Cardiac rehabilitation

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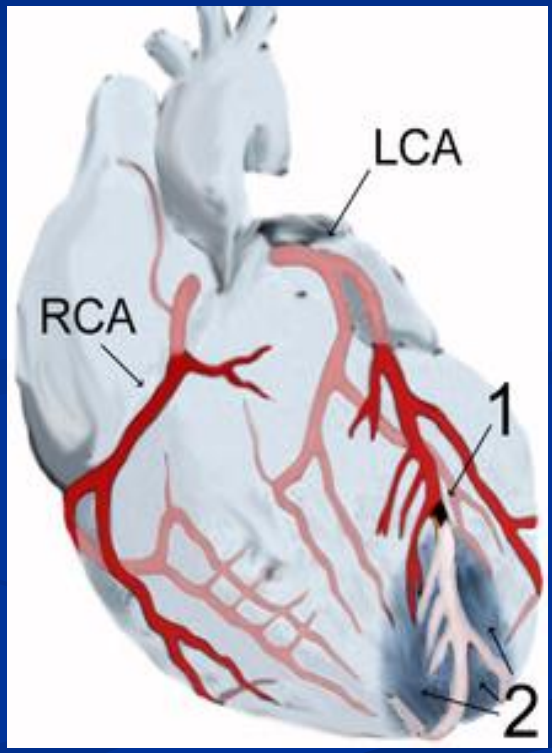
April, 2016

Definition of cardiac rehabilitation

- Coordinated measures used to restore patients to their optimal medical, psychological, social, emotional, sexual, vocational and economic status compatible with the severity of the their heart disease
- Interdisciplinary approach to functional limitation
- Primary prevention- screening of healthy individuals to identify and treat risk factors before heart disease develops
- Secondary prevention is initiated during cardiac rehabilitation to adress risk factors and limit further morbidity and mortality



*Picture 1 wikipedia.org; author: J. Hauser

Epidemiology of cardiovascular disease

- WHO (2008.g.): ishemic heart disease leading cause of death in middle (13,7%), and high income countries (15,6%)[1]
- Myocardial infarction leading cause of sudden death (24 hours first sympthoms-death)
- Cardiovascular disease leading cause of morbidity and mortality in men and women in USA
- CVD: 55-65 yrs 48/51% (M/F), over 75 yrs (71/79%)
- In Clinical Hospital Center Split number of hospitalization after IM 196-1981, whil 522-2005.g. (transportable defibrilator)[2]

[1] http://www.who.int/mediacentre/factsheets/fs310/en/index.html

[2] Miric D. et al. Coronary disease. HKD-ogranak Split, 2006:7-15

Historical development

- 1912. 2 months of bed rest following myocardial infarction (proposed concept then was that early activity leads to- congestive heart failure, ventricular aneurysm, cardiac rupture, sudden death)
- 1930. 6 weeks until scar is formed- histological studies (bed rest was prescribed)
- 1950. early ambulation programs at 4 weeks after MI, then 14 days- better outcome
- 1970. hospital lenght of stay shortened- economic reasons, earlier ambulation- no increase in occurence of angina, reinfarction, CHF or death

1 Jonathan H. Whiteson Chapter 34 Physical medicine and rehabilitation Randall L. Braddom, Third Ed 709-732

5 Frontera WR, Silver JK, RizzoTD Essentials of physical medicine and rehabilitatiton 2nd Ed 112,615-620

Cardiac rehabilitation- indications

- Myocardial infaction - primary reason for refferal for CR. Angina pectoris, post cathether based intervention, corono-aortal bypass graft, valve surgery, chronic heart failure, arrythmia and heart transplatation patients are being referred to CR

- The risk of cardiac event during exercise ranges from 1:50000 patient/hours to 1:120000 patient-hours[3-4]

[3] Lavie CJ et al. Exercise training and cardiac rehabilitation. Mayo Clinic Proc 2009;84:373-83
[4] Guidelines for cardiac rehabilitation and secondary prevention programs 4th Ed, Human Kinetics 2004

Cardiac rehabilitation contraindications

- High risk instable angina pectoris
- Systolic blood pressure in rest >200 mm Hg, diastolic >120 mm Hg, tachycardia >120, bradicardia >50 otk/min
- hipotension 90/60 mm Hg and lower
- Sympthomatic severe aortic stenosis
- fever, unregulated diabetes, renal insufficienty, tireotoxicosis
- Symptomatic arrhythmias, AV block III. grade
- Decompensation of congestive heart failure
- Acute pulmonary embolus
- ST denivelation more then 3 mm in rest
- acute myocarditis or pericarditis, acute aortic dissection

Managment of risk factors

Box 34-1 Risk factors for coronary artery disease

Modifiable

- Physical inactivity
- Hypertension
- Smoking
- Dyslipidemia
- Overweight or obesity
- Diabetes
- Metabolic syndrome
- Emerging factors (see below)

Non-modifiable

- Increasing age
- Gender: male > female
- Prior history: cardiac, peripheral vascular, or cerebrovascular disease
- Family history: genetics
- Cultural or socioeconomic

Exercise physiology

1. Cardiac arrhythmias occur more frequently under anaerobic conditions
2. Exercise intensities should be set below anaerobic threshold (spike of CO_2 production)
3. Level of activity can be measured in MET (metabolic eqivalent) –basal metabolic state equals 1 MET, 3.5 $cm^3/min/kg\ O_2$

Table 34-6 The metabolic equivalent energy expenditure of varying intensity activities

