# Exercise with cardiac patients

## Practical recommendations for sports therapy in cardiac rehabilitation

Project Group "Sport and Exercise Therapy in Cardiology"
of DVGS e.V. (German Association for Health-Related Fitness and Sport Therapy)

## ➤ Introduction

Physical activities are a natural necessity and – just as targeted training – result in lower cardiovascular and overall mortality of cardiac patients, while also improving these patients' prognosis, quality of life, and physical performance. They can therefore be considered an independent therapeutic method that is equal to therapy approaches based on medication, intervention, and surgery and can supplement them in a meaningful way. Sports therapy and physical education measures help patients acquire individual resources and abilities and have the potential to contribute to a change in exercise-related lifestyle. According to current insights, a beneficial exercise and training program for cardiac patients should include endurance and strength training. The following training recommendations for cardiac patients are intended to allow for therapeutically supported, dosed, controlled, and hence, successful management of training measures for people with cardiovascular diseases.

### Definition of "training"

Training must be clearly distinguished from terms such as everyday activities, a more active lifestyle, or lifestyle modification. Training is a regular, structured, dosed, and controlled treatment method, which is used specifically to improve the prognosis and quality of life of cardiac patients.

## ➤ Aspects of physical education activities

It should be clearly emphasized that sports therapy, and especially physical education activities, cannot simply consist of establishing training parameters during the patient's rehabilitation phases 1 and 2. Rather, the core task of physical education is to motivate inactive and ill people to exercise in a regular and healthy way for the long term.

Consequently, physical educators, who must consult with physicians and base their programs on diagnostic results, are much more than simple "exercise managers" within the scope of **their** activities. They play an essential role as advisors and accompany their patients throughout a long-term recovery process. Accordingly, this process is not only determined by curative measures, but also by gradually developing a focus on (secondary) prevention and permanent well-being during the course of the patient's treatment.

The didactic and methodological decisions with regard to physical exertion, selection of exercises, organizational forms etc. as well as communication and guidance therefore must, in addition to the physical condition of patients, take into account their psychological condition, mental resilience, social circumstances, personal motivation, attitudes, and intentions. After all, the demanding purpose of the treatment is to initiate behavior change or, at least, to achieve behavioral modifications. This can only be successful with the identification and consideration of as many behavior-relevant factors and determinants as possible.

A biography-based, multidisciplinary exercise history can provide valuable insights for this purpose. Such a patient history not only offers information about the living and working conditions of the patient (how can sport/exercise be integrated into the existing daily schedule?), but also clarifies the availability of exercise groups (how do I address situations in which no cardiac rehabilitation group is available in a radius of 20 km?) and sheds light on the opportunities and risks of the patient's social environment (family, friends, coworkers).

In this regard, information about the health potential of a person (experiences, knowledge, desires, goals etc. within and outside of physical activities and exercise forms) is of particular significance, since such information points out the health-promoting resources of people who are temporarily ill and, after all, only "partially". Particularly a salutogenetic educational outlook that does not focus on deficiencies may yield interesting starting points for successful sports therapy intervention.

It is helpful for sports therapy to keep the entire personality of a patient in mind in order to employ suitable impulses – including appropriate training management – to strengthen personal resources and abilities. Such an approach empowers patients to take responsibility for the long-term design of their healthy activities. The section below provides an overview of the therapy components endurance and strength training.

## ➤ Part 1: General aerobic endurance training

### Training resources

The following types of endurance sport can generally be recommended. The selection should always keep individual circumstances (motivation, primary illnesses, body weight, practical aspects etc.) as well as the cardiovascular training effect and controllability in mind:

- (Nordic) walking, running (jogging)
- Bicycle ergometer training
- Endurance training on cardio equipment (treadmill, stepper, cross trainer, rowing machine etc.)
- Bicycling
- Swimming, aquajogging
- Inline skating
- Cross-country skiing
- Rowing

### Objectives

**Improvement of patient prognosis**

- Decreased overall mortality
- Decreased cardiovascular mortality
- Improved life expectancy
- Decreased rate of cardiac events and rehospitalization
- Reduced cardiovascular risk factors

**Improved quality of life / fewer symptoms**

- Stabilized or enhanced general and cardiopulmonary physical fitness
- Fewer cardiopulmonary symptoms such as dyspnea, angina pectoris, and exercise intolerance
- Improved psychological well-being
- Enhanced psychological resilience
- Stabilized or enhanced psycho-vegetative resilience
- Improved social reintegration ("stake")
- Improved body perception and self-esteem

## How it works

See Tables 1 and 2.

