Resistance exercise in cardiac rehabilitation

Implementation of exercise training into cardiac rehabilitation program according to the guideline based on the results of the assessments - resistance training - theoretical basic knowledge

基于评估结果指导方针，运动训练在心脏康复中的应用-力量训练-基础理论知识

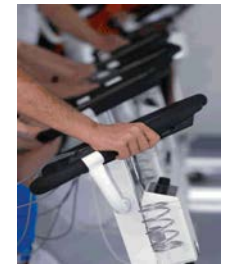
Prof. Dr. B. Bjarnason-Wehrens
Institute for Cardiology and Sports Medicine
心脏病学和运动医学研究所
German Sport University Cologne
德国科隆体育大学

Components of exercise based training interventions
运动训练干预成份




Aerobic endurance training

有氧耐力训练

Exercise to improve flexibility, agility coordination, balance, ...

Modified movement games and team games ...

改善灵活性、敏捷性、协调性、平衡性...的运动
修改过的活动游戏和团体游戏

Perception training, body awareness, practical skills of self-control

感知训练、身体意识、自控实际技能

抗阻训练
Resistance training

Exercise therapie in cardiac rehabilitation guidelines
心脏康复指南中的运动疗法

Pollock et al. Circulation 101 (2000), 828-833

AHA Science Advisory. Resistance exercise in individuals with and without cardiovascular disease: benefits, rationale, safety, and prescription:

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Exercise Standards for Testing and Training. A Statement for Healthcare Professionals From the American Heart Association.

Balady et al. Circulation 115 (2007), 2675-2682 Core Components of cardiac Rehabilitation/ Secondary Prevention Programs: 2007 Update.

Thompson et al. Circulation 107 (2003), 3109-16

Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease:

Bjarnason-Wehrens et al. Eur J Cardiovasc Prev Rehabil. 2004;11:352-61.

Recommendations for resistance exercise in cardiac rehabilitation.

Recommendations of the German Federation for Cardiovascular Prevention and Rehabilitation.

Braith et al. Circulation 2006; 113; 2642-2650

Resistance Exercise Training: Its Role in the Prevention of Cardiovascular Disease

Williams et al. Circulation. 2007;116:572-84

American Heart Association Council on Clinical Cardiology; American Heart Association Council on Nutrition, Physical Activity, and Metabolism.

Resistance exercise in individuals with and without cardiovascular disease: 2007 update: a scientific statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism.

Bjarnason-Wehrens B, et al. Clinical Research in Cardiology 2009;4:1-44

Leitlinie körperliche Aktivität zur Sekundärprävention und Therapie kardiovaskulärer Erkrankungen.

Vanhees et al. EJPC, 2012 DOI 10.1177/2047487312437063

Importance of characteristics and modalities of physical activity and exercise in the management of cardiovascular health in individuals with cardiovascular disease (Part III)

…

Giannuzzi et al. EJCPR 10 (2003), 319-27 Physical activity for primary and secondary prevention. Position paper of the Working Group on Cardiac Rehabilitation and Exercise Physiology of the European Society of Cardiology. Giannuzzi et al. Eur Heart J 24 (2003), 1273-8

Secondary prevention through cardiac rehabilitation: position paper of the Working Group on Cardiac Rehabilitation and Exercise Physiology of the European Society of Cardiology.

Corra et al. EJCPR 12 (2005), 321-2

Executive summary of the Position Paper of the Working Group on Cardiac Rehabilitation and Exercise Physiology of the European Society of Cardiology (ESC) core components of cardiac rehabilitation in chronic heart failure.

Piepoli et al. EJCPR (2010),

Secondary prevention through cardiac rehabilitation. 2009 Update; From Knowledge to Implementation. A Position paper from the Cardiac Rehabilitation Nucleus of the European Association of Cardiac Rehabilitation and Prevention

Smith et al. J Am Coll Cardiol. 2011;58:2432-46.

AHA/ACCF secondary prevention and risk reduction therapy for patients with coronary and other atherosclerotic vascular disease: 2011 update: a guideline from the American Heart Association and American College of Cardiology Foundation endorsed by the World Heart Federation and the Preventive Cardiovascular Nurses Association.

Fleg et al. Circulation. 2013;128:2422–2446

Secondary Prevention of Atherosclerotic Cardiovascular Disease in Older Adults: A Scientific Statement From the American Heart Association.

…

Resistance Training in Cardiac Rehabilitation

心脏康复中的抗阻训练

⇒ **Increase in muscular strength and endurance**

肌肉力量和耐力的增长

- by increasing muscle mass and/or improving coordination and metabolic situation

通过增加肌肉质量和/或改善协调性和代谢情况

⇒ **Work against loss in skeletal muscle mass and strength; reduce and prevent decreases in bone mass**

针对骨骼肌肉质量和力量的损失；减少并预防骨质下降

- age related; postmenopausal

年龄相关； 绝经后

- long-term bed-confinement or inactive due to illness

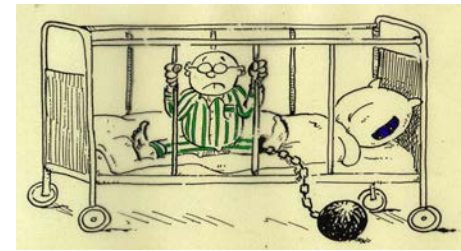
因为疾病长期卧床或静止

- catabolism of skeletal muscles (e.g. CHF)

骨骼肌的分解代谢 （比如 充血性心力衰竭）

- long-lasting immunosuppressive therapy

长期免疫抑制疗法



Resistance Training in Cardiac Rehabilitation心脏康复中的抗阻训练

⇒ **Increase in muscular strength and endurance 增加肌力和耐力**

⇒ increase exercise as well as functional capacity 增加活动力同时增加功能能力

⇒ reduce activity limitation 减少活动受限

⇒ improve functionality in carrying out everyday activity 改善每天执行的日常活动的功能性

⇒ preventing falls 摔倒预防

⇒ positively influence self-confidence and psychosocial well being, social re-adaptation and re-integration 对自信心，心理健康，社会再适应和再融入有积极影响

⇒ improve quality of life 改善生活质量

Impact of muscle strength in the elderly
肌力对老年人的影响

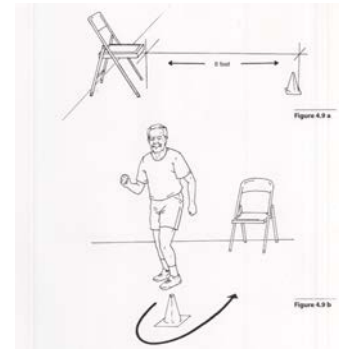
Reduced muscular strength in older persons has been determined to be a major cause of disability

老年人肌力的减少已被认为是残疾的主要原因之一。

Reduced lower leg strength has been associated with reduction in

下肢力量减少已被与下列方面变差联系起来：

- ✓gait speed
- ✓步态速度
- ✓balance
- ✓平衡
- ✓stair-climbing ability
- ✓上台阶能力
- ✓ability to get up from a seated position
- ✓从坐位站起的能力



Valenzuela T JAMDA 13 (2012) 418-428

Mangione KK et al. *PHYS THER.* 2010; 90:1711-1715.