Level	Self-care	Household	Recreational	Vocational
Light (1–3 metabolic) equivalents, METS	Sponge bathing Shaving Dressing or undressing	Preparing light meals Setting table Dusting	Walking 2 mph Writing Reading Playing piano	Typing Light machine work Lifting <10 lbs Using a sewing machine
Light to moderate (3–4 METS)	Showering Climbing stairs Driving	Light gardening Ironing Vacuuming Grocery shopping	Walking 3 mph Slow bicycling Golfing with cart	Light carpentry Working on an assembly line Lifting <20 lbs Bricklaying
Moderate (4–5 METS)	Having sexual intercourse.	Heavy gardening Waxing floors Moving furniture Raking leaves Washing car	Walking 3.5 mph Playing doubles tennis Slow dancing Easy swimming Bicycling 8 mph	Light shoveling Mixing cement Light farming Lifting <50 lbs
Heavy (5–7 METS)		Splitting wood Shoveling snow Climbing ladder	Walking 4–5 mph Playing singles tennis Cross-country skiing at 2.5 mph Doing gymnastics	Heavy farming Heavy industry Lifting 50–100 lbs
Very heavy (>7 METS)		Moving heavy furniture Pushing or pulling hard	Jogging at 5 mph Playing soccer Playing basketball Horseback riding	Heavy construction Lifting 100 lbs

Oxygen consumption

1. With increase in workload oxygen requirement surpases the capacity of physiological systems and anaerobic mechanisms produce additional energy
2. Due to the lactic acid accumulation only short duration of exercise is possible

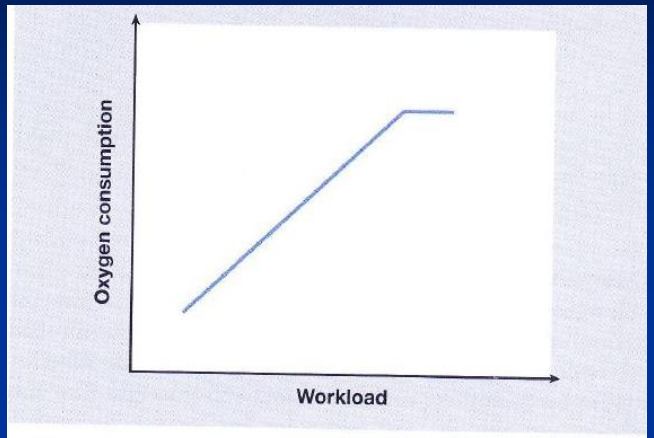
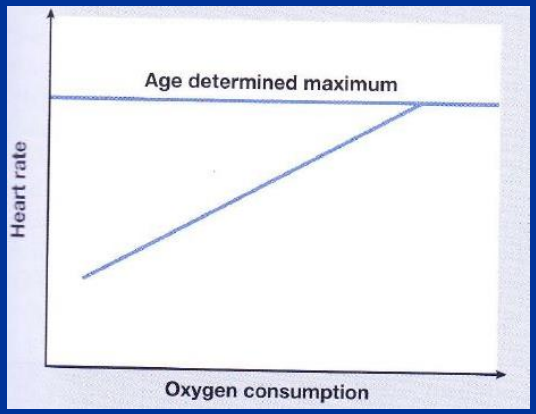
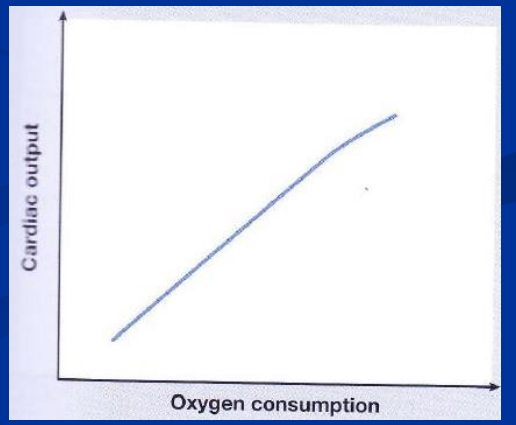


Figure 34-1 Relationship between oxygen consumption and intensity of work being performed.

The Fick equation:
oxygen consumption=cardiac output x arteriovenous oxygen difference



Cardiac output - product of heart rate and stroke volume
At lower exercise intensities cardiac output increases more due to SV, at higher intensities due to HR



Aerobic training

- Is habitual dynamic physical activity of sufficient intensity, duration and frequency to produce physiologic adjustment in the cardiopulmonary responce to exercise

In heart disease after prolonged bed rest:

- Resting tachicardia
- Reduced vagal tone
- Enhanced symphatetic drive due to circulating catecholamins
- Exaggerated HR responce to low level exercise
- Return to resting HR after exercise is delayed
- Lower cardiac output after MI or CHF (fluid)
- Decline of arteriovenous O2 difference
- Peak HR is 25% lower than in age matched controls, Vo_{2max} is 33% of predicted in heart transplantation, with tachycardia (denervation of vagal tone, catecholamins increased)

Box 34-4 Adaptations noted with aerobic training

Functional
- Higher peak work rate
- Reduced disturbance of body function
- Enhanced rate of recovery after exercise

Cardiovascular and pulmonary
- Increased stroke volume and peak CO
- Increased respiratory muscle strength, maximal voluntary ventilation
- Reduced dyspnea

Musculoskeletal
- Increased flexibility
- Increased muscle, tendon, and cartilage strength
- Increased bone density
- Increased lean muscle mass
- Reduced body fat percentage

