Standards for Physical Activity and Exercise In the Cardiac Population 2009

CONTENTS		PAGE

Introduction

These standards have been developed through a review of the evidence for best practice in cardiac rehabilitation (CR) (1-4), by a working party of the Association of Chartered Physiotherapists in Cardiac Rehabilitation (ACPICR). They have been peer reviewed by the British Association for Cardiac Rehabilitation (BACR) (1-4). The aim is to standardise the quality and approach taken by exercise professionals when delivering the exercise component of CR in order to provide service equity to the widest variety of people with cardiovascular disease (CVD).

Aim of the Booklet

This booklet aims to be a reference guide for current CR exercise professionals to deliver safe and effective exercise to all eligible cardiac patients and includes:

- a framework for setting up new programmes
- a guide for setting of local standards
- evidence for line managers
- a guide to health and safety
- guidance for managing the complex and high risk patient.

Each of the standards within this booklet are designed to meet a given core criteria and should be regularly monitored through audit (5). This booklet is not exhaustive and therefore further reading is recommended. These standards should be used in conjunction with the Chartered Society of Physiotherapy (CSP) Standards of Practice (6). For those individuals whose practice is not regulated by either the CSP or Health Professions Council (HPC), they should be applied within the realms of one's own profession's standards, e.g. The Code of Practice of the Register of Exercise Professionals (REPs) (7) or The Code of Practice of the British Association of Sports & Exercise Sciences (BASES) (8).

Target Patient Population

In keeping with the National Service Framework for Coronary Heart Disease (NSF CHD) (4) these guidelines recommend that the following groups will benefit from receiving CR and should be targeted:

- Coronary heart disease (CHD)
    - Patients with new onset or worsening exertional angina
    - Acute coronary syndrome (ACS)
- Before and after revascularisation – PCI or CABG
- Other cardiac surgery
- Following any step wise alteration in CHD condition
- Other atherosclerotic disease e.g. peripheral vascular disease (PVD)
- Stable heart failure (HF) and cardiomyopathy
- Congenital heart disease
- Following arrhythmias and implantable device interventions (ICD, PPM, CRT)
- Other specialised interventions such as cardiac transplantation and LVADs
- Those at high risk of progression of CVD

Adaptations should be made to the CR programme to allow inclusion of all cardiac patients according to their risk stratification (Appendix E), comorbidities and physical ability, thereby providing appropriate education, advice and supervision.

Equality and Diversity in Cardiac Rehabilitation

The burden of CVD is spread across all groups within the population but its concentration in some particular groups poses service planning issues for all exercise practitioners delivering the CR pathway. Services must be developed in ways which consider the diverse needs of the local population served by the programme. Staff must show socio-cultural competency when assessing and utilising interventions for patients from minority groups within CR as signified by the Diversity Strands Descriptors (e.g. the Age, Race, Gender, Sexual Orientation, Religion/Belief, Disability and Socio-Economic Status). In order to challenge inequalities and mainstream equality in health, patient feedback on the CR services should be sought at appropriate intervals (1,3,9,10). There is an obvious challenge when respecting the style and nature of exercise that may need to be considered with patients from different cultural backgrounds.

Key National Guidelines Associated With Cardiac Rehabilitation

A number of key publications guide the design and implementation of CR as summarised below.

Group	Guideline/Policy	Website
General (all)	• SIGN guidelines for CR • AACVPR • ACSM • Joint British Societies' Guidelines on Prevention of Cardiovascular Disease in Clinical Practice • BACR Guidelines for CR • BACR Standards and Core Components for CR • NSF - Coronary Heart Disease • NSF - Coronary Heart Disease - Welsh Version (in draft) • CREST – Guidelines for Northern Ireland	www.sign.ac.uk www.aacvpr.org www.acsm.org www.bhsoc.org www.bcs.com www.bcs.com www.dh.gov.uk www.crestni.org.uk
Myocardial infarction	Secondary Prevention in Primary and Secondary Care for Patients following a Myocardial Infarction (CG48)	www.nice.org.uk
Heart Failure	• Management of Chronic Heart Failure in Adults in Primary and Secondary Care (CG5) • European Society of Cardiology • SIGN 2007 Heart Failure Guidelines	www.nice.org.uk www.escardio.org www.sign.ac.uk
Arrhythmias and ICD	• NSF CHD - Chapter 8 of NSF • NICE guidelines for arrhythmia	www.dh.gov.uk www.nice.org.uk

Burden of Cardiovascular Disease

The World Health Organisation's (WHO) global estimate of deaths by cardiac and vascular disease stands at 17.5 million (based on 2005 data) with 7.6 million attributed to heart disease. CVD remains the number one cause of all deaths globally (30%). CVD is the most common cause of death in the United Kingdom (UK), accounting for approximately 198,000 deaths each year. The prevalence of CHD in Britain is 3.7% of all GP registrations. The prevalence is higher in Scotland (4.6%) than in Wales (4.3%) or England (3.5%) (12). There is an estimated 2.1 million men and 1.3 million women in the UK reporting angina and/or myocardial infarction (MI), and 707,000 men and women over the age of 45 years with definite HF (12).

By 2010 the government is committed to reducing the death rate by at least 40% from CVD for people under the age of 75 years. Recent trends suggest that this target will be met. There remain huge variations in the death rates across the country. Heart disease is more common in deprived areas and unskilled men have nearly three times the rate of CHD compared to doctors and lawyers. The overall burden of CVD is now far greater due to more people surviving cardiac illnesses and living much longer than previously (11,12).

Definition of Cardiac Rehabilitation

The WHO definition of CR is:

"The sum of activities required to influence favourably the underlying cause of the disease, as well as the best possible, physical, mental and social conditions, so that people may, by their own efforts preserve or resume when lost, as normal a place as possible in the community. Rehabilitation cannot be regarded as an isolated form or stage of therapy but must be integrated within the secondary prevention service of which it forms only one facet" (13).

Evidence for Physical Activity and Exercise within Rehabilitation, Primary and Secondary Prevention of Cardiovascular Disease

Physical activity is defined as any human movement above resting state. It is the total volume of physical activity as influenced by the size of muscle mass engaged and the intensity, frequency and duration of such activity. These factors should be considered when participating in structured exercise, recreation or activities of daily living as the accumulation of each will determine whether an individual is being physically active or not (14).

Physical activity is measured in kilocalories (kcal). Epidemiological evidence has shown that when individuals expend greater than 4.3 kcal/kilogram (kg) of body mass per day above their basal metabolic requirements, there is a decline in the incidence of CVD which is due to either a reduction in risk factors or in part from an actual improvement in endothelial status and/or a regression in the formation of atheromatous plaques (15-18). The greatest benefit in reducing the incidence or progression of CVD in both primary and secondary prevention is when physical activity is performed at an intensity which leads to an improvement in aerobic fitness (>40% of maximal aerobic capacity) (19-22). In both primary and secondary prevention of CVD, with every one metabolic equivalent (MET) increase in aerobic fitness there is a reduction of 8 – 17% in premature mortality (23). The key target of getting large

proportions of national populations to attain physical activity levels greater than 4.3kcal/kg/day has been to recommend individuals accumulating 30 minutes (min) of moderate activity most days of the week. Other initiatives have equated this to 10,000 steps per day (24,25).

The evidence supporting the efficacy of exercise-based CR following MI or coronary revascularisation demonstrates improvements in CVD risk factors and reductions in both all cause and cardiac mortality by 26% and 31% respectively (26,27). It is important to note that physical activity interventions in these CR trials were structured exercise programmes averaging 3 days per week that mainly focused on improving aerobic fitness. More recently similar systematic reviews have highlighted benefits to individuals with chronic heart failure (CHF), demonstrating evidence of decreased mortality, enhancement of quality of life (QOL) and that exercise is safe for these individuals (28,29).

It is therefore clear that physical activity and exercise therapy must be included as a core component of any programme that aims to either reduce the incidence of, or prevent further disease progression in "at risk" individuals with and without established CVD.

CR exercise performed that follows the recommended standards and guidelines is safe. Supervised CR has demonstrated one fatal event per 752,365 patient hours which compared favourably to one death per 565,000 person hours of general population exercise (30).

Provision of Cardiac Rehabilitation

CR is an integral and established part of cardiac care and the medical management of patients with CVD. In the UK there are 374 programmes registered through the National Audit of Cardiac Rehabilitation (NACRe) process (31). Programmes are provided in a variety of settings; either group based in a hospital or a community setting or alternatively home-based, all of which have been shown to be safe and effective (32-34).

CR continues to be recognised for some patients in four phases. Phase I – hospital in-patient period; Phase II – convalescent stage following discharge; Phase III – structured rehabilitation programme and Phase IV – long-term maintenance. Currently, service provision is much more inclusive of all CVD patients; emphasis is on empowering patients to play an active role in managing their condition. Primary and secondary care services working jointly have been shown to be essential for a seamless model of delivery (35).

Comprehensive CR, combining the key components of exercise, education, psychological and social support, is endorsed by NICE clinical guidance (34). It is important to acknowledge that this process involves a team of professionals working in an integrated way with the patient, his/her partner and family. Exercise should form a core element of the patient care-pathway, along with advice on lifestyle (regarding physical activity, diet, weight management and smoking cessation), health education, risk factor management and assessment and support of psychosocial needs (31,35).

By utilising a menu-based approach, the delivery of the service can be tailored to the individual patient. From the range of options available, the individual should be encouraged to attend the interventions appropriate to his/her clinical needs at a time and in a suitable setting. With appropriate screening, the exercise component can be effectively delivered within the community or at home (33).

In the long-term, the onus is on patients to maintain a healthy lifestyle with the support of the primary care team (PCT) by taking advantage of the many exercise and physical activity opportunities available in his/her local community. Continued secondary prevention healthcare support in the long-term management of CVD is also vital to complete the CR pathway (31).

NACRe is supported by the ACPICR and details can be obtained from:
www.cardiacrehabilitation.org.uk/dataset.htm

Cardiac Rehabilitation and the Physiotherapist's Role

Physiotherapists have a role in the physical activity component of all phases of CR (many Phase IV programmes however, are delivered by appropriately trained BACR exercise instructors). Comprehensive CR requires the combined skills of a multi-disciplinary team (MDT) of professionals, with the physiotherapist taking a lead role in the exercise training component (36). Chartered physiotherapists have the knowledge, assessment skills and clinical reasoning, combined with an evidence-based approach to treatment, to undertake the rehabilitation management of patients with multi-pathology problems (1,36). With their extensive clinical experience, knowledge of pathophysiology and exercise prescription, physiotherapists with the appropriate skills and competences are able to assess and interpret clinical status and functional capacity enabling the development and adaptation of safe, effective and individualised exercise (37).

Specialist Knowledge, Skills and Competences

Exercise professionals (with a relevant qualification as recognised by the CSP or BACR), who wish to work/specialise in this area should refer to the ACPICR Competences for the Exercise Component of Phase III Cardiac Rehabilitation (37) and the Skills for Health National Workforce Competence Guide for Coronary Heart Disease document (38). There are specific training courses (run by the BACR in association with the ACPICR – enquiries@bacrphaseiv.co.uk) for the individual to attend depending on the phase of CR in which he/she works in. The following are areas in which appropriate professional development are required:

- Exercise physiology and prescription in CVD
- Interpreting clinical exercise results and assessing fitness
- Synthesis of assessment results into a safe and effective exercise and physical activity plan, with appropriate goal setting, meeting individual patient psycho-social (cognitive and behavioural) capabilities and needs
- Designing, instructing/coaching appropriate exercise movement techniques and safely managing and monitoring groups of exercising patients
- Promoting physical activity both in prevention and rehabilitation of CVD, based upon the latest epidemiological and evidence based practice.

There is no substitute for experience and when coupled with guided feedback of results and reflective practice, all possible clinical scenarios can be managed successfully. We encourage the use of clinical and research cardiac networks to share experiences e.g. interactive CSP (www.csp.org.uk).

There are two documents specific to Phase III that reflect and are linked to the benchmark standards in this publication:

- The ACPICR Competences for the Exercise Component of Phase III Cardiac Rehabilitation 2008 (37).
- ACPICR Peer Review for the Exercise Component of Phase III Cardiac Rehabilitation 2008 (5).

The Competences' statements are further linked to the NHS Knowledge and Skills Framework (KSF) performance criteria (39). These booklets will help practitioners develop their continuing professional development (CPD), provide evidence during their development review process and help establish a means for quality assurance.

The BACR-EPG, 2008 position statement (40) on the exercise component of Phase III CR states that:

> "*Each member of the multidisciplinary CR team should ensure that he/she works within his/her professional scope of practice. Collectively the team must have the knowledge, skills and competences to deliver a safe and effective exercise programme. The key criteria that the team must fulfil and for which they take responsibility are:*
> - *Clinical assessment and screening for exercise*
> - *Clinical decision making regarding the suitability, eligibility and adaptability of each patient's exercise programme*
> - *Exercise prescription*
> - *Exercise instruction/delivery*
>
> *All of the above four criteria must consider the patients' risk stratification, comorbidities and complexity of their cardiac condition."*

Physiotherapy training and postgraduate experience enable physiotherapists to fulfil the four key criteria for delivery of the exercise component of CR.

STANDARD 1: Service Agreement for Recruitment and Referral

There should be an agreed local recruitment policy/protocol for all patients to be referred for physical activity advice and the exercise component of CR (4).

Criteria

1.1 There is an identified medical contact assuming responsibility for clinical issues that arise from CR.

1.2 There is evidence of a locally agreed written referral policy/protocol, which includes:

- Source of referral
- Designation of referrer
- Contact details of referrer
- Pathway for the patient within the CR service
- Agreed minimum patient information
- Referral criteria

- Management of inappropriate referrals
- Management of patients with specialist and complex needs

STANDARD 2: Initial Assessment

All patients should undergo thorough screening and an assessment prior to undertaking physical activity and exercise.