Physical training, and especially endurance training and the most frequently prescribed cardiovascular medications have a primarily synergistic effect, meaning that they can supplement one another in a relevant way, as illustrated in Table 3.

## Indications

Training is recommended for the following patient conditions with consideration for the contraindications listed further below:

- All stages of coronary heart disease, including
  - History of myocardial infarction (NSTEMI, STEMI)
  - History of instable angina pectoris
  - History of interventional and surgical revascularization
- Arterial hypertension/ hypertensive heart disease
- Cardiomyopathies (note contraindications)
- Stable chronic heart failure (NYHA classes I–III), including patients with history of decompensation
- Congenital or acquired heart defects (asymptomatic or clinically stable phase)
- Surgically repaired heart valve defects
- History of heart transplant
- Patients with increased cardiovascular risk profile such as diabetes mellitus, lipometabolic disorder, obesity, or metabolic syndrome

## Required diagnostics prior to the start of training

The following diagnostic findings must be available prior to the start of training:

- **Anthropometric, social, and personality information**
- **Patient history and clinical data** that allow for risk stratification of patients (particularly information on coronary status, NYHA class, ejection fraction, arrhythmia tendency, risk of decompensation)
- **Recent stress test** (spiroergometry is recommended for heart failure patients) with information about absolute and relative physical performance capability in watts, symptoms and diagnostic findings under exertion (ischemia, arrhythmia, blood pressure decrease)
- **Recent echocardiogram**

Depending on the patient's health status, data should be updated every six months and at least a stress test is required.

## Therapy monitoring

The following symptoms and parameters should be monitored during the training program: Heart rate, blood pressure if applicable, arrhythmia, cardiac symptoms such as angina pectoris or dyspnea, leg edema or sudden weight gain, deterioration of physical performance (see also contraindications).

## Risk stratification

To avoid risk, patients with the following health conditions need to be closely monitored with particular care during training:

- Acute myocardial infarction, intervention or cardiosurgical procedure in the past four weeks
- Severely restricted left or right ventricular function
- Symptomatic heart failure from NYHA class II
- Complex ventricular arrhythmia in the past history
- History of reanimation or fainting outside of acute events
- Blood pressure decrease under physical exertion
- Angina pectoris or heart failure under physical exertion < 5 MET

**Table 1** Documented effects of controlled physical training on cardiovascular risk factors.

| Verifiable single effects | Potential clinical effects |
|---|---|
| **Improved carbohydrate metabolism**<br>Insulin sensitivity ↑<br>Hyperinsulinemia ↓<br>Plasma glucose level ↓<br>Gluconeogenesis ↓ | Decreased cardiovascular risk profile<br>Prevention or treatment of metabolic syndrome and type II diabetes<br>Better metabolic performance in patients with manifest diabetes<br>Less insulin may have to be given |
| **Improved lipid metabolism**<br>Total cholesterol, LDL cholesterol ↓<br>Improved LDL profile: small dense LDL ↓<br>HDL cholesterol ↑<br>Triglycerides ↓<br>Lipoprotein a ↓<br>Free fatty acids ↓<br>Homocysteine level ↓ | Decreased cardiovascular risk profile<br>Fewer coronary events<br>Treatment option for coronary patients with low HDL values |
| **Improved body proportions**<br>Weight loss<br>Reduced intraabdominal fat<br>Decreased body-mass index (BMI)<br>Optimized ratio of fat mass to active body mass | Decreased cardiovascular risk profile<br>Prevention or treatment of metabolic syndrome |
| **Improved blood pressure control**<br>Decreased cardiac afterload<br>Upward regulation of baroreceptors<br>Increased arterial compliance<br>Decreased angiotensin-II-induced vasoconstriction | Decreased cardiovascular risk profile<br>Prevention and treatment of arterial hypertension |
| **Effects on skeletal muscles and fitness**<br>Enhanced general and cardiopulmonary fitness<br>Increased muscle mass<br>Enhanced maximum strength<br>Increased mitochondrial density and count<br>Increased capillary density and count | Decreased cardiovascular risk profile.<br>Epidemiological studies have pointed out that any improvement of cardiopulmonary fitness, $VO_{2max}$, muscle mass, and maximum strength may extend a patient's life expectancy, which makes them independent factors affecting the prognosis. |