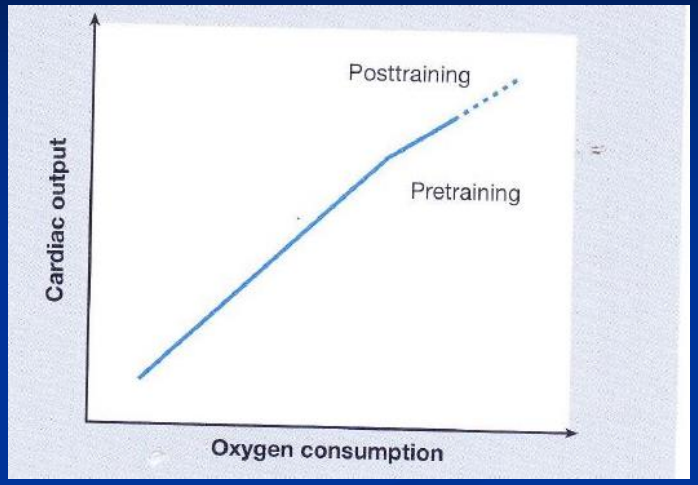
Biochemical
- Increased aerobic enzyme concentration

Endocrine
- Reduced stress hormone release

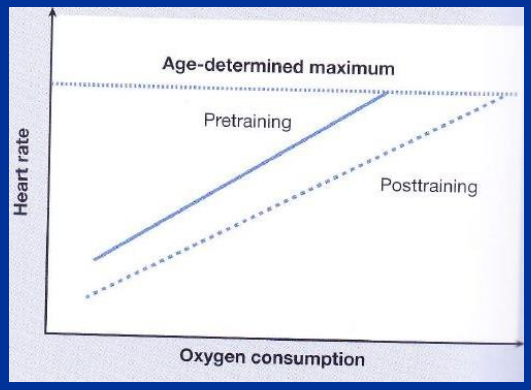
Psychologic
- Improved depression and anxiety

Benefits of aerobic exercise

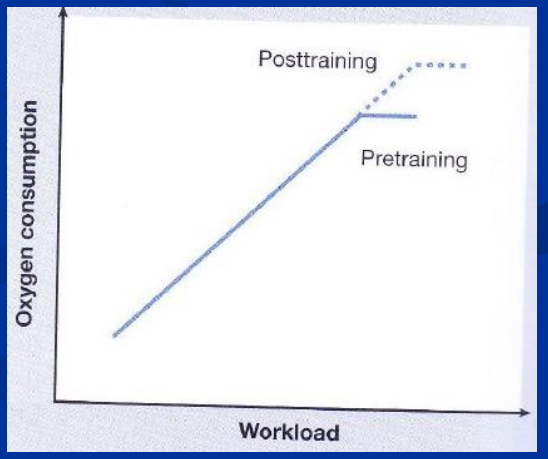
1. It influences all parts of Fick equation, small but significant increase of cardiac output is seen at higher work intensities, at rest and submaximal effort CO it is the same
2. HR is reduced in rest and effort – increased vagal tone- lonerf filling volume of LV- higher stroke volume



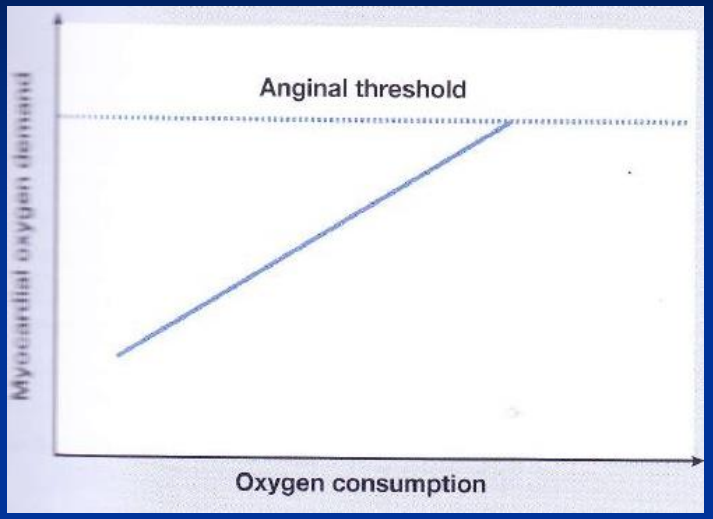
The Fick equation:
oxygen consumption=cardiac output x arteriovenous oxygen difference

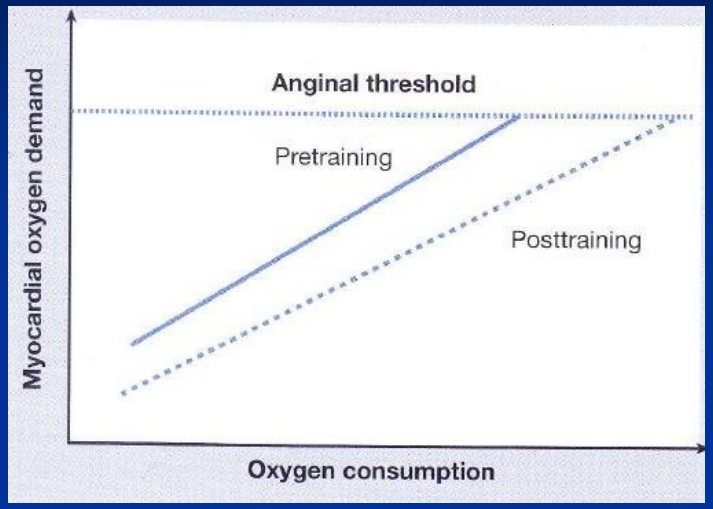


3. Arteriovenous O2 difference in increased, higher O2 utilization in maximal effort by aerobically trained muscles- increased VO2max



Myocardial oxygen consumption and training





- In normal coronary vessels arteries dilate as oxygen demand increases, in atherosclerotic disease anginal threshold occurs when oxygen demand is higher then supply
- Exercise does not affect anginal threshold (only catheter or CABG interventions)
- M Vo2 is lower at rest and submaximal effort with exercise(wider margin of safety)

