercise capacity is at optimum or target level for this patient.	**by physician** • maximum or symptom-limited exercise test (or in very exceptional cases SWT) plus Borg RPE scale (6–20); possibly scoring Anxiety, Angina and/or Dyspnea scales **by cardiac rehabilitation coordinator** • subjective physical score on KVL-H questionnaire	maximum or symptom-limited exercise test at start and end of exercise program
	Functional exercise capacity is at optimum or target level.	**by physical therapist** • as for goals 1 and 2 • SWT or 6MWT • possibly MET list and/or SAS	at start, every 4 weeks and at end of exercise program
4. diagnostic	Patient's physical condition and trainability are clear.	• as for goal 3 • scoring on Borg RPE scale (6–20) before, during and after exercise	continuous monitoring during rehabilitation process
5. overcoming fear of physical exertion	Patient is no longer afraid of exertion.	• history-taking and observation • questionnaire: see *Multidisciplinaire Richtlijn Hartrevalidatie 2011* (www.nvvc.nl) (in Dutch)	at start and end of rehabilitation and/or exercise program
6. developing an active lifestyle	Patient has adopted a physically active lifestyle.	• history-taking (motivational interviewing) • *Monitor Bewegen en Gezondheid* (www.tno.nl) (in Dutch) • post-rehabilitation activities started	at start and end of rehabilitation and/or exercise program
Focal points			
acquiring information about secondary prevention	Patient is familiar with secondary prevention	• checklist for risk factors / unhealthy behavior • Phase III activities started	at start and end of rehabilitation and/or exercise program
goals of relaxation program	Patient is familiar with the relaxation program and is able to relax.	• evaluation list • using a flowchart: see *Verantwoording en Toelichting* (review of the evidence), section A.3.3 (in Dutch) (www.kngfrichtlijnen.nl)	at interim and final evaluation of rehabilitation and / or relaxation program

Borg RPE scale = Borg Rating of Perceived Exertion; KVL-H = Kwaliteit van Leven vragenlijst voor Hartpatiënten (Dutch quality of life questionnaire for heart patients); 6MWT = 6-Minute walking test; MET = metabolic equivalent of task; PSC = Patient-specific complaints; SAS = Specific activity scale; SWT = Shuttle walk test.

All patients should be monitored by a secondary care physical therapist to check whether they are keeping up an active lifestyle (preferably 6 and 12 months after the cardiac rehabilitation has ended), in order to identify any relapses at an early stage and intervene.
If the monitoring shows that a patient is not sufficiently physically active[c] the patient is advised to join (or rejoin) an exercise program in primary care as defined above, or to start exercising at a certified exercise facility.

B Chronic heart failure

The physical therapist must satisfy the following professional requirements to be able to act in accordance with the present Guideline.

Treating patients with chronic heart failure
A physical therapist who treats patients with heart failure must be familiar with the 2011 Dutch multidisciplinary guideline on cardiac rehabilitation (*Multidisciplinaire Richtlijn Hartrevalidatie 2011*), must have completed and passed KNGF-accredited courses on 'cardiac rehabilitation' and 'Heart Failure' and must have been trained in Basic Life Support (BLS) and the use of an automated external defibrillator (AED).
A doctor must be available on call during the exercise program.

Introduction
Heart failure is defined as 'a complex of signs and symptoms associated with a structural or functional abnormality of the heart'.
Heart failure is a systemic disorder involving both peripheral and central changes, which are functional (as a compensation mechanism) in the short term, but have adverse consequences in the long term and result in reduced exercise capacity. The most common causes of heart failure are hypertension and coronary artery disease; less frequent causes include heart valve disease, arrhythmias or conduction defects and viral infections.

Physical exercise can enhance the exercise capacity and quality of life of patients with chronic heart failure. The mechanisms underlying these beneficial effects involve improvement of muscle perfusion, muscle metabolism, breathing efficiency, neurohormonal regulation and cardiac pump function.
The cardiac rehabilitation process is divided into the following phases:
- the clinical phase (Phase I), i.e. activities during the hospital stay;
- the rehabilitation phase (Phase II), i.e. activities on an outpatient basis (after clinical admission) or in the case of complex cardiac rehabilitation, activities during clinical admission to a rehabilitation center;
- the postrehabilitation or aftercare phase (Phase III), i.e. activities after the cardiac rehabilitation has ended.

This chapter of the guideline discusses the rehabilitation activities for patients with chronic heart failure for each phase of the cardiac rehabilitation process.
The recommendations are applicable to patients with chronic heart failure who are in a stable stage of the disease and who can be classified as New York Heart Association (NYHA) class II or III (Table 7).

Risk factors
Risk factors for heart failure can be subdivided into modifiable and non-modifiable factors. These risk factors are particularly relevant in patients who have developed heart failure as a result of multiple cardiac incidents (such as myocardial infarctions).

Cardiovascular risk factors

Modifiable factors:
- smoking
- unhealthy dietary pattern
- systolic) hypertension
- body-mass index (BMI) > 30 kg/m2 or waist circumference > 102 cm in men or > 88 cm in women
- abnormal blood lipids composition (hypercholesterolemia and hyperlipidemia)
- type 2 diabetes mellitus
- excessive alcohol use
- lack of physical activity
- lack of social support
- psychological factors like stress, depression and anxiety

Non-modifiable factors:
- genetic predisposition
- male sex
- age

Prognosis
The main prognostic factors for heart failure, regarding both survival and quality of life, are the remaining left ventricular function, the NYHA classification, the exercise capacity (global and / or maximal) and any comorbidities like osteoarthritis, COPD, peripheral vascular disease, obesity, cancer, diabetes mellitus and cerebrovascular accident (CVA). The prognosis also depends on the patient's ability to adapt, physically, socially and psychologically, to their new health status. Poor physical condition, psychological problems like anxiety and depression and a lack of social support can have an adverse effect on mortality rates and prognosis, and can contribute to the further deterioration of the patient's exercise capacity and quality of life.

Prevention
Secondary and tertiary prevention include all measures to induce patients to change their behavior and modify the abovementioned risk factors, measures which are taken to prevent progression of existing heart disease or the development of impairments due to the disease. Important factors in the prevention of chronic heart failure include encouraging physical activity, complying with the prescribed medication regime, giving up smoking (and alcohol use) and adopting a healthy dietary pattern.

c *The TNO monitoring instrument for exercise and health (TNO Monitor Bewegen en Gezondheid) can be used to establish whether a patient has a sufficiently active lifestyle.*

Table 7. New York Heart Association (NYHA) classification for heart failure.

NYHA	limitation of physical activity	VO_{2max}	MET	intensity (W)
class I	Patients without limitation of physical activity. Ordinary activity does not cause symptoms.	> 20 mL/kg/min	> 6	> 100
class II	Patients with slight limitation of physical activity. Comfortable at rest, but symptoms during moderate physical activity.	15-20 mL/kg/min	4-6	60-100
class III	Patients with marked limitation of physical activity. Minor activities result in symptoms.	10-15 mL/kg/min	3-4	30-60
class IV	Patients with severe limitations of physical activity. Symptoms present at rest.	< 10 mL/kg/min	< 3	< 30

VO_{2max} = maximum oxygen uptake; MET = metabolic equivalent of task; W = watt

B.1 Clinical phase (Phase I) in chronic heart failure

The care for patients with chronic heart failure who are admitted to hospital (e.g. due to cardiac decompensation or another cardiac incident) in the clinical phase is identical to that for patients with coronary heart disease. For the physical therapy interventions in this phase, see Section A.1.
A substantial number of patients with chronic heart failure are referred to cardiac rehabilitation straight from the outpatient setting, without recent clinical admission.

B.2 Rehabilitation phase (Phase II) in chronic heart failure

Patients with heart failure will be referred to the multidisciplinary cardiac rehabilitation team by their cardiologist when they have returned to a stable state (in terms of filling volume, medication use and functional classification) after a clinical admission or after a routine outpatient checkup (for instance if the patient's physical condition has deteriorated).
Relevant referral information includes:

- the (medical) diagnosis;
- any diagnostic cardiologic information deemed relevant by the physician:
  - details on the severity of the heart failure (expressed as left ventricular ejection fraction (LEVF) and NYHA class and VO_{2peak} as a percentage of the predicted value), the cause of the heart failure, the remaining left ventricular function (ejection fraction), the severity of any valve disease, and the presence of ischemia and status of the coronary vessels, as well as surgery details if applicable;
  - the nature and type of heart failure: with reduced or normal / preserved systolic function of the left ventricle;
  - arrhythmias and conduction defects;
  - presence or absence of an implantable cardioverter defibrillator (ICD) or (mostly biventricular) pacemaker (type, settings);
  - risk of decompensation;
- results of maximum or symptom-limited exercise test with gas analysis;
- any relevant comorbidity;
- prior history (cardiac or non-cardiac);
- medication (type and dosage).

All patients are eligible for a screening procedure and intake interview, carried out by a member of the rehabilitation team, in many cases the cardiac rehabilitation coordinator.
Screening takes place on the basis of a set of screening questions.

Based on the results of the screening questionnaire, the cardiac rehabilitation coordinator, in consultation with the patient, decides what type of care or what interventions is/are indicated. The resulting indication is then discussed at a multidisciplinary meeting, after which the patient is referred to one or more of the following programs offered by the various disciplines:

- information program:
  - the patient (and their partner, if any) is offered information about their disease and ways of coping with it, as well as about the way cardiac rehabilitation can facilitate physical, psychological and social recovery;
  - the patient is offered information about legal and other regulations relevant to regaining social participation;
- training program (in the multidisciplinary setting referred to here);[d]
- relaxation program;
- assisting behavior change (lifestyle program, behavior modification program);
- psychological programs:
  - psycho-education (educating patients about cardiac problems and how to deal with them);
  - program to treat psychological symptoms (various programs): e.g. stress management, cognitive behavioral therapy.

d *Since optimizing the patient's exercise capacity is the goal of cardiac rehabilitation for patients with chronic heart failure, the program for these patients is referred to as a training program, rather than an exercise program.*

Screening to assess indications for cardiac rehabilitation

1. Is the patient's physical functioning affected or threatened?
1a. Is the patient's exercise capacity objectively reduced in relation to future functioning?
1b. Is the patient able to realistically estimate their own current exercise capacity?
2. Is the patient's psychological functioning affected or threatened?
3. Is the patient's social functioning affected or threatened?
4. What is the patient's cardiovascular risk profile?
5. Does the patient engage in unhealthy behavior?

Source: NVVC-CCPH – Commissie Cardiovasculaire Preventie en Hartrevalidatie, LMDO-H – Landelijk Multidisciplinair Overleg Hartrevalidatie. Beslisboom Poliklinische Indicatiestelling Hartrevalidatie 2010. Utrecht: NVVC; 2010.

The patient then goes through specific intake procedures for each of the relevant disciplines, after which they start one or more cardiac rehabilitation programs.
If outpatient cardiac rehabilitation is contra-indicated, there may be an indication for specialized cardiac rehabilitation. This type of cardiac rehabilitation takes place at a rehabilitation center with a cardiac rehabilitation department (which implies clinical admission).

B.2.1 Diagnostic process for chronic heart failure in Phase II

The aim of the diagnostic process in physical therapy is to assess the nature and severity of the patient's health problem in relation to their physical functioning (in terms of movements) and to assess the extent to which it can be modified. The assessment is based on the patient's presenting problem and the physical improvement that can be expected.
The physical therapist assesses the patient's health status, their main symptoms, the target situation, the presence of favorable and unfavorable factors and the patient's need for information.
Based on the findings, the physical therapist determines the rehabilitation goals.
The diagnostic process involves history-taking, physical examination, analysis and designing a treatment plan.

History-taking

Some of the questions can be answered by the members of the cardiac rehabilitation team during the multidisciplinary meetings, while others are answered by the referral information provided by the patient's cardiologist, and some of the questions are answered by the patient themselves.

Focal points for history-taking include:
- inventarisatie van de hulpvraag van patiënt c.q. het gewenste activiteitenniveau (aanbevolen meetinstrument is de PSK);
- inventarisatie van het activiteitenniveau vóór het ontstaan van de huidige gezondheidstoestand;
- in kaart brengen van de gezondheidstoestand:
  - start, duration and course of the heart failure;
  - prognosis and risk factors (risk factor checklist);
  - comorbidities;
  - risk of decompensation (as apparent from prior history);
  - physical activity behavior;
- assessing the patient's current status:
  - functional impairments, activity limitations (preferably assessed using PSC) and restrictions of participation associated with the heart failure;
  - current general health status (in terms of body functions, activities and participation);
  - internal and external factors that may affect the recovery process;
  - current treatment: medication / additional treatment;
- other information:
  - personal details;
    - social details (occupational, family);
    - demands made on patient by their environment;
  - motivation;
  - patient's information requirements.