**Table 2** Vascular, cardiac, and hemodynamic effects.

| Verifiable single effects | Clinical effects |
|---|---|
| Cardiac and vascular effects | |
| NO synthase expression ↑ | Potential of reduced progression, stabilization, or regression of arterio-sclerotic coronary lesions<br>Reduced risk of myocardial infarction or stroke |
| Plaque stabilization | Reduced risk of myocardial infarction or stroke |
| Decreased myocardial $O_2$ consumption | Improvement of cardiac symptoms such as angina pectoris or dyspnea as well as increased symptom-free physical performance |
| Lower heart rate at rest and under exertion with proportional increase of stroke volume | Probable prognostic improvement |
| Decreased cardiac afterload | |
| Improved coronary flow reserve | |
| Improved endothelial function | |
| Enhanced angiogenesis<br>Stem cell release | Neogenesis of blood vessels and collaterals |
| **Improved autonomous regulation**<br>Sympathicotonia ↓, Parasympathicotonia ↑<br>Free catecholamines ↓<br>α- and β-adrenoreceptor density ↑ | Lower rate of arrhythmia events<br>Supporting therapy for heart failure |
| **Decrease of proinflammatory enzymes**<br>CRP, IL1, IL6, INF gamma, TNF | Supporting therapy for heart failure |
| **Improved hemostasis**<br>Platelet aggregation ↓<br>Fibrinolysis ↑ | Decreased rate of thrombotic and embolic events |
| **Improved psychosocial status**<br>**Improvement of impaired sexual activity**<br>**Strengthened immune system** | Positive impact on quality of life |

**Table 3** Medication and endurance training.

| Medication | Effect | Synergy effect of training |
|---|---|---|
| ASS, Clopidogrel | Antithrombotic effect | + |
| β-blockers | Decreased heart rate<br>Sympathicotonia ↓<br>Parasympathicotonia ↑ | ++<br>++<br>++ |
| ACE inhibitors or AT1 blockers | Afterload decrease<br>Improved endothelial function | ++<br>++ |
| Statins (cholesterol-lowering drugs) | LDL decrease<br>Anti-inflammatory effect<br>Improved endothelial function | +<br>++<br>++ |
| Nitrates | Increased NO release | ++ |

- Past history of bradycardic (tachycardic) arrhythmia
- Relevant post-cardiotomy syndrome

## Contraindications

Maintaining the best possible mobility is the highest priority for patients who cannot take part in endurance training due to contraindications.

**Relative contraindications**

- NYHA class IV
- Systolic blood pressure drop under physical exertion
- Resting heart rate > 100 BPM
- Complex ventricular arrhythmia at rest or under exertion
- Severe AV blocks or bradyarrhythmia
- Weight gain > 1.8 kg in three days with heart failure
- Post-cardiotomy syndrome, Dressler's syndrome, pericardial or pleural effusion
- Aortic or cerebral aneurysms
- Significant secondary diseases