Box 34-5 Adaptations enhancing arteriovenous O_2 difference following aerobic training

- Increased:
  - Hemoglobin oxygen saturation
  - Red blood cell hemoglobin concentration
  - Size of arteries perfusing type 1 fiber muscles
  - Capillary density
  - Blood supply to type 1 muscle fiber beds
  - Size of the type 1 muscle fibers
  - Muscle fiber myoglobin concentration
  - Mitochondrial size and concentration
  - Aerobic enzymes concentration
- Enhanced minute ventilation

Cardiac evaluation

- Careful history of heart disease review: type of pain, palpitations, dyspnea, edema, cough, dizziness, deconditioning, fatigue
- Physical examination: puls rhythm and rate examination, arrhytmias detection, blood pressure- resting BP more then 200/110 no exercise
- Heart and lung examination
- limb examination
- peripheral pulses
- neurological examination
- musculoskeletal examination,
- cognitive examination

Cardiac testing

- Resting ECG, chest roentgenogram, echocardiogram, ambulatory 24-h Holter monitoring
- A low level submaximal exercise stress testing - ergometry (50-75W) should be performed before hospital discharge to quantify functional activity tolerance- predetermined endpoint like HR 120/min, 70% of predicted maximum HR, or peak MET 5
- Medication should be taken as usual, no coffeinated drinks 3 hours before EST
- ECG and vital signs are recorded before, during and after testing. Systolic BP usually rises 10-30 mmHg, with a peak more then 140 mmHg
- Diastolic blood pressure remains stable or decreases
- Normal EST is terminated when 85% of age and gender maximum HR is achieved
- Cycle ergometers- rehabilitation, treadmills-evaluation
- The most frequently used protocol is Bruce-1.7mph, 10% grade, increase every three minute

Exercise stress testing contraindications

Box 34-6 Contraindications to exercise stress testing

Absolute

- Acute myocardial infarction (within 2 days)
- High-risk unstable angina
- Uncontrolled cardiac arrhythmias causing symptoms of hemodynamic compromise
- Symptomatic severe aortic stenosis
- Uncontrolled symptomatic congestive heart failure
- Acute pulmonary embolus or pulmonary infarction
- Acute myocarditis or pericarditis
- Acute aortic dissection

Relative

- Left main coronary artery disease
- Moderate stenotic valvular heart disease
- Electrolyte abnormalities
- Severe arterial hypertension (> 200 mmHg systolic blood pressure and/or 110 mmHg diastolic blood pressure)
- Tachyarrhythmias or bradyarrhythmias
- Hypertrophic cardiomyopathy and other forms of left ventricular outflow tract obstruction
- Mental or physical impairment leading to inability to exercise adequately
- High-degree atrioventricular block

Box 34-7 Indications for terminating exercise stress testing

Absolute

- Drop in systolic blood pressure (SBP) of > 10 mmHg from baseline, despite an increase in workload, with ischemia
- Moderate to severe angina
- Increasing nervous system symptoms (e.g. ataxia, dizziness, or near-syncope)
- Signs of poor perfusion (cyanosis or pallor)
- Technical difficulties in monitoring electrocardiogram or SBP
- Subject's desire to stop
- Sustained ventricular tachycardia (VT)
- ST elevation > 1.0 mm in leads without diagnostic Q waves (other than V1 or aVR)

Relative

- Drop in SBP of > 10 mmHg from baseline, despite an increase in workload, without ischemia
- ST or QRS changes such as excessive ST depression > 2 mm of horizontal, or down-sloping ST segment depression or marked axis shift
- Arrhythmias other than sustained VT, including multifocal premature ventricular contractions, triplets, or supraventricular tachycardia, heart block, or bradyarrhythmias
- Fatigue, shortness of breath, wheezing, leg cramps, claudication
- Development of bundle branch block or intraventricular conduction delay that cannot be distinguished from VT
- Increasing chest pain
- Hypertensive response: SBP > 250 mmHg and/or diastolic blood pressure > 115 mmHg

Exercise stress testing and prognosis

Table 34-8 Exercise stress test findings associated with poor prognosis

Exercise stress test finding	Associated outcome(s)
Post-myocardial infarction, exercise-induced angina symptoms	Stable angina within 1 year[52,210]
Achieving < 85% of age-predicted maximum heart rate	Increased 2-year mortality[123]
Delayed heart rate recovery after exercise stress test	Increased 6-year mortality[48]
Delayed fall in systolic blood pressure after exercise stress test	Increased mortality[141]
Post-myocardial infarction inadequate increase of systolic blood pressure	Left ventricular dysfunction[57,226]
Post-myocardial infarction rate-pressure product < 21 700	Increased 6-month mortality[227]
A 2-mm ischemic ST segment depression	Increased incidence of myocardial infarction[119,188] 1% annual increased mortality[210,231] Multivessel disease on angiography[146]
Early 1-mm ST segment depression	Increased incidence of myocardial infarction[143] 5% annual mortality[231]
Unable to tolerate exercise stress test	Highest adverse cardiac event rate[133]
Achieve < 5 metabolic equivalents	Increased mortality[162,199]

Risk stratification of patients after EST

- Low risk patients (I grade):
  - No signs of ishemia during and after EST
  - When sympthoms appear only during high grade exercise (>6MET; or >100W)
  - EF LV >40
  - Without complex arrhytmias
- Patients with some risk (II grade):
  - Signs of ishemia during exercise >1 mm
  - EF LV <40 with preserved functional capacity
  - Angina sympthoms well regulated with drugs
  - Complex arrhytmias (non sustained VT, R/T VES, prolonged QT period)
- High risk patients (grade III):
  - Cardiomegaly, significant ishemia with low level EST
  - EF LV <40 together with low functional capacity
  - Multi vessel coronary artery disease