Physical examination

The examination focuses on identifying impairments of body functions, limitations of activities, restrictions of participation and health problems that may influence the choice of exercise activities to be included in the rehabilitation program. Limitations of activities may regard their nature, duration and / or quality.
The physical therapist analyses the performance of problematic activities that were identified using the PSC instrument. The physical therapist assesses the quality of the patient's basic motor skills (including endurance, strength, speed, agility and coordination) and the degree to which the patient is able to use them.
The performance of the problematic activities can be scored in terms of duration and intensity, perceived fatigue (Borg Rating of Perceived Exertion (RPE) scale 6-20) and possibly in terms of anxiety, chest pain and dyspnea (on the Anxiety, Angina and / or Dyspnea scales). If requested by the patient's physician, the therapist can monitor the patient's heart rate and blood pressure during these activities.

The modified[e] Shuttle walk test (SWT) is used to determine the patient's functional exercise capacity. The MET method and the Specific Activity Scale (SAS) can be used to estimate whether any discrepancy between the actual performance level and the target level can be eliminated with a suitable training program. Finally, the physical therapist measures the patient's maximum inspiratory pressure (Pimax) using a Pimax meter.
The same measurement instruments used at this examination will also be used at the interim and final assessments.
Part of the activity assessment involves the physical therapist observing how the patient copes with their health problem, for instance if they show fear of exercise. As regards the patient's psychosocial functioning, the role of the physical therapist is to signal and report any problems.

e *The modified SWT has been validated for heart failure at an initial walking speed of 3 km/h. This initial speed is not feasible for all patients with heart failure. The patient may therefore also use the protocol with a walking speed of 1.8 km/h. The choice of initial speed is up to the physical therapist. Note: The same protocol should be used for both interim and final assessments. For further information see Supplement 3.*

Analysis
The analysis of the patient's health problems focuses on the following questions:
1. What is the patient's current health status in terms of body functions and structures (impairments), activities (limitations) and participation (restrictions)? What is the patient's current physical condition?
   - the basic motor skills (endurance, strength, speed, agility and coordination)?
   - functional exercise capacity using the modified SWT, possibly supplemented by the MET method or the SAS);
   - the maximum inspiratory muscle strength.
2. Are there any physical factors that may hamper efforts to improve the patient's physical condition, such as:
   - limited cardiac performance (check referral information provided by the cardiologist);
   - other diseases (comorbidities) or disorders (e.g. musculoskeletal problems, osteoarthritis, COPD, peripheral vascular disease, obesity, cancer, type 2 diabetes mellitus or CVA)?
3. Are there any other (internal or external) factors that could unfavorably affect the patient's natural ability to improve their physical condition, such as:
   - psychological impediments: anxiety, depression, emotional instability, stress, perceived disability, sleep disturbance;
   - dyspnea and fatigue;
   - lifestyle: smoking, lack of physical activity, dietary habits, alcohol use;
   - use of medication;
   - social network and social functioning?
4. What is the patient's target status in terms of the ability to perform activities of daily living, leisure activities, work and hobbies (patient's presenting problem, likely physical improvement and goal)?
5. Is the target status feasible in view of the conclusions drawn at points 2 and 3; in other words, can the impediments be reduced?
   - If not: what approach can be used to optimize the situation / degree of acceptance?
   - If yes: what approach can be used to reduce or eliminate the impediments and improve the patient's physical condition?
6. In view of the above, what options does physical therapy offer to alleviate the patient's health problem, that is, to improve the patient's body functions, activities and participation?

A patient may also experience health problems in other domains, whether or not associated with the heart disease, for which physical therapy is indicated. Where possible, these problem areas are taken into account in the rehabilitation program. If necessary, the physical therapist should consult the relevant KNGF guideline or the recommendations for physical activity.

Treatment plan
The information required to design a treatment plan comes partly from the multidisciplinary team and partly from the physical therapist's own analysis.
The following information is relevant for the treatment plan:
- the (medical) diagnosis;
- the diagnostic and prognostic referral details about the patient's physical condition (i.e. what the patient can physically handle), insofar as they are deemed relevant by the referring physician;
- all individual rehabilitation goals, but especially those regarding physical training and possible impediments to training, such as anxiety, a dysfunctional coping style, risk of decompensation and comorbidities;
- the results of the maximum or symptom-limited exercise test with gas analysis;
- if the patient has an ICD or pacemaker, the settings (e.g. the heart rate range at which the patient can safely exercise);
- all medications (type and dosage);
- the physical therapy diagnosis;
- information concerning work resumption and prognosis (especially for younger patients);
- any relevant further information about the patient's family and social support.

Table 8 lists the goals that can be pursued by means of physical therapy.
The specific goals apply to all heart failure patients. The general goals must be taken into consideration in efforts to attain the specific goals. For instance, working on general goals 1 and 2 should lead to an efficient balance between the patient's exertion level and their ability to cope with it. If the patient perceives their exercise capacity to be limited, the treatment should focus on goal 1 and/or goal 3. The problems addressed in goals 1 and 3 are often the starting points for treatment. Patients can only be trained if they first lose their fear of exertion and/or first explore their own limits, to prevent further deterioration of their physical condition. However, increasing the exercise capacity proves to be impossible for a substantial proportion of patients with heart failure. In such cases, the goal may be to maintain their current exercise capacity. An important goal is always to stimulate the patient to develop an active lifestyle. During the training sessions, the physical therapist teaches the patient to recognize signs of excessive strain and decompensation (see Section A.3.2).
The physical therapist determines the training intensity based on the results of the maximum or symptom-limited exercise test with gas analysis (referral information). The physical therapist must take account of any physical impairments that may hamper the improvement or preservation of the patient's physical condition (item 2 in the analysis), as well as other (internal or external) factors that could unfavorably affect the patient's natural ability to improve their physical condition (item 3 in the analysis) and the patient's personal training goals.

The following information is relevant in determining the training intensity:
- the patient's current physical condition, based on the maximum or symptom-limited exercise test with gas analysis (spiro-ergometry);
- the protocol used;
- the referring physician's evaluation of the electrocardiogram before, during and after exercise (criteria for cardiac ischemia, arrhythmias and the practical consequences of the findings);
- the heart rate at rest, the maximum heart rate and recovery heart rate (especially during the first minute);
- the maximum VO_{2max} and wattage achieved (and the percentage of the predicted value);

Table 8. Goals that can be pursued by means of physical therapy.

specific goals	description
I. optimizing exercise capacity	Attaining or preserving the intended physical condition. Training for patients in NYHA Class III mostly aims at preserving their exercise capacity and teaching them to use their limited energy in a sensible way. Training for patients in NYHA Class II aims to improve their physical condition to such an extent that they can function at the target or attainable level during ADL, at work or while engaging in sports and/or hobbies.
II. balancing exertion with physical abilities	Patient learns to adapt their exertion level to their physical abilities, is able to spread exertions and rest periods (work / rest) over the day and is able to recognize signs of exacerbation.
III. reducing dyspnea, fatigue and inactivity	Reducing, recognizing and coping with dyspnea (improving breathing control; more regular breathing). Efficient use of abilities and limited energy is essential to prevent severe fatigue (especially in NYHA Class III). Patient is encouraged to remain as physically active as possible (preventing deconditioning).
general goals	**description**
1. exploring one's own physical limits	Patient is able to deal with their own physical limits in daily life without assistance. Confronting patients with their objective and subjective limits teaches them what physical exertion is possible, i.e. what their physical limits are.
2. learning to cope with physical limitations	Confronting patients with their own physical limitations in various situations requiring movement and various forms of exertion, and teaching them to cope with these limitations. Patients in NYHA Class II can also be confronted with the limitations during ADL activities. This goal can only be attained if the patient comes to accept their situation. The dosage regime of the exercise load is decided in consultation with the patient. Active involvement is important to translate this dosage regime into everyday activities.
3. overcoming fear of physical exertion	Patient becomes familiar with exercise, thereby reducing their fear of exertion, both during and after rehabilitation.
4. developing and maintaining a physically active lifestyle	Patient discovers that exercising can be enjoyable, so that they will continue an active lifestyle in the home setting (including risk factor reduction). Patient learns to integrate exercise activities into their everyday routines and to recognize symptoms of decompensation at an early stage. The aim is to get patients to perceive the activities as routine, so that they will continue them in Phase III (within the limits of their abilities).

- blood pressure changes at rest, during exercise and during the recovery phase;
- the reason for terminating the test and the level of the impairment (central or peripheral);
- medication use (type and dosage);
- the patient's subjective symptoms during the test (angina/ dyspnea) and their Borg score;
- spiro-ergometry: gas exchange parameters like maximum oxygen uptake (VO_{2max}), the percentage of predicted VO_{2max}, O2-pulse, maximum respiratory minute volume (V_E) (tidal volume (TV) and respiratory rate), respiratory exchange rate (RER), anaerobic or ventilatory threshold, VE/VCO_2 ratio, saturation and any other relevant parameters (e.g. VO_2-oxygen uptake efficiency slope and the presence of respiratory oscillations);
- the maximum voluntary ventilation (MVV), which may be derived (37.5 x the forced expiratory volume (FEV_1)).

B.2.2 Therapeutic process in Phase II for chronic heart failure

The therapeutic process consists of information/advice, a tailored training program and a relaxation program.
The physical therapist systematically evaluates the treatment goals, during and at the end of the treatment.

Information / advice

Education about the disorder and the importance of treatment are required to enable the patient to cope effectively with their heart failure. Information and advice must be given in a multidisciplinary context.
Aims of information and advice may include:

- *Improving the patient's understanding of their disorder and rehabilitation*. The physical therapist educates the patient about the nature and cause (complexity and symptoms) and the course of heart failure, as well as healthy living, rehabilitation (goals, nature and expected duration of the treatment), risk factors (like smoking and overweight), prognosis and

specific symptoms/signs (such as dyspnea and severe fatigue) at rest and during exertion and ways of coping with them (by spreading their energy and exertions evenly over the day).
- *Multidisciplinary education on lifestyle*. This type of education relates to topics like regular/daily exercise, measuring one's body weight every day (preferably in the morning after getting up and emptying one's bladder), limiting sodium intake, fluid intake (limiting fluid intake to 1.5–2 L a day may be considered for patients in NYHA Class III), alcohol intake (limiting intake to 1–2 units a day, or total abstinence if alcohol-related cardiomyopathy is present or suspected), losing weight if obese (with the aim of reducing symptoms and progression of heart failure and promoting general well-being), unintentional weight loss (routine recommendations to lose weight are not indicated in all cases, as unintentional weight loss and chachexia are common in more advanced heart failure) and giving up smoking.
- *Recognizing signs of deterioration (decompensation) of the heart failure*. Such signs should be responded to with the right measures, like adjusting diuretics dosage or seeking medical advice. The patient can temporarily adjust their diuretics dosage, based on any known or predictable fluid balance problems (like rapid weight gain, exacerbation of dyspnea (orthopnea), increased sodium uptake, diarrhea, vomiting, fever and excessive perspiring). Heart failure may deteriorate not only due to weight gain, but also due to psychological problems like depression and anxiety, as well as certain personality traits. Symptoms of deterioration that should induce the patient to contact their doctor or specialist heart failure nurse include:
  - increasing (unexpected) dyspnea (raise the bed or use an extra pillow);
  - increasing or incipient angina;
  - unexpected weight gain (over 2 kg within 2–3 days) or visible fluid retention, for instance finding that their trouser belt needs to be loosened or shoes become too tight (patient may adjust diuretics dosage);
  - increasing fatigue (with normal ADL activities like stair walking);
  - persistent or recurrent dizziness and collapse;
  - agitation or cognitive changes, confusedness;
  - palpitations;
  - sleeping problems due to nocturnal dyspnea;
  - sudden, unexplained mobility problems;
  - abdominal pain, sense of full stomach, loss of appetite;
  - more frequent micturition (less so during the day than at night, which is a sign of fluid retention).
- *Promoting compliance*. The learning process involves continuing the regimens, functions, activities and behaviors the patient has learned during the treatment, and incorporating them into their daily life. The patient will have to learn and develop an intuition for ways to cope with their heart failure.
- *Promoting effective ways of dealing with symptoms and exertion in daily life (level of dyspnea and fatigue)*. The patient must learn to correctly interpret and control their symptoms. The learning process may be based on reducing anxiety and accepting one's physical limitations, removing any barriers / thresholds that hamper exercise, and promoting self-management and self-efficacy. The physical therapist must take care not to give the patient unclear or contradictory information. Reassuring information can have a favorable effect on patients who have too negative a view of their own cardiac condition, and thus help to prevent unnecessary disability. The patient's partner should be involved in the information process, especially if this partner is extremely worried.
- *Work / Occupational activities*. Where applicable (most patients are past retirement age) the physical therapist includes aspects of paid work or returning to work in their communication with the patient. Having a paid job or returning to work will certainly not be an option for all patients (on average, this will not be possible for patients in NYHA Class III).