The clinical information gained at assessment should be entered onto the relevant section of the national database, as part of the NACRe process (41).

Criteria

2.1 The assessment should encompass the following CSP core standards:
- Standard 5 – Information relating to the patient and his/her presenting condition should be collected
- Standard 6 – Taking account of the patient's problems, with published, standardised, valid, reliable and responsive outcome measures used to evaluate the changes in a patient's health status.

2.2 The results of previous investigations should be taken into consideration and interpreted, including:
- Electrocardiogram (ECG)
- ECG exercise tolerance test (ETT)
- Echocardiogram (Echo)
- Diagnostic angiogram
- Cardiac MRI/CT scan
- Myoview/Thalium scan
- Any other medical assessment that highlights limitations in performing physical activity

2.3 All relevant medication (including dosage) should be documented and compliance discussed

2.4 All relevant signs and symptoms should be established:
- Angina
- Shortness of breath (SOB)
- Palpitations
- Dizziness
- Orthopnoea
- Ankle swelling
- Fatigue
- Claudication
- Weight gain of >2kg in two days

2.5 All relevant comorbidities should be identified.

2.6 Any contraindications to exercise should be identified

The following are absolute contraindications which preclude a patient from joining or continuing the exercise component of an inpatient and outpatient cardiac rehabilitation programme (22):

- Unstable angina
- Resting systolic blood pressure (SBP) of >200mmHg, or diastolic BP >110mmHg (should be assessed on a case-by-case basis)
- Orthostatic blood pressure (BP) drop of >20 mmHg with symptoms
- Critical aortic stenosis
- Acute systemic illness or fever
- Uncontrolled atrial or ventricular arrhythmias
- Acute pericarditis or myocarditis
- Uncompensated congestive heart failure (CCF)
- 3rd degree AV block (without pacemaker)
- Active pericarditis or myocarditis
- Recent embolism
- Thrombophlebitis
- Resting ST segment displacement (>2 mm)
- Uncontrolled diabetes (should be assessed in accordance with local protocol and on a case-by-case basis)
- Severe orthopaedic conditions that would prohibit exercise
- Other metabolic conditions, such as acute thyroiditis, hypokalaemia or hyperkalaemia, hypovolaemia etc
- Severe rejection (cardiac transplantation recipients)

2.7 Assessment of prior and current physical activity (41,42)

2.8 The individual's readiness to participate in both physical activity and exercise should be established including psychological status, health beliefs and stage of change (Standard 4; Appendix A).

2.9 The individual's goals in relation to physical activity and exercise should be established e.g. returning to work, activities of daily living (ADL) and sport.

2.10 Physical measures should be taken including:

- Heart rate (HR)/rhythm
- BP
- Blood glucose, if appropriate
- Weight
- Body Mass Index (BMI)
- Waist-to-hip ratio, waist circumference

2.11 All patients should be risk stratified as low, moderate or high risk for exercise using recognised criteria (Appendix E). This will determine the level of exercise intensity prescribed and supervision required (43,44).

2.12 All patients should undergo a functional capacity test (FCT) (Appendix A).

- Choice of test should be dependent on individual's ability, prior exercise habits/exposure and comorbidities.
- The test should be performed following standardised procedures
- The test endpoint should be established i.e. sub-maximal or symptom limited
- Each test should include a warm-up and cool-down component
- The exercise response should be monitored using a combination of HR (Appendix C), rating of perceived exertion (RPE) (Appendix D) (45), BP and observation.

STANDARD 3: Informed Consent

Valid consent must be obtained from the patient prior to starting any assessment, functional testing and intervention. Exercise professionals should consult and be aware of guidance on consent issued by their relevant regulating body and national bodies (46-49).

Criteria

3.1 The patient should be fully informed and understand their role in the decision making process.

3.2 All treatment options should be explained, including risks, benefits and side effects. Confirmation of the patient's understanding of the explanation should be established.

3.3 The patient is given the opportunity to ask questions prior to giving consent.

3.4 Consent must be voluntary.

3.5 The patient is informed of their right to decline treatment at any stage. If the patient does decline this should be documented in the patient's record including the reasons (if known).

3.6 Consent can either be verbal or written. The process by which consent is obtained should be documented in the patient's records.

3.7 If the patient's treatment plan is changed at any time, further consent should be given and documented.

3.8 No one may give consent on behalf of another adult over the age of 18 (16 in Scotland) unless with qualified power of attorney (e.g. the disabled or cognitively impaired).

3.9 16 to 17 year olds can give their own consent. Children under 16 must have consent gained from a parent or guardian.

STANDARD 4: Physical Activity Behaviour and Goal Planning

An individual physical activity plan should be developed by the exercise professional in consultation with the patient, reflecting his/her goals and accurately representing clinical, functional and psychosocial status. To facilitate long-term maintenance of a physically active lifestyle, the exercise professional should be skilled in addressing barriers to exercise, motivational counselling, promoting self-efficacy and empowering change.

Criteria

4.1 The process of devising the physical activity plan, based on information gathered, should encompass the CSP Core Standards 7 and 8 (6).

4.2 Previous activity levels, interests and comorbidities should be considered and physical activity adapted as necessary.

4.3 Individual beliefs about exercise should be considered and theoretical models used to facilitate behaviour change. The most commonly used model within CR being the Transtheoretical Model (50).

4.4 Motivational counselling should be used to facilitate a patient-centred approach. The professional should use non-verbal communication, active listening skills, empathy and open questioning.

4.5 Goals set should be specific, measurable, achievable, realistic, timely, empowering and revisable (SMARTER) (51). Goals should be re-evaluated following any change from initial assessment i.e. clinical need, response and attitude to exercise.

4.6 Ongoing educational and motivational support should be provided to enable patients to become more physically active and maintain this in the long-term.

STANDARD 5: Safety Information for Physical Activity

All patients should receive safety information prior to commencing a guided programme of physical activity and this may need to be reinforced as part of an ongoing education programme.

Criteria

5.1 There is documented evidence that the patient has received and understood information relating to the following:

Preparation for physical activity:

- Suitable clothing and footwear
- Pre and post exercise eating and drinking
- Exercise environment, circuit and equipment where appropriate
- Benefits and purpose of physical activity

Pre-screen:

- Relevance of change in medication
- Relevance of worsening of symptoms e.g. suspected angina, arrhythmias or excessive breathlessness despite apparent compliance with the prescribed medication
- Relevance of deteriorating exercise performance/functional capacity despite apparent compliance with the prescribed exercise regimen
- Appropriate monitoring e.g. blood glucose testing kit
- Information regarding when not to exercise.
- Ensuring essential medication is available during physical activity e.g. GTN

Any significant change in status may mean that exercise is contraindicated until relevant problems are solved

How to exercise safely:

- Importance of warm-up and cool-down
- Understanding appropriate exercise intensity
- Self monitoring and symptom recognition during exercise i.e. use of HR monitoring and RPE scales

When to stop/seek advice:

- Recognition of the signs and symptoms of over exertion
- Management of chest pain and severe breathlessness
- Other symptoms relating to either metabolic dysfunction (hypoglycaemia) or circulation (PVD).

STANDARD 6: Assisting Patients to Become More Physically Active

It is recognised that not all patients are ready to undertake a regular physical activity plan and continue in the long-term. The exercise professional should consider all approaches to assist the patient to maintain current levels of activity or to become more physically active.

Criteria:

6.1 It is essential to encourage activity that is achievable (Standard 4). For low functioning or sedentary patients the initial goal may be to achieve enough activity to gain health benefits (Appendix B) or simply to prevent decline.

6.2 The physical activity should be enjoyable, non-inhibiting, non-competitive, individualised and promote confidence and success (14).

6.3 Patients should be educated about the benefits of regular physical activity and understand that his/her programme is individualised to their needs and the condition of CVD.

6.4 Consideration of referral to other professionals may be appropriate to maximise independence and activity levels of low functioning patients.

6.5 For patients who relapse from physical activity, re-referral to CR should be encouraged when appropriate.

6.6 To encourage a physically active lifestyle in the long-term it is important to consider all options e.g. mainstream Phase IV classes, low level Phase IV classes, gym programmes, home exercises, DVDs, walking plans, structured health walks, local options of classes of suitable intensity/structure and any physical recreation performed frequently that is appropriate.

STANDARD 7: Structured Exercise Programming

All patients should participate in an individualised progressive exercise training programme. The exercise programme should be designed to produce a training effect; achieved by varying the frequency, duration, intensity, and mode of exercise. This can be undertaken in a hospital, community or home setting.

Many structured programmes include both cardiovascular (CV) and resistance exercise stations. It is essential that all programmes include a warm-up, conditioning phase and cool-down component.

Although the same principles for exercise training apply for all patients, special considerations and adaptations for specific patient groups can be found in the following appendices:

F – Heart Failure
G – Implantable Cardioverter Defibrillator
H – Cardiac Transplantation
I – Left Ventricular Assist Devices

Criteria:

7.1 Warm-up

A low intensity graduated warm-up is essential to**:**

- Prevent ischaemia and arrhythmia by ensuring that the myocardium, coronary arteries and conductive tissues are able to meet the metabolic demands of exertion
- Ensure the neuro-musculo-skeletal system is in an appropriate metabolic state to perform sustained physical exertion to effective levels.

The aim is to:

- Prevent cardiopulmonary distress due to acute rises in catecholamines
- Prevent any unnecessary fatigue or postural instability
- Prevent muscle and joint injuries
- Aid performance of activities within the conditioning phase
- Allow time to assess exercise technique.

A warm-up should:

7.1.1 Last for 15 min. For lower functioning patients the period of warm-up should be reduced proportionally to the length of the conditioning phase.

7.1.2 Mobilise joints and warm-up all large muscle groups that will be engaged in the exercise training session.

7.1.3 Include pulse raising activities which are appropriate in content to the activities being performed in the conditioning phase.

7.1.4 Include static stretching interspersed with pulse raising moves to maintain heart rate – at present the evidence for preparatory stretching as a part of the above is equivocal but the performance of stretches by patients often provide periods of active recovery within the warm-up and act as a useful guide to assess the patients' proprioceptive/motor control abilities and joint mobility limitations.

7.1.5 Perform a 'rewarm' after preparatory stretching before commencing the conditioning component

7.1.6 Allow for alternative intensities of aerobic work.

7.1.7 Increase exercise effort gradually so that by the end of the warm-up the following should have been reached:

- A maximum of 50% of peak capacity
- HR within 20 beats per min (bpm) below training/target heart rate (THR)
- A maximum of 60% of maximal heart rate (MHR)
- A maximum of 40% heart rate reserve (HRR)
- A RPE of BORG <11 (RPE scale) or <3 (CR10).

7.2 Conditioning phase

There is an interactive relationship (dose response) between the frequency and intensity of exercise prescription, whereby the most favourable fitness improvements occur with high intensity, high frequency, followed by moderate intensity, high frequency and then high intensity, low frequency exercise (1,52-54). High intensity exercise is not recommended for cardiac patients therefore in terms of CR, exercise practitioners should focus on moderate intensity, high frequency as this is safe and effective (22,52,54,55). The conditioning phase of the programme should be designed to achieve a training effect through varying the frequency, duration, intensity and mode of exercise (FITT) (Appendix B).

7.2.1 Frequency

In order to improve functional capacity, exercise is recommended at least 2 to 3 times a week (1,22,44,56).

7.2.2 Intensity

- Moderate intensity aerobic exercise, designed to suit a range of fitness levels is recommended for most patients undergoing exercise training (1,22,52,56,57)

- During the initial conditioning phase, patients should be working at 40% – 60% VO2 max and may progress up to 70% in later stages once 20 minutes of continuous CV work has been achieved. In practical terms this can be denoted by:

- 60 – 75% HR max, progressing to 80%
- 40 – 60% HRR, progressing to 70%
- RPEs of:
  - 12 – 14 RPE, progressing to 15
  - 3 – 4 CR10 scale, progressing to 5

- Low functioning or high risk patients should work to the lower end of these intensity targets i.e. 60% HR max, 40% HRR or RPE 12 (BORG RPE scale) and RPE 3 (CR10) (22,44).

To work out THRs, see Appendix C.

7.2.3 Type of exercise

- The primary aim is for patients to be able to perform a minimum of 20 min of continuous CV exercise
- An interval training approach with periods of active recovery/muscular strength and endurance (MSE) may be required initially.
- Aerobic exercise utilising large muscle groups in a rhythmical manner is recommended
- Common CV exercises include circuit training, walking, cycling or gym-based activities using exercise machines.
- Alternative options should be available for low functioning, high risk patients or those with comorbidities.

7.2.4 Duration of exercise

A minimum duration of 20 to 30 min is recommended for the conditioning period of the structured aerobic exercise programme (22,44,52,53).

7.3 Cool-down

The risk of hypotension, ischaemia and arrhythmias within the first 30 min after stopping an exercise session is well documented. A graded cool-down has been found to reduce the incidence of these complications. Cool-down exercise should be the reverse of the warm-up in most respects with the aim to gradually return the cardio-respiratory system to near resting levels within 10 to 15 min (22,44,55-57).

7.3.1 The duration should be a minimum of 10 min.

7.3.2 Exercise effort should be gradually decreased from the individual's exercise prescription.

7.3.4 Stretching for the purposes of improving flexibility can be incorporated into the cool-down (58).

7.3.4 Patients should be supervised for a minimum of 15 min from the end of the cool-down.

7.4 Resistance training

Resistance training is associated with maintenance of strength and can be performed safely by many patients with CVD (22,57). It can enhance MSE, functional capacity, independence and QOL. Resistance training can be used as either an independent session or as part of the active recovery component in an aerobic circuit; when undertaken after the CV component, a partial cool-down is necessary prior to resistance work. Resistance work should be followed by a final cool-down.