Phases of rehabilitation according to ESC* i HKD

- 1. phase: inpatient acute rehabilitation setting (IM, STENT, or CABG)
- 2. phase: in specialized institution for rehabilitation for 3-6 weeks (patients with high risk) or in outpatient program for 4-12 weeks (low or moderate risk patients)
- 3. phase: continuum of care
  - In institutions like Association of heart disease patients
  - Recreational programs in gyms for HD patients
  - Patient exercises at home

***http://www.escardio.org/guidelines-surveys/esc-guidelines/GuidelinesDocuments/guidelines-CVD-prevention.pdf**

I. Inpatient acute medical setting

- Bed rest of 6 weeks leads to decrease in actin and myosin, decrease of circulating volume of blood for 700-800 mL, hypercoagulability and DVT)
- Start of rehabilitation in Cardiology Department 24 hours after chest pain, decrease of the value of troponin and creatine kinaze, control ECG
- Chest physical therapy (breathing exercise, incentice spirometer and manual techniques- for secretion clearance), passive range of motion to maintain muscular tone and prevent contractures- intensive care unit
- Early mobilization to 2-3 METs prevents loss of cardiovascular reflexes due to proloned bed rest, 2-5 minutes 4 times a day
- Training of activities of daily living and pacing up to 4-6 METs, education regarding nutrition
- Exercises help prevent hypotrophy and decrease in tonus, act against depression, development of pneumonia and urinary infection
- Type and intensity of exercises is individual and is sympthom related, duration is 3-7 days

II. Inpatient acute rehabilitation

- It starts 2 to 4 weeks after cardiovascular incident
- Exercise stress testing at 50, 75 or 100 W determines duration, intensity and number of weekly exercises
- Aerobic type of exercise is the foundation of cardiac rehabilitation (cycling, treadmill), but strenghtening exercises are used in protocols also
- I. part.: warm up 2 till 5 minutes, low intensity (joint mobilization, opening of collateral circulation and decrease of resistance in peripheral arteries)
- II. part: continuous or discontinuous telemetry monitored exercise for 20-30 up to 60 min, under physiatrist observation (intensity of 70-80%)
- III. part: cool down phase- minimal intensity exercise 5-10 min
- Strenghtening exercises are used in patients with sufficient left ventricle function. 3 series of 10-15 repetition with weight up to 13 on Borg scale (all major muscle groups)

II. Phase outpatient program

- It is suitable for patients with moderate or low chance for adverse cardiac event
- Patients that were enroled in I. and II. phase of rehabilitation had 6-years mortality of 14%, while the ones that were enroled only in I. phase had 34% mortality
- Cardiac events such as myocardial infarction or malignant arrhythmias occur in 1:50000 - 1:120000 patient-hours of exercise[7-8]

[7] Lavie CJ et al. Exercise training and cardiac rehabilitation. Mayo Clinic Proc 2009;84:373-83
[8] Guidelines for cardiac rehabilitation and secondary prevention programs 4th Ed, Human Kinetics 2004

Aerobic exercises

Frequency	3-5 days/week
Intensity	55-90 % max HR
	40-85 % max VO_2 or HRR
Duration	20-60 min
Legs	Walking
	Jogging/running
	Stair climbing
	Ergometry
Arms	Rowing
Whole body	Cross-country skiing
	Combined arm/leg exercise
	Swimming
	Aerobic

Strenghtening exercises

Frequency	2-3 days/week
Intensity	1-3 series from 8-15 repetitions for each muscle group
Legs	Hamstrings and quadriceps exercises
	Abductors/adductors
Arms	Biceps curls
	Triceps extension
	Bench exercises
	Pull downs for latissimus dorsi
	Rowing

*** HR-(heart rate), HRR -(heart resting rate)**

Example of phase II protocol

TABLE 112-3 Cardiac Rehabilitation Exercise Prescription

Type	Aerobic	Treadmill Bicycle (circle one)
Include	Strength training?	Yes No (circle one)
Intensity: Based on heart rate		
Target heart range		
70% to 85% of maximum heart rate if the patient is not taking β-adrenergic blockade		
85% maximum completed on treadmill if the patient is taking β-adrenergic blockade		
High resting heart rate (HR), by exercise testing results (Karvonen formula):		
Target HR = resting HR + [(HRmax − HRrest) × (60 + MTmax/100)]		
Intensity: Based on workload		
Target 66% MET level completed on treadmill testing		
Target 25 watts or 150 kpm less than completed stage on bicycle ergometer testing		
Intensity: Based on perceived exertion		
Borg scale target 11 to 15		
Warm-up phase		
Treadmill ambulation at _____ speed _____grade for _____ minutes.		
Bicycle ergometry at _____ kpm/watts for _____ minutes.		
Check blood pressure, pulse rate, and perceived exertion.		
Advance to stimulus phase.		
Stimulus phase		
Treadmill ambulation at _____ speed _____ grade _____ minutes with/without rest. Repeat _____ sets.		
Bicycle ergometry at _____ kpm/watts for _____ minutes with/without rest. Repeat _____ sets.		
Check blood pressure, pulse rate, and perceived exertion.		
Advance to cool-down phase.		
Cool-down phase		
Treadmill ambulation at _____ speed _____ grade for _____ minutes.		
Bicycle ergometry at _____ kpm/watts for _____ minutes.		
Check blood pressure, pulse rate.		
Frequency	3 times per week	
Duration	1 hour per visit for 12 weeks	

- I coefficient
- Low risk 70-85%
- Moderate 55-70
- High 40-55%

- In B blockers 10-20% above resting

- Other modality is start at 60% of max HR then higer until first sympthoms and than 10 beats below that