**Absolute contraindications**

- Significant ischemia at a low level of exertion (< 2 MET or < 50 W)
- Manifest heart failure after myocardial infarction in the past three weeks
- Evident deterioration of stress tolerance or increasing dyspnea at rest or under physical exertion in the past five days
- Severe or symptomatic aortic valve stenosis
- Acute coronary syndrome/ instable angina pectoris
- Cardiac valve insufficiency requiring surgery
- Newly occurring atrial fibrillation/flutter
- Florid pericarditis, myocarditis, endocarditis
- Uncontrollable blood sugar irregularities (positive ketone test)
- Recent embolic event
- Acute general illness or fever, infection
- Recent thrombophlebitis/phlebothrombosis
- Currently uncontrollable blood pressure irregularities
- Symptomatic or severe hypertrophic-obstructive cardiomyopathy

## Dosing endurance training

- Every patient should receive an exercise recommendation from his/her provider (physician/therapist) that defines the type, frequency, duration, and intensity of the recommended training (“exercise prescription").

- As a general rule and for reasons of safety, the exercise levels must allow cardiac patients to work out in the ranges where symptoms (i.e. angina pectoris, dyspnea) or diagnostic findings (i.e. arrhythmia, blood pressure decrease, or ST segment depressions) can be excluded.
- The type, frequency, and intensity of the exercise should match the motivation of the patient to ensure that it results in long-term, sustained improvement of their physical activity.
- The current state of the relevant studies does not yet permit a final evaluation of the optimal dosage of endurance training. Consequently, aerobic endurance training can be used with low, medium, and high aerobic intensity.
- If the training is intended to improve cardiorespiratory performance, it is recommended to exceed a threshold value of 40% of the maximum performance capability. According to current study data, even a lower intensity can produce beneficial prognostic effects.
- The dosage should be gradually increased with consideration for the overall condition of the patient's musculoskeletal system.
- The recommended training frequency, depending on duration and intensity of exercise, should result in an additional energy consumption of 1,500 to 2,000 kcal a week from physical activity.
- The parameters to monitor for the management and control of training intensity should include, individually or in combination, heart rate, watts, $VO_2$, and lactate, supplemented by the rating of perceived exertion (Borg RPE scale).

## Recommendations for all indications except heart failure

Exercise intensity can generally be managed with the following 5 parameters:

- **Heart rate**
  Since the heart rate (HR) is universally available and can be used routinely for many types of exercise stress tests, it is suitable for training management of patients who show good physical performance capability and regular heart rate increases under exertion. The desired training heart rate (THR) is calculated on the basis of the heart rate reserve (HRR). This calculation model postulates that most people can do endurance training in the aerobic range with 60% of the HRR. The HRR is calculated as the maximum heart rate ($HR_{max}$) achieved during an exercise test minus the resting heart rate ($HR_{rest}$). The training ranges defined in Table 4 use a HRR of 0.35–0.75.
- **Practical example:**
  Heart rate reserve formula (according to Karvonen)
  $THR = (HR_{max} - HR_{rest}) \times [0.35 - 0.75] + HR_{rest}$
  Sample calculation for 60% of HRR:
  $HR_{rest} = 64/min$; $HR_{max} = 132/min$;
  $THR = (132 - 64) \times 0.6 + 64 = 104$ beats/min
  It should be noted, however, that the training pulse is a parameter that cannot be set to a fixed value. Instead, it is recommended to define individual training ranges for every patient. In the above example, the optimal training range would be between 88 and 115 beats per minute. Adequate training should take place within this range, depending on the patient's medical condition and the objective of the training program.