7.4.1 Frequency
2 to 3 resistance training sessions a week

7.4.2 Intensity
Upper body 30 – 40% one repetition max (1RM)
Lower body 50 – 60% 1RM
This intensity should be used to begin with. Participants can be progressed for intensity based on clinical and functional needs. Determination of intensity should be set by appropriate exercise instruction methods in keeping with best practice (59). The method for determining the appropriate %1RM can be performed by a number of methods in keeping with standard weight-training practices. The method chosen, as in aerobic fitness testing, should be relevant to the needs and clinical status of the patient

7.4.3 Time
One set of 10 to 15 repetitions

7.4.4 Type
Between 8 to 10 different key muscle groups
(22,43,60).

7.4.5 Resistance training should be performed:

- In a rhythmical manner
- At a controlled moderate to slow speed (i.e. 3 seconds concentric and 3 seconds of eccentric contraction)
- Through a full range of motion
- By alternating between lower and upper body to allow muscles to rest between exercises.

7.4.6 Patients should avoid gripping the weights excessively and avoid breath holding as both can cause a rapid increase in BP.

7.5 Key exercise considerations

7.5.1 Ensure good posture is maintained throughout.

7.5.2 The exercise prescription should consider posture and muscle balance ensuring that opposing muscle groups are targeted.

7.5.3 Overuse and overload of any one muscle group should be avoided. Different muscle groups should be used throughout sessions to gain global strengthening and to allow patients to exercise for longer.

7.5.4 During MSE exercises, the feet should be kept moving maintaining venous return (61,62).

7.5.5 Sustained isometric exercises that involve breath holding should be avoided due to the risk of rapid increases in BP and rate pressure product (RPP) (22,28,44,53, 56,57,63,64).

7.5.6 Avoid rapid changes in position as this can lead to hypotension particularly in the elderly and those on beta blockers.

7.5.7 Exercises performed in lying should be avoided during the main conditioning phase (57,61,64). Floor work when indicated (e.g. relaxation exercise and stretching) should be carried out after a cool-down period when the CV system has returned to near resting state.

7.5.8 Arm exercise above chest height, whilst seated, is acceptable but requires specific adaptation, i.e. low intensity leg work (alternate heel raises), to ensure that cardiac output is not compromised (61,64). This is particularly important for low functioning patients who may need to spend time seated during the conditioning phase.

7.5.9 Correct exercise technique and adaptation of exercise for comorbidities is essential and may require more supervision.

7.5.10 Lower functioning patients and those with certain comorbidities may need to perform some/all of their exercise session in sitting and have adaptations made to exercise stations appropriate to their functional level.

7.5.11 Within six weeks of a sternotomy, during the bone healing process, exercises that put excessive strain on the sternum should be avoided.

7.5.12 Music can be used during rehabilitation classes though it should not be allowed to dominate the session.

STANDARD 8: Screening, Monitoring and Progression

All physical activity and exercise should be continuously monitored and evaluated to ensure that it is safe, effective and relevant to changing circumstances. The level of monitoring should be individualised to the patient's needs with the aim of progressing towards patient self-monitoring (6).

Criteria:

8.1 Screening

8.1.1 Pre-screening should take place prior to each physical activity/exercise session to ensure that it is safe to continue. This should include:

- Presence of systemic illness
- Change in signs and symptoms
- Impact of any changes in comorbidities since assessment
- Change in medication or medication dose
- Details of doctor review
- Results of further investigations
- Wound healing
- Glucose check for patients with diabetes (newly diagnosed or those new to exercise)
- Medication available e.g. GTN
- Response to recent physical activity – home or recent exercise session.

8.1.2 Patients should be educated to self-monitor the above when undertaking physical activity alone.

8.1.3 Physical activity/exercise should be adapted in light of the findings from the pre-screening.

8.2 Monitoring

8.2.1 Exercise intensity should be monitored using a combination of:

- HR response
- BP response
- RPE achieved (45)
- Observation

8.2.2 HR response

- This can be monitored manually or with a HR monitor during CV exercise.
- Patients should work within their pre-determined THR range during CV exercises.
- A post cool-down HR should be taken to ensure that the individual has returned to their pre-exercise state.
- In certain situations, medication or clinical status may influence the effectiveness of using HR as a monitoring tool i.e. arrhythmias, HR control medication or with cardiac transplant recipients

8.2.3 BP response

- Resting BP should be taken:
  - Using a properly maintained, calibrated and validated device
  - With tight clothing removed around arm to be tested
  - With the arm supported at heart level and hand relaxed
  - Avoiding talking during the measurement procedure
  - Using a cuff of the appropriate size

- Using the same arm for consistency (66).

- Should resting BP be borderline or above the level to contraindicate exercise (Standard 2) the patient should be advised to rest for a further 5 min and BP should be rechecked. If BP remains borderline, allow the patient to complete the warm-up and recheck their BP response
- BP should be assessed on a case-by-case basis
- Consider the BP reading in relation to the time of anti-hypertensive medication and compliance with medication
- Resting and exercise BP should be taken initially to confirm the appropriate response
- If it is not practical to monitor BP at the time of CV exercise, BP should be taken as soon as the conditioning component is completed
- Should the SBP fall >20mmHg (in the absence of suitable explanation i.e. patient has rushed or is stressed), this may be indicative that the intensity is too high for the individual to maintain the necessary cardiac output to meet the activity demands. In this circumstance, the intensity should be reduced and the patient monitored more closely.

8.2.4 RPE

- RPE can be monitored using either the BORG RPE or CR10 scale (45) (Appendix D).
- When educating patients about how to rate their exertion they should consider 'anchoring to known exertions' and using total body feelings rather than an isolated sensation. To include:
  - Strain and fatigue in the muscles
  - Breathlessness
- To increase the reliability, validity and effectiveness of RPE:
  - Keep the chart in view at all times
  - Rate exertion during a CV activity
  - Focus on the verbal statements rather than a number
  - In order to avoid patients just giving the rating the practitioner asks for – initially, do not tell patients which level you want them to achieve. Simply guide their intensity of exertion to a level which elicits the appropriate RPE. With practice the patient will then realise the appropriate target levels (this may take up to 3 or 4 sessions (14,45,67)
- Compare the HR response with the RPE level stated to determine if the patient is competent with self pacing or whether further education is required.

8.2.5 Observation

- It is essential to observe patients to ensure:
  - Safety
  - Absence of signs and symptoms of over exertion:
    - Excessive breathlessness/accessory muscle usage
    - Excessive fatigue
    - Chest pain
    - Excessive sweating
    - Dizziness
    - Nausea
    - Poor colour

        - Poor quality of movement
    - Compliance with exercise prescription
    - Correct exercise posture and technique

8.3 Progression

8.3.1 Patient progression should be based upon the agreed individual goals and evaluation of outcome measures taken at appropriate times.

8.3.2 Progression should consider all aspects of the FITT principle. The primary aim is to improve the duration and efficiency of exercise. Once the recommended duration of 20 min of continuous CV exercise has been achieved then the intensity of exercise should be increased. Intensity can be progressed to 80% of MHR or 15 on the BORG RPE scale or 5 on CR10.

8.3.3 Progression may be achieved by increasing ratios of:

- CV : active recovery time
- Work : active rest
- Standing : seated exercise

8.3.4 Once an appropriate HR and BP response has been established, weaning of these objective measures should be considered. Correlation of HR and RPE levels should be established before objective measures can be weaned to ensure patients can accurately monitor their exertion levels.

Standard 9: Home-Based Programmes and Independent Exercise

Home-based programmes are a safe and effective form of physical activity/exercise. Evidence suggests that long-term improvements are maintained in home-based CR and that self management of exercise programmes induces a permanent change in lifestyle (68). The patient may choose a home-based option either alongside or in replacement of structured group sessions.

Criteria:

9.1 Home-based exercise can take the form of:

- An individualised physical activity plan given to patients on discharge from hospital (graduated walking)
- Validated home-based programme e.g. Heart Manual (69), Road to Recovery (70)
- Individualised home-based non-equipment circuit
- Unsupervised home activities (exercise DVDs, golf, dancing).

9.2 When developing a home-based programme it is essential to consider:

- Previous and present habitual and occupational activity
- Individual values and beliefs
- Individual goals
- Education on the benefits of physical activity
- RPE and monitoring intensity
- Regular reviews and record keeping

- Use of home activity diaries.

9.3 To ensure safe unsupervised exercise, patients will require thorough instructions and the practitioner should ensure that the instructions have been understood. This should include:
- Demonstration and correction of exercise technique
- Instruction on self-monitoring during exercise (Standard 8)
- Education on the recognition of signs and symptoms of over-exertion
- Education on appropriate warm-up and cool-down in relation to the activity to be undertaken
- Advice on progression of physical activity/exercise.

9.4 Adherence and compliance to home physical activity plans should be regularly monitored throughout the CR pathway via telephone contact or with further home visits. This allows issues to be highlighted and addressed and for appropriate progression to be advised.

9.5 Lower functioning, higher risk and more vulnerable patients may be more likely to be given a home programme due to difficulties in accessing hospital or community-based programmes. It should be considered that these patients will need more regular contact and supervision.

Standard 10: Long-term Physical Activity Planning

By the end of the patient's clinically supervised rehabilitation, individual long-term physical activity plans are agreed and arrangements are made for transference of care (1,3,6). The aim is to develop the individual's confidence in their ability to exercise independently and to take responsibility for their health. Continued secondary prevention and support by healthcare and exercise professionals is necessary to assist adherence to physical activity recommendations in the long-term.

Criteria:

10.1 The patient should be considered for transference to long-term care when they are able to exercise independently, safely and effectively according to an individual exercise prescription (71). They should be:
- Able to recognise their optimum level of exercise intensity
- Able to recognise the signs and symptoms of over-exertion and take appropriate action (e.g. stop/reduce activity level, take GTN)
- Able to monitor and regulate the intensity of their activity
- Competent in self pacing exercise
- Able to progress exercise effectively
- Able to demonstrate compliance with home-based activities
- Able to identify goals for long-term activity.

10.2 Once the patient has been assessed as suitable for independent long-term care a detailed discharge assessment of changes and improvements should be undertaken with the patient.

10.3 In order to support long-term maintenance of physical activity patients should be provided with:

- Contact details of the CR team
- Details of medical follow-up
- Advice on long-term exercise prescription and modification.
- Information on appropriate local physical activity sessions e.g. Phase IV exercise session.
- Advice on how to deal with relapse
- Advice on the importance of social support
- Information on local support groups
- Onward referral/access to additional support services where appropriate.

10.4 Information is available to carers and families so that they may encourage adherence to long-term physical activity goals.

10.5 There is documented evidence that advice on long-term physical activity has been given to the patient, carer and family (4).

10.6 When transferring a patient to ongoing cardiac exercise sessions:

- The exercise professional should evaluate local services available
- In the event the exercise professional feels the best next step for the patient is to be referred on to a specialist exercise professional, he/she should be appropriately qualified (e.g. REPs Level 4 Cardiovascular Health)
- Patients should be transferred to appropriately qualified exercise instructors (REPs Level 4 qualified CR exercise instructors)
- If the patient is being transferred to a structured Phase IV class, a BACR Phase III-IV transfer form should be completed and either given to the patient or sent to the identified exercise professional. To download visit: www.bacrphaseiv.co.uk/pdfs/Phase-III-to-IV-Transfer-form-2008.pdf

10.7 A rehabilitation summary has been produced and made available to primary care, secondary care and community services involved in the long-term support of patients.

10.8 For detailed service delivery guidelines for Phase IV see reference 71.

Standard 11: Outcome Measures

Consistent measuring of outcomes is recognised as an essential component in the evaluation of the effectiveness of the CR pathway and is considered vital to quality improvement. In CR, it is the measure of a patient's progress towards a defined goal. Outcomes provide meaningful feedback to patients on their progress encouraging the maintenance of healthy behaviours. Outcomes also provide data to demonstrate the efficacy of a programme and are important to justify the value of services both clinically and financially.

Outcome measures are standardised for benchmarking purposes. These performance measures allow programmes over time to compare their specific patient population against standard benchmarks.

Criteria:

11.1 Outcome measurement/assessment tools used in CR (Appendix A) should be both reliable and valid. Outcome measures should be:

- Clinically relevant and meaningful
- Patient focused
- Easily obtained through current practice
- Comparable between programmes of varying sizes and resources.

11.2 Taking part in the NACRe is one of the minimum standards for CR set out by the BACR (32). The NACRe (database and minimum dataset) is a standardised set of basic CR outcome measures (41).

The three main elements of the NACRe process are:

- Clinical (Standard 2 – assessment including FCTs)
- Behavioural – activity levels via PAQs
- Health – physical fitness question on the Dartmouth COOP Domain (77)

There is some flexibility in the process which allows individual programmes to determine their audit priorities whilst maintaining standardisation through the UK.

STANDARD 12: Health and Safety

Local protocols for health and safety should be followed at all times. The safety of patients during the exercise component of CR is paramount. This will be optimised with an accurate risk stratification assessment (Appendix B), an appropriate exercise prescription (Standard 7) and an effective induction (Standard 5) by appropriately trained members of staff. All patients should be screened prior to each exercise session to ensure they are safe to participate (Standard 8). All staff should be trained and updated regularly in local protocols for life support, moving and handling, infection control and fire.