[5] Frontera WR, Silver JK, RizzoTD Essentials of physical medicine and rehabilitatiton 2nd Ed 112,619

Specific group rehabilitation

- In large MI exercise delayed 4-6 weeks. Combined resistance and aerobic training better for QOL. ACE inhibitors limit LV remodeling
- Despite concern that exercise is prothrombotic no increase in restenosis of STENT seen, but instead improve of VO2 max and funcional capacity occur
- CABG exercise improves myocardial perfusion, increases ishemic threshold, improves autonomic function, reduces arrhythmias
- Aerobic exercise in congestive heart failure should utilize continuous, steady state training protocol
- Because of accelerated atherosclerosis after heart transplantation aerobic exercise should be continuous
- Prolonged warm up and cool down time could reduce the frequency of arrythmias in such patients, because exercise is arrhytmogenic due to increased sympathetic activity and circulating cathecolamins

Return to work or not?

- Depend on value of MET before the patient has ishemic sympthoms (1 MET-3,5 mL/kg/min)
- Patients with MET-om 3-4 are unlikely to return to work, even dusting or vacuuming can provoke sympthoms
- Patients with MET from 5-7 can do a office type job
- Patients with MET more then 7 have no limitations except everyday hard physical labour
- Sports (tennis 4-7 MET, golf 2-5 MET, bowling 4-5 MET, skiing 7-8 MET)
- Sexual activity (5 MET with familiar partner, 6-7 MET new partner)

Borg G.A. Psychophysical bases of perceived exertion. Medicine and Science in Sports and Exercise. 1982; 14:377-381.

Definition of pulmonary rehabilitation

- Individual tailored multidiscilplinary program formulated after accurate diagnosis
- Aim is to stabilize or reverse physiopathology of pulmonary diseses through therapy, education and emotional support
- The physical medicine tries to return the patients to the highest functional capacity allowed by his or hers pulmonary hendicap
- Reversal of deconditioning and dyspnea, airway secretion managment, restoration of respiratory muscle function, reduce of frequency of hospitalization and pulmonary complications

Epidemiology of pulmonary disease

- Need to distinguish two kinds of impairment:
- Oxygenation impairment: disfunction due to the lung or airways disease- hypoxia with normal CO2 level
- Ventilation impairment: alveolar ventilation dysfunction in the presence of normal lung parenchyma- hypoxia and hypercapnia

- COPB is the fourth leading cause of death in USA and the most common cause of ventilatory impairment)prevalence 4-5% men, 1-3% women

- Ventilatory impairment 1 in 800 people: most common respiratopry muscle dysfunction caused by CVI and traumatic brain injury- they have more benefit from mechanical ventilation devices

Ventilatory impairment >>

Oxygenation impairment

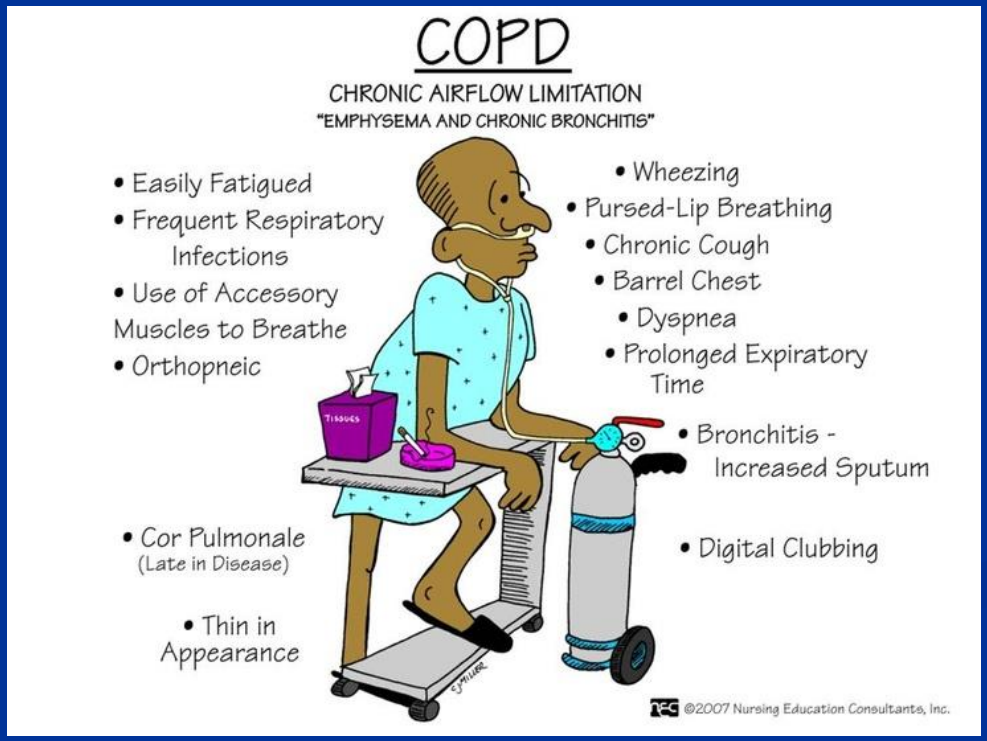
Conditions with predominant oxygenation impairment
Chronic obstructive pulmonary disease
Asthma
Emphysema and emphysema that follows lung volume reduction surgery
Cystic fibrosis
Bronchiectasis
Some restrictive diseases (e.g., pulmonary fibrosis, primary parenchymal disease)