  In cases of low heart rate reserve, chronotropic incompetence, and atrial fibrillation, the HR can only be used to a limited extent or not at all for training management. Other cases in which the training heart rate may not be a reliable factor for training management include restricted physical ability or a recent change of medication.
- **Load in watts**
  Watt-based management refers to a maximum watt value achieved during an exercise test. This approach involves measuring a certain percentage of the performance in watts for endurance training (see Table 4, e.g., 50% of $W_{max}$). One disadvantage of this approach is the fact that only bicycle ergometer training can be exactly quantified in watts so that patients may have to look up their watt load if using other forms of exercise.
- **Oxygen uptake ($VO_2$)**
  Training management based on $VO_2$ uses the results of spiroergometry, in which the anaerobic threshold (AT as defined by Wassermann) and the maximum oxygen uptake ($VO_{2peak}$) can be determined. For endurance training, a specific exertion level can then be recommended, for example 50–80% of $VO_{2peak}$ or a level just below the anaerobic threshold determined by spiroergometry. This method has also proven successful in studies involving heart failure patients. As an added benefit, AT can also be determined with a submaximal stress test, regardless of patient motivation. However, it should also be mentioned that spiroergometry is not available everywhere, that values such as AT and $VO_{2peak}$ cannot be precisely quantified by spiroergometry, and that the appli-

**Table 4** Recommendations for all indications except heart failure.

| Desired aerobic training range | Frequency and duration | Intensity (only in ranges where symptoms and diagnostic findings can be excluded!) | Notes |
|---|---|---|---|
| **High intensity** | Maximum 1–2 times a week<br>10–30 minutes | 55–70% $W_{max}$<br>60–75% of HRR after max. cardiac load<br>80–90% W AT or 60–70% $VO_{2peak}$<br>Lactate (85–95% W anaerobic threshold)<br>As a supplement only: BORG RPE scale (14–15) | Not useful for training novices. Preparatory training in the low to mid-level range required. |
| **Medium intensity** | 3–5 times a week<br>20–60 minutes | 40–54% $W_{max}$<br>60–59% of HRR after max. cardiac load<br>60–79% W AT or 50–59% $VO_{2peak}$<br>Lactate (60–84% W anaerobic threshold)<br>As a supplement only: BORG RPE scale (12–13) | Most training sessions should be performed within this exercise range. |
| **Low intensity** | Can be done on a daily basis<br>30–90 minutes | 30–39% $W_{max}$<br>35–49% of HRR after max. cardiac load<br>40–59% W AT or 40–49% $VO_{2peak}$<br>Lactate (45–59% W anaerobic threshold)<br>As a supplement only: BORG RPE scale (9–11) | Especially suitable for training novices for regeneration after intensive sessions<br>Suitable training range for exercise lasting several hours. |

cation of data gathered from an incremental exercise test to the endurance range is sometimes problematic.

- Blood lactate level
  The measurement of the lactate concentration in the blood is intended to distinguish exertion ranges with an aerobic, partially aerobic, and predominantly anaerobic energy supply. These ranges correlate with exertion-induced catecholamine release and therefore indicate the risk potential of physical exertion in cardiac patients. The upper limit of the aerobic exertion range is best represented by the determination of the maximum lactate steady state (maxLaSS), which is the highest continued exertion at which the lactate accumulation and elimination are still balanced. In case of a 30-minute endurance exercise session with continuous intensity, lactate values are not allowed to increase more than 1.0 mmol/liter between the 10th and the 30th minute. Because the determination of maxLaSS is very time-consuming, an "individual anaerobic threshold" is often estimated with a shorter procedure that involves an incremental exercise test (lactate performance test). A number of different threshold concepts (e.g., method according to Mader, Keul, David/Gass, Stegmann, Simon, and Dickhuth as well as Dmax according to Cheng) can be used for assessment and training management. Since these threshold concepts for the assessment of physical performance were primarily developed for high-performance athletes and not for use with cardiac patients, they are not generally transferable to specific patient groups (age, diabetics, patients with peripheral arterial occlusive disease etc.). Extensive knowledge and experience with the use of lactate testing in patients is required for this approach to avoid misinterpretations.
  Training can be evaluated by repeating the test after a period of training. In this regard, a right shift of the lactate performance curve indicates training progress.
- BORG RPE scale
  Management according to the BORG scale (rate of perceived exertion; Table 5) assumes that training measures a patient perceives as light to mid-level exertion are in the aerobic range and also are effective. However, used by itself, this parameter is subject to a large number of interference factors (e.g. impaired body perception, misguided ambition, peer pressure) and should only be used to supplement the other management parameters listed above.

