



CLINICAL REVIEW

Cardiac rehabilitation

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Cardiac rehabilitation is a complex intervention offered to patients diagnosed with heart disease, which includes components of health education, advice on cardiovascular risk reduction, physical activity and stress management. Evidence that cardiac rehabilitation reduces mortality, morbidity, unplanned hospital admissions in addition to improvements in exercise capacity, quality of life and psychological well-being is increasing, and it is now recommended in international guidelines.¹⁻⁶ This review focuses on what cardiac rehabilitation is and the evidence of its benefit and effects on cardiovascular mortality, morbidity and quality of life.

Why is cardiac rehabilitation important?

Although mortality from coronary heart disease has fallen over recent decades, annually it still claims an estimated 1.8 million lives in Europe,⁷ and 785 000 new and 470 000 recurrent myocardial infarctions occur in the US.⁸ In the UK, around 110 000 men and 65 000 women have an acute myocardial infarction every year, equivalent to one every three minutes.⁹ With improved survival and an aging population, the number of people living with coronary heart disease in the UK has increased to an estimated 2.3 million.⁹

What is cardiac rehabilitation and who should get it?

Various organisations and national bodies have defined cardiac rehabilitation, which is encompassed by: “Cardiac rehabilitation (and secondary prevention) services are comprehensive, long term programmes involving medical evaluation, prescribed exercise, cardiac risk factor modification, education, and counselling. These programmes are designed to limit the physiological and psychological effects of cardiac illness, reduce the risk for sudden death or re-infarction, control cardiac symptoms, stabilise or reverse the atherosclerotic process, and

enhance the psychosocial and vocational status of selected patients.” Although exercise training is a core component, current practice guidelines consistently recommend “comprehensive rehabilitation” programmes that should include other components to optimise cardiovascular risk reduction, foster healthy behaviours and compliance to these behaviours, reduce disability, and promote an active lifestyle.⁵

The National Institute for Health and Care Excellence (NICE), Department of Health, British Association for Cardiovascular Prevention and Rehabilitation (BACPR), and wider European guidelines agree that the patient groups listed in box 1 will benefit from cardiac rehabilitation.¹⁻¹² and the core components of cardiac rehabilitation are illustrated in figure 2.¹

Historically, cardiac rehabilitation in the UK, US, and most European countries has been delivered to groups of patients in healthcare or community centres.^{13 14} Recent guidance from the UK Department of Health¹² refers to a seven stage pathway of care that begins with diagnosis of a cardiac event and is followed by assessment of eligibility, referral, clinical assessment, and core delivery of cardiac rehabilitation before progressing to long term management (fig 1).¹

Formal rehabilitation programmes vary in intensity and duration. The European guide for patients with established cardiac disease provides a full review of the impact of the mode and dose of exercise based cardiac rehabilitation.¹⁵ In the UK, formal rehabilitation is predominantly provided to supervised groups in outpatient hospital clinics or community centres, starting 2–4 weeks after percutaneous coronary intervention or myocardial infarction and usually 4–6 weeks after cardiac surgery.¹⁴ The BACPR standard recommends delivery of the seven core components of cardiac rehabilitation after clinical assessment (fig 2).¹ Programmes are typically delivered by specialist nurses or physiotherapists supported by exercise therapists, although ideally an integrated multidisciplinary team led by an experienced clinician with a special interest in cardiac

The bottom line

- Globally, the prevalence of coronary heart disease and heart failure is increasing, and there is some evidence of the health benefits of cardiac rehabilitation
- Effective implementation of cardiac rehabilitation after acute coronary syndrome, coronary revascularisation, and heart failure has remained suboptimal, with overall participation rates <50% over recent decades despite international recommendations
- International guidelines now recommend that cardiac rehabilitation programmes include health education and psychological counselling
- Patients should be offered a choice of community based and home based cardiac rehabilitation programmes to fit their needs and preferences
- Clinicians should endorse cardiac rehabilitation for patients with a recent diagnosis of coronary heart disease or heart failure