Conditions with predominant ventilatory impairment
Myopathies
Duchenne muscular dystrophy
Becker muscular dystrophy
Limb-girdle muscular dystrophy
Emery-Dreifuss muscular dystrophy
Facioscapulohumeral muscular dystrophy
Congenital, autosomal recessive, myotonic muscular dystrophy
Generalized nondystrophic myopathies
Congenital, metabolic, inflammatory myopathies
Myasthenia gravis
Mixed connective tissue disease myopathies
Neurologic disorders
Amyotrophic lateral sclerosis
Spinal cord dysfunction
Spinal muscular atrophies
Motor neuron diseases
Poliomyelitis
Hereditary sensory motor neuropathies
Phrenic nerve neuropathies, Guillain-Barré syndrome
Multiple sclerosis
Friedreich ataxia
Myelopathies
Botulism
Sleep-disordered breathing
Central and congenital hypoventilation syndromes
Hypoventilation associated with diabetic microangiopathy
Down syndrome
Familial dysautonomia
Musculoskeletal
Thoracic wall deformities
Kyphoscoliosis
Ankylosing spondylitis
Osteogenesis imperfecta
Rigid spine syndrome
Spondyloepiphyseal dysplasia congenita
Restrictive lung diseases
Obesity hypoventilation
Diseases of the pleura and chest wall
Tuberculosis
Milroy disease

Symptoms and physical examination

Oxygenation impairment

- Dyspnea on exertion, chronic sputum production, wheezing, weight loss, orthopnea, sleep disturbance, low endurance
- Blue bloater, pink puffer



Ventilatory impairment

- Fatigue is dominant, weight loss, low endurance, intercurrent respiratory tract infections, ineffective cough
- Neuromuscular disease cause weakness of the inspiratory (breathing), expiratory (coughing), and bulbar innervated (speech, swallowing and air protection muscles)
- Shallow breathing, dysphagia, nasality of speech
- Measure of unassisted and assisted cough flows (less then 270 L/min)- air stacking with closed glottis and then abdomial thrust

Candidates for rehabilitation

- Clinical exercise testing to determine if bronchospasm is pulmonary, cardiac or exercise induced
- Monitoring of: vital signs, ECG, oxygen consumption, CO2 production, minute ventilation, metabolic rate on treadmill, stationary bicycle or upper extremity ergometry
- 3, 6 or 12 minute walk test with increase in intensity
- Test is done when maximal oxygen consumption is reached, maximum allowable heart rate for age, or dyspnea, ECG changes, chest pain, fatigue
- Oxymetry is performed during exercise and if SpO2<90% or PO2<60 mmHg there is a need for supplemental O2 therapy

Treatment

Oxygenation impairment

- Smoking cessation, avoidance of pollutants
- Adherence to medication-bronchodilatators 20% increase to FEV, influenza and pneumococcal vacination, good nutrition, adequate hydration
- Respiratory secretion managment: chest percusion, postural drainage, airway secretion clearance devices
- Home oxygenation device PO2<60 mm Hg – 2 month or more (decreases pulmonary hypertension, polycytemia, improves cognition, prolonges survival
- In sleep disordered breathing , opstructive or central apneas CPP device

Ventilatory impairment

- Abdominal binder for tetraplegic and thoracic level paraplegic patients to increase diaphragmatic excursion and vital capacity
- Inspiratory muscle exercise does not increase muscle strenght or vital capacity
- Chest wall and lung mobilization +
- Positive airway pressure for patients who do not have sufficient bulbar innervated muscle function for air stacking
- Patient that can do air stacking should rather use volume-cycled ventilators

Slika 84 i 85. Acapella

Respiratory secretion managment

TABLE 141-5 Pulmonary Hygiene Options[11,14,43]

Inhalers

Bronchodilators

Inhaled steroids

Leukotriene inhibitors

Mucolytics

Methods of airway secretion elimination

Oral, nasal, or transtracheal suctioning

Chest percussion and postural drainage

Positive expiratory pressure breathing

Flutter mucus clearance devices

Mechanical vibration devices to the chest wall

Intrapulmonary percussive ventilation with aerosolized medications

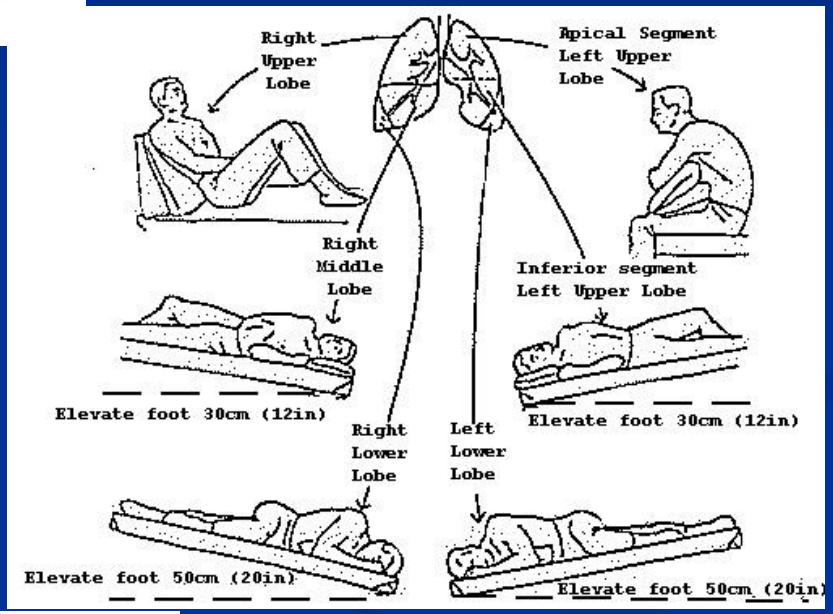
Mechanical insufflation-exsufflation applications