Impact of improving muscle strength in the elderly …
改善老年人肌力的影响

Enhanced muscular strength
增强肌力可以

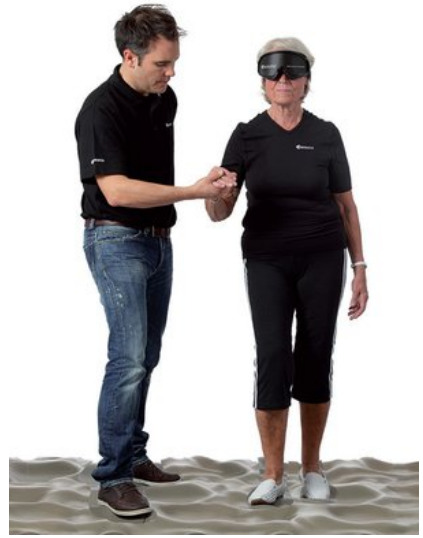
- reduces activity limitation
-减少活动限制
- improves functional capacity
-改善功能性能力
- maximizes independence
-使自理能力最大化
- slows the progression of Dementia
-减缓老年痴呆症的进展
- promotes sleep
-改善睡眠
- enhances quality of life and well-being
-提高生活质量和健康状况
- reduces risk of falls
-降低摔倒风险

Valenzuela T JAMDA 13 (2012) 418-428

balance training in the elderly …
老年人的平衡训练

The exercise program should include exercises that maintain or improve balance in order to reduce the risk of injury from falls.
运动计划应包含保持或改善平衡性的运动练习，以减少因跌倒而受伤的风险。

Balance exercises should be performed daily or at least on three days a week
平衡性练习应每天或至少一周训练3天
Example of exercises:
运动范例：
- walking backwards,
  向后走
- toe walking,
  用脚尖走路
- standing from a sitting position …
-从坐位站起



Nelson ME. et al. Physical Activity and Public Health in Older Adults Recommendation From the American College of Sports Medicine and the American Heart Association. Circulation. 2007;116:1094-1105
Elsawy et al. Physical activity guidelines for Older Adults; American Family Physician 2010 81 55-59

Resistance Training in Cardiac Rehabilitation

心脏康复中的抗阻训练

⇒ **Positive effects on cardiovascular risk factors**

对心血管疾病风险因素的积极影响

⇒ enhancement of weight reduction and stabilization

帮助减重和增强稳定性

⇒ improvement of insulin sensitivity, independent from changes in body weight and endurance capacity

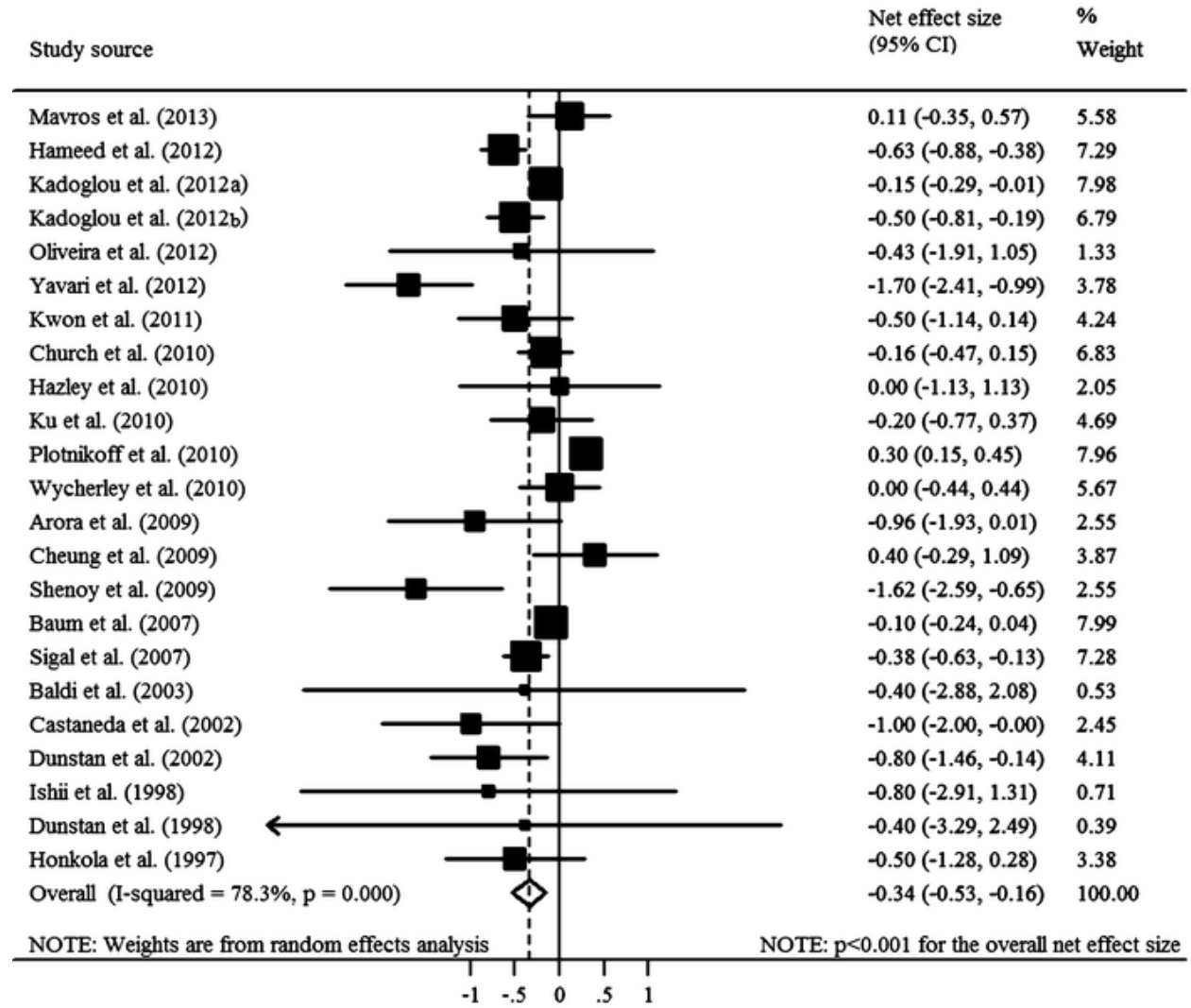
改善胰岛素敏感度，不受体重和耐力变化影响

⇒ reduction of blood pressure

降低血压

In Search of the Ideal Resistance Training Program to Improve Glycemic Control and its Indication for Patients with **Type 2 Diabetes** Mellitus: A Systematic Review and Meta-Analysis.
寻找理想的抗阻训练计划，以改善**2型糖尿病**患者的血糖控制及其适应症:一个系统回顾和荟萃分析。
Ishiguro et al. Sports Med. 2016;46:67-77.

- Resistance training is associated with HbA_{1c} reduction
  -0,34% (p<0,001).
- **抗阻训练与糖化血红蛋白减少0.34% 有关。（p<0,001)**



Exercise training for blood pressure: a systematic review and meta-analysis.
血压运动训练：一个系统性回顾和荟萃分析
Cornelissen & SmartJ Am Heart Assoc. 2013;2:e004473.