Criteria:

12.1 Staffing

12.1.1 Each exercise session should be appropriately staffed:

- There should be a minimum of one appropriately qualified exercise professional at all supervised exercise sessions
- In the early rehabilitation process (Phase III) a minimum of two appropriately trained CR professionals who meet the criteria identified by the BACR-EPG, 2008 position statement (40) on page 7 should be present at all supervised exercise sessions
- The ratio of staff to patients should be dependent on the risk stratification of the patients and level of supervision required by the individuals within the group
- The ACPICR currently recommends a minimum staff to patient ratio of 1:5 (Phase III). Staff to patient ratio will depend on the phase of rehabilitation and

the risk stratification of patients present. This ratio can be reduced for those who are considered as safe independent exercisers.
- The number of staff should be increased for more complex patient presentation.

12.1.2 Irrespective of venue, staff supervising patients during CR exercise sessions should have maintained their competences in basic life support (BLS), defibrillator training and have access to advanced life support (ALS) services at every supervised exercise session.

12.2 Emergency protocols

12.2.1 Appropriate resuscitation equipment including a defibrillator should be readily available at every supervised exercise session.

12.2.2 There should be evidence of a locally agreed protocol for medical emergencies during an exercise session.

12.2.3 Appropriate incident reporting systems should be used to report any clinical events or adverse events which may occur.

12.2.4 There should be a written emergency procedure clearly displayed in the exercise area.

12.2.5 Resuscitation equipment must be maintained in accordance with local protocols.

12.2.6 Access to a telephone should be available.

12.3 Reducing the risk of adverse events when exercising

CR exercise is designed to reduce the incidence of adverse events (Standards 2, 7 and 8). This is achieved by:
- Individualised assessment and prescription
- Risk stratification
- Pre-screening
- Prolonged graduated warm-up
- Moderate intensity exercise/physical activity
- Keeping the feet moving during active recovery
- Avoiding breath holding and Valsava manoeuvre
- Avoiding floor work during the conditioning phase
- Adaptation for comorbidities
- Monitoring and supervision
- Prolonged graduated cool-down
- Observation of patients for 15 min post cessation of exercise

12.4 Venue and environment

12.4.1 The size of the exercise area should allow for appropriate space around patients and equipment e.g. floor space required for aerobic exercise per patient of 20 to 25

sq ft (1.8 to 2.3 sq m) and 6 sq ft (0.6 sq m) per space per individual using equipment (22). General risk assessment of the environment should be carried out.

12.4.2 The temperature should be maintained between 18 to 23c (65-71) and humidity of 65% (1,22).

12.4.3 Exercise equipment must be maintained in accordance with local protocols and in line with manufacturer's guidelines (CV and resistance training equipment) with risk of use appropriately assessed in keeping with standard health and safety practices.

12.4.4 Infection control procedures should be followed at all times e.g. cleaning of equipment, hand washing, disposal of sharps.

12.4.5 Drinking water should be available at all times.

12.5 Lone working

12.5.1 Policies and procedures for working alone should be followed at all times.

12.5.2 A full risk assessment should take place prior to visiting a patient's home alone.

STANDARD 13: Documentation

Clear and accurate records must be kept which fully reflect each episode of care. The most appropriate style of record keeping will be determined by the clinical setting. Local security policies and Caldicott guidelines must be followed and records must satisfy legal requirements (6,7,72).

Criteria:

13.1 Records must be completed by the end of the day or as soon after the session as possible.

13.2 Records must be concise, legible, timed, dated and signed.

13.3 The patient's name and hospital number/NHS number must be documented on all pages.

13.4 Clinical records must be stored in a secure and confidential manner.

13.5 When referrals to other hospitals and/or phases are sent, it must be done in a secure and confidential manner.

Appendix A: Measurement Tools

Physical

- Six minute walk test (6MWT) (73)
- Shuttle walk test (SWT) (74)
- Chester step test (CST) (75)
- Ergometer tests including treadmill and cycle (22, 67, 76)
- Physical activity questionnaires (PAQs) (77)

Psychosocial

- Hospital Anxiety and Depression Scale (HADS) (78)
- Dartmouth COOP Domain (79)
- Minnesota www.mlhfq.org (80-82)
- SF 36 and SF 12 (83,84)
- QLMI questionnaire (85)
- Cardiovascular Limitations and Symptoms Profile (CLASP) (86)
- Macnew (87)
- Global Mood Score (88)
- Illness Perception Questionnaire (89)
- EQ – 5D (formerly the EuroQuol) (90)

Appendix B: Exercise Prescription

The content of the exercise prescription depends on the aim of the exercise. De-conditioned patients may require an adapted prescription initially until they are able to perform the prescription for health benefits. In some circumstances, the aim is to maintain their current level of activity. Some patient groups may require specific considerations (Appendices F,G,H,I).

	F **Frequency** Number of days per week *How often?*	**I** **Intensity** How much exertion? *How hard?*	**T** **Time** How many min per day? *How long?*	**T** **Type** What specific activity? *What sort?*
Health benefits	Every day – incorporate into daily routine	Moderate BORG RPE 11 – 13 or CR10 3 – 4 e.g. brisk walking	Accumulate 30 min (can be done in bouts of 10 to 15 min)	Formal structured activity or informal lifestyle activities e.g. walking, climbing stairs, washing the car, cleaning windows, gardening, cycling
CV fitness	2 to 3 times per week	Moderate Initially 40% – 60% VO2 max progressing to 70%: Denoted by: • 60 – 75% HR max, progress to 80% • 40 – 60% HRR, progress to 70% RPEs of: • 12 – 14 RPE, progress to 15 • 3 – 4 CR10 scale, progress to 5	45 to 60 min continuous: • 15 min warm-up • 20 to 30min workout • 10 min cool-down	Aerobic activity (starting with interval then progress to continuous as fitness improves)
Muscle strength and endurance	2 to 3 times per week	• Upper body 30 – 40% 1RM • Lower body 50 – 60% 1RM	1 set of 10 to 15 reps	8 to 10 different muscle groups
De-conditioned patient with functional capacity <3 METS	Every day – incorporate into daily routine	Moderate BORG RPE 12 CR10 3 40% HRR 60% HR max Lower intensity may be required for very low functioning patients.	5 to 10 min bouts (gradual increase to accumulate 30 min per day)	Activities to improve function, muscle strength and endurance, posture, balance and coordination e.g. walking, low step-ups, sit to stand, seated activities.

Appendix C: Estimation of Exercise Target Heart Rate

The gold standard for determining peak/MHR is a 12 lead ECG stress test (Method 1) or if not possible, from a sub-maximal exercise test. Where this is not the case, one of the estimated approaches can be utilised although less accurate. There is no single definitive approach to HR estimation; rather each patient should have their THR estimated in respect of the resources available. The following section aims to clarify three approaches. It is recommended that the Karvonen formula (91) be used, however it is recognised that other formulae do exist.

Each individual patient should have his or her THR calculated, based on thorough assessment (Standard 2) and risk stratification (Appendix E). The training intensities for most patients range between 60 – 80% of MHR (40 – 70% HRR) for the majority of the population group. The more complex patient will require lower intensities (40 – 50% HRR) and hence appropriate adjustments to the calculations below will be required. All the methods applied in this section are based on key institutional resources that are updated regularly (22,43,44).

Using HR in isolation as a measure of exercise intensity has a number of limitations and hence other methods of monitoring intensity should additionally be used. Appropriate adjunctive tools include the use of validated RPE scales (45) and direct clinical observation for signs of exertion.

HR can remain one of the appropriate intensity markers even when patients are influenced by chronotrophic medication such as beta-blockers or Diltiazem. In this instance, the resting HR rate and the MHR are reduced by 20 to 40 bpm and the THR can be re-calculated on this basis. If the patient's medication is held constant, HR will be a reliable measure from which improvement can be determined.

Method 1: Karvonen formula (HRR)

This formula can be used either from a true HR max (Example 1) or from an age-estimated maximum (Method 3) and can be adjusted for beta blockers as in Example 2. This formula is advantageous in that it accounts for the individual's resting HR. A percentage of this is selected, based on the assessment findings, noting that 50 – 70% of HRR is equivalent to 50 – 70% VO2 max and approximately 60 – 75% of HR max.

a. Heart Rate Reserve (HRR) is calculated: –

HRR = MHR – Resting HR

b. Training intensity is selected and calculated i.e. 50 – 70% HRR

c. Resting HR is added to HRR percentage

Example: 1

Patient X (low risk and uncomplicated) has a resting HR of 60 bpm and achieves a MHR of 155 during the ETT. The intensity of training following assessment has been set at 50 – 70% of HRR.

a. Calculation of HRR = 155 – 60 = 95
b. Selection of % of HRR
   50% of HRR = 0.50 x 95 = 47.5
   70% of HRR = 0.70 x 95 = 66.5
c. Add resting HR =
   47.5 + 60 = 107.5
   66.5 + 60 = 126.5
   Conclusion: 108 to 127 bpm

Example 2:

Patient X (low risk and uncomplicated) has a resting HR of 50 bpm, achieves a MHR of 140 during the ETT and is taking a beta blocker. The intensity of training following assessment has been set at 50 – 70% of HRR.

a. Calculation of HRR = 140 – 50 – 30 (beta blocker) = 60
b. Selection of % of HRR
   50% of HRR = 0.5 x 60 = 30
   70% of HRR = 0.7 x 60 = 42
c. Add resting HR =
   30 + 50 = 80
   42 + 50 = 92

Conclusion: THR = 80 to 92 bpm

Example 3:

Patient X (age 60, low risk and uncomplicated) has a resting HR of 50bpm and has no observed MHR. The intensity of training following assessment has been set at 50 – 70% of HRR.

a. Age estimated MHR = 220 – age (50) = 160
b. Calculation of HRR = 160 – 60 = 100
c. Selection of % of HRR
   50% of HRR = 0.50 x 100 = 50
   70% of HRR = 0.70 x 100 = 70
d. Add resting HR =
   50 + 60 = 110
   70 + 60 = 130
   Conclusion: THR = 110 to 130 bpm

Method 2: Calculating THR based on 60 – 75% intensity of MHR

As with the Karvonen formula, this calculation can be performed using either a true observed MHR or from an age-estimated method and can be adjusted for patients on beta-blockers. This method does not allow for resting heart rate. Estimating MHR uses a predicted MHR based on age (220 – age) and as such can have an error margin of as much as + / - 10 bpm

Example 1:

Patient X (low risk and uncomplicated) achieves a MHR of 155 during an ECG exercise test. The intensity of training following assessment has been set at 60 – 75% of MHR.

0.60 x 155 = 93
0.75 x 155 = 116

Conclusion: THR = 93 to 116 bpm

Example 2:

Patient X (low risk and uncomplicated) is 68 years of age.
Maximum age predicted HR = 220 – 68 = 152

60 – 75% of predicted MHR =
0.60 x 152 = 91.2
0.75 x 152 = 114

Conclusion: THR = 91 to 114 bpm

Appendix D: BORG Scales

Please see refereces 45, 92, 93 and 94 for the Borg RPE Scale® and Borg CR10 scale®.

Appendix E: Risk Stratification

Risk stratification is a multi-factorial measure used to establish prognosis of future major cardiac events and chances of survival. Mortality risk within the first year for an individual assessed as:

- low risk is 2%
- moderate risk is 10 – 25%
- high risk is >25%

It can also help determine the chances of disease progression in terms of arterial, myocardial or electrophysiological function. This tool helps the exercise professional to identify relevant information for patient management, appropriate level of supervision and monitoring.

AACVPR stratification for risk of cardiac events

LOWEST RISK C	MODERATE RISK B	HIGHEST RISK A
Absence of complex ventricular arrhythmias during exercise testing and recovery		Presence of complex ventricular arrhythmias during exercise testing or recovery
Absence of angina or other significant symptoms (e.g. unusual SOB, light-headedness or dizziness, during exercise testing and recovery)	Presence of angina or other significant symptoms (e.g. unusual SOB, light-headedness or dizziness, occurring only at high levels of exertion (≥ 7METS)	Presence of angina or other significant symptoms (e.g. unusual SOB, light-headedness or dizziness at low levels of exertion (<5METS) or during recovery)
	Mild to moderate level of silent ischaemia during exercise testing or recovery (ST-segment depression <2 mm from baseline)	High level of silent ischaemia (ST-segment depression ≥ 2mm from baseline) during exercise testing or recovery
Presence of normal haemodynamic responses during exercise testing and recovery (appropriate increases and decreases in HR and SBP with increasing workloads and recovery		Presence of abnormal haemodynamics with exercise testing (i.e. chronotrophic incompetence or flat or decreasing SBP with increasing workloads) or recovery (severe post-exercise hypotension
Functional capacity ≥ 7METS		History of cardiac arrest or sudden death
Resting EF >50%	Functional capacity <5 METS	Resting EF <40%
Uncomplicated MI or revascularisation procedure	Resting EF 40 – 49%	Complicated MI or revascularisation procedure
Absence of complicated ventricular arrhythmias at rest		Complex dysrhythmias at rest
Absence of CHF		Presence of CHF
Absence of signs or symptoms of post-event/post-procedure ischaemia		Presence of signs and symptoms of post-event/post-procedure ischaemia
Absence of clinical depression		Presence of clinical depression
Lowest classification is assumed when each of the above factors in this category is present	**Moderate risk is assumed for patients who do not meet the classification of either highest or lowest.**	**Highest risk classification is assumed with the presence of <u>any one</u> of the above factors in this category is present.**

(43)

Criteria checklist for use when risk stratifying CHD patients prior to exercise

Indicators of severity of event	Indicators of LV function	Indicators of ongoing ischaemia	Other considerations
• An anterior rather than inferior MI • More than one previous infarct • High cardiac enzymes or troponin levels at time of infarct • Complicated recovery	• LV function – moderate (EF = 40 – 49%) or poor (EF = <40%) • Presence of HF	• Positive ETT • Ongoing angina/ischaemia • Awaiting further investigations	• Arrhythmias (especially ventricular) • Cardiac arrest secondary to event

(71)

Supervision level

This relates to potential difficulties when taking part in the exercise component of cardiac rehabilitation e.g. hard of hearing, poor vision, poor balance, musculoskeletal/neurological problems which may affect the staff to patient ratio or type of exercises prescribed.