**Conclusion:** In summary, there is no easily available method of training management that is ideal for every patient. Consequently, it is recommended to use as many of the above parameters as possible based on availability and individual experience.

## Recommendations for patients with stable chronic heart failure

**Recommended intensity**

- Up to 70% $VO_{2peak}$ or the anaerobic threshold at maximum
- 40–70% W max.
- $HR_{rest}$+60% HRR; ideally with additional verification by lactate measurement

A spiroergometric test (exertion until occurrence of symptoms or sub-maximal stress test) should be performed for heart failure patients to determine the endurance and anaerobic threshold. As an alternative, the result of an ergometric examination (exertion until occurrence of symptoms) can be used as well. However, these results are less meaningful.

**Recommended intensity (Table 6)**

As an alternative to the endurance method, the interval method can also be used for ergometric bicycle training. This should involve a change of the load level between a minimum of 0 and a maximum of 50% of the maximum value determined as part of the "steep ramp test" measured in seconds (mode 1: 20 seconds exertion and 40 seconds pause; mode 2: 30 seconds exertion and 60 seconds pause).

## Side effects/ adverse events

- When the above dosage guidelines and contraindications are observed, endurance training is a very safe activity for patients. This has been documented in a number of studies and practical observations. Endurance training is now included in the therapy guidelines of many renowned professional associations, including DGK, ESC, ACC, AHA, and DGPR.
- Adverse events can in particular be caused by overdosing (duration, intensity, and frequency) or failure to observe the contraindications.
- The following symptoms require particular attention: Angina pectoris, dyspnea, cardiac arrhythmia, signs of heart failure, unusual blood pressure and/or blood sugar values.

**Table 5** RPE scale according to BORG (Borg G: Med Sci Sports Exerc. 1982; 14: 377–381).

| Original BORG scale | | New BORG scale | |
|---|---|---|---|
| 6 | | 0 | No exertion at all |
| 7 | Very, very light | 0.5 | Very, very light |
| 8 | | 1 | Very light |
| 9 | Very light | 2 | Light |
| 10 | | 3 | Moderate |
| 11 | Fairly light | 4 | Somewhat hard |
| 12 | | 5 | |
| 13 | Somewhat hard | 6 | Hard |
| 14 | | 7 | |
| 15 | Hard | 8 | Very hard |
| 16 | | 9 | |
| 17 | Very hard | 10 | Very, very hard |
| 18 | | | |
| 19 | Very, very hard | | |
| 20 | | | |

**Table 6** Recommended intensity.

| Endurance capability | Recommendations |
|---|---|
| 25–40 Watt (<3 MET) | Several times a day 5–10 minutes each |
| 40–80 Watt (3–5 MET) | 1–2 times a day 15 minutes each |
| >80 Watt (>5 MET) | 3–5 times a week, 20–30 minutes each |

- Training should be suspended when adverse events occur. Another physical examination should be performed and the patient's exertion capability should be tested again before the patient resumes the activity.

## Part 2: Strength training

The emphasis of strength training in rehabilitation is not on reaching maximum muscle power, but on economic and optimally prepared execution of movements in everyday situations and leisure activities.

### Training resources

- Sequential training equipment
- Pulley traction equipment
- Dumbbells
- Expanders or latex/Thera Band® resistance bands
- Body's own weight

### Objectives

- Compensating loss of strength and muscle/ bone substance due to age, disease, or periods of rest
- Primary prevention of muscular and skeletal diseases
- Maintenance and improvement of mobility
- Improved symptoms/quality of life
- Improved physical performance
- Preparation for everyday situations/job
- Reduced cardiovascular risk factors
- Optimized innervation ability
- Development of neuromuscular balances
- Adaptations of the passive musculoskeletal system
- Improved posture
- Improved intermuscular and intramuscular coordination to prevent falls