Meta analyses including 29 RCS resistance exercise

荟萃分析包含29项回顾性群组研究，抗阻训练

Mean blood pressure
平均血压
resistance exercise
抗阻训练
-1,8 /-3,2 mmHg

normal blood pressure
正常血压
-0,59/ -3,4 mmHg

prehypertension
高血压前期
-4,0/ -3,8 mmHg

Hypertension
高血压
+ 0,47/ -1,0 mmHg

Comparison of the Effects of Aerobic Training to Resistance Training on Health and Fitness Variables 有氧训练和抗阻训练对健康变量影响的对比

Variable变量	Aerobic Exercise	ResistanceExercise
Bone mineral density骨矿物质密度	↑	↑↑↑
Body composition身体成分		
Fat mass脂肪质量	↓↓	↓
Muscle mass肌肉质量	↔	↑↑
Strength肌力		
Glucose metabolism葡萄糖代谢		
Insulin response to glucose challenge胰岛素反应	↓↓	↓↓
Basal insulin levels基础胰岛素水平	↓	↓
Insulin sensitivity胰岛素敏感度	↑↑	↑↑
Serum lipids血清脂质		
High-density lipoprotein高密度脂蛋白	↑↔	↑↔
Low-density lipoprotein低密度脂蛋白	↓↔	↓↔
Resting heart rate静息心率	↓↓	↓
Blood pressure at rest静息血压		
Systolic收缩压	↓↓	↓
Diastolic舒张压	↓↓	↓
Physical endurance身体耐力	↑↑↑	↑↑
Basal metabolism基础代谢	↑	↑↑

↑ indicates increased; ↓, decreased; and ↔ negligible effect
↑ 表明升高; ↓, 降低; 而 ↔ 表明可以忽略的影响
(Randy et al. Circulation 2006;113;2642-2650)

Effect of combined aerobic and resistance training versus aerobic training alone in individuals with coronary artery disease: a meta-analysis
对比有氧抗阻综合训练与单独有氧训练对冠状动脉疾病患者的影响：一个荟萃分析
Marzolini et al. EJPC (2012);19;81-94

Aim: To compare the effect of aerobic training alone versus combined aerobic and resistance training on body composition, cardiovascular fitness (VO_{2peak}), strength, and quality-of-life (QOL) in coronary artery disease (CAD).

目标：比较单独有氧训练和有氧抗阻综合训练对冠状动脉疾病患者身体成份、心血管健康（耗氧量峰值）、力量和生活质量的影响。

Meta analyses: 12 studies N= 504; CAD-Patient

荟萃分析：12项研究 N=504；冠状动脉疾病患者

n: 229 aerobic training patients

229名有氧训练患者

n: 275 combined aerobic and resistance training patients

275名有氧抗阻综合训练患者

Exercise Capacity 运动能力

Difference combined vs. Aerobic exercie only 综合训练与单独有氧训练的对比

a) + 0.41 mL/min/kg V02peak (ns) + 0.41 毫升/分钟/千克 耗氧量峰值(未明确)

b) + 0.88 watt/exercise time (p<0.01) + 0.88 瓦特/运动时间 (p<0.01)

Marzolini et al. Prev Cardiol 2012;19:81-91

body composition(DEXA):
combined vs.
aerobic exercise only:
身体成份（骨密度）：
综合训练与单独有氧
训练的对比：

a) fat-free mass
去脂肪质量
+ 0.88 (p<0.001)

b) percent body fat
体脂含量
- 2.30 (p<0.001)

c) trunk fat
躯干脂肪
- 0.56 (p <0,001)

Marzolini et al. Prev Cardiol 2012;19:81-91

Combined vs. aerobic exercise only

综合训练与单独有氧训练的对比

a) upper body strength + 0.77 (p<0.001)

上身力量

b) lower body strength + 1.07 (p <0,001)

下身力量

Marzolini et al. Prev Cardiol 2012;19:81-91

Effects of resistance training on muscle strength, exercise capacity, and mobility in middle-aged and elderly patients with coronary artery disease: A meta-analysis.
抗阻训练对中老年冠状动脉疾病患者肌力、运动能力和活动性的影响：一个荟萃分析
Yamamoto et al. J Cardiol 2016; 68:125-34

Aim: to investigate the effects of RT on exercise capacity, muscle strength, and mobility in middle-aged and elderly patients with coronary artery disease (CAD).

目标：研究抗阻训练对中老年冠状动脉疾病患者运动能力、肌力和活动性的影响

Meta analysis: 22 RCS N= 1095; CAD-Patienten;

荟萃分析： 22 个回顾性群组研究 N=1095；冠状动脉疾病患者

7 RCS strength vs. Control Group

7 RCS 力量 vs. 对照组

16 RCS strength vs. combined aerobic and strength training

16 RCS 力量 vs. 有氧力量综合训练

exercise capacity 运动能力

differences compared to control 与对照组相比的差异

middle-aged 中年 + 0.90 mL/min/kg V02peak

elderly 老年 + 0.70 mL/Min /kg $V0_2$peak

Yamamoto et al. J Cardiol 2016;68:125-134

lower extremity muscle strength *(*knee extension*)* **下肢肌力** （伸膝）

- differences compared to control 与对照组相比的差异

middle-aged 中年人 SMD + 0.65

elderly 老年人 SMD + 0.63

Yamamoto et al. J Cardiol 2016;68:125-134

upper extremity muscle strength (chest press – biceps curls) **上肢肌力** （胸推--二头肌卷曲）

differences compared to control 与对照组相比的差异

middle-aged 中年人 SMD + 0.73

elderly 老年人 SMD + 1.18

Yamamoto et al. J Cardiol 2016;68:125-134

mobility (six-mintes-walking-distance) **灵活性** （6分钟步行距离）

differences compared to controle 与对照组相比的差异

middle-aged 中年人 SMD + 0.13 ns.

elderly 老年人 SMD + 0.61 (p = 0,003)

Yamamoto et al. J Cardiol 2016;68:125-134

The effect of resistance training on clinical outcomes in heart failure: A systematic review and meta-analysis

抗阻训练对心力衰竭临床结果的影响：一个系统性回顾和荟萃分析

Jewiss et al. Int J Cardiol 2016;221:674-681

Meta analysis: 27 RCS (29 exercise groups)

荟萃分析：27个回顾性群组研究（RCS）（29个运动组）

N= 2321; chronic heart failure

N=2321；慢性心力衰竭

6 RCS strength vs. control

6 RCS 力量训练 vs. 对照组

18 RCS combined strength and aerobic exercise vs. control

18 RCS 有氧力量综合训练 vs. 对照组

5 RCS combined strength and aerobic exercise vs. aerobic exercise only

5 RCS 有氧力量综合训练 vs. 单独有氧训练

Intensity: 60-80% 1RM

强度： 60-80% 1次最大肌力值

Program duration : ≤ 6 weeks – 26 weeks

项目持续时间： ≤ 6 周 – 26 周

Outcome Parameter:

结果参数：

mortality, hospitalization, peak VO2, peak HR, LVEF%, 6MWD, Qual,

死亡率、住院、 耗氧量峰值、 心率峰值、左心室射血分数、 6分钟步行距离、质量

exercise capacity 运动能力

+ 3.99 mL/min/kg V02peak; p<0.001(strength vs. control) （力量训练 vs. 对照组）

+ 1.43 mL/Min /kg V02peak; p=0,002 (combined vs. control)（综合训练vs.对照组）

+ 0.61 mL/Min /kg V02peak **ns.** (combined vs. aerobic only)（综合训练vs.有氧训练）

Jewiss et al. Int J Cardiol

quality of Life (MLwHFQ)
生活质量 （心力衰竭问卷）
strength vs. control - 8.31 (p <0,001)
力量训练 vs. 对照组 - 8.31 (p <0,001)