1 = High supervision needs 2= Moderate supervision needs 3= Low supervision needs

Appendix F: Extra Considerations for Patients with Heart Failure

HF is characterised by an inability of the heart to adequately deliver oxygenated blood to metabolising tissue. It is a clinical syndrome with objective evidence of cardiac dysfunction at rest and hallmark symptoms of breathlessness or fatigue either at rest or during exertion, as quantified by the New York Heart Association (NYHA I - IV) classification system [95]. Impaired cardiac output, defined by an ejection fraction (EF) of <40%, and abnormalities in central haemodynamic function can lead to abnormalities in skeletal muscle metabolism and morphology, peripheral blood flow, vascular function, neuro-hormonal responses and pulmonary function, with consequent progression of disease. The prognosis for HF is poor with 50% of diagnosed patients dying within 4 years and in patients with severe HF, 50% of those will die within one year (56,96).

Systematic reviews of exercise-based CR in stable CHF patients have confirmed the safety and effectiveness of exercise as an intervention (28,57,65,96). Benefits have been reported in increased exercise capacity, decreased symptoms and improved QOL (28,57,96,97). In particular, the Cochrane review reported average increases in:

- VO_2 max by 2.16ml/kg per min
- exercise duration by 2.38 min
- work capacity by 15.1 watts (W)
- six minute walk test (6MWT) by 40.9 metres.

The European Society of Cardiology (ESC) (56,98), American Heart Association (60) and the ACSM (22) provide guidelines and protocols for exercise training with HF patients.

Risk stratification

HF patients are classified amongst those deemed at highest risk of further cardiac events according to the AACVPR stratification criteria (i.e. an EF of <40%) (43). Patients may additionally present with other criteria:

- significant symptoms at low levels of activity of less then 5 METs
- abnormal haemodynamics with exercise testing
- peak VO2 of <10 ml/kg per min
- 6MWT of <300m which is associated with poorer short-term survival.

Given the pathophysiology of HF and acknowledged increased risk with exercise, rigorous individual patient assessment and risk profiling need to be coupled with appropriate monitoring and a safe management and delivery system when undertaking exercise training (22,96).

Assessment

In addition to the assessment process (Standard 2), the following points should also be considered prior to prescribing exercise:

- No episode of de-compensation within a month
- No change in medication within a month (up-titration acceptable)
- No weight gain of >2kg over two days
- No recent significant deterioration in exercise tolerance or increase in breathlessness on exertion.

Significant change in status may mean exercise is contra-indicated until relevant problems are resolved.

Exercise prescription

The evidence-based approach to increasing CV and muscle endurance in HF patients recommends initially adopting an interval versus a steady state approach, with focus on increasing the peripheral stimulus whilst minimising the CV stress.

Graduated warm-up and cool-down are especially important in the HF patient as without the appropriate graduated transition periods at the beginning and end of exercise, HF patients are at particular risk of ischaemia, post exercise hypotension or threatening ventricular dysrhythmias. This should be moderated in length and intensity to match the main conditioning phase (Standard 7).

The FITT principle dose should be adapted appropriately (Appendix B).

Initially short, frequent periods of 5 to 10 min of activity are more effective and better tolerated in very de-conditioned and compromised patients (<3METs).

Recommended type or mode of exercise training

- Combine CV aerobic and MSE resistance training

- Low to moderate intensity dynamic large muscle group work e.g. walking, stationary cycling (Appendix B – initial intensity may be 40% or less of HRR, carefully monitored against RPE)
- Resistance training exercises to target specific muscle groups to assist ADL and function
- Interval approach initially with work phases of 1 to 6 min and rest phases of 1 to 2 min (18)
- Consider intervals of work:rest ratio (1:2; 1:1), CV:MSE ratio (1:1; 2:1) and alternating seated:standing work ratio (1:1; 1:3)
- Include breathing exercises, breathlessness management and recovery strategies
- Emphasise posture training and core trunk strength
- Promote energy conservation techniques and guidance on pacing.

Cautions

- Avoid excessive accessory muscle use and muscle fatigue with arm and upper body exercise in very de-conditioned patients
- Avoid breath holding and Valsalva manoeuvre
- Avoid abrupt postural changes and stooped activities
- Avoid keeping legs stationary
- Show caution with resistance training (low weight/high repetitions)
- Show caution with seated exercise (reduced venous return). If performed, lower the intensity and combine with gentle leg exercise e.g. alternate heel raises.

Key points

- Promote benefits of exercise training – 'strong legs, spare the heart'
- Encourage leg and calf muscle exercise to increase venous return
- Pace effort/promote 'walk & talk'
- Promote exercise philosophy 'little and often'
- Promote self-management approach with exercise goal setting.

Appendix G: Extra Considerations for Patients with an Implantable Cardioverter Defibrillator

The first prospective randomised control trial in ICD patients with low capacity (EF <35%) demonstrated that exercise-based rehabilitation (including aerobic circuit training) has significant and beneficial outcomes in terms of cardio-respiratory function (CRF) and psychological wellbeing (101). Similar findings have been found in larger retrospective studies with a 20% mean improvement in CRF following regular aerobic exercise training (102).

Clinicians are often concerned about exercising a patient with a known arrhythmia because the consequence of poorly performed exercise at a relatively high intensity could be a cardiac arrest, which in most cases is fatal. The important point, in terms of CR, is that clinicians are often exercising patients well below the intensities associated with exercise-induced arrhythmias. Manchester Heart Centre data (2007) shows the average METs associated with exercise-induced arrhythmias was 9.4 which is higher than the level prescribed in most CR programmes.

Physical activity and exercise has a substantial role in enabling patients with an ICD to take control of their condition. Exercise can be performed safely without increasing the risk of cardiac complications so long as the exercise is prescribed at the appropriate intensity and the exercise session incorporates an effective warm-up and cool-down period.

Risk stratification

The majority of ICD patients will be classified as high risk via the AACVPR criteria due to their underlying cardiac status or previous history of arrhythmia.

Assessment

In addition to the assessment process (Standard 2), the following points should also be considered prior to prescribing exercise:

- Knowledge of the following ICD parameters:
  - ICD detection threshold setting in bpm
  - Whether the device is set for ventricular tachycardia (VT) or ventricular fibrillation (VF)
  - Rapid onset setting
  - Sustained ventricular tachycardia settings
  - ICD therapy e.g. anti-tachycardia pacing or shocks.

- Knowledge of contact details and communication links for the electrophysiology referral team for follow up of missing referral information and to discuss any concerns.

- Knowledge of prior shock history – 90% of patients will have assigned a cause to a shock (103) leading to avoidance behaviour. If a shock has been previously experienced on physical exertion this may be a barrier to exercise

- Knowledge of the relationship between the ICD and exercise training thresholds.

Exercise prescription considerations and cautions

It is not inevitable that the ICD will interpret an exercise sinus tachycardia as an arrhythmia whilst in the detection zone; however sinus tachycardia can be misinterpreted and cross over in this situation. Given the physical and psychological implication of dealing with a shock and the long-term issues with inappropriate ICD therapies, a proactive approach to avoid this situation is considered best practice (104-106). To reduce the risk of this occurring, the exercise prescription should follow the recommended standards for structured exercise training (Standard 7) with the following additional considerations:

- Keep the exercise HR 10 bpm below ICD detection threshold (99) using HR monitoring initially until effective use of RPE has been established.
- Avoid excessive ranges of shoulder movement and/or highly repetitive vigorous shoulder movements to reduce the risk of failure of a lead (63,64,100)
- Perform most exercises in standing
- Horizontal and seated arm exercises should be kept to a minimum. (63,64,101). Seated arm exercise is associated with reduced venous return, reduced end-diastolic volume, a concomitant decrease in cardiac output and increased likelihood of arrhythmia (63,64,101). If performed, lower the intensity and place emphasis on muscular endurance. Mild leg exercise, for example alternate heel raises, when

combined with arm exercise, reduces the haemodynamic response compared with strict arm work (61)
- The use of the standard 75% THR, in patients with slow ventricular tachycardia, will often mean that the target exercise HR is above the detection threshold of the ICD (101). Therefore use of the Karvonen formula (91) and reducing the exercise intensity to the lower end of moderate is recommended
- Avoid breath holding and sustained isometric work which are associated with reduced venous return, reduced end-diastolic volume, a concomitant decrease in cardiac output and increased likelihood of arrhythmia. Isometric work, particularly of the abdominal region, should be avoided especially during arm exercise in patients with low functional capacity (22,43,53,56,57,64,65)
- Avoid contact sports which could damage the device
- Avoid dangerous alone activities i.e. swimming, climbing ladders.

It is recommended that all practitioners have a protocol of what to do, should the device deliver therapy to the patient during an exercise session:
- If the patient recovers quickly and feels well after a shock, the follow-up centre should still be informed and advice gained as appropriate.
- If the patient is feeling unwell after a shock or more than one shock is delivered an ambulance (999) should be called.

It should be remembered that the ICD is designed to provide immediate emergency treatment rather than constricting activity due to fear of activity provoking an arrhythmia.

Appendix H: Considerations for Patients Post Cardiac Transplantation

Cardiac transplantation is associated with a mêlée of physiological alterations which may influence exercise capacity. These include:
- surgical denervation of the transplanted heart in the recipient (107)
- decreased chronotrophic competence
- altered ventricular function (108)
- altered vascular endothelium (109)
- pulmonary diffusion changes (110)
- accelerated graft vascular disease (111)
- reduced bone mineral density (112)
- changes in skeletal muscle morphology (113,114).

The aerobic capacity and therefore exercise tolerance in heart transplant recipients can be between 40% – 60% lower than aged matched controls (115). Despite this, transplant recipients can benefit from exercise training. An increase in aerobic capacity, muscle mass, muscle strength and bone density has been documented. (116-118). Much of the training effect occurs through peripheral adaptation (119). This is limited initially by poor musculature as disuse atrophy and defects of muscle metabolism associated with HF may persist from the pre-operative period (117,120).

Implications of denervation on exercise

- Loss of vagal tone to the sino-atrial (SA) node resulting in an increased resting HR of around 30% (119)

- No increase in HR through sympathetic stimulation on commencing exercise; some increase in cardiac output occurs through the Frank- Starling mechanism
- As steady exercise continues, increasing HR is achieved over 10 to 15 min due to the chronotrophic effect of circulating catecholamines (119,121)
- The peak HR and VO2 max is significantly lower than in normally innervated subjects (120)
- Breathlessness and fatigue are more likely due to:
    - increased CO2 production compared with healthy subjects
    - decreased O2 delivery to peripheral working skeletal muscles
- Loss of sensation of pain in the presence of cardiac ischaemia (122)
- Interference with salt and water retention
- Causes some loss of control of peripheral vasculature.

Effects of denervation on ceasing exercise

- Slow decline in HR due to:
    - no vagal brake on the SA node (121)
    - slow removal of catecholamines from the circulation, taking 10 to 15 min (122)
- An increased risk of hypotension on ceasing exercise abruptly as venous return from working muscles drops whilst HR remains high.

Risk stratification

The majority of heart transplant recipients will be classified as low risk via the AACVPR criteria (120,123) but it should be considered that the age limit of donors has increased in recent years and therefore there is a risk of donor CHD being present.

Assessment

- An ETT protocol should allow a warm-up and cool-down stage to allow circulating catecholamines to become effective and have continuous progressive increments in work rates of 1 to 2 METs per stage, allowing the denervated heart to adapt to the increased workload (124)

- CV endurance training should be set between the anaerobic threshold and 10% below, as established by an incremental ETT (111,125). If this information is not available a percentage of the peak HR should be used to guide the training depending on how the peak exercise capacity compared with predicted measures (125).

- Maximal effort can be assumed from the BORG RPE of 19 to 20 and the ventilatory threshold from a rating of 12 to 14. Having noted the level of energy expenditure on the exercise test where the ventilatory threshold or RPE 12 to 14 is achieved, this can be translated in terms of exercise pace or ergometer power output (120,123).

- If ETT results are not available, a FCT should be carried out to determine exercise intensity and baseline measurements. Test protocols should allow time for an appropriate increase in HR and oxygen consumption at each workload.

- Consensus of the UK Transplant Centres demonstrates that the most practical method of prescribing exercise for this group relies on the patient perception of having

exercised until there is some mild muscle fatigue or shortness of breath and then checking their description of these feelings against the BORG RPE scale (45) to maintain a rating of 12 to 14.

Exercise prescription

Although there is evidence that CV and resistance training for heart transplant recipients is beneficial for many reasons (112,126,127), the current literature does not demonstrate consensus regarding what should be included in the exercise programme. There are very few studies which have investigated exercise programmes for patients in Phase III rehabilitation and to date there have not been any randomised control trials (RCT) in this area.

The exercise regimens that have been shown to make significant improvements in physical parameters include those described below:

- A resistance training programme of 10 to 15 repetitions at 50% of 1RM has been shown to cause significant improvements in bone mineral density; including: – lumber extensions, chest press, knee extension, seated leg-curl, seated tricep-dip, bicep curl, shoulder press and leg press. Once patients are able to perform 15 repetitions, the resistance should be increased by 5 – 10% (128)

- To include aerobic and resistance exercises: 30 to 40 min of treadmill or exercise cycle, five days a week for 12 weeks at an intensity of 12 to 14 on the BORG RPE scale and a lower limb resistance training regimen of between 3 to 5 sets of 10 repetitions of 50% of 1 RM (112,126,128)

- Walking at 60% – 70% peak VO2 for 15 to 20 min (confirmed by a BORG RPE of 12 to 14) after a 5min warm-up and light limb strengthening exercises (127)

- Magnitude of improvement is related to the duration of training (12 to 16 weeks, 3 to 5 times/week) and intensity (work at levels 11 to 14 BORG RPE scale for sessions 30 min long excluding warm-up and cool-down) (119,122,129).