Sources and selection criteria

RST is a member of the Cochrane Heart Group and has led and conducted several systematic reviews of cardiac rehabilitation. We searched the Cochrane database (www.cochrane.org) for cardiac rehabilitation and equivalent terms. We identified current national and international clinical guidelines based on systematic reviews and meta-analyses. We referred to the National Audit of Cardiac Rehabilitation annual report, which was led by PD, and the British Heart Foundation's website for statistics on coronary heart disease in the UK. We also consulted recent review articles from the UK, US, Canada, and Australia. We have included topics that would be of interest to hospital doctors and general practitioners based on a previous review coauthored by HMD and also the level 1 evidence provided by the Cochrane reviews. We also used our personal reference collections.

Box 1: Patient groups who benefit from cardiac rehabilitation*

- Patients with acute coronary syndrome—including ST elevation myocardial infarction, non-ST elevation myocardial infarction, and unstable angina—and all patients undergoing reperfusion (such as coronary artery bypass surgery, primary percutaneous coronary intervention, and percutaneous coronary intervention)
- Patients with newly diagnosed chronic heart failure and chronic heart failure with a step change in clinical presentation
- Patients with heart transplant and ventricular assist device
- Patients who have undergone surgery for implantation of intra-cardiac defibrillator or cardiac resynchronisation therapy for reasons other than acute coronary syndrome and heart failure
- Patients with heart valve replacements for reasons other than acute coronary syndrome and heart failure
- Patients with a confirmed diagnosis of exertional angina

*According to NICE, Department of Health, BACPR, and European guidelines¹⁻¹²

rehabilitation should deliver the programme (BACPR standard 2, box 2).¹ Most programmes involve weekly attendance at group sessions for an average of 56 (SD 3.6) days or approximately 8 weeks.¹⁶ Centre based sessions involve graduated exercise training, education (covering coronary risk factors and diet), common cardiac misconceptions, preventative medication, and stress management.¹⁴ Ideally, patients should be given information about the cardiac event and lifestyle advice, including the importance of smoking cessation (if appropriate), healthy diet, and physical activity to encourage progressive mobilisation. Prior to discharge, clinicians should ensure that patients are prescribed drugs for secondary prevention and drugs that are beneficial for those with systolic heart failure such as angiotensin-converting enzyme (ACE) inhibitors and beta-blockers.¹ Good communication between secondary and primary care after discharge can improve uptake of cardiac rehabilitation and optimise secondary prevention.¹⁷

Cardiac rehabilitation programmes in the US and Europe tend to be more intensive than those in the UK and are delivered from outpatient departments over 3–6 months. Some European countries offer residential programmes lasting 3–4 weeks. The focus is mainly on “monitored exercise and aggressive risk factor reduction” in medically supervised sessions.^{13 18}

What are the benefits of cardiac rehabilitation?

The benefits of cardiac rehabilitation for individuals after myocardial infarction and revascularisation and for those with heart failure have been reviewed comprehensively in several meta-analyses, including six Cochrane reviews and a recent clinical review from the US.¹⁸⁻²⁴

Mortality

A 2011 Cochrane review and meta-analysis of 47 randomised controlled trials that included 10 794 patients showed that cardiac rehabilitation reduced overall mortality (relative risk 0.87 (95% confidence interval 0.75 to 0.99), absolute risk reduction (ARR) 3.2%, number needed to treat (NNT) 32) and cardiovascular mortality (relative risk 0.74 (0.63 to 0.87), ARR 1.6%, NNT 63), although this benefit was limited to studies with a follow-up of greater than 12 months.²⁵ With the exception of one large, UK based trial that showed little effect of cardiac rehabilitation on mortality at two years (relative risk 0.98 (0.74 to 1.30)),²⁶ findings from meta-analyses and observational studies support a mortality benefit.²⁷ Another systematic review and meta-analysis of 34 randomised controlled trials including 61 11 patients after myocardial infarction showed that those who attended cardiac rehabilitation had a lower risk of all-cause mortality than non-attendees (odds ratio 0.74 (0.58 to 0.95)).²⁸