Training program (tailored)

A doctor must be available on call during the training program at a (usually specialized) rehabilitation center or at the hospital rehabilitation center where the cardiac rehabilitation takes place.

The goal of the training program is to optimize the patient's exercise capacity, within the limits of their abilities.

The training program is intended for patients:
- who have been referred by a cardiologist;
- who have been hemodynamically stable for more than 3 weeks;
- who are in NYHA Class II or III;
- whose medication regime has been optimized.

Contra-indications for participation in the training program include:
- progressive increase in heart failure symptoms;
- severe ischemia of the cardiac muscle upon exertion;
- dyspnea while speaking;
- respiratory frequency of more than 30 breaths per minute;
- heart rate at rest > 110 bpm;
- VO_{2max} < 10 mL/kg/min;
- ventricular tachycardia upon increasing exertion;
- poorly controlled diabetes mellitus (in consultation with patient's internal medicine specialist);
- fever;
- acute systemic diseases;
- recent pulmonary embolism (< 3 months ago) causing severe hemodynamic strain;
- thrombophlebitis;
- acute pericarditis or myocarditis;
- hemodynamically serious aortic stenosis or mitral valve stenosis;
- heart valve failure constituting an indication for surgical intervention;
- myocardial infarction less than 3 weeks before the start of the training;
- atrial fibrillation with rapid ventricular response at rest (> 100 bpm);
- serious cognitive problems (memory, attention and concentration);
- weight gain of > 3 kg within a few days, whether or not accompanied by increased dyspnea at rest.

The physical therapist should keep an eye on the patient's training intensity, observe their individual response, the way they tolerate the exercise load and their clinical stability, and check whether the patient shows any signs of excessive strain (monitoring). To this end, blood pressure, fatigue (Borg RPE scale 6–20) and heart rate (and heart rhythm) are assessed in all patients before, during and after the training program.
The exercise session must be terminated if any of the following reasons for excessive strain apply:

- severe fatigue or dyspnea out of proportion to the level of exertion;
- increase in breathing rate out of proportion to the level of exertion;
- low pulse pressure (< 10 mmHg);
- reduction of systolic blood pressure during exercise (> 10 mmHg);
- increasing ventricular or supraventricular arrhythmias;
- angina;
- vegetative reactions like dizziness or nausea.

Patients at high risk of excessive cardiac strain (based on an abnormal electrocardiogram [ECG] during the maximum or symptom-limited exercise test), may need to have their cardiac rhythm monitored by ECG, if indicated by their doctor.
The following safety criteria should be observed:

- If the patient has an ICD device, the physical therapist must consult the patient's cardiologist about the safe heart rate range during the training program. Cardiologists impose certain restrictions on patients for the first 6–8 weeks after their ICD or pacemaker is implanted, such as 'don't lift any heavy objects' or 'be cautious about moving the arm on the side where the device was implanted', which the physical therapist must take into account when implementing the training program.
- Patients who have undergone a CABG (or another operation involving sternotomy) are advised not to engage in (submaximal) strength training of the upper extremities during the first 6–8 weeks, so as not to hamper the consolidation of the sternum. The guideline development team is of the opinion that symmetrical functional movements below the patient's pain threshold (with comfortable rather than forceful movements and controlled breathing) can be started within 6 weeks after surgery (which can also help to prevent the development of a frozen shoulder).
- For patients with comorbidities, the physical therapist should consult the current KNGF guidelines. The guideline development team recommends paying special attention to the safety aspects mentioned in the relevant guidelines, and emphasizes the following criteria for patients with type 2 diabetes mellitus and those with pulmonary problems.
  - The physical therapist should regularly check a patient with type 2 diabetes mellitus for wounds and sensory defects (monofilament test). In addition, the physical therapist should check the diabetic patient's blood glucose values before, during and after the exercise session. Retinopathy of grade ≥ 3 and blood glucose values ≤ 5 and ≥ 15 mmol/L are relative contra-indications for exercising.
  - Patients with pulmonary problems must not be allowed to desaturate; this usually means that 02 saturation (Sa02) should remain ≥ 90% during exercising (and should not fall by ≥ 4%). The physical therapist should consult the patient's pulmonologist or cardiologist to decide on the minimum individual saturation value.

The training program is designed on the basis of:

- the patient's specific symptoms (i.e. the activities indicated in the PSC questionnaire) and abilities;
- the patient's physical condition (as assessed by maximum or symptom-limited exercise test with gas analysis);
- the patient's individual goals.

These aspects determine the priorities in the training program, the nature and type of activities included in it and the training variables to be used.

Prioritization
The patient's individual physical therapy goals determine what aspects of the training program have to be given priority (see Table 9).

Nature and type of exercise activities
Patients may use a bicycle or rowing ergometer, treadmill, fitness equipment, sports/games, water-based exercises, ADL-, work- or hobby-related activities, functional exercises or relaxation. The exercise activities should present the most effective and specific physical stimuli to improve or optimize the patient's functioning in daily life, within the limits of their abilities (e.g. activities derived from the results of the PSC).
One consideration in the choice of exercise activities is always to get the patient to enjoy exercising, in order to promote their self-management, and encouraging them to develop a more physically active lifestyle

> The guideline development team recommends that bicycle ergometers and other exercise equipment be calibrated, in view of the large variability in loads.

Training variables and loading stimuli
The specific training variables to be used depend on the patient's physical condition and the presence of comorbidities and risk factors.

Training variables for aerobic training include:

- training frequency;
- training duration;
- training intensity;
- work / rest intervals;
- content and dosage of exercises.

If the aim is to improve the patient's objective aerobic exercise capacity, the choice of training variables should also be based on the physiological exercise principles of 'specificity', 'overload (sufficient intensity)', 'supercompensation', 'diminishing returns' and 'reversibility'.
The intensity of strength training is determined by the external resistance against muscle contraction, as well as the speed, the number of repeats, the number of series and the recovery interval between series, and depends on the goal of the strength training

(increasing maximum strength, promoting hypertrophy or increasing muscular endurance).
In the case of comorbidities, the guideline development team recommends starting the training program based on the exercise principles relating to the most restrictive pathology or disorder. A low-intensity start is recommended in case of doubt.

Aerobic endurance or interval training
Aerobic endurance or interval training increases the exercise capacity and quality of life of patients with chronic heart failure (NYHA Classes II-III). The mechanisms underlying these beneficial effects involve improvement of the patient's muscle perfusion, muscle metabolism, breathing efficiency, neurohormonal regulation and cardiac pump function.
The results of a maximum or symptom-limited exercise test with gas analysis can be used to calculate the individual training intensity. The patient's training intensity should preferably be based on a percentage of their VO_{2max}, their $VO_{2reserve}$ (the difference between the VO_{2max} and the VO_2 at rest) or the ventilatory or anaerobic threshold, converted into heart rate or wattage.
If no gas analysis has been done (which may happen in exceptional cases), the maximum heart rate attained can be used to calculate the training zone. In both cases, the Karvonen formula is used to calculate the training heart rate as a percentage of the heart rate reserve (the difference between the maximum heart rate and the heart rate at rest), added to the resting heart rate. If the patient's heart rate does not rise sufficiently during the maximum or symptom-limited exercise test with gas analysis, the training intensity should be based on a percentage of the maximum capacity expressed in Watt or METs, and/or the Borg score (6–20).
The patient's exercise capacity can be increased by means of aerobic endurance or interval training, preceded by warming up and followed by cooling down. The intensity can be gradually raised

Physical targets can be attained by means of aerobic training (preferably interval training), supplemented if necessary by strength training of peripheral muscle groups and/or inspiratory muscles.

from 50% to 80% of their VO_{2max} or $VO_{2reserve}$, as measured by the maximum or symptom-limited exercise test with gas analysis. Intensive aerobic interval training may consist of four 4-minute blocks, during which the patient trains at an intensity of 80-90% of their VO_{2peak}, with 3 minutes of active recovery during which they exercise at an intensity of 40-50% of their VO_{2peak}. Patients should preferably start with two weeks of exercise at 40-50% of their VO_{2max}. Patients with a VO_{2max} > 10.5 mL/kg/min, but < 17.5 mL/kg/min (3-5 METs/40-80 W) appear to benefit most from 1 to 2 training sessions a day for 15 minutes, focusing on aerobic interval training. Patients with a VO_{2max} > 17.5 mL/kg/min (≥ 5 METs / ≥ 80 W) can limit their training to 2 to 3 sessions a week, for 20-30 minutes per endurance training session.

Strength training
Strength training involves training peripheral muscle groups and the inspiratory muscles.
Strength endurance training of peripheral muscle groups may be considered in preparation for, or as an adjunct to, aerobic endurance or interval training for patients with stable chronic heart failure. This type of training is particularly suitable for patients who experience strength-related limitations in activities of daily living and during social participation. The strength training starts with a 2-week pretraining program, with 2–3 series against a low resistance(< 30% of the repetition maximum (1RM)). After this pretraining period, the patient's 10RM is determined, in order to estimate their maximum strength. A protocol is used to determine

Table 9. Priorities within the training program.

prioritization	intended outcome
practicing skills and activities (to enable the patient to utilize their general or strength endurance in motor activities) training aerobic (general) endurance and encouraging physical activity	optimized skills and increased activity level; improving ADL functioning; awareness of one's own physical limits; learning to cope with limited exercise capacity; learning to cope with dyspnea; optimizing or preserving general endurance; improving blood pressure and heart rate response during suboptimal exertion; reducing O_2 requirement of myocardium; reducing peripheral vascular resistance; efficient ventilation, reducing risk factors
training local strength endurance of peripheral muscle groups and / or inspiratory muscles	optimizing muscle strength and local endurance; improving housekeeping, hobby and possibly sports activities; if applicable, improving ability to work; reducing sensation of dyspnea; increasing maximum oxygen uptake; increasing muscle strength of respiratory muscles
practicing functions / activities to make patient realize that exercise can be enjoyable, to increase physical activity and to modify risk factors	patient enjoys exercise; integration of exercise activities in daily routine; physically active lifestyle (within the limits of patient's abilities, depending on prognosis and severity of heart failure); good balance between relaxation and exertion; reducing risk factors, e.g. increased energy expenditure as a precondition for obesity / overweight reduction, reducing fear of exertion, anxiety and stress, improved blood pressure response, reduced hypercholesterolemia, improved insulin sensitivity of patients with type 2 diabetes mellitus

the patient's resistance level for strength training (see Supplement 5). Muscle strength can be improved by gradually increasing the external resistance from 40% to 65% of the 1RM. The guideline development team recommends training the large muscle groups at a frequency of 2–3 times a week, in 2–3 series of 10–15 repetitions. The training program may also include training the respiratory muscles by means of inspiratory muscle training (IMT), as an adjunct to aerobic endurance or interval training. IMT results in increased Pi_{max} and reduced sensation of dyspnea in heart failure patients (NYHA Classes II–III) with a maximum inspiratory pressure (Pi_{max}) < $70\%_{predicted}$ or a ventilatory impairment (according to the maximum or symptom-limited exercise test with gas analysis). IMT should be practiced against a resistance of 20–40% of Pi_{max} for 30 min/day or 2 times 15 min/day, on 3–4 days a week, preferably for a period of 8–12 consecutive weeks, using a threshold device.

Relaxation program

The physical therapist may consider offering a relaxation program as an adjunct to the training program. A relaxation program can lead to tranquility (a more quiet / less stressful mind), better breathing control (more regular breathing), reduced sensation of dyspnea and a better quality of life (stress reduction).
The patient should attend 2 sessions to try out the relaxation program. If the program proves beneficial, they attend a further 6–8 sessions lasting 60–90 minutes each. The program addresses themes like tranquility, the balance between exertion and rest, the influence of psychological factors on physical functioning and the differentiation between cardiac factors in relation to stress, ways of dealing with anger, anxiety, depression and pressure of time. Instructions for relaxation can be given during exercising (active relaxation) or at rest (passive relaxation), partly in the context of warming up and cooling down, and partly as a separate relaxation program.

Interim and final evaluations

The physical therapist should 'continuously' evaluate the patient during the treatment. In addition, a more comprehensive interim evaluation should be carried out at least every 4 weeks, or more often if necessary. A final evaluation must be carried out at the end of the rehabilitation program. Which screening instruments are used for these evaluations, and what is measured, is determined by the patient's individual rehabilitation goals.
One of the following situations may prevail in the final evaluation at the conclusion of the rehabilitation program:

- The patient has attained their goals.
- The patient has partially attained their goals, and it seems likely that they will be able to continue the training activities elsewhere, under supervision, and thus attain their goals eventually.
- The patient has not attained their goals and it seems likely that they have attained their maximum achievable level.