Jewiss et al. Int J Cardiol
2016;221:674-681

6 minute walking distance

6分钟步行距离

+ 41,77 m; p<0.001(strength vs. control) （力量训练 vs. 对照组）

+ 13,49 m; p=0,002 (combined vs. control) （综合训练 vs. 对照组）

Jewiss et al. Int J Cardiol
2016;221:674-681

Resting heart rate

静息心率

+ 5.43; p<0.001 (strength vs. control) （力量训练 vs. 对照组）

- 0.56; ns. (combined vs. control) （综合训练 vs. 对照组）

No advantage in improving

在改善以下方面并无优势：

-Mortality

-死亡率

-Re-Hospitalisation

-再入院治疗

-LVEF%

-左心室射血分数比率

Jewiss et al. Int J Cardiol 2016;221:674-68

The effect of resistance training on clinical outcomes in heart failure: A systematic review and meta-analysis

抗阻训练对心力衰竭临床结果的影响：一个系统性回顾和荟萃分析

Jewiss et al. Int J Cardiol 2016;221:674-681

Conclusions:

结论：

Resistance only or combined training improves：

单独抗阻训练或综合训练能改善：

-peak VO2,

耗氧量峰值

-quality of life and

心力衰竭患者的生活质量和

-walking performance in heart failure patients.

行走能力

Implementation of exercise Training in cardiac rehabilitation
运动训练在心脏康复中的应用

Careful clinical evaluation including: risk stratification, symptom limited exercise testing

细致的临床评估，包括：风险分级、非触发症状强度运动测试

Individual objectives of the exercise program

运动项目的个人目标

Individual exercise prescription and training protocol

个人运动处方和训练方案

Individually dosed and adapted exercise training

基于个人设定剂量的适应性运动训练

Control of efficacy

Modification and adaptation of the exercise prescription and training protocol referring to the patients objective medical and subjective health status

对疗效的控制 参考患者的客观医学情况和主观健康情况调整其运动处方和训练方案

Resistance training in cardiac rehabilitation
心脏康复中的抗阻训练

Resistance training is prescribed according to dosage parameters such as:
抗阻训练应按照如下剂量参数制定：

−**Intensity** (resistance)
-**强度**（抗阻）
−Volume
-训练量
−Frequency
-频率
−Duration
-时长
−Rate of progression
-训练逐级进展情况

A number of methods for determining the **intensity** for resistance training exist
要确定抗阻训练强度，有一系列方法。
One method is based on a percentage of the one repetition maximum (1RM)
其中一个是根据一次最大重复值比率

Implementation of resistance training in cardiac rehabilitation
抗阻训练在心脏康复中的实施应用

pre-training - Implementation of exercise; improvement of self perception and coordination; learning to correctly perform exercise

训练前- 运动实施；自我感知和协调能力的改善；学习正确的运动方式

Evaluation of muscle strength - *one repetition maximum measurements*

肌力评估- 一次最大重复值测量

Improvement stage I Improvement of aerobic endurance and coordination

改善阶段 I 有氧耐力和协调性的改善

Improvement stage II increase of muscle mass; improvement of coordination

改善阶段 II 肌肉质量的增长；协调性改善

Improvement stage II Increase in muscle strength

改善阶段 III 肌肉力量的增长

Resistance training in cardiac rehabilitation recommendations
心脏康复中的抗阻训练推荐

Intensity
强度
⇨% one repetition maximum(1RM)
⇨一次最大重复值比率
30-60% 1RM - (70-80 1RM)

Number of reps
重复次数
⇨ depending on intensity (8-25 reps)
⇨根据强度（8-25次重复）

Number of sets
组数
⇨1-3

Resting time between sets/ exercises
每组运动后的休息时间
⇨> one minute
⇨ 1分钟
⇨progression (gradual increase)
⇨进展（逐渐增加）

4-8 exercises
4-8次运动
Frequency
频率
2-3 days per week
每周2-3天
– with resting day in between
中间有休息日

Importance of characteristics and modalities of physical activity and exercise in the management of cardiovascular health in individuals with cardiovascular disease (Part III)
Vanhees et al. EJPC 2012

Table 2: Implementation of dynamic strength training in patients with cardiovascular disease *(modified according to Bjarnason-Wehrens B et al.[118], Williams MA et al.[119])*

General recommendations: if possible training should include all muscle groups. Training should change between agonist and antagonist muscle groups. Between training of each muscle group there should be a pause of more than 1 minute.

	Aim	Intensity	Number of repetitions per muscle group	Training frequency
Initial stage (pre-training)	Implementation of exercise; improvement of self perception and coordination; learning to correctly perform exercise	< 30% 1-RM RPE ≤11	5-10	2-3 training units per week, 1-3 sets each unit
Improvement stage I	Improvement of aerobic endurance and coordination	30-50% 1-RM RPE 12-13	10-15	2-3 training units per week; 1–3 sets each unit
Improvement stage II	increase of muscle mass; improvement of coordination	40-60% 1-RM (> 60% in selected patients) RPE ≤15	10-15	2-3 training units per week; 1–3 sets each unit
Improvement stage III	Increase in muscle strength	60 to 80% of 1-RM (in selected patients in good clinical condition and with heavy physical employment or those returning to sport)	8-10	2-3 training units per week; 1–3 sets each unit

1-RM = one repetition maximum; RPE = rate of perceived exertion

在心血管疾病患者的心血管健康管理中，体育活动和运动特点及其方式的重要性 (第三部分)

Vanhees et al. 《欧洲预防心脏病学杂志》, 2012

表 2： 动态力量训练在心血管疾病患者身上的应用（根据*Bjarnason-Wehrens B et al.*[118], *Williams MA et al.*[119] 修改）

一般建议： 如果可能的话，训练应涉及所有的肌肉群。对主动肌群和拮抗肌群的训练应该有变化。开始训练另一个肌肉群前，应有1分钟以上的停顿。

	目标	强度	每个肌肉群的重复速度	训练频率
最初阶段（训练前）	**运动实施；自我感知和协调能力的改善；学习正确的运动方式**	< 30% 1次最大重复值 主观体力感觉评定≤11	5-10	每周2-3个训练单元， 每单元1-3组训练
改善阶段 I	**有氧耐力和协调性的改善**	30-50% 1次最大重复值 主观体力感觉评定12-13	10-15	每周2-3个训练单元， 每单元1-3组训练
改善阶段 II	**肌肉质量的增长；协调性改善**	40-60% 1次最大重复值(入选患者> 60%) 主观体力感觉评定 ≤15	10-15	每周2-3个训练单元， 每单元1-3组训练
改善阶段 III	**肌肉力量的增长**	60 to 80% 1次最大重复值(临床状况好、体力活动程度高或者继续运动的入选患者)	8-10	每周2-3个训练单元， 每单元1-3组训练

1-RM =1次最大重复值；RPE = 主观体力感觉评定

Prof. Dr. B. Bjarnason-Wehrens, Institute for Cardiology and Sports Medicine, German Sport University Cologne

Familiarisation prior to resistance exercise
抗阻训练前的熟悉阶段

A familiarisation process as a begin of the resistance exercise program is essential to avoid injury, to assure a proper lifting technique, without compensatory movements and without breath holding