Autogenic drainage

Manual assisted cough

Abdominal binder

Respiratory secretion managment



Physical medicine treatment

Oxygenation impairment

- From 50 to 80% of HRmax or O2 consumption
- In patients with B blockers or Ca channel blockers subjective measures
- The Borg rating scale of percieved exertion, from 6-20 is linearly related to heart rate BCx10=HR
- Endurance training: arm cycling, stationary bycicle, low impact aerobics, pool therapy
- Strenght training increases function in daily activities, mobility and specific occupation related task
- Breathing retraining exercises: modifing the breathing pattern to decrease the work of breathing and improving the cough mechanism
- Pursed lips and diaphragmatic breathing decrease respiratory rate, prevent collaps of smaller bronchi
- Air shifting is performed several times per hour, deep inspiration that is holed by glottis for 5 sec- preventes microatelectases. Expiration through the pursed lips
- For hypercapnic patients periods of respiratory muscle rest with respiratory muscle exercise- nasal device at night

$$\text{Target HR} = 0.60 \times [\text{HR}_{\text{max}} = 220 - \text{age}]$$

Another is the Karvonen formula. For the target heart rate range for 50% to 85%:

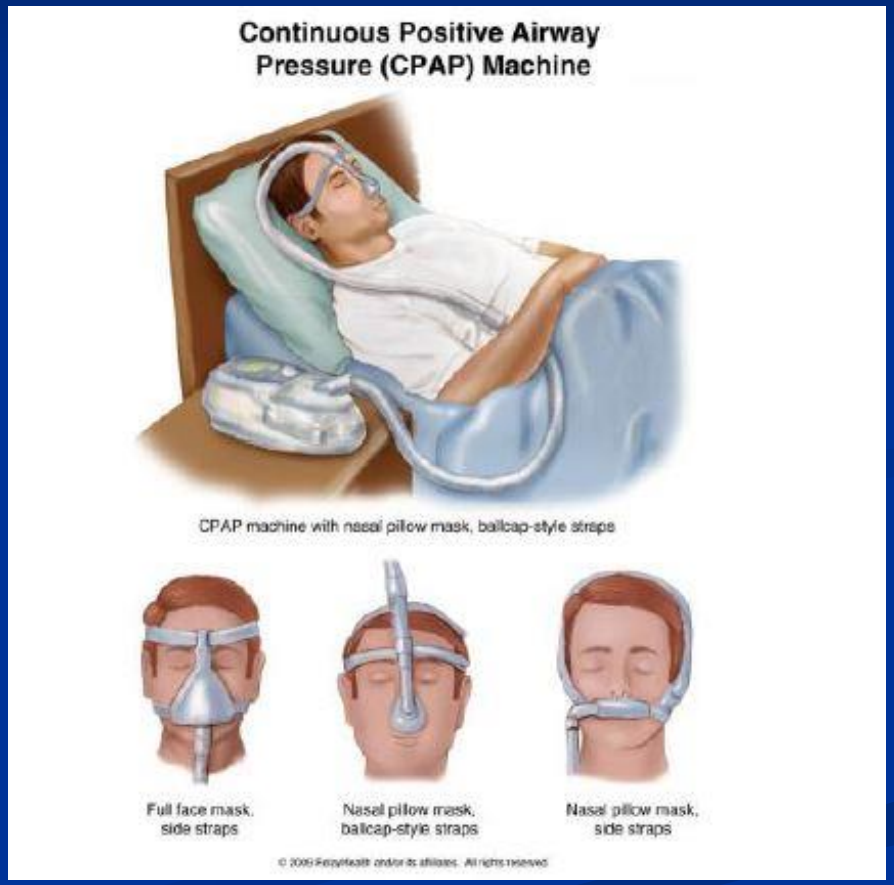
$$\text{HR reserve} = [(\text{HR}_{\text{max}} - \text{HR}_{\text{rest}}) \times 0.50] + \text{HR}_{\text{rest}}$$

$$= [(\text{HR}_{\text{max}} - \text{HR}_{\text{rest}}) \times 0.85] + \text{HR}_{\text{rest}}$$

Physical medicine treatment

Ventilatory impairment

- If cough peak flow is less than 160 L/min tracheostomy should not be removed
- When assisted cough flow is less then 270 l/min pateints are prescribed oxymeters and trained in air stacking through mouth or nasal interfaces from AMBU bag to improve cough flows
- Mannually assisted coughing (abdominal thrust after maximal lung insufflation)
- When oxyhaemoglobin saturation drops below 95%- airway secretion clearance device
- Nocturnal SPO2 below 95% IPPVD to rest inspiratory muscles



Benefits of pulmonary rehabilitation

Type of Exercise	Example
Ventilatory muscle training	Inspiratory resistive exercise: maximum sustained ventilation, inspiratory resistive loading, inspiratory threshold loading, sustained hyperpnea
Strength training	Upper extremity exercise: pulleys, elastic bands, supervised circuit training, weightlifting with low resistance
	Lower extremity exercise: supervised circuit training, weightlifting with low resistance
Endurance training	Upper extremity exercise: unsupported upper extremity activities ranging from activities of daily living to athletic activities, supervised arm cycling, low-impact aerobics, pool therapy
	Lower extremity exercise: incremental treadmill program, supervised walking, cycling and stair climbing program, low-impact aerobics, pool therapy

Summary - Benefits of Pulmonary Rehabilitation

NHS Tayside

- Improved exercise capacity (Evidence A)
- Improved health-related quality of life (Evidence A)
- Reduces perceived intensity of breathlessness (Evidence A)
- Reduced hospitalisations and length of stay (Evidence A)
- Reduced anxiety and depression associated with COPD (Evidence A)
- Increased survival (Evidence B)
- Benefits probably extend well beyond the period of rehab, especially if exercise training is maintained at home. (Evidence B)
- Improved psychological wellbeing (Evidence C)

Thank you for Your attention