Exercise considerations

- Resting HR is 30% higher, therefore exercise prescription at a percentage of HR maximum (as calculated by the 220 – age method) is not appropriate for these patients.

- RPE has been investigated with this population of patients (128) and has been found to be effective to guide exercise intensity. However, caution should be taken as it has not been validated in cardiac transplant patients.

- Careful prolonged warm-up necessary (10 to 15 min) to allow catecholamine levels to increase HR.

- Prolonged cool-down and muscle stretches (10 to 15 min) to allow decrease in circulating catecholamines and therefore HR, to avoid a rapid drop in BP (123).

Exercise cautions

- An accelerated form of coronary atherosclerosis may develop post transplant so that at 5 years post surgery around 45% of patients have angiographic evidence of disease and at 9.5 years post surgery this increases to 53% (129). Cardiac ischaemia will be absent as a result of denervation, therefore other symptoms such as breathlessness should be considered.

- Recent biopsy score:
    - If cellular rejection is present it is graded on a scale from 1 to 4 (mild-severe). If rejection is severe, the patient should discontinue CV and resistance exercises until the biopsy result is clear. During moderate rejection, exercise should be maintained at current levels without progression; in mild rejection the exercise regimen should be progressed slowly (121,123)
    - Rejection increases the risk of arrhythmia and reduced cardiac output
    - With rejection, high dose corticosteroids are given for three days followed by a tapering down regimen, increasing the risk of skeletal fractures on high impact exercises
    - After a rejection episode, the exercise programme should be tailored to reduce impact/stress on the skeletal system initially with a gradual progression back to pre-rejection exercise levels.

- Patient reported temperature – the transplant patient should take their temperature daily to monitor the first signs of an infection. If immunosupression is low, a patient can become unwell very quickly in the presence of an infection. Exercise should not be continued in the presence of pyrexia.

Appendix I: Considerations for Patients with Left Ventricular Assist Devices

Currently there is a lack of evidence regarding exercise training protocols for people who have LVADs implanted for end-stage HF. To date there are no studies published investigating the effects of different exercise training protocols (including the FITT principle) with this patient group. Of the papers that have described rehabilitation post-LVAD implantation many of them are single case studies, have less than 10 subjects; or are retrospective analysis (132,133,134).

There are currently many versions of LVADs available and the capacity of exercise will depend on the ability of the device to deliver an output that matches the intensity of exercise required. There are two basic forms of blood pump that are in current use:

- pulsatile positive displacement pumps
- rotary continuous flow non-pulsatile pumps.

The newer generation of continuous- flow pumps have been shown to have the same effects as pulsatile pumps in regards to left ventricular unloading and cardiac haemodynamics (135).

Patients are discharged home once they can mobilise independently, perform ADL, climb stairs and have achieved a set level of knowledge about the device so that they can care for themselves independently. Some patients will require a carer with them 24 hours a day, depending on their underlying cardiac function. Other patients are able to be alone in the day but are required to have an adult in the house with them during the night. Each patient

will learn how to change the power source so that they can mobilise independently away from the main unit and will be able to perform emergency procedures in case of device alarms and pump failure.

Exercise considerations

- The mechanism of non-pulsatile devices means that it is extremely difficult, if not impossible at times, to measure an accurate BP and HR using non-invasive means. It should not be assumed that the pump rate of the pulsatile devices is equal to the HR.

- Hypotension and low pump flows are one of the most common problems so the patient must be well educated regarding the normal flow values so that they are able to take appropriate action when required.

- If a carer is needed with the patient 24 hours a day, a fully trained person must be present in the vicinity of the assessment or exercise session so that they are able to deal with any device emergencies should they occur.

- Patients must be asked about problems with drive-line infection as it is not advisable to exercise when an active infection is present.

- The position of the drive-line (the line that is tunnelled from the device implanted in the heart to the external controller system and power source) may affect the type of exercise that the person is able to perform. Due to the position of the drive-line through the abdominal wall the patient is not able to perform any specific abdominal exercise.

- The underlying condition requiring LVAD insertion and post-operative effects will affect the degree of exercise tolerance at any time. Each patient with an LVAD will require an individual assessment and exercise programme depending on their physical limitations and the ability of the LVAD to affect exercise capacity.

- If you are referred an LVAD patient then it is advisable to contact the implantation centre prior to commencing an exercise programme.

Exercise prescription

LVAD insertion has been shown to improve oxygen deficiency and exercise capacity measured by peak VO2 during maximal exercise (136). It has also been shown that after five months of LVAD insertion peak VO2 was significantly better than that of NYHA class III patients, 15.4 ± 1.0 ml/kg/min and that the pulsatile pump itself was the limiting factor to further improvements in exercise capacity (137). Significant improvements in EF and cardiac index have been shown following LVAD implantation (138).

- Treadmill exercise testing with a modified Bruce, Naughton or modified Naughton protocol and a supine bicycle protocol beginning at 50W increasing by 25W every 3 min until fatigue have been used safely with this patient group (135,137). The modified Wassermann ramp protocol for a cycle ergometer has also been used safely to assess maximal exercise capacity (135).

- Treadmill exercise with a workload of 3 to 5 METs (2.1mph, 2% gradient) for 20 to 30 min has been shown to be safe and effective as has the use of the supine bicycle (132).

Contraindications/cautions to exercise

Currently only one study has published any contraindications to exercise for LVAD patients but these are only stated as contraindications to exercise four to six weeks post surgery (138). These contraindications include:

- the onset of angina
- a drop in SBP below resting BP
- an increase in SBP exceeding 200mmhg
- ECG changes
- oxygen desaturation <85%
- a drop in LVAD flow <3 l/min.
- or a 6 to 20 RPE rating of >13 at sub maximal workloads.

The only investigation to report any incidents during exercise training states that the events were all minor resulting in no morbidity or mortality. These include venous pooling, hypovolaemia and decreased drive line air volume in the pulsatile pump (132).

Useful Website Addresses

www.acpicr.com
http://www.cardiacrehabilitation.org.uk/dataset.htm
http://www.csp.org.uk
www.bacrphaseiv.co.uk
http://www.bcs.com
http://aacvpr.org
www.nice.org.uk
http://www.bhf.org.uk
http://www.heartstats.org
http://www.dh.gov.uk/
www.americanheart.org
www.who.int
www.emedicine.com
www.library.nhs.uk/cardiovascular/Page.aspx?&pagename=CRINTRO08
www.library.nhs.uk
www.bhfactive.org.uk
www.patient.co.uk
www.diabetes.org.uk
www.ash.org.uk

<u>England:</u>
www.mapofmedicine.com
www.walkit.com
http://www.whi.org.uk

Ireland:
www.hscni.net
www.crestni.org.uk
www.healthpromotionagency.org.uk

Scotland:
http://www.sign.ac.uk
www.healthscotland.com
www.show.scot.nhs.uk

Wales:
www.wales.nhs.uk
www.ww2h.org.uk
http://new.wales.gov.uk/hcwsubsite/healthchallenge/?lang=en

Association of Chartered Society of Physiotherapists in CR (ACPICR)

CR is an expanding speciality within physiotherapy and in 1995 the Association of Chartered Physiotherapists Interested in Cardiac Rehabilitation (ACPICR) was established to develop the interests of all physiotherapists involved in CR. This has since changed its name to the Association of Chartered Physiotherapists in Cardiac Rehabilitation.

The group is recognised as a clinical interest group by the CSP and the BACR, the national multi-disciplinary organisation for CR professionals.

Writing Group

Heather Probert, BSc (Hons), MCSP, Royal Brompton and Harefield NHS Foundation Trust, Harefield Hospital
Helen Barritt BSc (Hons), MCSP, University Hospital of South Manchester NHS Foundation Trust / Manchester Heart Centre
Samantha Breen MPhil, MCSP, (Co-chair ACPICR) Manchester Heart Centre
Dr John Buckley BPE, MSc, PhD, University of Chester
Keri Graham MSc, MCSP, NHS Greater Glasgow and Clyde
Fiona Green Grad Dip, MCSP, University Hospital of South Manchester NHS Foundation Trust
Lesley Simpson Dip Health and Fitness, Cert Ed, RSA, City & Guild 7307**,**
TDLB 32/33 Group Health Promotion Manager Nexus Community, Buckinghamshire
Joanne Street BSc (Hons), MCSP, Manchester Heart Centre
Catrin Warren MSc, MCSP, North Wales NHS Trust

Acknowledgements for Appendices

Cathy Bindoff, BSc (Hons), MCSP, Royal Brompton and Harefield NHS Foundation Trust, Harefield Hospital
Sue Dennell, Grad Dip, MCSP, University Hospital of South Manchester NHS Foundation Trust
Fiona Lough, MPhil, MCSP, University College London,

Previous Contributors

Janet Deavin, Grad Dip, MCSP
Sharon Denbury, Grad Dip, MCSP
Prof. Patrick Doherty, PhD, MCSP
Nicola Froggat, Grad Dip, MCSP
Jo Ganachaud, Grad Dip, MCSP
Andrea Goodliffe, Grad Dip, MCSP
Elaine Hayward, Grad Dip, MCSP
Sally Hinton, MSc, MCSP
Jenni Jones, MSc, MCSP
Rachel King, MCSP
Judy Meade, CSP, MCSP
Melanie Reardon, MSc, MCSP
Joanne Robinson, BSc, MCSP
Sushma Sanghvi, MSc, MCSP
Dr Ann Taylor, PhD, MCSP
Dr Sally Turner, PhD, MCSP
Hayley Yates, Grad Dip, MCSP

Peer Reviewers

ACPICR Committee
EPG committee
Bernie Downey, MBE, RGN, BSc (Hons), MSc, Belfast Health & Social Care
Siobhan Doyle, MCSP, BSc (Hons), Belfast Health and Social Care Trust
Gillian Edmundson, MCSP, BSc, University Hospital of South Manchester
NHS Foundation Trust

List of Abbreviations

AACVPR	American Association of CV & Pulmonary Rehabilitation
ACPICR	Association of Chartered Physiotherapists in CR
ACS	Acute Coronary Syndrome
ACSM	American College of Sports Medicine
ADL	Activities of Daily Living
AED	Automated External Defibrillator
ALS	Advanced Life Support
BACR	British Association for Cardiac Rehabilitation
BLS	Basic Life Support
BASES	British Association of Sports & Exercise Sciences
BMI	Body Mass Index
BP	Blood Pressure
bpm	Beats Per Minute
CABG	Coronary Artery Bypass Surgery
CCF	Congestive Cardiac Failure
CHD	Coronary Heart Disease
CHF	Chronic Heart Failure
CLASP	Cardiovascular Limitations and Symptoms Profile
CPR	Cardiopulmonary Resuscitation
CPD	Continuing Professional Development

CR	Cardiac Rehabilitation
CRF	Cardio-respiratory Function
CRT	Cardiac Resynchronisation Therapy
CSP	Chartered Society of Physiotherapy
CST	Chester Step Test
CV	Cardiovascular
CVD	Cardiovascular Disease
ECG	Electrocardiogram
Echo	Echocardiogram
EF	Ejection Fraction
ESC	European Society of Cardiology
FCT	Functional Capacity Test
ETT	Exercise Tolerance Test
FITT	Frequency, Intensity, Time, Type
GTN	Glycerine Trinitrate
HADS	Hospital Anxiety and Depression Scale
HPC	Health Professions Council
HR	Heart Rate
HF	Heart failure
HRR	Heart Rate Reserve
ICD	Implantable Cardioverter Defibrillator
ILS	Immediate Life Support
kcal	Kilocalories
kg	Kilogram
KSF	Knowledge and Skills Framework
LVAD	Left Ventricular Assist Device
MDT	Multidisciplinary Team
MET/METS	Metabolic Equivalent
MHR	Maximal Heart Rate
Min	Minute
MI	Myocardial Infarction
mph	Miles Per Hour
MSE	Muscular Strength & Endurance
NACRe	National Audit Cardiac Rehabilitation
NHS	National Service Framework
NICE	National Institute for Health and Clinical Excellence
NSF	National Service Framework
NSTEMI	Non ST Elevation Myocardial Infarction
NYHA	New York Heart Association
PAQ	Physical Activity Questionnaire
PCI	Percutaneous Coronary Intervention
PCT	Primary Care Team
PPM	Permanent Pacemaker
PVD	Peripheral Vascular Disease
QOL	Quality of Life
RCT	Randomised Control Trial
REPs	Register for Exercise Professionals
RM	Repetition Maximum
RPE	Rating of Perceived Exertion
RPP	Rate Pressure Product
SA	Sino-atrial
SBP	Systolic Blood Pressure
SIGN	Scottish Intercollegiate Guidelines Network

SMARTER	Specific, Measurable, Achievable, Realistic, Timely, Empowering and Revisable (goals)
SOB	Shortness of Breath
SOBOE	Shortness of Breath on Exertion
STEMI	ST Elevation Myocardial Infarction
SWT	Shuttle Walking Test
THR	Training/Target Heart Rate
UK	United Kingdom
VF	Ventricular Fibrillation
VO2max	Aerobic Power
VT	Ventricular Tachycardia
W	Watts
WC	Waist Circumference
WHO	World Health Organisation
6MWT	Six Minute Walk Test