Patients with heart failure are referred to Phase III activities; in exceptional cases they may be referred to clinical rehabilitation. Table 10 lists the intended outcomes for the various general and specific physical goals, as well as recommendations for assessment and evaluation. Two new evaluation points have been added to this: 'acquiring information about heart failure and healthy living' and 'evaluating the goals of the relaxation program'.

B.3 Post-rehabilitation phase (Phase III) in chronic heart failure

Patients with heart failure should be advised and encouraged to continue training (for the rest of their lives) after the Phase II training period has ended, at a physical therapist's practice or at a certified exercise facility (i.e. one registered with the Dutch *Hart- en Vaatgroep* patient association) or independently.
Heart failure patients who are advised to engage in high-intensity maintenance training (≥ 60% of VO_{2max}) are referred to a physical therapist's practice or a certified exercise facility that offers professional supervision. Physical therapists wanting to work with heart failure patients in primary care are urgently advised to attend a KNGF-accredited course on 'heart failure for primary care physical therapists' before they start treating these patients. Patients should preferably continue their training activities at a primary care practice that is part of a local 'network' which includes the hospital or rehabilitation center where the cardiac rehabilitation program took place, as this implies easy access and frequent contacts.
Patients requiring low- or moderate-intensity maintenance training (< 60% VO_{2max}) can choose to do this independently, or at a certified exercise facility (provided supervision and coordination by a secondary care physical therapist or a cardiologist is available).
If a patient is likely to soon relapse into an inactive lifestyle, they should be offered a training program at a primary care physical therapist's practice, under the supervision of a physical therapist who has attended the course on 'heart failure for primary care physical therapists'.
All patients with heart failure should be monitored by secondary care professionals to check whether they are keeping up an active lifestyle (preferably 6 and 12 months after the cardiac rehabilitation has ended), in order to identify relapses at an early stage and intervene. This is often done by the patient's cardiologist during outpatient consultations.

Table 10. Evaluation and screening instruments for each goal in physical therapy for chronic heart failure.

goal	final outcome	evaluation instrument	when
specific physical goals			
I. optimizing exercise capacity	Exercise capacity is at optimum or target level for this patient	**by physician** • maximum or symptom-limited exercise test with gas analysis plus Borg RPE scale (6–20); possibly scoring Anxiety, Angina and/or Dyspnea scales **by cardiac rehabilitation coordinator** • subjective physical score on KVL-H questionnaire	maximum or symptom-limited exercise test with gas analysis and KVL-H questionnaire at start and end of training program
	Functional exercise capacity is at optimum or target level.	**by physical therapist** • as for goals 1 and 2 • (modified) SWT • possibly MET method and/or SAS	at start, every 4 weeks and at end of training program
II. balancing exertion with physical abilities	Patient (and partner) coping effectively with symptoms, that is, patient avoids excessive strain and (if possible) improves exercise capacity (goal 1). Patient is able to spread their energy expenditure and to deal with their dyspnea in a functional way.	• compare subjective exercise capacity score with objective score • ask for 5 most problematic activities (PSC) and score these on the Borg RPE scale (6–20); possibly score Anxiety and/or Angina and/or Dyspnea scales	at start and end of rehabilitation and / or training program, but also continuous evaluation to check for excessive strain
III. reducing fatigue, dyspnea and inactivity	Patient's sensation of dyspnea is at optimum or target level. Patient has adopted a physically active lifestyle.	• Borg RPE scale (6–20) and Dyspnea scale for fatigue and dyspnea • Monitor Bewegen en Gezondheid, see goal 4 (www.tno.nl) (in Dutch)	at start and at end of rehabilitation and / or training program
general physical goals			
1. exploring one's own physical limits	Patient is aware of their own physical limits, that is, they know what level of physical exertion is possible.	• ask for 5 most problematic activities (PSC) • ask patient to carry out problematic activities and possibly score them for duration and quality, or using the Anxiety and / or Angina and / or Dyspnea scales. • score using Borg RPE scale (6–20) for fatigue and dyspnea, if indicated	at start and end of rehabilitation and / or training program; monitoring heart rate, measuring blood pressure and scoring on Borg scale before, during and after each session
2. learning to cope with physical limitations	Patient is able to cope with their physical limitations and utilize their limited energy efficiently, and has achieved a balance between exertion and relaxation.		

Table 10. Continued.

goal	final outcome	evaluation instrument	when
3. overcoming fear of exertion	Patient is no longer afraid of exertion.	• history-taking and observation • questionnaire: see Multidisciplinaire Richtlijn Hartrevalidatie 2011 (www.nvvc.nl) (2011 Dutch multidisciplinary guideline on cardiac rehabilitation) (in Dutch)	at start and end of rehabilitation and / or training program
4. het ontwikkelen van een actieve leefstijl	Patient has adopted an active lifestyle or is able to keep up the most active achievable lifestyle (NYHA Class III).	• history-taking (motivational interviewing) • Monitor Bewegen en Gezondheid (www.tno.nl) (in Dutch) • post-rehabilitation activities started	at start and at end of rehabilitation and / or training program
Focal points			
acquiring information about healthy living and secondary prevention	Patient knows about healthy living and secondary prevention.	• checklist for risk factors / unhealthy behavior • Phase III activities started • ability to cope effectively with symptoms • ability to recognize signs of decompensation	at start and at end of rehabilitation and / or training program
goals of relaxation program	Patients is familiar with the relaxation program and is able to relax.	• evaluation list • using a flowchart: See Verantwoording en toelichting (review of the evidence; in Dutch) Section B.3.3 (www.kngfrichtlijnen.nl)	at interim and final evaluation of rehabilitation and / or relaxation program

Borg RPE scale = Borg Rating of Perceived Exertion; KVL-H = Kwaliteit van Leven vragenlijst voor Hartpatiënten (Dutch quality of life questionnaire for heart patients); 6MWT = 6-Minute walking test; MET = metabolic equivalent of task; PSC = Patient-specific complaints; SAS = Specific activity scale; SWT = Shuttle walk test.

C Reporting, concluding the treatment and record-keeping

The physical therapist must report to the cardiac rehabilitation team about the treatment process, the treatment outcomes and the recommendations (aftercare). This should happen at least at the end of the treatment, but possibly also during the treatment period. In addition, the physical therapist also informs the patient's cardiologist, family physician and, if applicable, their rehabilitation physician or company doctor. The cardiac rehabilitation program is then either continued or concluded, after consultation with the rehabilitation team.

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The inclusion of the above persons as consultants does not imply that each of them agrees with every detail of the Guideline.

Supplements

Supplement 1 Recommendations

Introduction

The level of evidence of the conclusions based on the literature has been categorized on the basis of Dutch national agreements (EBRO/CBO). A distinction is made between four levels, based on the quality of the articles from which the evidence was obtained:

Level 1: study at A1 level or at least two independent A2 level studies
Level 2: one study at A2 level or at least two independent B level studies
Level 3: one B or C level study
Level 4: expert opinion

Quality levels (intervention and prevention)

A1 Systematic review of at least two independent A2 level studies
A2 Randomized, double-blind, comparative clinical trial of good quality and sufficient sample size
B Comparative study not meeting all criteria mentioned under A2 (including case-control studies and cohort studies)
C Non-comparative study
D Opinions of experts, for instance the members of the guideline development team

If a systematic review comprised RCTs of moderate quality, the quality of the literature was classified as B rather than A1. Depending on the number of moderate quality (B-level) studies, the conclusion was allocated an evidence level of 2 (≥ 2 RCTs of moderate quality) or 3 (1 RCT of moderate quality).

If a comparative study failed to meet any of the criteria for A2 level research, it was allocated a C quality status.

Summary of recommendations for patients with coronary heart disease

1 Preoperative physical therapy, including 'inspiratory muscle training' (IMT)

Preoperative physical therapy including IMT is recommended for patients who have undergone a coronary artery bypass graft (CABG) operation and / or valve replacement and are at high risk of developing a postoperative pulmonary complication (PPC).
The risk of developing a PPC is calculated using the following scoring system.
The risk is low if the total score is ≤ 1, and high if the total scorre is ≥ 2.

parameters	score
age > 70 years	1
productive cough	1
diabetes mellitus	1
smoking	1
COPD: FEV_1 < 75%$_{predicted}$ or requiring medication	1
BMI > 27.0 kg/m^2	1
lung function: FEV_1 < 80%predicted and FEV_1/FVC < 70%$_{predicted}$	2

PPC = postoperative pulmonary complication; COPD = chronic obstructive pulmonary disease; FEV1 = forced expiratory volume in 1 second; FVC = forced vital capacity.

IMT is carried out using an inspiratory threshold device. The guideline development team recommends starting IMT at least 2 weeks, and if possible 4 weeks, before the operation, at a frequency of 7 days a week for 20 minutes at an intensity of 30% of Pi_{max}. The resistance should be adjusted once a week on the basis of the Borg score (0-10). If the Borg score (0-10) is < 5, the resistance should be increased by 5%.
The treatment also focuses on coughing, huffing and breathing techniques, to promote sputum evacuation and stimulate optimum ventilation, and on preserving or improving physical fitness (in consultation with the patient's cardiologist).

2 Stay at intensive care unit (ICU) or coronary care unit (CCU)
Relative rest is indicated; PPCs are treated if necessary. The physical therapist checks for problems of mucus clearance and ventilation. Treatment is given if necessary (as indicated by the pulmonologist or other specialist). The perioperative pulmonary treatment by the physical therapist involves explaining the purpose of physical therapy, teaching the patient techniques to improve ventilation and to mobilize and cough up sputum (breathing, huffing and coughing techniques) and advising the patient.

3 Mobilization phase for patients with coronary heart disease
The guideline development team recommends starting active functional exercises, such as ADL-related exercises, walking and stair climbing, at an early stage of this phase. The goal is to help the patient improve their physical (ADL) functioning to the highest attainable level.
(≥ 3–4 METs). The physical therapist educates the patient about the nature of their heart disease (and possibly about the operation and the postoperative course), effective ways of coping with cardiac and other symptoms and the disease itself, ways to recognize signs of excessive strain and the way the intensity of activities at home can be gradually increased. If relevant, the physical therapist educates the patient about possible pains at the surgery site, strains on the wound and the right posture and way to move.

4 Aerobic exercise for patients with coronary heart disease
Aerobic exercise is recommended for patients with coronary heart disease. The exercise principles to be applied depend on the goals of the physical therapy and the patient's physical condition.
If the goal is to improve the patient's exercise capacity, the aerobic endurance or interval training level can be gradually increased over a number of sessions from 50 to 80% of VO_{2max}, 20–30 minutes per session, ≥ 2–3 times a week. High-intensity interval training appears to be more effective than moderate-intensity endurance training. High-intensity interval training may consist of four 4-minute blocks, during which the patient exercises at an intensity of 80–90% of their VO_{2peak}, with 3 minutes of active recovery during which they exercise at 40–50% of their VO_{2peak}. Interval training is indicated for patients in poor physical condition; if the patient is in sufficiently good physical condition, both endurance training and interval training can be used. Patients should start with two weeks of exercise at 40–50% of their VO_{2max}.

5 Submaximal strength training for patients with coronary heart disease
Submaximal strength training is recommended as an adjunct to aerobic exercise for patients with coronary heart disease, especially patients who experience exertion-related limitations regarding ADL, social participation and return to work, due to lack of muscle strength and strength endurance. Muscle strength can be improved using 8–10 exercises of the large muscle groups, at a frequency of 2–3 times a week (depending on the goals) against a resistance that is gradually increased from 50% to 70–80% of the 1RM. Exercising should preferably start with 2 weeks at 30–40% of 1RM.

6 Relaxation therapy as a component of cardiac rehabilitation for patients with coronary heart disease
Relaxation therapy is recommended for patients with coronary heart disease. The relaxation program addresses cognitive themes like understanding the value of rest, the balance between exertion and rest, the influence of psychological factors on physical functioning and differentiating between cardiac factors in relation to stress, anger, depression and pressure of time. The patient should attend 2 sessions to try out the relaxation program. If the program proves beneficial, they attend a further 4–6 sessions lasting 60-90 minutes each.

7 Adoption and monitoring of physically active lifestyle for patients with coronary heart disease
Patients may be referred to exercise programs offered by certified exercise facilities (i.e. those registered with the Dutch *Harten Vaatgroep* patient association), but may also individually make use of regular sports facilities. Patients with coronary heart disease who are unable to maintain an active lifestyle without assistance, or have not yet attained all physical goals during the outpatient phase, but are deemed to be capable of doing so, should participate in an exercise program which is designed in accordance with the KNGF guidelines for exercise interventions in coronary heart disease (*KNGF-Standaard Beweeginterventie Coronaire Hartziekten*), or an equivalent KNGF-accredited intervention, supervised by a primary care physical therapist who has completed additional training.
Monitoring is important in order to identify any relapses at an early stage and intervene. The guideline development team recommends monitoring the patient's active lifestyle (preferably after 6 and 12 months), by telephone or using a web-based or printed questionnaire.