将熟悉过程作为抗阻训练的开端很重要，这样是为了避免受伤，确保恰当的提拉技巧，没有代偿性运动和憋气的情况。

➢Teach and practice correct lifting and breathing technique at very low load

➢在负荷很低的情况下，教导患者并使其练习正确的提拉和呼吸技巧

- one session in younger and experienced individuals
  对于年轻的、有经验的患者，只要一次课就够了
- multiple sessions in older inexperienced patients
- 对于年老、缺少经验的患者，要有几次课

➢*This familiarisation process should be performed prior to strength testing, so it can be used for testing and training*

➢**这个熟悉过程需要在力量检测前进行，所以它可以被用来做测试和训练前的准备工作。**

Prof. Dr. B. Bjarnason-Wehrens, Institute for Cardiology and Sports Medicine, German Sport University Cologne

Levingera et al. Journal of Science and Medicine in Sport (2009) 12, 310—316

Implementation of resistance training in cardiac rehabilitation

心脏康复中抗阻训练的实施

Initial stage – pre-training – familiarisation

最初阶段-训练前-熟悉过程

To implement the exercises; learn to correctly perform exercise; improve of self perception and coordination

运动实施；学习正确的运动方式；自我感知和协调能力的改善

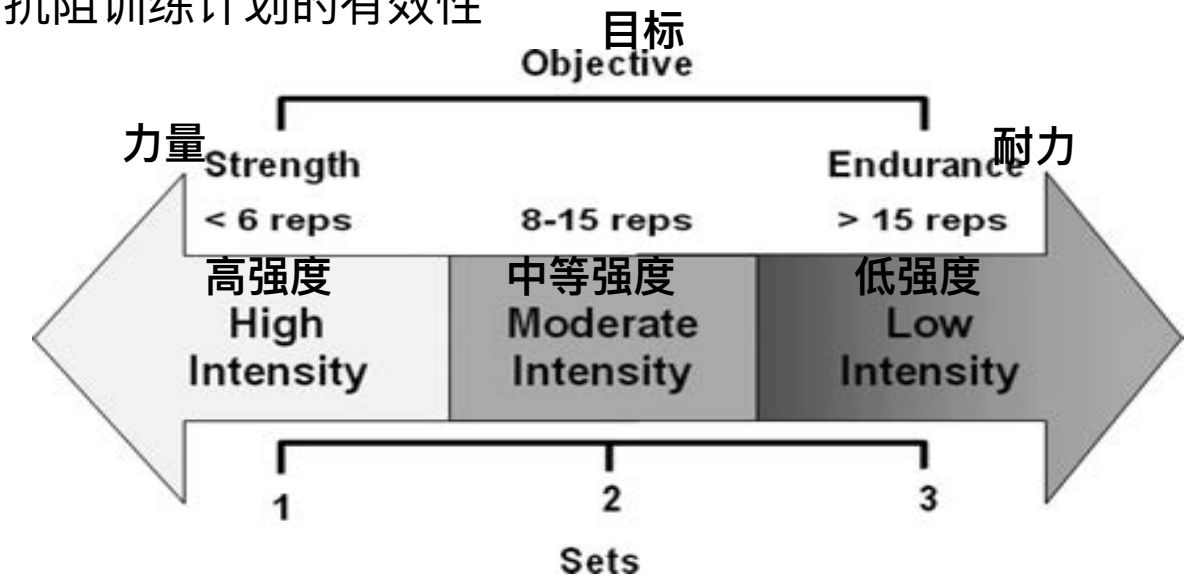
- very low intensity, < 30 % of 1 RM，RPE ≤11; breathing control
- 很低的强度，低于30%的1次最大重复值负荷，主观体力感觉评定 ≤11；呼吸控制
- few repetitions (5 –10) at low speed of movement,
- 在低速运动的情况下重复次数很少（5-10）
- 2-3 sets with ≥ 1Min rest between the sets
- 2-3组，每组间休息1分钟以上
- 2-3 training units per week,
- 每周2-3个训练单元

Bjarnason-Wehrens et al. Eur J Cardiovasc Prev Rehabil 11 (2004), 352-361

Evaluation of muscle strength cardiac rehabilitation recommended *one repetition maximum measurements*

心脏康复肌肉力量评估推荐
一次最大重复值测量

- to prescribe individualised safe and effective resistance training intensities
- 制定安全有效的个人化抗阻训练强度
- to track the progress of an individual
- 跟踪患者的进展
- to evaluate the efficacy of resistance training regime
- 评估抗阻训练计划的有效性
-



Williams et al. Circulation 116 (2007), 572-854)

Evaluation of muscle strength cardiac rehabilitation

one repetition maximum

心脏康复肌肉力量评估

一次最大重复值

The one repetition maximum test has been shown to be reliable for various populations – also in untrained middle-aged as well as old individuals

一次最大重复值测试被认为对多种人群都有可靠的适用性-包括未经训练的中老年患者

1RM a gold standard in dynamic resistance exercise testing

一次最大重复值是动态抗阻训练中的黄金标准

The 1RM is defined as the maximum amount of weight/resistance that can be performed for only a single repetition for a given exercise - with a proper lifting technique, without compensatory movements and without breath holding

一次最大重复值的定义，是某一特定运动单一重复执行时所能使用的最大重量/阻力-有恰当的抬起技巧，没有代偿性动作和屏息的情况。

Kramer et al. Curr Sports Med Rep 2002 ; 1 (3) 165-171; Levinger et al. J Sci Med Sport 2009;12 (2)310-316; Schroeder et al. J Gerontol A Biol Sci Med Sci 2007; 62 (5), 543-549; Taylor & Fletscher J Sci Med Sport 2012;15, 69-73)

Evaluation of muscle strength cardiac rehabilitation

one repetition maximum measures

心脏康复肌肉力量评估推荐

一次最大重复值测量

This method is comparatively simple and requires relatively inexpensive non-laboratory equipment

这种方法相对简单，需要的非实验用设备相对便宜。

The 1RM test can be performed using the same patterns as those undertaken by the exercising individuals during their normal training

一次最大重复值测量可以按照患者正常训练时的模式进行

Numerous studies have reported that the 1RM method to assess muscle strength is safe for patients with cardiovascular disease

多项研究报告称，评估肌肉力量的一次最大重复值测量方法对心血管疾病患者是安全的

(Ghilarducci et al. *Am J Cardiol* 1989;64:866-70.; Featherstone et al. *Am J Cardiol 1993;71:287—92)*. Shaw, et al. J Cardiopulm Rehabil 15: 283-287, 1995. Barnard, et al. J Cardiopulm Rehabil 19: 52-58, 1999. Levingera et al. Journal of Science and Medicine in Sport (2009) 12, 310—316

One repetition maximum testing prescription
-standard protocol -
一次最大重复值测量
-标准方案-

1. A light warm-up of 5-10 repetitions at 40-60% of assumed 1RM

一次轻负荷的热身，5-10次重复，1次最大重复值的40-60%。

rest period ≥ 1-min

休息时间1分钟以上

2. 3-5 repetitions at 60-80% of assumed 1RM

3-5次重复，1次最大重复值的60-80%

rest period of ≥ 2-3 min

休息时间2-3分钟以上

3. After 3-5 attempts the weight which can be lifted in a single repetition shall be identified

3-5次尝试后，单词重复可抬起的重量就可以被确定

The 1RM value is reported as the weight of the last successfully completed lift

1次最大重复值即最后一次成功抬起的重量

Communication between supervisor and test person is of particular importance

监督人员和受试者之间的沟通尤为重要

Skinner Exercise testing and exercise prescription for special cases. Lippincot Williams & Wilkins 2005)