Bibliography

1. Scottish Intercollegiate Guidelines Network (SIGN). Cardiac Rehabilitation: A National Clinical Guideline. Edinburgh: Scottish Intercollegiate Guidelines Network; 2002.
2. Joliffe J, Taylor R, and Ebrahim S. A report on the clinical and cost effectiveness of physiotherapy in cardiac rehabilitation. London: Chartered Society of Physiotherapy; 2000.
3. NHS Centre for Reviews and Dissemination. Cardiac rehabilitation: Effective Health Care Bulletin. York: University of York. 1998.4. 4.
4. Department of Health (DH) 2000. National Service Framework for Coronary Heart Disease. London: Department of Health; 2000.
5. Association of Chartered Physiotherapists in Cardiac Rehabilitation. Peer review. London: ACPICR; 2007.
6. Chartered Society of Physiotherapy. Physiotherapy Core Standards. London: Chartered Society of Physiotherapy; 2005.
7. Register of Exercise Professionals of the United Kingdom. Code of Ethical Practice; 2008 [accessed 9 May 2009]. Available from: http://www.exerciseregister.org/custom/documents/CodeOfEthicalPractice.pdf.
8. British Association of Sports and Exercise Sciences. Code of Conduct; 2000 [accessed 30 April 2009]. Available from:http://www.bases.org.uk/pdf/Code%20of%20Conduct.pdf.
9. Department of Health. Our health, our care, our say: a new direction for community services. London: Department of Health; 2006.
10. Department of Health. The NHS Knowledge and Skills Framework (NHS KSF) and the Development Review Process. London: Department of Health; 2004.
11. World Health Organisation. Cardiovascular diseases. Factsheet 317; 2007 [accessed 13 March 2009]. Available from http://www.who.int/mediacentre/factsheets/fs317/en/index.html.
12. British Heart Foundation. Coronary heart disease statistics. London: British Heart Foundation; 2008.
13. World Health Organisation Expert Committee. Rehabilitation after cardiovascular disease with special emphasis on developing countries. Technical report series 831. Geneva: WHO; 1993.
14. Buckley J and Hughes A. Introduction. In: Buckley J, editor. Exercise Physiology in Special Populations. Oxford: Churchill Livingstone; 2008. p1-19.
15. Hambrecht R, Niebauer J, Marburger C, Grunze M, Kalberer B, Hauer K, et al. Various intensities of leisure time physical activity in patients with coronary artery disease: effects on cardiorespiratory fitness and progression of coronary atherosclerotic lesions. J Am Coll Cardiol. 1993; 22(2):468-77.
16. Hambrecht R, Wolf A, Gielen S, Linke A, Hofer J, Erbs S, et al. Effect of exercise on coronary endothelial function in patients with coronary artery disease. N Engl J Med. 2000; 342(7):454-460.
17. Hambrecht R, Adams V, Erbs S, Linke A, Krankel N, Shu Y, et al. Regular physical activity improves endothelial function in patients with coronary artery disease by increasing phosphorylation of endothelial nitric oxide synthase. Circulation. 2003; 107(25):3152-3158.
18. Pate R R, Pratt M, Blair S N, Haskell W L, Macera C A, Bouchard C, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA. 1995; 273: 402-7.
19. Farrell SW, Kampert JB, Kohl HW 3rd, Barlow CE, Macera CA, Paffenbarger RS Jr, et al. Influences of cardiorespiratory fitness levels and other predictors on cardiovascular disease mortality in men. Med Sci Sports Exerc. 1998; 30(6):899-905.
20. Williams P T. Physical fitness and activity as separate heart disease risk factors: a meta-analysis. Med Sci Sports Exerc. 2001; 33:754–761.
21. Myers J, Prakash M, Froelicher V, Do D, Partington S, Atwood JE. Exercise capacity and mortality among men referred for exercise testing. N Engl J Med. 2002; 346 (11):793-801.
22. American College of Sports Medicine. Guidelines for Exercise Testing and Prescription. 7th ed. Baltimore: Lippincott Williams & Wilkins; 2006.

23. Kavanagh T, Mertens DJ, Hamm LF, Beyene J, Kennedy J, Corey P, et al. Prediction of Long-Term Prognosis in 12 169 Men Referred for Cardiac Rehabilitation. Circulation. 2002; 106: 666 - 671.
24. Department of Health. At least five a week: Evidence on the impact of physical activity and its relationship to health. London: Department of Health; 2004.
25. Department of Health. Choosing Health: Making healthy choices easier. London: HMSO; 2004.
26. Jolliffe J A, Rees K, Taylor R S, Thompson D, Oldridge N, Ebrahim S. Exercise-based rehabilitation for coronary heart disease. Cochrane Database Syst Rev. 2000: CD001800.
27. Taylor RS, Brown A, Ebrahim S, Jolliffe J, Noorani H, Rees K, et al. Exercise-based rehabilitation for patients with coronary heart disease: systematic review and meta-analysis of randomized controlled trials. Am J Med. 2004 15;116:682-92.
28. Rees K, Taylor RS, Singh S, Coats AJ, Ebrahim S. Exercise based rehabilitation for heart failure. Cochrane Database Syst Rev. 2004: CD003331.
29. ExTraMATCH collaborative. Exercise training meta-analysis of trials in patients with chronic heart failure (ExTraMATCH). *BMJ.* 2004; 328:189–192.
30. Thompson PD, Franklin BA, Balady GJ, Blair SN, Corrado D, Estes MNA, et al. Exercise and Acute Cardiovascular Events: Placing the Risks Into Perspective: A Scientific Statement From the American Heart Association Council on Nutrition, Physical Activity, and Metabolism and the Council on Clinical Cardiology. Circulation. 2007; 115: 2358 -2368.
31. National Audit of Cardiac Rehabilitation Annual Statistical Report 2008, University of York; [accessed 9 March 2009]. Available from: http://www.cardiacrehabilitation.org.uk/docs/NACR_2008.pdf
32. British Association for Cardiac Rehabilitation. Standards and Core Components for Cardiac Rehabilitation. London: British Association for Cardiac Rehabilitation, 2007.
33. National Institute for Health and Clinical Excellence. Commissioning a Cardiac Rehabilitation service. NICE; [accessed 3 Dec 2008]. Available from: http://www.nice.org.uk/usingguidance/commissioningguides/cardiacrehabilitationservice/CommissioningCardiacRehabilitationService.jsp
34. National Institute for Health and Clinical Excellence. Clinical Guideline 48: MI: secondary prevention in primary and secondary care for patients following myocardial infarction. London: NICE, 2007.
35. Dalal HM, Evans PH, Campbell JL, Taylor RS, Watt A, Read KL, et al. Home-based versus hospital based rehabilitation after myocardial infarction: A randomised trial with preference arms – Cornwall Heart Attack rehabilitation Management Study (CHARMS). Int J Cardiol. 2007; 119:202-11.
36. Brodie D, Bethell H, Breen S. Cardiac rehabilitation in England: a detailed national survey. Eur J Cardiovasc Prev Rehabil. 2006; 13(1):122-8.
37. Association of Chartered Physiotherapists in Cardiac Rehabilitation. Competences for the Exercise Component of Phase III Cardiac Rehabilitation. London: ACPICR; 2008.
38. Skills for Health. Coronary Heart Disease Framework. 2007 [accessed 13 April 2009]. Available from www.skillsforhealth.org.uk
39. Department of Health. The Knowledge and Skills Framework (NHS KSF) and the Development Review Process. London: Department of Health; 2004.
40. BACR Exercise Professionals Group (EPG) Position Statement. The Exercise component of Phase III Cardiac Rehabilitation. London: BACR Exercise Professionals Group; 2008.
41. IPAQ; The International Physical Activity Questionnaire. 2004. Available from: http://www.ipaq.ki.se/
42. National Audit of Cardiac Rehabilitation. Available from: http://www.cardiacrehabilitation.org.uk/dataset.htm
43. AACVPR. Guidelines for Cardiac Rehabilitation and Secondary Prevention Programs. 5th ed. Champaign, IL: Human Kinetics; 2005.
44. Fletcher GF, Balady GJ, Amsterdam EA, Chaitman B, Eckel R, Fleg J, et al. Exercise standards for testing and training: a statement for healthcare professionals from the American Heart Association. Circulation. 2001; 104(14):1694-74.

45. Borg GA. V Borg's Rating of Perceived Exertion and Pain Scales. Champaign, IL: Human Kinetics; 1998.
46. Department of Health. Reference Guide for Consent to Examination or Treatment. London: Department of Health; 2001.
47. Health Commission Wales. Reference Guide for Consent to Examination or Treatment. Cardiff: Welsh Assembly Government; 2009.
48. Scottish Executive Health Department. Good Practice Guide on Consent for Health Professionals in NHS Scotland. Edinburgh: Scottish Executive Health Department, 2006.
49. Department of Health, Social Services and Public Safety. Reference Guide for Consent to Examination, Treatment or Care. Belfast; DHSS, 2003.
50. Prochaska JO and Diclemente CC. Stages and processes of self-change of smoking: Toward an integrative model of change. Journal of Consulting and Clinical Psychology. 1983; 51: 390-395.
51. Biddle SJH, Mutrie N. Psychology of physical activity: determinants, well-being and interventions. London: Routledge; 2001.
52. Duncan GE, Anton SD, Sydeman SJ, Newton RL, Jr, Corsica JA, Durning PE, et al. Prescribing exercise at varied levels of intensity and frequency: a randomized trial. Arch Intern Med. 2005; 165(20):2362-9.
53. Lee IM, Sesso HD, Oguma Y, Paffenbarger RS, Jr. Relative intensity of physical activity and risk of coronary heart disease. Circulation. 2003; 107(8):1110-6.
54. Kemi OJ, Haram PM, Loennechen JP, Osnes JB, Skomedal T, Wisloff U, et al. Moderate vs. high exercise intensity: differential effects on aerobic fitness, cardiomyocyte contractility, and endothelial function. Cardiovasc Res. 2005; 67(1):161-72.
55. Belardinelli R. Arrhythmias during acute and chronic exercise in chronic heart failure. International journal of cardiology. 2003; 90(2-3):213-8.
56. Pina IL, Apstein CS, Balady GJ, Belardinelli R, Chaitman BR, Duscha BD, et al. Exercise and heart failure: A statement from the American Heart Association Committee on exercise, rehabilitation, and prevention. Circulation. 2003; 107(8):1210-25.
57. Vincent KR, Vincent HK, Braith RW, Bhatnagar V, Lowenthal DT. Strength training and hemodynamic responses to exercise. Am J Geriatr Cardiol. 2003;12(2):97-106.
58. American College of Sports Medicine. Position stand on the recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in adults. Med Sci Sports Exerc. 1998; 30:975–991.
59. Williams MA, Haskell WL, Ades PA, Amsterdam EA, Bittner V, Franklin BA et al. 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. Circulation. 2007; 116: 572-584.
60. AHA/AACVPR SCIENTIFIC STATEMENT**:** Balady GJ, Williams MA, Ades PA, Bittner V, Comoss P, Foody JM, et al. Core Components of Cardiac Rehabilitation/Secondary Prevention Programs: 2007 Update: A Scientific Statement From the American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee, the Council on Clinical Cardiology; the Councils on Cardiovascular Nursing, Epidemiology and Prevention, and Nutrition, Physical Activity, and Metabolism; and the American Association of Cardiovascular and Pulmonary Rehabilitation. Circulation.2007; 115: 2675 - 2682.
61. Toner MM, Glickman EL, McArdle WD. Cardiovascular adjustments to exercise distributed between the upper and lower body. Med Sci Sports Exerc. 1990; 22(6):773-8.
62. Faria EW, Faria IE. Cardiorespiratory responses to exercises of equal relative intensity distributed between the upper and lower body. J Sports Sci. 1998; 16(4):309-15.
63. Pashkow FJ, Schweikert RA, Wilkoff BL. Exercise testing and training in patients with malignant arrhythmias. Exerc Sport Sci Rev. 1997; 25:235-69.
64. Lampman RM, Knight BP. Prescribing exercise training for patients with defibrillators. Am J Phys Med Rehabil. 2000; 79(3):292-7.
65. Smart N, Marwick TH. Exercise training for patients with heart failure: a systematic review of factors that improve mortality and morbidity. Am J Med. 2004; 116(10):693-706.