Summary of recommendations for patients with chronic heart failure

8 Aerobic endurance or interval training for patients with chronic heart failure

Aerobic endurance or interval training is recommended for patients with chronic heart failure (NYHA Classes II-III). As the patient's physical condition improves, the focus of training may shift from interval training to endurance training.
Intensive interval training can involve interval blocks of 4 times 4 minutes at 80–90% of VO_{2peak}, with active recovery for 3 minutes at 40–50% of VO_{2peak} (as determined by the maximum or symptom-limited exercise test with gas analysis). The endurance training could gradually increase from 50% to 80% of VO_{2max} (or perhaps heart rate reserve or VO_{2max} reserve). The program should preferably start with a 2-week introductory period in which the patient trains at an intensity of 40–50% of VO_{2max}. A frequency of 2–3 times a week is recommended.
Patients with a VO_{2max} > 10.5 mL/kg/min, but < 17.5 mL/kg/min (3-5 METs/40-80 W) appear to benefit most from 1 to 2 training sessions a day for 15 minutes, focusing on aerobic interval training. Patients with a VO_{2max} > 17.5 mL/kg/min (≥ 5 METs / ≥ 80 W) can limit their training to 2 to 3 sessions a week, for 20–30 minutes per endurance training session.

9 Strength training for patients with chronic heart failure

Strength endurance training may be considered in preparation for, or as an adjunct to, aerobic endurance or interval training for patients with stable chronic heart failure. This type of training is particularly suitable for patients who experience strength-related limitations in activities of daily living and during social participation.
The strength training starts with a 2-week 'pre-training' period, involving 2–3 series of 10 repetitions (against a low resistance estimated at < 30% of 1RM). After this pre-training period, the resistance level for strength training can be estimated on the basis of the repetition maximum (RM). The maximum strength should be estimated on the basis of the 10RM.
If the goal is to improve the patient's muscle strength, the external resistance can be gradually raised from 40% to 65% of the 1RM. Training the large muscle groups is recommended, at a frequency of 2–3 times a week, in 10–15 series of 2–3 repetitions.

10 Inspiratory muscle training (IMT) for patients with chronic heart failure

IMT can be included in the training program as an adjunct to aerobic endurance or interval training for patients with chronic heart failure in NYHA Classes II–III with a Pi_{max} < $70\%_{predicted}$ and / or ventilatory limitations (as shown by the maximum or symptom-limited exercise test with gas analysis). The guideline development team recommends IMT using a threshold device against a resistance of 25–45% of Pi_{max} for 15–20 minutes, 3–4 days a week, preferably for a period of 8–12 consecutive weeks. Independent continuation of maintenance training is recommended after the end of the cardiac rehabilitation program.

11 Relaxation therapy for patients with chronic heart failure

The physical therapist may consider offering a relaxation program as an adjunct to the training program.
The heart failure patient should attend 2 sessions to try out the relaxation program. If the program proves beneficial, they attend a further 6–8 sessions lasting 60–90 minutes each.
An important goal of the relaxation program appears to be to teach the patient to calm their mind and to breathe more slowly. In addition, the program may address cognitive themes like understanding the value of rest, the balance between work and rest, the influence of psychological factors on physical functioning and differentiating between cardiac factors in relation to stress, anger, depression and pressure of time.

12 Continuation of a physically active lifestyle by patients with chronic heart failure

The physical therapist should actively refer a patient with heart failure to a Phase III activity; the referral should be effectuated preferably during the rehabilitation period, but definitely at the end of this period.
Patients with heart failure who have to attend high-intensity maintenance training (≥ 60% V02max) are referred to a physical therapy practice or a certified exercise facility (i.e. one registered with the Dutch *Hart- en Vaatgroep* patient association), where professional supervision is available (by a physical therapist who has attended the KNGF-accredited course on heart failure for primary care physical therapists). Patients should preferably continue their training activities in a setting that participates in a local network which includes the hospital or rehabilitation center where the cardiac rehabilitation program took place, as this implies easy access and frequent contacts.
Patients requiring low- or moderate-intensity maintenance training (< 60% of VO_{2max}) can choose to do this independently, or at a certified exercise facility (provided supervision and coordination is supplied by a secondary care physical therapist or cardiologist). If a heart failure patient who is advised to attend low- to moderate-intensity maintenance training is deemed likely to soon relapse into an inactive lifestyle, they should be referred to a training program at a primary care physical therapy practice, under professional supervision.
Monitoring of the active lifestyle is recommended for all patients with heart failure (preferably 6 and 12 months after the end of the cardiac rehabilitation program).

Supplement 2 Borg RPE scale for patients with coronary heart disease and chronic heart failure

The Borg scale is a subjective measure of the patient's level of exertion or their reaction to activities.[1,2] Patients can use the Borg scale to adjust their level of exertion during daily life activities to their limited physical abilities.[2,3] They learn to limit their exertion to a specified level during their daily life activities, e.g. during sports or games.[4]
Patients indicate on a scale from 6 to 20 the degree of fatigue and any dyspnea and / or angina they perceive at a particular level of exertion.
The Borg scale level can be combined with pulse or heart rate measurements (resting, maximum and recovery rates) to give the patient feedback about normal or abnormal symptoms they may experience upon exertion. The Borg scale can also be used to enable patients to learn to listen to their own bodies, to monitor the exertion and spread it over the day, to evaluate the effects of exercise, to overcome their fear of exertion, to explore their physical limits, to increase their self-efficacy and finally to provide feedback to the physical therapist.

Perceived exertion scale

Scale	15 points scale A	15 points scale B
6		no perceived exertion at all
7	very, very light	extremely light
8		
9	very light	very light
10		
11	fairly light	light
12		
13	somewhat hard	somewhat hard
14		
15	hard	hard
16		
17	very hard	very hard
18		
19	very, very hard	extremely hard
20		maximum exertion

Source: Borg[2,3] and Pollock & Wilmore.[5] Table reproduced by kind permission of the original authors/publishers.

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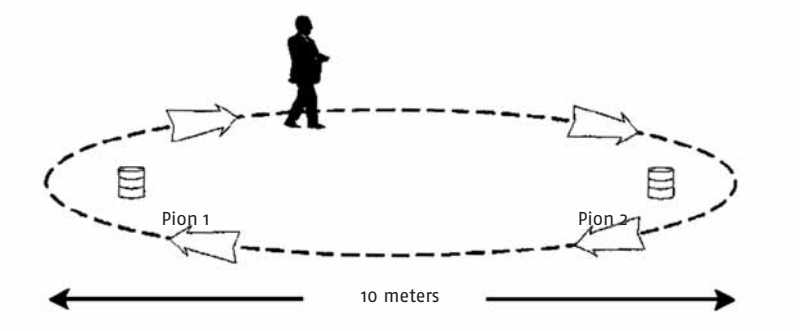
Supplement 3 Shuttle walk test

The shuttle walk test (SWT) is a reliable and valid test for repeated measurements of submaximal functional) exercise capacity.[1-4]
The heart patient walks up and down between two cones at a speed that is indicated by an auditory signal.
The patient starts to walk at the first cone when the signal sounds and walks toward the second cone, where they should have arrived when the next signal sounds. The patient is not supposed to walk ahead of the signal.
After a number of shuttles, the walking speed is increased by reducing the interval between the signals. This happens when the patient moves up another 'step' or 'level'. The patient tries to cover as many rounds as they can.[5]



For patients with **coronary heart disease**, the physical therapist uses the protocol by Singh et al.[6]
For patients with **chronic heart failure**, the therapist preferably uses the test protocol of the modified SWT, which starts at 3 km/h (Hollywood scoring list). If a patient with heart failure is unable to walk at this initial speed, the physical therapist can also use the protocol by Singh et al.[6] The protocol used for the baseline measurement must also be used for the interim evaluation test and the final evaluation.
The physical therapist records the patient's score on the scoring form.

Scoring form for shuttle walk test

Name of patient: _____

Name of physical therapist: _____

		measurement 1	measurement 2	measurement 3	measurement 4	measurement 5	measurement 6
Date							
Weight							
Heart rate	before						
	after						
Fatigue (Borg-RPE scale)	before						
	after						
Dyspnea (Borg-RPE scale)	before						
	after						
Score on shuttle walk test (in meters)							
Reason to terminate shuttle walk test							

Scoring list for Hollywood shuttle walk test

Circle the last fully completed round.

Name of patient: _____

Date: _____

Speed	Time	score	Speed	Time	score	Speed	Time	score
3,0 km/h level 1 2,5 METs	0:00:12	1	5,0 km/h level 5 4,5 METs	0:08:12	52	6,5 km/h level 8 6,0 METs	0:14:03	106
	0:00:24	2		0:08:19	53		0:14:09	107
	0:00:36	3		0:08:27	54		0:14:14	108
	0:00:48	4		0:08:34	55		0:14:20	109
	0:01:00	5		0:08:41	56		0:14:25	110
	0:01:12	6		0:08:48	57		0:14:31	111
	0:01:24	7		0:08:55	58		0:14:36	112
	0:01:36	8		0:09:03	59		0:14:42	113
	0:01:48	9		0:09:11	60		0:14:47	114
	0:02:00	10		0:09:18	61		0:14:53	115
3,5 km/h level 2 3,0 METs	0:02:10	11		0:09:25	62		0:14:58	116
	0:02:20	12		0:09:32	63		0:15:04	117
	0:02:30	13		0:09:40	64		0:15:09	118
	0:02:40	14		0:09:47	65		0:15:15	119
	0:02:50	15		0:09:54	66		0:15:20	120
	0:03:00	16		0:10:01	67		0:15:26	121
	0:03:10	17	5,5 km/h level 6 5,0 METs	0:10:07	68		0:15:31	122
	0:03:20	18		0:10:14	69		0:15:37	123
	0:03:30	19		0:10:20	70		0:15:42	124
	0:03:40	20		0:10:27	71		0:15:48	125
	0:03:50	21		0:10:33	72		0:15:53	126
	0:04:00	22		0:10:40	73		0:15:59	127
4,0 km/h level 3 3,5 METs	0:04:09	23		0:10:46	74	7,0 km/h level 9 6,5 METs	0:16:04	128
	0:04:17	24		0:10:53	75		0:16:09	129
	0:04:26	25		0:11:00	76		0:16:14	130
	0:04:35	26		0:11:06	77		0:16:20	131
	0:04:44	27		0:11:12	78		0:16:25	132
	0:04:53	28		0:11:19	79		0:16:30	133
	0:05:02	29		0:11:25	80		0:16:35	134
	0:05:11	30		0:11:32	81		0:16:40	135
	0:05:20	31		0:11:38	82		0:16:45	136
	0:05:29	32		0:11:45	83		0:16:50	137
	0:05:38	33		0:11:51	84		0:16:56	138
	0:05:47	34		0:11:58	85		0:17:01	139
	0:05:56	35	6,0 km/h level 7 5,5 METs	0:12:04	86		0:17:06	140
	0:06:05	36		0:12:10	87		0:17:11	141
4,5 km/h level 4 4,0 METs	0:06:13	37		0:12:16	88		0:17:16	142
	0:06:21	38		0:12:22	89		0:17:22	143
	0:06:29	39		0:12:28	90		0:17:27	144
	0:06:37	40		0:12:34	91		0:17:32	145
	0:06:45	41		0:12:40	92		0:17:38	146
	0:06:53	42		0:12:46	93		0:17:43	147
	0:07:01	43		0:12:52	94		0:17:48	148
	0:07:09	44		0:12:58	95		0:17:53	149
	0:07:17	45		0:13:04	96		0:17:59	150
	0:07:25	46		0:13:10	97			
	0:07:33	47		0:13:16	98			
	0:07:41	48		0:13:22	99			
	0:07:49	49		0:13:28	100			
	0:07:57	50		0:13:34	101			
	0:08:05	51		0:13:40	102			
				0:13:46	103			
				0:13:52	104			
				0:13:58	105			

Scoring list for the shuttle walk test (12-level protocol according to Singh et al.) [6]

level (m)	speed (km/h)	distance (m)	total distance	duration (minutes)
1	1.80	30	30	1
2	2.41	40	70	1
3	3.02	50	120	1
4	3.63	60	180	1
5	4.24	70	250	1
6	4.85	80	330	1
7	5.46	90	420	1
8	6.07	100	520	1
9	6.68	110	630	1
10	7.29	120	750	1
11	7.90	130	880	1
12	8.51	140	1020	1

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Supplement 4 MET-lijst

The MET method can be used to estimate a patient's exercise capacity. This method makes it possible to indicate the metabolic cost of motor activities independent of the person's bodily dimensions.
For each person, 1 MET is equivalent to that person's basal metabolism while at rest. The number of METs for a particular motor activity is the ratio between the energy cost for that activity and the energy cost at rest.
The number of METs required has been determined for a large number of activities.[1,2] The assumption is then usually that the energy cost while at rest corresponds to a VO_2 of 3.5 $mL/kg^{-1}/min^{-1}$. The physical therapist can use the MET method to estimate whether any gap between the patient's actual and target exercise capacity can be bridged by a suitable rehabilitation program.