Predictive one repetition maximum

预测性一次重复最大值

http://www.exrx.net/Calculators/OneRepMax.html

Brzycki´s equation to determine max load:
确定最大负荷的Brzycki公式

Weight ÷ (1.0278 – (0.0278 x number of repetitions))
重量÷ (1.0278 – (0.0278 x 重复次数))

Baechle equation to dertermine max load:
确定最大负荷的Baechle公式

Reps:		1	2	3	4	5	6	7	8	9	10	11	12	15
% 1RM	Brzycki	100	95	90	88	86	83	80	78	76	75	72	70	
	Baechle	100	95	93	90	87	85	83	80	77	75		67	65

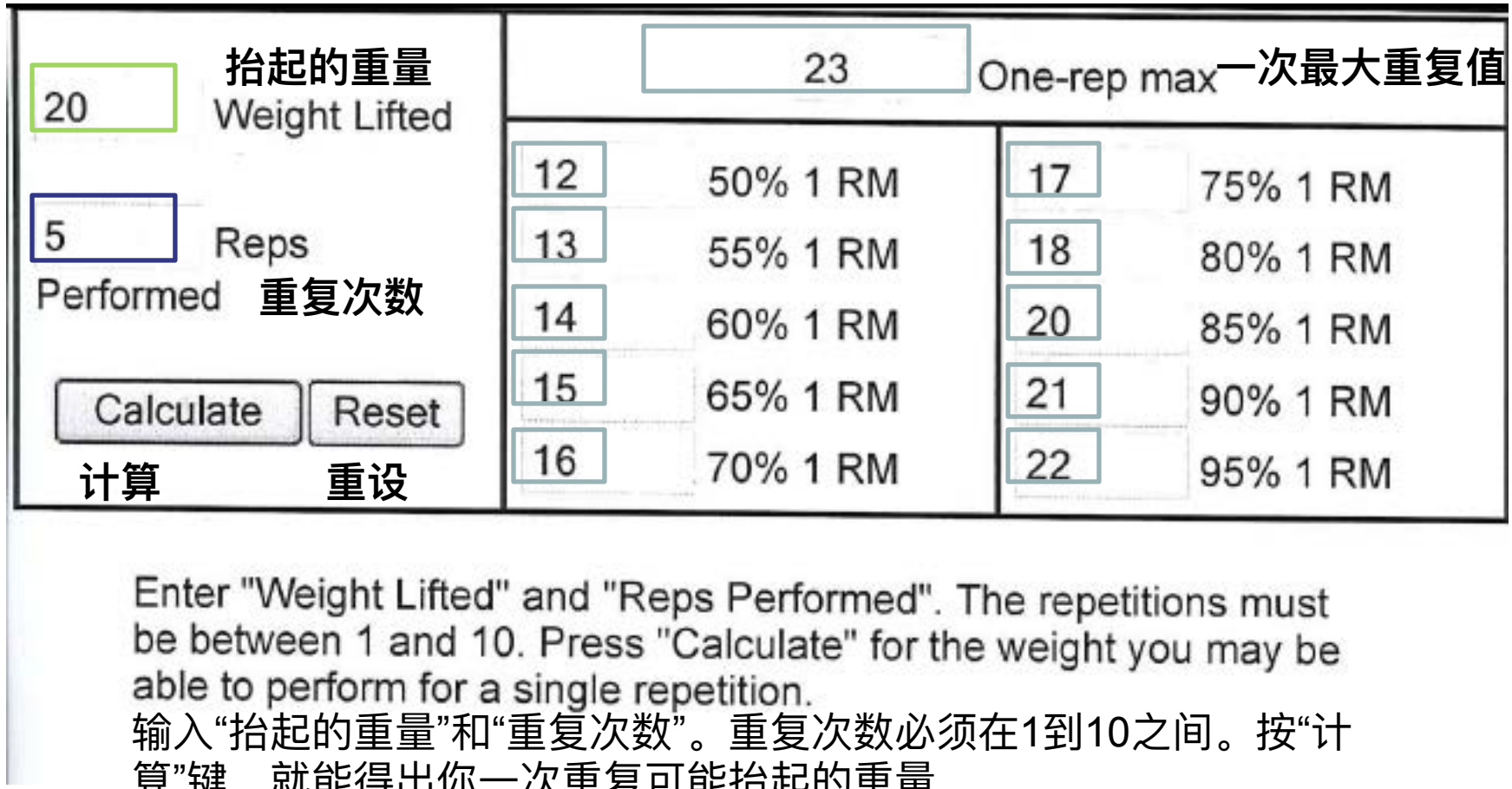
Brzycki, M (1993). Strength testing-Prediction a one-rep max from reps-to-fatique . JOPERD, 68 p. 88-90

Baechle TR, Earle RW, Wathen D (2000). Resistance Training In: Naechle TR & Earle RW eds. Essentials of Strength Training and Conditioning, 2nd ed. Champaign, IL Human Kinetics p: 395-425.

http://www.exrx.net/Calculators/OneRepMax.html

Predictive One Rep. Max.
预测性一次重复最大值

http://www.exrx.net/Calculators/OneRepMax.html



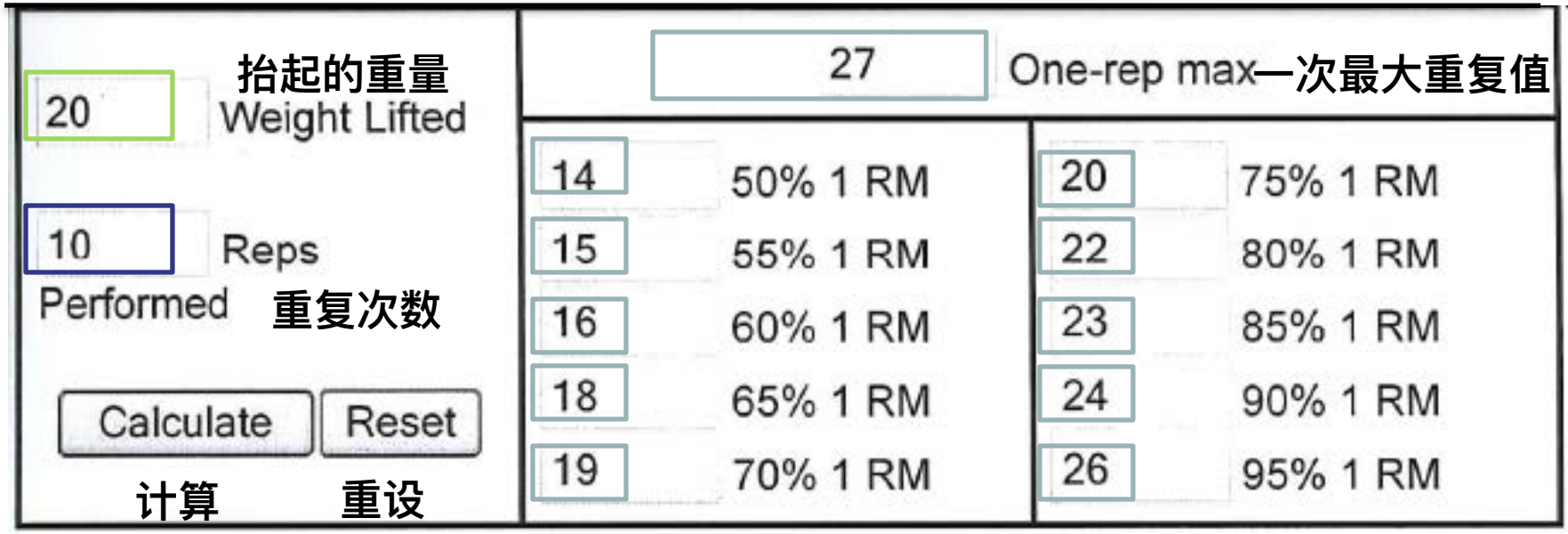
Enter "Weight Lifted" and "Reps Performed". The repetitions must be between 1 and 10. Press "Calculate" for the weight you may be able to perform for a single repetition.