The latest updated Cochrane review of exercise based cardiac rehabilitation for coronary heart disease reports an absolute risk reduction in cardiovascular mortality from 10.4% to 7.6% (NNT 37) for patients after myocardial infarction and revascularisation who received cardiac rehabilitation compared with those who did not.¹⁹ No significant reduction occurred in overall mortality,¹⁹ which contrasts with results in previous meta-analyses.^{25 29} The inclusion of patients from the UK based randomised controlled trial²⁶ is cited as one reason for this lack of reduction in mortality.¹⁹ The negative findings of this trial have also led to scepticism about the content and delivery of UK based cardiac rehabilitation programmes in the late 1990s,^{30 31} and this controversial trial has been the subject of much debate.²⁷⁻³²

Box 2: Core components of cardiac rehabilitation. Adapted from BACPR Standard 2¹

1. Health behaviour change and education
2. Lifestyle risk factor management
 - Physical activity and exercise
 - Diet
 - Smoking cessation
3. Psychosocial health
4. Medical risk factor management
5. Cardioprotective therapies
6. Long term management
7. Audit and evaluation

Delivery of the core components requires expertise from a range of different professionals. The team may include:

- Cardiologist, community cardiologist, physician, or general practitioner with a special interest
- Nurse specialist
- Physiotherapist
- Dietitian
- Psychologist
- Exercise specialist
- Occupational therapist
- Clerical administrator

Reduced hospital admissions

Although the 2015 Cochrane review in coronary heart disease reported no reduction in the risks of fatal or non-fatal myocardial infarction or coronary revascularisation (coronary artery bypass graft or percutaneous coronary intervention), there was a reduced risk of hospital admission (from 30.7% to 26.1%, NNT 22).¹⁹ In another Cochrane review of 33 randomised controlled trials and 4740 patients with heart failure, exercise based cardiac rehabilitation reduced the risk of overall hospitalisation (relative risk 0.75 (0.62 to 0.92), ARR 7.1%, NNT 15) and hospitalisation for heart failure (relative risk 0.61 (0.46 to 0.80), ARR 5.8%, NNT 18).³³

Improvement in psychological wellbeing and quality of life

A US observational study of 635 patients with coronary heart disease reported improvements in depression, anxiety, and hostility scores after cardiac rehabilitation.³⁴ Early cardiac rehabilitation programmes only offered interventions that focused predominantly on exercise, but significant ($P<0.01$) improvements in anxiety and depression scores were reported in one randomised controlled trial of 210 men admitted with myocardial infarction undergoing gym based exercise training.³⁵ Furthermore, a meta-analysis of 23 randomised controlled trials (3180 patients with coronary heart disease) that evaluated the impact of adding psychosocial interventions to standard exercise based cardiac rehabilitation reported a greater reduction in psychological distress (effect size 0.34) and improvements in systolic blood pressure and serum cholesterol (effect sizes -0.24 and -1.54 respectively).³⁶

Several studies have reported improvement in psychological stress in patients with coronary heart disease who have attended cardiac rehabilitation: one recent US observational study of 189 patients with heart failure (left ventricular ejection fraction $<45\%$) reported a decrease in symptoms of depression by 40% after exercise training cardiac rehabilitation (from 22% to 13%, $P<0.0001$).³⁷ Also depressed patients who completed their cardiac rehabilitation had a 59% lower mortality (44% v 18%, $P<0.05$) compared with depressed dropout patients who did not undergo cardiac rehabilitation.³⁷