Whether a patient is able to carry out a particular physical activity does not depend only on their exercise capacity. It is also influenced by the presence of anxiety, the efficiency with which the patient moves, and their motor behavior and ability to learn to improve it.

The table below lists the number of METs for a number of activities. Note that these are always average values. Estimations of the level of exertion required for a particular activity have to take the patient's individual skills levels into account.

Metabolic equivalents of some activities.

capacity (watt)	**Metabolic equivalents (METs)**	**daily life activities**	**occupational activities**	**leisure activities**	**leisure and**
0	1	sitting quietly, eating		sleeping	
1,5	1,5	washing, shaving		tv kijken kaarten	rechtop staan gedurende 15 minuten naai- en knipwerk
20	2	driving a car, cooking, brushing, mopping, dusting	light desk work (e.g. typing), light handicrafts (while sitting down)	playing music (piano, guitar), light woodworking, drawing, fishing, playing billiards / snooker	light cycling exercises with little or no resistance
40	3	making beds, vacuuming, ironing, polishing furniture,	standing upright for 15 minutes	bowling, golfen (vervoer), schilderen, vliegtuig nemen, autowassen, boogschieten	fietsen 8 km/u, wandelen 3-4 km/u lichte gymnastiek
60	4	showering, cleaning windows, scrubbing the floor, descending stairs, mowing the lawn (motor-driven mower), weeding, raking mown grass together, trimming hedges and lawn edges	assembly line work < 20 kg, driving in screws, electrician, bricklaying, painting, driving a truck, car mechanic	dancing (slow tempo)	fietsen 10 km/u, wandelen 5 km/u, volleybal, tafeltennis (2), golfen, zwemmen (schoolslag), badminton seksuele activiteiten
80-90	5	shopping with heavy shopping bags, sexual activities (with other than own partner), digging in the garden, mowing the lawn (hand-pushed mower)	heavy desk work, wall papering, pushing wheelbarrow, constructing footpath, mixed construction work: digging, brick laying / farming: feeding animals	dancing, river fishing, hunting, playing golf (carrying own bag)	cycling at 12 km/h, walking at 5.5 km/h, horse riding (trot), tennis doubles, badminton singles, rowing (exercise machine)

Metabolic equivalents of some activities.

Capacity (watt)	Metabolic equiva-lents (METs)	daily life activities	occupational activities	leisure activities	leisure and
110	6	ascending stairs, digging holes	digging, manual plowing, using pneumatic drill, transporting objects 20–29 kg, mixed construction site work, mining, carpenter (assembly)	horse riding (gallop), low impact aerobics	walking at 6.5 km/h, tennis singles, canoeing, alpine skiing, ice skating, basketball, football (non-competition)
140	7	shoveling loose snow, chopping wood, walking up gentle slopes carrying weight < 5 kg	sawing wood, laying rails, transporting objects 30–39 kg	dancing (fast; swing)	cycling at 15 km/h, walking at 7.5 km/h, walking up gentle slopes, fencing, ski touring 4–9 km/h
160–170	8	shoveling wet snow, chopping down trees (slowly), walking up a slope carrying a 10 kg weight	manual carpentry (sawing), heavy digging with pickax, transporting objects 40 kg, mucking out stables	high impact aerobics	cycling at 19 km/h, jogging at 8 km/h, cross-country skiing without slopes, swimming (crawl) 35 m/min, horse racing, field hockey
190–200	9	walking up a slope carrying 10–20 kg, comfortable speed	working in high temperatures, at blast furnace, market gardening, manually stacking hay on a cart	cross-country walking	skipping rope 70 – 80 / min, very fast swimming (crawl)
220	10	Carrying weights > 30 kg, carrying 8 kg weight up a slope at 6 km/h	cleaning out slag from blast furnace in steel production		cycling at 23 km/h, playing squash, handball, rowing, skipping rope 125/min, high jump, racquetball, very fast backstroke swimming
240	11			judo	skipping rope 145/min, walking at 10 km/h
260–270	12	carrying weights < 50 kg		rugby	cycling at 25 km/h, walking at 12 km/h, swimming at 3 km/h (1 km in 20 mins)
290	13				walking at 15 km/h
300–340	14–15				walking at 17 km/h
350 en	16 en meer	carrying a 10 kg weight up a 16% slope at 6 km/h	chopping down a tree with an ax (fast)		competition sports, cycling (racing), walking at 18 km/h, dumb-bells > 13 kg

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Supplement 5 Protocol for test to estimate 1RM from 10RM (or more) in patients with chronic heart failure

RM = repetition maximum.

Protocol

1. Select an exercise.
2. Do a warm-up.
3. Practice the correct technical execution of the exercise.
4. Select a starting weight, have the patient do as many repetitions as possible, while maintaining correct technique if possible. The starting weight (in kg) is called Y.
   (Note: Make sure the starting weight is not too high, to enable the patient to complete at least 10 repetitions. Ensure sufficient warming-up.)
5. Look up the corresponding percentage in the table below. There are several options, as a result of overlap between the numbers of repetitions. This percentage is called Z.
6. Calculate the 1RM using the following equation:

   1RM = 100/Z × Y

   Y = starting weight in kg
   Z = the percentage found in the table.
7. Remember that this is an estimated value.

Number of repetitions for a particular load percentage

Load Percentage (%RM)	Number of repetitions
100	1
95	2 - 3
90	3 - 4
85	4 - 6
80	6 - 9
75	7 - 11
70	9 - 15
65	12 - 18
60	16 - 22
55	20 - 25
45	30 - 26
40	34 - 40

Note: The 1RM is never determined directly in people with a chronic disease or older people, as the risk of injury is too high.[1]

Instead, the 1RM can be derived from the 10RM. The 10RM can be safely determined using the above protocol.[2]

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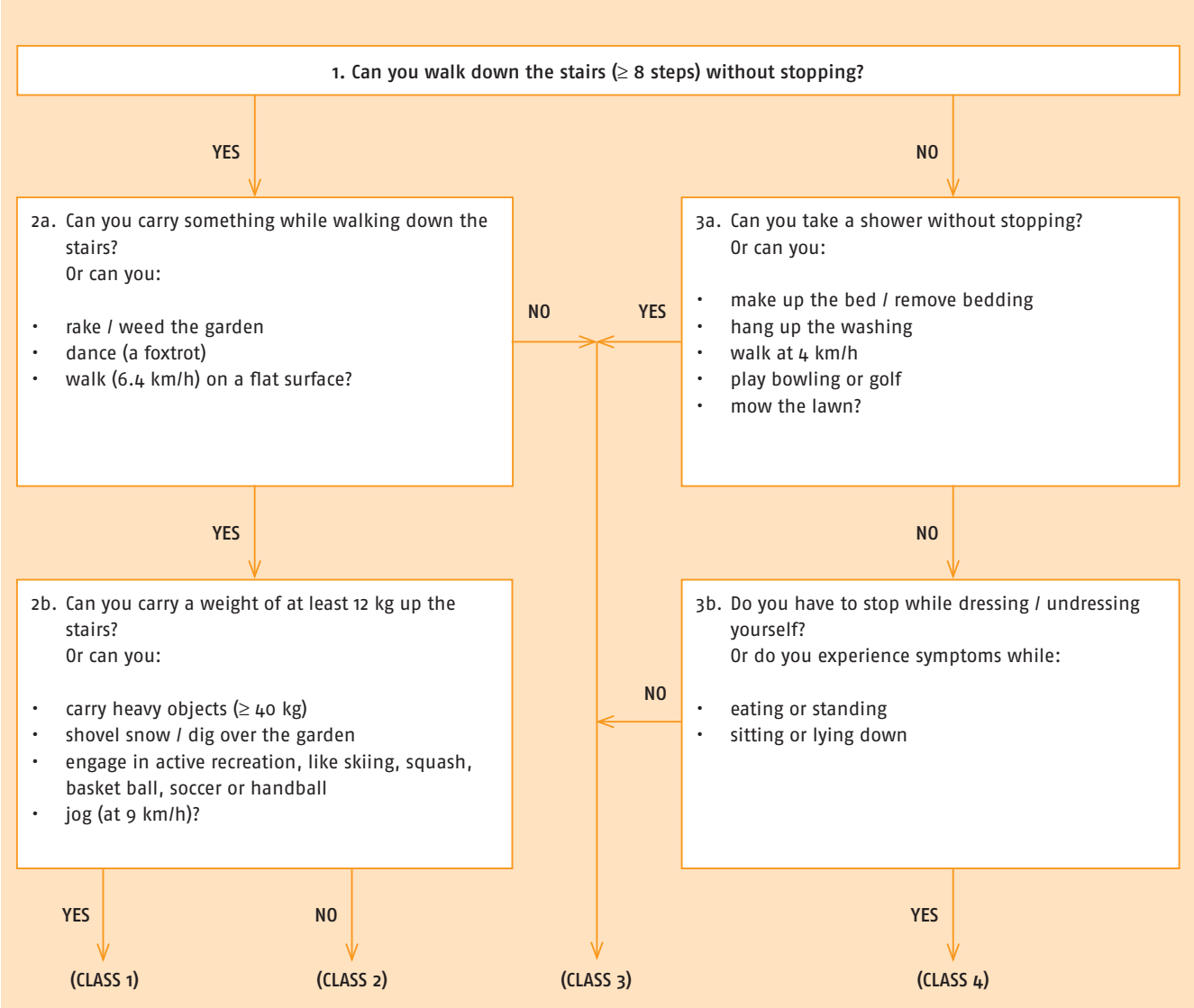
Supplement 6 Specific Activity Scale



Source: Goldman L, Hashimoto B, Cook EF, Loscalzo A. Comparative reproducibility and validity of systems assessing cardiovascular functional class: advantages of a new specific activity scale. Circulation 1981; 64: 1221–34. Reproduced by kind permission. © 2000.

Supplement 7 Instructions for relaxation

It is very important that the patient not only receives instructions on how to relax, but that the physical therapist also evaluates to what extent the patient has actually understood the instructions and is able to apply them. To date, however, there are no reliable assessment instruments.

The following assessments can be used. Assessments 1 and 2a are highly recommended. Assessment 3 takes more of the patient's time, but yields more differentiated information.

Three assessment instruments for relaxation instructions

Assessment 1 Assessment by therapist

Does the therapist have the impression that the patients has learned to relax?

1 = yes, clearly:	patient is able to carry out the instruction and actually does so, then perceives that concrete changes have occurred, which they regard as positive.
2 = unclear:	the patient rarely if ever carries out the instruction, perceives little or no change and regards any changes as mixed or neutral.
0 = no:	the patient does not carry out any relaxation exercises or perceives no change at all or perceives mostly unpleasant changes.

Assessment 2 Self-assessment by patient

2a. Evaluation questions to be asked at end of treatment:

1a. Have you managed to find a way to practice relaxation that you can continue at home?
2 = yes, definitely
1 = yes, to some extent
0 = no
1b. If yes, which exercises do you prefer?

2a. Do the relaxation exercises that you do at home have any effect?
2 = yes, clearly
1 = yes, to some extent
0 = no
2b. How do you notice this?

3. Do you expect that you'll keep up the relaxation exercises in the longer term?
2 = yes, definitely
1 = yes, provided...
0 = no

A sum score of 5 or 6 for these questions signifies a positive result of the relaxation instructions, while a sum score of 0 or 1 indicates the absence of any effect.

Additional questions:
4. Would you like further relaxation instructions?
☐ yes, definitely
☐ 1 = yes, provided....
☐ no

5. 1 = yes, provided...
☐ in a group
☐ individually

2b. The patient can be asked to indicate their experience with each instruction in a matrix.

Each instruction can be given 4 times and can be assessed in terms of doing (D), feeling (F) and appreciation (A). The percentage of instructions for which the patient has entered three plus signs says something about their ability to relax.

Instruction	**D**	**F**	**A**	**D**	**F**	**A**	**D**	**F**	**A**	**D**	**F**	**A**

D = Doing: + well able to do, easy
o not clear if able to do
– unable to do

F = Feeling + clear sense of effect
o unclear sense of effect
– no clear sense of effect

A = Appreciation: + pleasant, positive
o mixed, neutral
– unpleasant, negative

Supplement 8 Flowchart for cardiac rehabilitation for coronary heart disease

Name of patient: .....

Date: .....