66. O'Brien E, Asmar R, Beilin L, Imai Y, Mallion J, Mancia G, et al. European Society of Hypertension recommendations for conventional, ambulatory and home blood pressure measurement. Journal of Hypertension. 2003; 21:821–848.
67. Buckley J, Holmes & Mapp G. Exercise on Prescription: Activity for Cardiovascular Health. Oxford:Butterworth Heinemen; 1999.
68. Marchionni N, Fattirolli F, Fumagalli S, Oldridge N, Del Lungo F, Morosi L, et al. Improved exercise tolerance and quality of life with cardiac rehabilitation of older patients after myocardial infarction: Results of a randomised, controlled trial. Circulation. 2003;107: 2201-2206.
69. Heart Manual: A self management programme for patients with coronary artery disease. Edinburgh: NHS Lothian; 2009.
70. Road to Recovery: A Cardiac Rehabilitation programme. (British Heart Foundation pilot)
71. British Association for Cardiac Rehabilitation (2006) BACR Phase IV Exercise Instructor Training Manual, 4th Edition. Leeds, Human Kinetics.
72. Chartered Society of Physiotherapy. Rules of professional conduct 2nd edition. London: CSP; 2002.
73. Butland RJ, Pang J, Gross ER, Woodcock AA, Geddes DM. Two-, six-, and 12-minute walking tests in respiratory disease. Br Med J (Clin Res Ed). 1982; 284(6329):1607-8.
74. Singh SJ, Morgan MD, Scott S, Walters D, Hardman AE. Development of a shuttle walking test of disability in patients with chronic airways obstruction. Thorax. 1992; 47(12):1019-24.
75. Sykes K and Roberts A. The Chester step test—a simple yet effective tool for the prediction of aerobic capacity. Physiotherapy. 2004; 90: 183-188.
76. Heyward V. Advanced Fitness Assessment and Exercise Prescription. Fourth ed: Human Kinetics, Champaign, Illinois; 2002.
77. Pereira MA, FitzerGerald SJ, Gregg EW, Joswiak ML, Ryan WJ, Suminski RR, et al. A collection of Physical Activity Questionnaires for health-related research. Med Sci Sports Exerc. 1997; 29(6 Suppl):S1-205.
78. Zigmond AS, Snaith RP. The hospital anxiety and depression scale. Acta Psychiatr Scand. 1983; 67(6):361-70.
79. Wasson J, Keller A, Rubenstein L, Hays R, Nelson E, Johnson D. Benefits and obstacles of health status assessment in ambulatory settings. The clinician's point of view. The Dartmouth Primary Care COOP Project. Med Care. 1992; 30(5 Suppl):MS42-9.
80. Rector TS, Kubo SH, Cohn JN. – Patients' self-assessment of their congestive heart failure: Content, reliability, and validity of a new measure, the Minnesota Living with Heart Failure questionnaire. Heart Failure. 1987; 3: 198–209.
81. Rector T, Cubo S, Cohn J. Patient's self assessment of their congestive heart failure. Part 2: Content, reliability and validity of a new measure, the Minnesota Living with Heart Failure Questionnaire. Heart Failure. 1987; 3: 192–6.
82. Rector TS, Cohn JN. Assessment of patient outcome with the Minnesota Living with Heart Failure questionnaire: reliability and validity during a randomized, double-blind, placebo-controlled trial of pimobendan. Am Heart J. 1992; 124:1017-1025.
83. Ware JE, Jr., Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care. 1992; 30(6):473-83.
84. Ware, JE, Kosinski, M. and Keller, SD. A 12-Item Short-Form Health Survey: Construction of Scales and Preliminary Tests of Reliability and Validity. Medical Care. 1996; 34(3):220-233.
85. Hillers TK, Guyatt GH, Oldridge N, Crowe J, Willan A, Griffith L, et al. Quality of life after myocardial infarction. J Clin Epidemiol. 1994; 47:1287– 96.
86. Lewin RJ, Thompson DR, Martin CR, Stuckey N, Devlen J, Michaelson S, et al. Validation of the Cardiovascular Limitations and Symptoms Profile (CLASP) in chronic stable angina. J Cardiopulm Rehabil. 2002; 22(3):184-91.
87. Valenti L, Lim, L., Hellar, R. KnappJ. An improved questionnaire for assessing quality of life after mycocardial infarction. Quality of Life Research. 1996; 5:151-61.
88. McGee HM, Hevey D, Horgan JH. Psychosocial outcome assessments for use in cardiac rehabilitation service evaluation: a 10-year systematic review. Soc Sci Med. 1999; 48(10):1373-93.

89. Moss-Morris R, Weinmen, J., Petrie, K., Horne R, Cameron L, Buick D. The Revised Illness Perception Questionnaire. Psychology and Health. 2002; 17(1):1-16.
90. Devlin N, Hansen P, Herbison P, Macran S. A "new and improved" EQ-5D valuation questionnaire? Results from a pilot study. Eur J Health Econ. 2005; 6(1):73-82.
91. Karvonen M. Problems of training of the cardiovascular system. Ergonomics.1959; 2:207–215.
92. Borg G. The Borg CR10 Scale Folder. A method for measuring intensity of experience. Hasselby, Sweden. Borg Perception, 2004.
93. Borg, E. and Borg, G. A comparison of AME and CR100 for scaling perceived exertion. Acta Psychologica. 2002; 109:157-175.
94. Borg E and Kaijser L. A comparison between three rating scales for perceived exertion and two different work tests. Scandinavian Journal of Medicine & Science in Sports, 2006; 16:57-69.
95. The Criteria Committee of the New York Heart Association. Nomenclature and Criteria for Diagnosis of Diseases of the Heart and Great Vessels. 9th ed. Little, Brown & Co; 1994; 253-256.
96. Hunt SA. ACC/AHA 2005 guideline update for the diagnosis and management of chronic heart failure in the adult: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Update the 2001 Guidelines for the Evaluation and Management of Heart Failure). J Am Coll Cardiol. 2005; 46(6):e1-82.
97. Austin J, Williams R, Ross L, Moseley L, Hutchison S. Randomised controlled trial of cardiac rehabilitation in elderly patients with heart failure. Eur J Heart Fail. 2005; 7(3):411-7.
98. Heart Failure Guidelines. European Heart Journal. 2008; 29; 2388 - 2442
99. Fitchet A, Doherty PJ, Bundy C, Bell W, Fitzpatrick AP, Garratt CJ. Comprehensive cardiac rehabilitation programme for implantable cardioverter-defibrillator patients: a randomised controlled trial. Heart. 2003; 89(2):155-60.
100. Vanhees L, Schepers D, Heidbuchel H, Defoor J, Fagard R. Exercise performance and training in patients with implantable cardioverter-defibrillators and coronary heart disease. Am J Cardiol. 2001; 87(6):712-5.
101. Sears SF, JR, Rauch S, Handberg E, Conti JB. Fear of exertion following ICD storm: considering ICD shock and learning history. J Cardiopulm Rehabil.2001; 21: 47-9.
102. Exner DV, Klein GJ, Prystowsky EN. Primary Prevention of Sudden Death With Implantable Defibrillator Therapy in Patients With Cardiac Disease Can We Afford to Do It? (Can We Afford Not To?) Circulation 2001; 104; 1564-1570.
103. Pinski SL and Fahy GJ. The Proarrhythmic Potential of Implantable Cardioverter-Defibrillators Circulation.1995; 92: 1651 - 1664.
104. Wilkoff BL. Pacemaker and ICD Malfunction—An Incomplete Picture JAMA.2006; 295: 1944-1946.
105. Banner NR. Exercise Physiology and Rehabilitation after Heart Transplantation. J Heart Lung Transplantation. 1992; 11(4/2):S237-S240.
106. Notarius CF, Levy RD, Tully A, Fitchett D and Magder S. Cardiac versus noncardiac limits to exercise after heart transplantation. Am Heart J. 1998; 135:339-348.
107. Schmidt A, Pleiner J, Bayerle-Eder M, Wiesinger GF, Rodler S, Quittan M, Mayer G and Wolzt M. Regular physical exercise improves endothelial function in heart transplant recipients. Clinical Transplantation. 2002; 16:137-143.
108. Al-Rawas O, Carter R, Stevenson R, Naik K, Weatley D. Exercise intolerance following heart transplantation. The role of pulmonary diffusing capacity impairment. Chest. 2000; 118:1661-1670.
109. Schwaiblmair M, von Scheidt W, berfuhr P, Reichart B, Vogelmeier C. Lung Function and Cardiopulmonary Exercise Performance After Heart Transplantation. Influence of Cardiac Allograft Vasculopathy. Chest. 1999; 116:332-339.
110. Braith RW, Mills RM, Welsch MA, Keller JW, Pollock ML. Resistance exercise training restores bone mineral density in heart transplant recipients. J Am Coll Cardiol. 1996; 28(6):1471-7.

111. Tegtbur U, Busse M, Jung K, Pethig K, Haverich A. Time course of physical reconditioning during exercise rehabilitation late after heart transplantation. J Heart Lung Transplantation. 2005; 24:270-274.
112. Richard R, Zoll J, Mettauer B, Piquard F, Geny B. Counterpoint: Cardiac denervation does not play a major role in exercise limitation after heart transplantation. J Appl Physiol. 2008; 104:560-562.
113. McKenzie D. Effects of upper extremity exercise training on peak aerobic and anaerobic fitness in patients after transplantation. Am J of Cardiol. 2004; 93:939-943.
114. Banner N, Guz A, Heaton R, Innes JA, Murphy K, Yacoub M. Ventilatory and circulatory responses at the onset of exercise in man following heart or heart-lung transplantation. J Physiol. 1988; 399:437-49.
115. Banner NR, Lloyd MH, Hamilton RD, Innes JA, Guz A, Yacoub MH. Cardiopulmonary response to dynamic exercise after heart and combined heart-lung transplantation. Br Heart J. 1989; 61(3):215-23.
116. Kobashigawa JA, Leaf DA, Lee N, Gleeson MP, Liu H, Hamilton MA, et al. A controlled trial of exercise rehabilitation after heart transplantation. N Engl J Med. 1999; 340(4):272-7.
117. Kavanagh T, Yacoub MH, Mertens DJ, Kennedy J, Campbell RB, Sawyer P. Cardiorespiratory responses to exercise training after orthotopic cardiac transplantation. Circulation. 1988; 77(1):162-71.
118. Kavanagh T. Physical training in heart transplant recipients. J Cardiovasc Risk. 1996; 3(2):154-9.
119. Pope SE, Stinson EB, Daughters GT, 2nd, Schroeder JS, Ingels NB, Jr., Alderman EL. Exercise response of the denervated heart in long-term cardiac transplant recipients. Am J Cardiol. 1980; 46(2):213-8.
120. Keteyian S, Ehrman J, Fedel F, Rhoads K. Exercise following cardiac transplantation. Recommendations for rehabilitation. Sports Med. 1989; 8(5):251-9.
121. Badenhop DT. The therapeutic role of exercise in patients with orthotopic heart transplant. Med Sci Sports Exerc. 1995; 27(7):975-85.
122. Savin W M, Haskell W L, Schroeder J S, Stinson E B. Cardiorespiratory Responses Of Cardiac Transplant Patients To Graded, Symptom–limited Exercise. Circulation. 1980b 62: 55-60
123. Tegtbur U, Pethig K, Machold H, Haverich A, Busse M. Functional endurance capacity and exercise training in long-term treatment after heart transplantation. Cardiology. 2003; 99:171-176.
124. Haykowsky M, Eves N, Figgures L, McLean A, Koller M, Taylor D and Tymckak W. Effect of exercise training on VO2peak and left ventricular systolic function in recent cardiac transplant recipients. Am J Cardiol. 2005; 95:1002-1004.
125. Wu Y-T, Chien C-L, Chou N-K, Wang S-S, Lai J-S and Wu Y-W. Efficacy of a home-based exercise programme for orthotopic heart transplant recipients. Cardiology. 2008; 111:87-93.
126. Braith R, Magyari P, Fulton M, Aranda J, Walker T, Hill J. Resistance exercise training and alendronate reverse glucocorticoid-induced osteoporosis in heart transplant recipients. J Heart Lung Transplantation. 2003; 22:1082-1090.
127. Haykowsky M, Eves N, Figgures L, Koller M, Burton J, Tymchak W. Early initiation of aerobic and resistance training improves peak aerobic power, leg-press maximal strength and distance walked in six minutes in recent cardiac transplant recipients. J Heart Lung Transplantation. 2003; 22:S179.
128. Keteyian S, Ehrman J, Fedel F and Rhoads K. Heart rate-perceived exertion relationship during exercise in orthotopic heart transplant patients. J Cardiopulm Rehabil.1990; 10:287-293.
129. Taylor DO, Edwards LB, Boucek MM, Trulock EP, Deng MC, Keck BM, et al. Registry of the International Society for Heart and Lung Transplantation: twenty-second official adult heart transplant report--2005. J Heart Lung Transplantation. 2005; 24(8):945-55.
130. Morrone T, Buck L, Catanese K, Goldsmith R, Cahalin L, Oz M and Levin H. Early progressive mobilization of patients with left ventricular assist devices is safe and optimises recovery before heart transplantation. J Heart Lung Transplantation. 1996; 15:423-9.
131. Arena R, Humphrey R and McCall R. Altered exercise pulmonary function after left ventricular assist device implantation. J Cardiopulm Rehabil. 1999; 19:344-346.

132. Kormos R, Murali S, Dew M, Armitage J, Hardesty R, Borovetz H and Griffith B. Chronic mechanical circulatory support: rehabilitation, low morbidity, and superior survival. Annals of Thoracic Surgery. 1994; 57(1):51-7.
133. Garcia S, Kandar F, Boyle A, Colvin-Adams M, Llias K, Joyce L and John R. Effects of pulsatile- and continuous-flow ventricular assist devices on left ventricular unloading. J Heart Lung Transplantation. 2008; 27(3); 261-7.
134. Feldman C, Khan S, Slaughter M, Sobieski M, Graham J, Eaheart B and Silver M. Improvement in early oxygen uptake kinetics with left ventricular assist device support. ASAIO Journal. 2008; 54:406-411.
135. Nishimura M, Radovancevic B, Odegaard P, Myers T, Springer W, Frazier O. Exercise capacity recovers slowly but fully in patients with a left ventricular assist device. ASAIO Journal. 1996; 42:M568-M570.
136. Frazier O, Benedict C, Radovancevic B, Bick R, Capek P, Springer W, Macris M, Delgado R, Buja M. Improved left ventricular function after chronic left ventricular unloading. Annals of thoracic surgery. 1996; 62:675-82.
137. Jaski B, Kim J, Maly R, Branch K, Adamson R, Favrot L, Smith S, Dembitsky W. Effects of exercise during long-term support with a left ventricular assist device. Results of the experience with left ventricular assist device with exercise (EVADE) pilot trial. Circulation. 1997; 95:2401-2406.
138. Humphrey R, Buck L, Cahalin L, Morrone T. Physical therapy assessment and intervention for patients with left ventricular assist devices. Cardiopulmonary Physical Therapy. 1998; 9:3-7.

These standards are due for review in 2011.