A Cochrane review of exercise based rehabilitation for coronary heart disease showed that seven out of 10 randomised controlled trials that reported quality of life using validated outcome measures found “significant improvement,” but the authors were not able to pool the data to quantify the effect because of the heterogeneity of the outcome measures.²⁵ Similarly, another Cochrane review of exercise based cardiac rehabilitation for heart failure reported a clinically important improvement in the Minnesota Living with Heart Failure questionnaire (mean difference 5.8 points (95% confidence interval 2.4 to 9.2), $P=0.0007$) in the 13 randomised controlled trials that used this validated quality of life measure.³³

Cardiovascular risk profile

Before the use of statins for the secondary prevention of coronary heart disease, two observational studies demonstrated the beneficial effects of diet and exercise in improving lipid profiles.^{38,39} The findings of a small case series of 18 patients prescribed a low cholesterol diet and daily exercise for 30 minutes on a bicycle ergometer resulted in regression of coronary artery atheroma on angiography in seven of the 18 patients, compared with only one of 18 in the usual care group.³⁹ Significant reductions in total serum cholesterol concentration (-2% , $P=0.05$) and low density lipoprotein:high density lipoprotein cholesterol ratios (-9% , $P\leq 0.0001$) were reported after 36 sessions of cardiac rehabilitation in another US observational study from the 1990s involving 313 cardiac patients.³⁸

The prevalence of obesity in those attending cardiac rehabilitation in the US has increased in the past two decades, with $>40\%$ having a body mass index >30 and 80% with a body mass index >25 .⁴⁰ Ades et al conducted a randomised controlled trial of 74 overweight patients with coronary heart disease and showed that a “walk often and walk far” (“high calorie, high expenditure”) exercise protocol of 45-60 minutes per session of lower intensity exercise (70% peak oxygen uptake) resulted in twice the weight loss (8.2 kg v 3.7 kg, $P<0.001$) compared with the standard cardiac rehabilitation exercise session of 25-40 minutes. This study also reported significant improvements ($P<0.05$) in systolic blood pressure, body mass index, serum triglycerides, HDL cholesterol, total cholesterol, blood glucose,

and peak oxygen uptake in the high calorie, high expenditure exercise group.

What are the risks of cardiac rehabilitation?

A French observational study of more than 25 000 patients undergoing cardiac rehabilitation reported one cardiac event for 50 000 hours of exercise training, equivalent to 1.3 cardiac arrests per million patient-hours.⁴¹ An earlier US study reported one case of ventricular fibrillation per 111 996 patient-hours of exercise and one myocardial infarction per 294 118 patient-hours.⁴²

Patients with unstable angina, uncontrolled ventricular arrhythmia, and severe heart failure (New York Heart Association (NYHA) level 3 or 4, ejection fraction <35%) have been considered at high risk, with formal risk stratification (to include factors such as a history of arrhythmias and functional capacity) conducted by an experienced clinician before they engage in the exercise component of cardiac rehabilitation.¹ However, the most recent Cochrane review found “no evidence to suggest that exercise training programmes cause harm in terms of an increase in the risk of all cause death in either the short or longer term” in patients with stable chronic heart failure (NYHA level 1–3).²²

Access to cardiac rehabilitation

For those who have difficulty accessing centre based cardiac rehabilitation, or those who dislike groups, home based cardiac rehabilitation programmes are sometimes available.^{17 43} The most widely used programme in the UK is the *Heart Manual*⁴⁴—a six week intervention that uses written material and a relaxation CD and is delivered by a trained healthcare facilitator who makes home visits and provides telephone support—which has been shown to be just as effective as centre based programmes.^{45 46}

Overcoming barriers to cardiac rehabilitation

Despite robust evidence of clinical and cost effectiveness, uptake of cardiac rehabilitation varies worldwide and by patient group, with participation rates ranging from 20% to 50%.¹⁻⁴⁸ Poor uptake has been attributed to several factors, including physicians’ reluctance to refer some patients, particularly women and those from ethnic minorities or lower socioeconomic classes, and lack of resources, capacity, and funding.⁶⁻⁵² Adherence to cardiac rehabilitation programmes is affected by factors such as psychological wellbeing, geographical location, access to transport, and a dislike of group based rehabilitation sessions (box 3).¹³⁻⁴³ The most effective way to increase uptake and optimise adherence and secondary prevention is for clinicians to endorse cardiac rehabilitation by inviting patients still in hospital after a recent diagnosis of coronary heart disease or heart failure to participate and for nurse led prevention clinics to be linked with primary care and cardiac rehabilitation services.²⁻⁵⁶