Referral information

diagnosis:

diagnostic cardiac data:
- hemodynamic stability
- size of infarct
- location of infarct
- left ventricular function / dysfunction

details:
- ○ operation
- ○ complications
- ○ transplantation
- ○ pacemaker/ICD
- ○ comorbidities

medication:
- ○ anticoagulants
- ○ β-blockers
- ○ statins
- ○ ACE inhibitors
- ○ diuretics
- ○ Ca_2^+ channel blockers
- ○ other: .....

risk profile:
- ○ overweight
- ○ sex
- ○ age
- ○ smoking
- ○ family history
- ○ physical activity
- ○ blood lipids
- ○ blood pressure

coping with symptoms: .....

.....

.....

Ergometry data

date of test: .....

time relative to cardiac incident: .....

test type:
- ○ walking
- ○ cycling

protocol (e.g. Bruce, Naughton):
- ○ endurance test
- ○ duration of exercise blocks
- ○ load progression
- ○ type of progression (wattage, speed, slope)

reason to terminate test:
- ○ maximum
- ○ symptom-limited

course / maximum of parameters:
- ○ heart rate
  resting .....
  maximum .....
- ○ blood pressure
- ○ Borg score
- ○ ECG (details)
  cardiac rhythm (details)
- ○ VO_{2max}
  walking speed / slope

assessment of exercise capacity:
METs
- ○ translated into functional activities
- ○ percentage of normative value (Ascoop)
  relative to patient's preferences / needs
  described on the basis of patient-specific complaints, Specific Activity Scale

training parameters:
Karvonen
40% HRR (= 40% VO_{2max}): ..... beats/min.
50% HRR (= 50% VO_{2max}): ..... beats/min.
60% HRR (= 60% VO_{2max}): ..... beats/min.
70% HRR (= 70% VO_{2max}): ..... beats/min.

PSC
3 activities:
1. ..... degree of difficulty experienced
2. ..... degree of difficulty experienced
3. ..... degree of difficulty experienced

Specific Activity Scale: class 1 / 2 / 3 / 4

quality of life:
physically active lifestyle
- ○ NNGB (Dutch national recommendations for healthy physical activity)
- ○ "fitnorm" (Dutch recommendations for physical fitness)

behavior change stage: precontemplation / preparation / action / maintenance / relapse

complaints/symptoms: .....

.....

perceived barriers against adopting an active lifestyle: .....

fear of exercise: yes / no

Physical therapy exercise test (6-minute walk test or shuttle walk test)

Purpose of test: .....

Main test requirements: .....

Test results: .....

Conclusion regarding the use of the test results or evaluation: .....

.....

Analysis

- ○ 1. Patient's health status (in terms of impairments / limitations / participation problems)
- ○ 2. Are there any physical impediments against improving the patient's physical condition?
  - limited cardiac capacity
  - other diseases or disorders, such as musculosketelal problems
- ○ 3. Are there any other factors that affect the patient's natural ability to improve their physical condition?
  - psychological impediments: anxiety, depression, perceived disability, sleeping problems
  - stress, fatigue
  - lifestyle, smoking, lack of physical activity, dietary habits
  - use of medication
  - social functioning
- ○ 4. What is the intended future status as regards ADL, leisure, work and hobbies? (Patient's presenting problem and goals)
- ○ 5. Is the target status feasible (in view of points 2 and 3); in other words, can the impediments be reduced?
- ○ 6. What are the options for physical therapy to reduce the patient's health problem?

Screening questions

- ○ 1. Is the patient's exercise capacity objectively reduced?
- ○ 2. Is the patient's exercise capacity subjectively reduced due to anxiety or high degree of perceived disability?
- ○ 3. Is there a gap between patient's current and optimal psychological functioning?
- ○ 4. Is the patient's social functioning affected or threatened?
- ○ 5. Does the patient engage in modifiable unhealthy behavior?

Treatment plan

The treatment plan sets out the patient's individual rehabilitation goals.

The physical therapy has the following objectives for the patient:

- ○ 1. exploring one's own physical limits
- ○ 2. learning to cope with physical limitations
- ○ 3. optimizing exercise capacity
- ○ 4. diagnostic: evaluating the patient's exercise capacity and its correlation with objectifiable defects
- ○ 5. overcoming fear of physical exertion
- ○ 6. developing and maintaining a physically active lifestyle

Therapeutic process for cardiac rehabilitation

- ○ information / advice
- ○ individual exercise program
- ○ relaxation program

Patient-centered exercise program

Depending on:
- patient's preferences (PSC),
- patient's abilities,
- patient's physical condition (ergometry),
- individual subgoals (PSC),

the physical therapist makes choices regarding:

1. priorities in the exercise program:
   - ○ practicing skills
   - ○ training aerobic endurance
   - ○ training local endurance (strength)
   - ○ developing enjoyment of exercise
   - ○ reducing modifiable risk factors,

as well as

2. the nature / type of activities, including:
   - ○ ADL activities
   - ○ ergometer
   - ○ field training
   - ○ sports and games
   - ○ fitness
   - ○ aerobics
   - ○ swimming / water exercises
   - ○ other, namely: .....

3. ○ training variables
   - ○ training frequency
   - ○ training duration
   - ○ intensity
   - ○ work / rest intervals
   - ○ structure of training (load progression)

Exercise goals in order of priority:

1. .....

2. .....

3. .....

What will the patient do under supervision? .....

What will the patient do independently? .....

Supplement 9 Models of behavior changen

I-Change Model

TheI-Change model involves a number of stages; each stage is characterized by a specific information requirement, regardless of test or training results. The physical therapist must adapt their treatment to these requirements.[1]

Factors that play a role in behavior change include:
- motivation factors;
- predisposing factors;
- information factors;
- awareness factors;
- ability factors; and
- barriers.

Behavior change is subdivided into 5 stages:
1. Precontemplation stage. Someone who is in the precontemplation stage is insufficiently physically active, and has no intention to change their inactive lifestyle.
2. Contemplation stage. Someone who is in the contemplation stage already has the intention to change their physical activity pattern within the foreseeable future (i.e. within 1 to 6 months).
3. Preparation stage. Someone who is in the preparation stage is actively preparing to increase their physical activity level within 1 month.
4. Action stage. Favorable behavior changes are taking place. Someone who is in the action stage has clearly taken more exercise in the last 6 months.
5. Maintenance stage. The changed behavior is maintained.

Series of steps proposed by Van der Burgt and Verhulst
Van der Burgt and Verhulst based their proposal for a sequence of steps on the steps proposed by Van Hoenen et al., adding 'ability to act' and 'maintenance', specifically intended for the physical therapy setting.[2]

Series of steps proposed by Van der Burgt and Verhulst
1. *Receptiveness*. The physical therapist must ensure that the education they give is geared toward the patient's perceptions, expectations, questions and worries. Important questions include: What is the patient's main concern and what concerns prevent the patient from being receptive to information about behavior change?
2. *Understanding*. The information must be offered in a form that the patient can understand and remember. It is important not to offer too much information at once, to decide what information must be presented first and what can wait until later, to repeat the message (perhaps using different wording) or explain it with the help of brochures, video, etc. The physical therapist must check whether the patient has really understood the information.
3. *Willing*. The physical therapist identifies what motivates or demotivates a patient to do something. Important aspects include the benefits that exercising can have for the patient, whether the patient experiences support or pressure from their immediate environment, and whether the patient feels they are able to influence their own situation. The physical therapist supports the patient and offers information about options and alternatives. Feasible goals are agreed upon.
4. *Ability to act*. The patient must be able to carry out the required behavior. The functions and skills required for this must be practiced. It is important to identify what practical problems the patient expects and to try and find ways to solve these problems, in consultation with the patient.
5. *Actual practice*. This is the step where the patient actually performs the new behavior. The physical therapist makes clear, concrete and feasible arrangements with the patient and sets specific goals. Positive feedback is given if possible.
6. *Maintenance*. The patient will have to continue the new behavior after the end of the treatment. During the treatment, the physical therapist must discuss with the patient whether they think they will be able to do this. It is important to examine what aspects are difficult for the patient, what encourages them and whether there will be short- and long-term benefits. What will help the patient resume the intended behavior after a relapse?

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Supplement 10 Effects of medication on heart rate, blood pressure, ECG and exercise capacity

Medications	Heart Rate	Blood Pressure	ECG	Exercise Capacity
ß-Blockers (including carvedilol, labetalol)	↓ (R and E)	↓ (R and E)	↓ HR (R) ↓ ischemia (E)	↑ in patients with angina; ↓ or ↔ in patients without angina
II. Nitrates	↑ (R) ↑ or ↔ (E)	↓ (R) ↓ or ↔ (E)	↑ HR (R) ↑ or ↔ R (E) ↓ ischemia (E)	↑ in patients with angina; ↔ in patients without angina ↑ or ↔ in patients with congestive heartfailure (CHF)
III. Calcium channel blockers				
Amlodipine, Felodipine, Isradipine, Necardipine, Nifedipine, Nimodipine	↑ or ↔ (R and E)		↑ or ↔ HR (R and E) ↓ ischemia (E)	↑ in patients with angina' ↔ in patients without angina
Nisoldipine		↓ (R and E)		
Bepridil, Diltiazem, Verapamil	↓ (R and E)		↓ HR (R and E) ↓ ischaemia (E)	
IV. Digitalis	↓ in patients with atrial fibrillation and possibly CHF Not significantly altered in patients with sinus rhythm	↔ (R and E)	May produce nonspecific ST-T wave change (R) May produce ST segment depression (E)	Improved only in patients with atrial fibrillation or in patients with CHF
V. Diuretics	↔ (R and E)	↔ or ↓ (R and E)	↔ or PVCs (R) May cause PVCs and 'false positive' test results if hypokalemia occurs May cause PVCs in hypomangnesemia occurs (E)	↔, except possibly in patients with CHF
VI. Vasodilators, nonadrenergic	↑ or ↔ (R and E)	↓ (R and E)	↑ or ↔ HR (R and E)	↔, except ↑ or ↔ in patients with CHF
ACE inhibitors	↔ (R and E)	↓ (R and E)	↔ (R and E)	↔, except ↔ ↑ or ↔ in patients with CHF
α-Adrenergic blockers	↔ (R and E)	↓ (R and E)	↔ (R and E)	↔
Antiadrenergic agents without selective blockade	↓ or ↔ (R and E)	↓ (R and E)	↓ or ↔ HR (R and E)	↔
VII. Antiarrhythmic agents	All antiarrhythmic agents may cause new or worsened arrhtyhmias (proarrhythmic effect)			
Class I				
Quinidine, Disopyramide	↑ or ↔ (R and E)	? or ↔ (R) ↔ (E)	↑ or ↔ HR (R) may May prolong QRS and QT intervals (R) Quinidine may result in 'false negative' test results (E)	↔
Procainamide	↔ (R and E)	↔ (R and E)	May prolong QRS and QT intervals (R) May result in 'false positive' test results (E)	↔
Phenytoin, Tocainide, Mexiletine, Flecainide	↔ (R and E)	↔ (R and E)	↔ (R and E)	↔
Moricizine	↔ (R and E)	↔ (R and E)	May prolong QRS and QT intervals (R) ↔ (E)	↔
Propafenone	↓ (R) ↓ or ↔ (E)	↔ (R and E)	↑ HR (R) ↑ or ↔ HR (E)	↔
Class II				
ß-Blockers (see I.)				
Class III				
Amiodarone	↓ (R and E)	↔ (R and E)	↓ HR (R) ↔ (E)	↔
Class IV				
Calcium Channel Blockers (see III.)				