输入“抬起的重量”和“重复次数”。重复次数必须在1到10之间。按“计算”键，就能得出你一次重复可能抬起的重量。

Predictive One Rep. Max.

预测性一次重复最大值

http://www.exrx.net/Calculators/OneRepMax.html



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Prof. Dr. Birna Bjarnason-Wehrens, Institute for Cardiology and Sports Medicine, German Sport University Cologne

Implementation of resistance training in cardiac rehabilitation
心脏康复中抗阻训练的实施应用

Improvement stage I – muscle endurance training

改善阶段I - 肌肉耐力训练

To improve local aerobic endurance and coordination
改善局部有氧耐力和协调性

- dynamic, low isometric component!

  动态的、较少等长对抗!

- low to moderate intensity (30 – 50% 1RM)
- 低到中等强度 （30-50% 1次最大重复值）
- number of repetitions (10-15)
- 重复次数（10-15次）
- 2-3 sets with ≥ 1Min rest between the sets
- 2-3组，每组间休息1分钟以上
- 2 – 3 days per week for

  每周2-3天

- RPE (Borg-scale) 12-13 主观体力感觉评定 （Borg量表）12-13

Bjarnason-Wehrens et al. Eur J Cardiovasc Prev Rehabil 11 (2004), 352-361

Implementation of resistance training in cardiac rehabilitation
心脏康复中抗阻训练的实施应用

Improvement stage II

改善阶段 II

To increase muscle mass and improve coordination
增加肌肉质量和协调性

- dynamic, low isometric component!
  动态的、较少等长对抗!
- moderate intensity (40 – 60% 1RM)
- 中等强度 （ 40% - 60% 1次最大重复值）
- number of repetitions (10-15)
- 重复次数（10-15次）
- 2-3 sets with ≥ 1Min rest between the sets
- 2-3组，每组间休息1分钟以上
- 2 – 3 days per week for
  每周2-3天
- RPE (Borg-scale) ≤ 15 主观体力感觉评定 （Borg量表） ≤ 15

Bjarnason-Wehrens et al. Eur J Cardiovasc Prev Rehabil 11 (2004), 352-361

Implementation of resistance training in cardiac rehabilitation
心脏康复中抗阻训练的实施应用

Improvement stage III – in selected patients in good clinical condition

改善阶段III - 临床状况好的入选患者

To increase muscle mass strength
改善肌肉质量力量

- dynamic, low isometric component!
  动态的、较少等长对抗!
- high intensity (60 – 80% 1RM)
- 高强度（60-80% 1次最大重复值）
- number of repetitions 8-10
- 重复次数8-10
- 2-3 sets with ≥ 1Min rest between the sets
- 2-3组，每组间休息1分钟以上
- 2 – 3 days per week for
  每周2-3天
- RPE (Borg-scale) ≤ 15 主观体力感觉评定 （Borg量表） ≤ 15

Resistance training in cardiac rehabilitation - at what time and for whom?

心脏康复中的抗阻训练 -何时做和为谁做？-

- Resistance training may be considered for patients in phase II and phase III cardiac rehabilitation
- II期和III期心脏康复期患者可考虑进行抗阻训练

- it is contraindicated in phase I (acute hospital phase)
- 第一阶段(住院急性期)禁忌

- Exercise training should be started as an aerobic endurance training
- 运动训练应以有氧耐力训练开始

- Resistance training should be considered as an additional element, it can be integrated early into the training program (*after 4 to 6 units of endurance training – earliest)*
- 抗阻训练应被认为是一个额外因素，它可以在早期被整合进训练计划(在4到6个耐力训练单元之后)

Prof. Dr. B. Bjarnason-Wehrens, Institute for Cardiology and Sports Medicine, German Sport University Cologne

Patients after Bypass Surgery

心脏搭桥手术后的患者

- wound healing is usually completed in 4 – 6 weeks.
  伤口愈合一般需要4-6周
- physical exertion causing tangenital vector forces in the sternal area (pressure or sheering stress) should be avoided at least 6 weeks (up to 3 months) after surgery.
  在手术后至少6周（最多3个月）内应避免能造成胸骨区域压力或剪切力形式的体力消耗。
- the sternum should be checked for stability by an experienced healthcare professional before resistance training is initiated.
  在开始抗阻训练之前，应该由一个有经验的医疗专业人员检查胸骨稳定性。
- no postoperative complications provided, patients may start with low intensity resistance training for lower limb at an earlier stage – a stable body trunk is required
  如没有术后并发症，患者可以在较早阶段开始低强度的下肢训练，需要有一个稳定的躯干。

Prof. Dr. B. Bjarnason-Wehrens, Institute for Cardiology and Sports Medicine, German Sport University Cologne

Patients after cardiac transplantation

心脏移植后的患者

- usually patients suffer from a preoperative loss of muscle mass and strength
  通常患者术前的肌肉质量和力量都会下降

- post-operative a long-lasting immunosuppressive therapy results in atrophy of skeletal muscles and loss in bone mass
  术后的长期免疫抑制治疗，会导致骨骼肌萎缩和骨质量丧失

- Stable patients should start a moderate, individually adjusted muscle endurance and resistance exercise training to avoid these negative side effects - as soon as possible.
  状况稳定的患者应尽快开始适度的、根据个人调整的肌肉耐力和阻力训练，以避免受到这些副作用的影响。

Braith et al. The Journal of Heart and Lung Transplantation, 12 (1993), 1018-1023
Braith et al. J Am Coll Cardiol 28 (1996), 1471-1477

Implementation of resistance training in cardiac rehabilitation
心脏康复中抗阻训练的实施应用

Special directions for training:

训练特别指导：

- Program should include a standardized exercise program for mobilisation and stretching for warming-up, and cooling-down
- 项目应包含一个标准化的运动项目，用于热身和结束时的活动和拉伸。
- start the restistance training with **a single set of 4 to 8 exercises - later increase number of sets (2-3) and exercises**
- 开始**1组4 - 8次练习**的抗阻训练-**稍后增加组数(2 - 3)和练习**
- perform varied training covering the major muscle groups; chest, shoulders, arms, back, abdomen, thigh, lower legs
- 多样化训练，涵盖主要的肌肉群；胸部、肩部、手臂、背部、腹部、大腿、小腿
- some of the exercises may be performed unilateral

有些运动可能是单边进行的

Implementation of resistance training in cardiac rehabilitation
心脏康复中抗阻训练的实施应用

perform the resistance training,
开展抗阻训练

- in a rhythmical manner at a moderate controlled speed
  以一种有节奏的方式，控制速度适中
- through a full range of motion,
  完全的活动度
- avoid a continuous, tensed-up grip
  避免持续的、紧张的抓握