Novel ways of providing cardiac rehabilitation are emerging using the internet and mobile phones.^{57 58} A recent systematic review has evaluated alternative models of delivery⁵⁹ that can be provided via secondary prevention clinics.⁶⁰ Offering patients a choice of centre based, home, or online programmes on an equitable basis is likely to improve uptake across all groups of

cardiac patients. Self management and collaboration with care givers can also improve uptake and outcomes.⁶¹⁻⁶³

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Competing interests: We have read and understood the BMJ Group policy on declaration of interests and declare the following interests. HMD and PD have co-authored Cochrane reviews in cardiac rehabilitation with RST. RST is an author on several other Cochrane reviews of cardiac rehabilitation. HMD and RST are co-chief investigators on the REACH-HF programme of research, which is developing and evaluating a home based cardiac rehabilitation intervention for people with heart failure and their carers (NIHR PGfAR RP-PG-0611-12004).

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Box 3: Barriers to cardiac rehabilitation participation. Adapted from Menezes et al¹⁸

- Poor referral rates, especially for certain groups:
 - Women
 - People from ethnic minority groups
 - Elderly people
 - People living in rural settings
 - People in low socioeconomic classes
- Poor patient adherence, leading to low enrolment and high dropout rates
- Lack of endorsement by a doctor
- Obesity (high body mass index)
- Multiple morbidities, leading to poor functional capacity
- Poor exercise habits
- Cigarette smoking
- Depression
- Problems with transport
- Poor social support
- Lack of leave from work to attend centre-based sessions

Ongoing research and unanswered questions*Ongoing research*

- The NIHR has sponsored two UK based studies:
 - REACH-HF aims to develop a new self help manual for people with heart failure and their caregivers, which may help them to manage the condition using the principles of cardiac rehabilitation. The team will then evaluate the clinical effectiveness, cost effectiveness, and acceptability of the manual for people with heart failure and their caregivers. www.rcht.nhs.uk/RoyalCornwallHospitalsTrust/WorkingWithUs/TeachingAndResearch/ReachHF/Homepage.aspx. (A protocol paper on REACH-HF has been submitted to BMJ Open.)
 - CADENCE is a feasibility study and pilot randomised controlled trial to establish methods to assess the acceptability and the clinical and cost effectiveness of enhanced psychological care in cardiac rehabilitation services for patients with new onset depression. <http://medicine.exeter.ac.uk/esmi/workstreams/cochranecardiarehabilitationreviews/>
- WREN pilot study of web based cardiac rehabilitation for those declining or dropping out of conventional rehabilitation. <http://public.ukcrn.org.uk/search/StudyDetail.aspx?StudyID=19260>
- Telerehab III, a multicentre randomised controlled trial of 140 patients with coronary heart disease in Belgium, is evaluating the effectiveness of tele-rehabilitation, which has been proposed as an adjunct or alternative to standard, centre based cardiac rehabilitation. The study aims to investigate the long term effectiveness of adding to standard cardiac rehabilitation a patient tailored, internet based, rehabilitation programme that implements multiple core components of cardiac rehabilitation and uses telemonitoring and telecoaching strategies. www.biomedcentral.com/content/pdf/s12872-015-0021-5.pdf

Unanswered questions

- What characteristics are associated with uptake and adherence to cardiac rehabilitation after an acute myocardial infarction when rehabilitation is started early?
- How can referral and participation rates for eligible patients be increased?
- Should referral be the responsibility of the physician or the healthcare team?
- How will working and non-working patients afford to pay for these services?
- Can advances in information and communication technologies be used to develop novel ways of delivering cardiac rehabilitation to improve uptake and adherence?
- How can we improve uptake in hard to reach groups, such as patients living in rural communities, patients from ethnic minority groups, and those from low socioeconomic classes?
- Is cardiac rehabilitation, as delivered in routine clinical practice, still effective?