### How it works

- Improves muscle strength (maximum strength, endurance strength)
- Inter-/ intramuscular coordination ↑
- Creatine phosphate level and activity of the corresponding enzymes ↑
- Increases muscle mass
- Positive impact on cardiovascular risk factor profile
  - Improved body proportions
- Improves glucose metabolism
- Long-term positive impact on hemodynamics under exertion
  - Decreased cardiac afterload
- Reduces cardiac pressure output
- Reduces rate-pressure product and therefore, $O_2$ requirement of the heart
- Compensates strength deficits and muscular imbalances
- Improves body perception

**Table 7** Exertion dosage.

| Training goal | Frequency | Intensity |
|---|---|---|
| Strength endurance | 2–3 times a week<br>1–3 sets<br>15–30 repetitions | 30–50% 1RM*<br>Medium perceived exertion<br>(BORG 11–15)<br>Slow, controlled movements |
| Muscle build-up | 2–3 times a week<br>1–3 sets<br>8–14 repetitions | 50–80% 1RM*<br>Medium perceived exertion<br>(BORG 13–15)<br>Slow, controlled movements |

* 1RM = one-repetition maximum, correctly performed without press power.

### Indications

Keeping in mind the contraindications listed below, strength training should be a standard treatment for **all cardiac patients** especially those with

- atrophy as a result of postoperative immobility
- disease-related muscular atrophy
- general physical weakness
- secondary orthopedic diseases

**No minimum physical performance level is required.**

### Required diagnostics prior to the start of training

See Part 1: General aerobic endurance training.

### Risk stratification

See Part 1: General aerobic endurance training.

### Contraindications

All conditions for which endurance training is contraindicated (see Part 1: General aerobic endurance training).

In addition to the contraindications listed above, strength training is problematic with the following health conditions:

- Hypertension that is difficult to manage
- Higher-level pulmonary hypertension
- Critical thoracic/abdominal aortic aneurysm
- Ventricular aneurysm at an early stage
- Severe and/or symptomatic hypertrophic cardiomyopathy

### Dosage

Due to the small muscle mass and short exertion times used in comparison with endurance training, strength training primarily represents an exertion of the peripheral regions (skeletal muscles, passive musculoskeletal system). Accordingly, the heart rate alone is not a suitable criterion for management. Although strength training should not exceed the training heart rates used in endurance training, the **actual load dosage** relies on the parameters “number of repetitions" and “intensity" as follows:

The **number of repetitions** results from the desired training goal (Table 7).

The **intensity** can either be defined objectively with 1RM or subjectively with perceived exertion.

- The determination of 1RM does not cause cardiovascular complications for cardiac patients or the elderly. However, it is not a suitable method to determine the training weight, since there is no significant correlation between percentage-based intensity and the possible number of repetitions. 1RM is only useful to estimate the training intensity and helps determine the upper limits.
- A subjective approach in which the intensity is defined on the basis of perceived exertion (e.g., BORG RPE scale) makes more sense.
- Maximum muscular exertion must be strictly avoided due to possible peaks in blood pressure; patients should not train to the last possible repetition. The weight must allow the patient to complete even the last repetition correctly, **without press power**, and with a perceived exertion of no more than RPE 15/“hard".
- In addition, the methodological-pedagogical guidelines of health-oriented strength training apply to the design and implementation of the training protocol.

Very weak patients usually tolerate strength training better than endurance training. If the training is poorly tolerated, the following measures can be taken to further reduce the exertion as necessary:

- Select only exercises that can be completed with an upright upper body, preferably in a seated position
- Add additional breaks or extend the pauses between exercises

- Use a training protocol of 3–5 sets with 5–10 repetitions each
- Add a short break (3 seconds) after every repetition
- Keep the muscle groups as small as possible, e.g., train only one leg instead of both legs

### Side effects/ adverse events

- When the above dosage guidelines and contraindications are observed, strength training is a very safe activity for patients. This has been documented in multiple studies.
- Adverse events can in particular be caused by overdosing or failure to observe contraindications.
- Blood pressure peaks and overload of the active and passive musculoskeletal system may occur with improper implementation.
- Training should be suspended when adverse events occur. Another physical examination should be performed before the patient resumes the activity.

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