Prof. Dr. B. Bjarnason-Wehrens, Institute for Cardiology and Sports Medicine, German Sport University Cologne

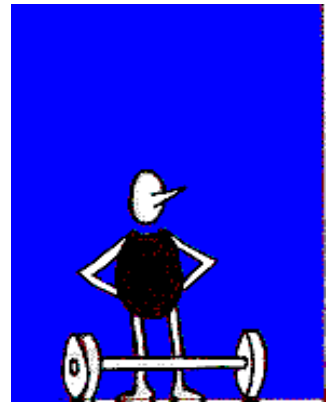
Implementation of resistance training in cardiac rehabilitation
心脏康复中抗阻训练的实施应用

Special directions for training:
训练特别指示：

- If symptoms occur, discontinue the training immediately (vertigo, arrhythmias, dyspnoea, angina pectoris …).
  如果出现症状,立即停止训练(眩晕、心律失常、呼吸困难,心绞痛…)。

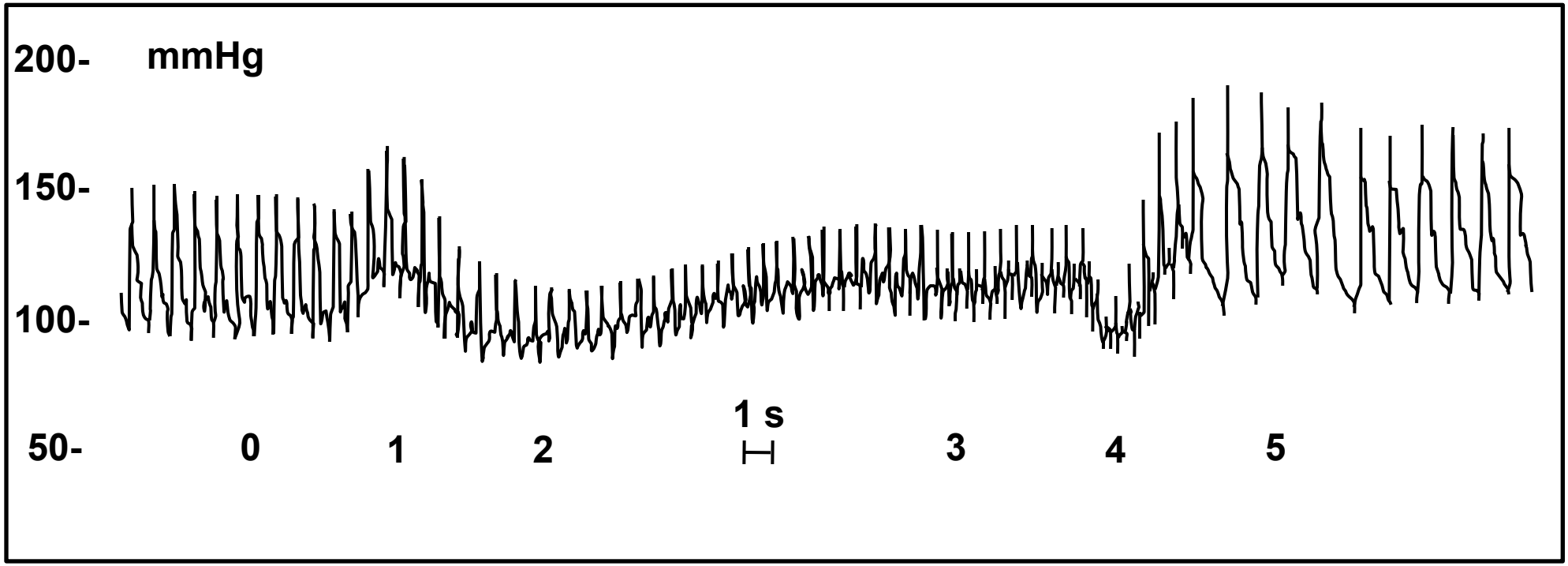
Blood pressure response during Valsalva maneuver

瓦氏动作时的血压反应



- avoid breath holding and straining (Valsalva maneuver) by exhaling during the contraction or exertion phase of the lift and inhaling during the relaxation phase)

肌肉收缩阶段或用力时呼气，肌肉放松阶段或离心收缩阶段吸气（瓦氏动作），这样能够防止出现呼吸过程憋气或异常压迫



Implementation of resistance training in cardiac rehabilitation

20	
19	extremely hard
18	
17	very hard
16	
15	hard / heavy
14	
13	somewhat hard
12	
11	light
10	
9	very light
8	
7	extremely light
6	

- **Use the Borg Rate of Perceived Exertion Scale.**
- The correct load is also determined by the perceived exertion of the patient!
- To learn self-perception control heart-rate as well as RPE-assessment
- Patients with moderate risk should achieve RPE 15 at the very most, better RPE 12-13.

心脏康复中抗阻训练的实施应用

20	
19	极其困难
18	
17	很困难
16	
15	困难/重
14	
13	有些难
12	
11	轻
10	
9	很轻
8	
7	极轻
6	

- 使用Borg 主观体力感觉评定量表
- 正确的负荷也是由患者的主观体力感觉评定决定
- 学习自我知觉控制心率和主观体力感觉评定评估
- 中度风险的患者应达到主观体力感觉评定至多15，12 - 13更好。

Prof. Bjarnason-Wehrens : Resistance exercise in the cardiac patient: what evidence do we have?

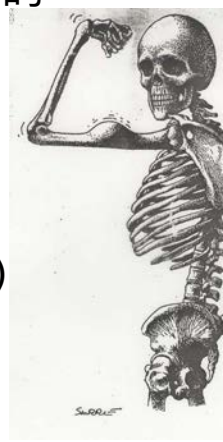
Absolute and Relative Contraindications to Resistance Training抗阻训练的绝对和相对禁忌症

Absolute 绝对禁忌

Unstable CHD 不稳定型冠心病
Decompensated HF 失代偿性心力衰竭
Uncontrolled arrhythmias未能理想控制的心律失常
Severe pulmonary hypertension (mean pulmonary arterial pressure >55 mmHg)未能理想控制 的心律失常
Severe and symptomatic aortic stenosis严重的和症状性主动脉瓣狭窄
Acute myocarditis, endocarditis, or pericarditis急性心肌炎、心内膜炎或心包炎
Uncontrolled hypertension (>180/110 mmHg)未能理想控制的高血压(> 180/110毫米汞柱)
Aortic dissection主动脉夹层
Marfan syndrome马凡氏综合症
High-intensity RT (80% to 100% of 1-RM) in patients with active proliferative retinopathy or moderate or worse nonproliferative diabetic retinopathy对有活性增殖性视网膜病变，或中度乃至更严重的非增殖性糖尿病视网膜病变的患者进行高强度抗阻训练(80%至100%的1 次最大重复值)

Relative (should consult a physician before participation)相对禁忌（遵医嘱）

Major risk factors for CHD 冠心病的主要风险因素
Diabetes at any age 任何年龄段的糖尿病
Uncontrolled hypertension (>160/>100 mmHg)未能理想控制的高血压(> 160 / > 100毫米汞柱)
Low functional capacity (<4 METs) 低功能性能力(< 4 METs)
Musculoskeletal limitations肌肉骨骼限制
Individuals who have implanted pacemakers or defibrillators植入起搏器或除颤器的人



Williams et al. Circulation 116 (2007), 572-854)

Thank you for your attendance

感谢您的参与