Additional educational resources*Resources for healthcare professionals*

- Anderson L, Taylor RS. Cardiac rehabilitation for people with heart disease: an overview of Cochrane systematic reviews. *Cochrane Database Syst Rev* 2014;(2): CD011273. <http://onlinelibrary.wiley.com/doi/10.1002/14651858.CD011273.pub2/abstract>
This overview describes six Cochrane systematic reviews in cardiac rehabilitation, which included 148 randomised controlled trials in 98 093 participants.
- British Heart Foundation. *The National Audit of Cardiac Rehabilitation: annual statistical report 2014*. British Heart Foundation, 2014. www.bhf.org.uk/~media/files/publications/research/nacr_2014.pdf.
Provides information to commissioners and clinicians on the inequalities and insufficiencies in delivery against key service indicators for over 320 cardiac rehabilitation programmes in the UK.
- Menezes AR, Lavie CJ, Milani RV, Forman DE, King M, Williams MA. Cardiac rehabilitation in the United States. *Prog Cardiovasc Dis* 2014;56:522-9.
A clinical review that provides clinicians with information on the benefits of cardiac rehabilitation, risk factors, and factors affecting participation from a US perspective.
- National Institute for Health and Care Excellence. Secondary prevention in primary and secondary care for patients following a myocardial infarction (clinical guidance 172). NICE, 2013. www.nice.org.uk/guidance/cg172.
Provides clinicians and commissioners with new and updated recommendations on cardiac rehabilitation, drug therapy, and communication of diagnosis.

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Resources for patients and carers

- American Heart Association: What is cardiac rehabilitation? www.heart.org/HEARTORG/Conditions/More/CardiacRehab/What-is-Cardiac-Rehabilitation_UCM_307049_Article.jsp. Provides answers to frequently asked questions about cardiac rehabilitation, including who needs it and for how long.
- Association of Chartered Physiotherapists in Cardiac Rehabilitation. Patient information. <http://acpicr.com/patient-information>. Information on cardiac rehabilitation, its main components, and when to start it.
- British Heart Foundation. www.bhf.org.uk/heart-health/living-with-a-heart-condition/cardiac-rehabilitation. Information on cardiac rehabilitation programmes and how they can help prevent a heart attack and cardiac surgical interventions. Also has a video clip.
- Healthtalkonline. www.healthtalk.org/peoples-experiences/heart-disease/heart-attack/cardiac-rehabilitation-support, www.healthtalk.org/peoples-experiences/heart-disease/heart-attack/topics#ixzz3lzyXycP. Text and personal stories on film from UK patients who have had a heart attack. Has stories from 37 people (including four carers) in their own homes.
- NHS Choices. CHD Dave’s story: high cholesterol. www.nhs.uk/video/Pages/chd-high-cholesterol.aspx?searchtype=Tag&searchterm=Heart_vascular. A video in which Dave shares his battle with his cholesterol levels and talks about how he got to where he is now, successfully managing his condition.
- NHS Choices. Coronary heart disease-recovery. www.nhs.uk/Conditions/Coronary-heart-disease/Pages/Recovery.aspx. Information on what to do after having heart surgery or problems such as a heart attack and how it is possible to resume a normal life.
- NHS Choices. Heart attack: real story. www.nhs.uk/video/Pages/heart-attack-mike.aspx?searchtype=Tag&searchterm=Heart_vascular. An account of how a man who is nearly 60 has survived three heart attacks. He explains how the attacks affected him and how his recovery was different for each of them.
- NICE information for the public. www.nice.org.uk/guidance/cg172/ifp/chapter/Helping-you-recover-from-a-heart-attack#your-cardiac-rehabilitation-programme. Patient information based on the latest NICE guidance on cardiac rehabilitation and includes information on exercise and sessions covering a range of topics including health education and information. Also encourages partners or carers to be involved in cardiac rehabilitation.