Medications	Heart Rate	Blood Pressure	ECG	Exercise Capacity
VIII. Bronchodilators	↔ (R and E)	↔ (R and E)	↔ (R and E)	Bronchodilators ↑ exercise capacity in patients limited by Bronchospasm
Anticholinergic agents	↑ or ↔ (R and E)	↔	↑ or ↔ HR May produce PVC's (R and E)	
Sympathomimetic agents	↑ or ↔ (R and E)	↑, ↔ or ↓ (R and E)	↑ or ↔ HR (R and E)	
Cromolyn sodium	↔ (R and E)	↔ (R and E)	↔ (R and E)	
Corticosteroids	↔ (R and E)	↔ (R and E)	↔ (R and E)	
IX. Hyperlipidemic agents	Clofibrate may provoke arrhytmias, angina in patients with prior myocardial infarction Nicotinic agents may ↓ BP All other hyperlipidemic agents have no effect on HR, BP, and ECG			
X. Psychotropic medications				
	Minor tranquilizers	May ↓ HR and BP by controlling anxiety: no other effects		
	Antidepressants	↑ or ↔ (R and E)	↓ or ↔ (R and E)	Variable (R) May result in 'false positive' test results (E)
	Major tranquilizers	↑ or ↔ (R and E)	↓ or ↔ (R and E)	Variable (R) May result in 'false positive' or 'false negative' test results (E)
	Lithium	↔ (R and E)	↔ (R and E)	May result in T wave changes and arrhythmias (R and E)
XI. Nicotine	↑ or ↔ (R and E)	↑ (R and E)	↑ or ↔ HR May provoke ischemia, arrhythmias (R and E)	↔, except ↓ or ↔ in patients with angina
XII. Antihistamines	↔ (R and E)	↔ (R and E)	↔ (R and E)	↔
XIII. Cold medications with Sympathomimetic agents	Effects similar to those described in sympathomimetic agents, although magnitude of effects is usually smaller			↔
XIV. Thyroid medications	↑ (R and E) Only levothyroxine	↑ (R and E)	↑ HR May provoke arrhythmias	↔, unless angina worsened ↑ ischemia (R and E)
XV. Alcohol	↔ (R and E)	Chronic use may	May provoke have role in ↑ BP (R and E)	↔ arrhythmias (R and E)
XVI. Hypoglycemic agents Insulin and oral agents	↔ (R and E)	↔ (R and E)	↔ (R and E)	↔
XVII. Dipyridamole	↔ (R and E)	↔ (R and E)	↔ (R and E)	↔
XVIII. Anticoagulants	↔ (R and E)	↔ (R and E)	↔ (R and E)	↔
XIX. Antigout medications	↔ (R and E)	↔ (R and E)	↔ (R and E)	↔
XX. Antiplatelet medications	↔ (R and E)	↔ (R and E)	↔ (R and E)	↔
XXI. Pentoxyfiline	↔ (R and E)	↔ (R and E)	↔ (R and E)	↑ or ↔ in patients limited by intermittend claudication
XXII. Caffeine	Variable effects depending upon previous use Variable effects on exercise capacity May provoke arrhythmias			
XXIII. Anorexiants/diet pills	↑ or ↔ (R and E)	↑ or ↔ (R and E)	↑ or ↔ (R and E)	

Key: ↑ = increase; ↔ = no effect; ↓ = decrease; R = rest; E = exercise; HR = heart rate; PVC's = premature ventricular contractions

* ß-Blockers with ISA lower resting HR only slightly.
\+ May provide or delay myocardial ischemia.

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Supplement 11 Organization of cardiac rehabilitation in the Netherlands

The Netherlands Society of Cardiology (NVVC) has drawn up a list of practice requirements to ensure the safety and quality of Phase II cardiac rehabilitation and as a basis for the new 'diagnosis and treatment combination' which is to be developed. [1] As indicated in the 2011 multidisciplinary guideline on cardiac rehabilitation (*Multidisciplinaire Richtlijn Hartrevalidatie 2011*), all forms of cardiac rehabilitation must offer a multidisciplinary and complete care program, including at least:

- intake;
- 4 cardiac rehabilitation programs:
  - information program;
  - exercise program;
  - relaxation program;
  - lifestyle program / behavior modification program;
- psychological programs;
- evaluation and reporting.

Requirements have been established for each of these levels, relating to the care services available, the training of care providers, quality and safety issues, facilities, and the composition of the multidisciplinary team. Further information is available in the NVVC's practice guideline for cardiac rehabilitation (*Praktijkrichtlijn Hartrevalidatie*, in Dutch).[1]

Level I cardiac rehabilitation
This type of cardiac rehabilitation is designed for non-complex presenting problems. This involves the care for low-risk patients, as judged by the patient's cardiologist. The following criteria can be used to decide whether a patient is at low risk:

- stable medical condition;
- no psychological and / or cognitive disorders;
- no angina and / or documented ischemia at low exertion levels;
- left ventricular ejection fraction ≥ 40%;
- no serious arrhythmias during exertion;
- no significant heart valve disease;
- no congenital heart disease;
- no ICD;
- no serious comorbodity that could impede the rehabilitation process (e.g. COPD, diabetes mellitus, locomotor disorders

Level II cardiac rehabilitation
This type of cardiac rehabilitation is designed for complex presenting problems. This involves the care for patients who meet at least one of the following criteria:

- psychological and / or cognitive disorders;
- chronic stable angina or silent ischemia;
- NYHA Class III;
- heart failure (left ventricular ejection fraction < 40%).
- serious arrhythmias;
- significant heart valve disease;
- congenital cardiac disease;
- having had an ICD implanted;
- having undergone a heart transplant;
- comorbidities that may impede exercise capacity (e.g. COPD, diabetes mellitus, locomotor disorders, intermittent claudication).

Level III cardiac rehabilitation
This type of cardiac rehabilitation is designed for patients who are eligible for level I or Level II cardiac rehabilitation and also meet at least one of the following criteria:

- Patient is as yet physically unable to start actual rehabilitation, for instance because they still need nursing care and / or their Phase I rehabilitation or mobilization has not yet been sufficiently successful.
- Patient has other, non-cardiac-related limitations that impede a successful specialized outpatient cardiac rehabilitation.
- Patient has evident fear of exertion or of the recurrence of manifestations of their heart disease. These patients temporarily require a safe (i.e. hospital-related) environment. They are sent home for weekends as soon as possible, which is then expanded in stages, to prevent their anxiety being perpetuated.
- Patients who need to be temporarily taken out of their home environment as it is unfavorable for their recovery, to enable them to regain confidence, learn to cope with physical and other limitations, give up certain unhealthy behaviors or reduce certain risk factors such as extreme overweight. At the same time, efforts must be made to eliminate the factors in the patient's home environment that impede recovery.
- Patients who have unsuccessfully taken part in a specialized cardiac rehabilitation program elsewhere.
- Patients for whom specialized cardiac rehabilitation is indicated but for whom the traveling distance to outpatient treatment is prohibitive.

Locations offering cardiac rehabilitation in the Netherlands
Cardiac rehabilitation on an outpatient basis is offered by 101 Dutch hospitals, and proves sufficient for over 98% of the heart patients.[2] In 2002, 26,000 patients took part in a cardiac rehabilitation program, compared to 17,000 in 1998, an increase of over 50%.
An increasing number of centers offer outpatients not only an exercise program, but also a relaxation program, an information program and a psycho-education program. Research has shown that all centers were familiar with the Dutch guidelines for cardiac rehabilitation.[3]
Level I and level II cardiac rehabilitation is provided on an outpatient basis at hospitals and rehabilitation centers which have a cardiac rehabilitation department. An exception is made for those patients (level I) who are unable to take part in an exercise program at a hospital or rehabilitation center with a cardiac rehabilitation department for logistical reasons, such as traveling distance and / or transport problems. These patients can attend their exercise program at a primary care physical therapy practice. They can also attend their relaxation and lifestyle programs outside the referring center, provided they are supervised by specially trained professionals. The information program must always take place at the referring center. The exercise program for these patients must meet the following criteria:

- There is a formal written cooperation agreement between the referring hospital or cardiac rehabilitation center or the patient's cardiac rehabilitation cardiologist and the primary care physical therapy practice.
- The participating physical therapy practice meets the general quality and safety standards for a level I cardiac rehabilitation center.
- The physical therapy practice meets the requirements regarding the facilities for exercise or training programs available at a level I cardiac rehabilitation center.
- During the cardiac rehabilitation, there are at least two team members present who have been trained in basic life support (BLS) and the use of an automated external defibrillator (AED), including at least one physical therapist who has completed a training program for cardiac rehabilitation accredited by KNGF or the *Vereniging voor Hart- Vaat en Longfysiotherapie* (the Dutch association for cardiovascular and pulmonary physical therapy).
- Team members have been trained before the exercise or training program is offered to patients, and then regularly (at least twice a year) attend refresher courses or instructions by the referring hospital or rehabilitation center with a cardiac rehabilitation department.
- The physical therapist reports in writing to the referring hospital or rehabilitation center with a cardiac rehabilitation department at the completion of the patient's exercise or training program.

Level III cardiac rehabilitation takes place in a clinical setting. [2] Clinical cardiac rehabilitation is offered by three centers in the Netherlands: Rijnlands Zeehospitium in Leiden (province of South-Holland), Hoensbroek rehabilitation center (province of Limburg) and Groningen University Medical Center's Rehabilitation Center at Beatrixoord in Haren (province of Groningen). These centers have 4, 14 and 6 beds, respectively, available for cardiac rehabilitation. The numbers of patients attending cardiac rehabilitation at these centers each year are 30, 100–150 and 75, respectively..

Quality and safety of cardiac rehabilitation
All safety and quality criteria for cardiac rehabilitation established by the NVVC have been included in the NVVC's 2011 practice guideline on cardiac rehabilitation (Praktijkrichtlijn Hartrevalidatie 2011).[1]
The following criteria and requirements are relevant for physical therapists engaged in level I cardiac rehabilitation:

- The patient's cardiologist and the other members of the cardiac rehabilitation team have completed the cardiac rehabilitation training program and refresher courses recommended by their respective professional associations. The cardiologist must make sure that all team members involved satisfy this requirement. (This also applies if the exercise program takes place at a primary care physical therapy practice.)

- Before starting the exercise program, each patient must undergo a maximum or symptom-limited exercise test (with gas analysis in the case of patients with heart failure), for the purpose of risk stratification and training coordination.
- The number of professionals involved in the program is in proportion to the number of patients and the complexity of their situation. This applies to all cardiac rehabilitation programs.
- Before cardiac rehabilitation can be offered, a 'process description for cardiac rehabilitation' must be prepared. This document clearly sets out and defines the tasks and responsibilities of all members of the multidisciplinary team. The content of the document is known to all team members and is endorsed by all of them.
- Multidisciplinary team meetings are held at least once every two weeks. This also applies if the exercise program takes place at a primary care physical therapy practice.
- The cardiac rehabilitation center has a safety plan (emergency plan) in place, which is regularly updated. This plan also indicates how the resuscitation team can be alerted. If no resuscitation team is present on site (because the exercise program takes place at a primary care practice), there must be a clear and verifiable written agreement with the ambulance service.
- All treatment rooms can be contacted by phone and are fitted out with an alarm system.
- An AED is present in the building where the exercise program takes place. (This also applies if the program takes place at a primary care physical therapy practice.)
- All team members are familiar with the alarm system, the emergency plan and the use of the AED.
- All team members have been trained in BLS or AED use, and practice at least twice a year to keep up their skills in this respect.
- At least two BLS-trained team members are present during the exercise program, and a doctor is available on call. If no doctor is present at the center (if the exercise program takes place at a primary care physical therapy practice) logistical arrangements must be in place to allow a doctor to be consulted by phone immediately when necessary.
- The center where the cardiac rehabilitation takes place has a safety management system in place, or participates in the safety management system used at the hospital or rehabilitation center.
- At the end of a patient's Phase II cardiac rehabilitation program, a discharge letter is prepared which indicates whether the individual goals have been achieved, and which discusses any complications.
- There is a verifiable written cooperation agreement with a level II cardiac rehabilitation center. Patients with complex problems (see level II cardiac rehabilitation) are referred; patients are discussed with the center in regular meetings.

In addition to these quality and safety requirements for level I cardiac rehabilitation, the following requirements must be met for patients with complex problems, whether or not they are treated in a clinical setting (level II and level III cardiac rehabilitation). The level of complexity is determined by the patient's cardiologist:

- In addition to an AED, a 'crash car' must also be available, as well as a resuscitation team whose members have been trained in advanced life support (ALS).
- The ratio of cardiac rehabilitation team members to heart patients during the exercise or training program for patients with complex problems is at least 1 to 5.

Requirements for facilities

Facilities for level I cardiac rehabilitation must meet the following requirements:

- an exercise room with a sufficient range of sports and games equipment and a fitness room with cycling, treadmill and rowing ergometers and strength training equipment;
- equipment to measure blood pressure and heart rate before, during and after exercises;
- facilities for information transfer to groups;
- separate showers and change rooms for men and women.

The following additional requirements must be met for level II and level III cardiac rehabilitation:

- equipment to monitor cardiac rhythm during the exercise or training program.

Composition of the multidisciplinary cardiac rehabilitation team

A level I cardiac rehabilitation team includes a smaller range of professionals than a level II team.
A level I multidisciplinary cardiac rehabilitation team consists of:

- a cardiac rehabilitation coordinator (e.g. a nurse of nurse practitioner);
- a cardiac rehabilitation cardiologist, possibly in combination with a sports physician or rehabilitation physician;
- a nurse;
- a dietician;
- a physical therapist;
- a social worker.

A level II or level III cardiac rehabilitation team additionally includes:

- a health psychologist (as a permanent member of the cardiac rehabilitation team);
- a rehabilitation physician (on a consultative basis);

- a specialized diabetes nurse (on a consultative basis);
- a psychiatrist (on a consultative basis).

Professionals from a level II or level III cardiac rehabilitation team may be consulted by a level I team, based on agreements between the various centers.
Also other care providers may be asked to assist in the cardiac rehabilitation.

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