Cardiac rehabilitation—a personal view from Philip Boorman

I am a 65 year old retired air traffic controller, and had been treated for hypertension and high cholesterol since 1998. I had experienced mild chest pains in the past, which I could always walk through, but more severe pains in December 2014 led me to seek advice from my general practice, which resulted in a referral to the Fast Track Chest Pain Clinic. Ironically, while I was waiting for my outpatient appointment, I experienced a bout of more severe pain at home and was rushed to hospital, where I was told that I had had a heart attack.

Treatment in hospital was first class, and a single stent was fitted. My first contact with the cardiac rehabilitation team was a home visit by a rehabilitation nurse. She was suitably encouraging, but the cynic in me thought that she was probably encouraging to everyone. However, her advice was sound, and I followed it to the letter. Rehabilitation sessions at the gym started about eight weeks after my heart attack and not only proved to be physically demanding and rewarding (no stopping for at least 50 minutes) but also helped to rebuild my slightly flagging confidence. The programme included “teach-ins” on lifestyle, relaxation, diet, and exercise regimens, and I am extremely grateful for the opportunity to attend.

Will I have another heart attack? I don’t know, but I do know that cardiac rehabilitation has fast-tracked me back to a normal life and given me the knowledge that the chances of another heart attack are greatly reduced. It is also helpful to know that I will have regular follow up by my GP and see the practice nurse in the cardiac clinic at least once a year.

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Figures

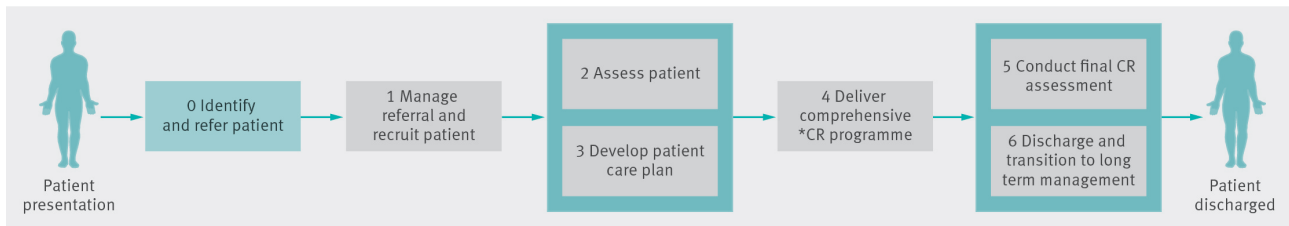


Fig 1 BACPR standards pathway, showing a patient’s journey through cardiac rehabilitation (reproduced with permission from BACPR¹). *CR=cardiac rehabilitation

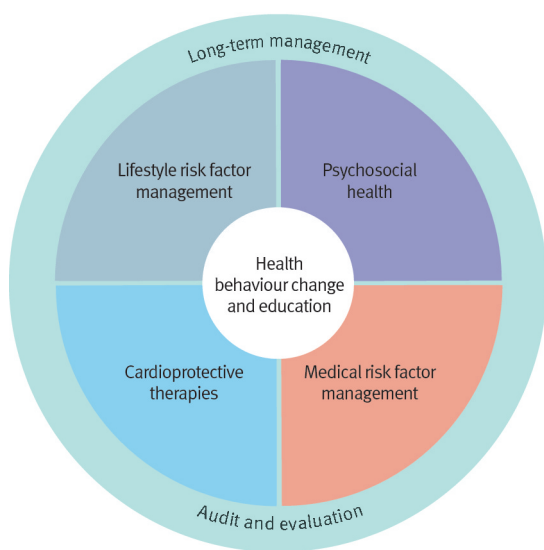


Fig 2 Core components of cardiac rehabilitation. Reproduced with permission from BACPR¹