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Review Article

Cardiac rehabilitation: Appraisal of current evidence and utility of technology aided home-based cardiac rehabilitation

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ABSTRACT

Cardiac rehabilitation (CR) is an evidence-based intervention that uses exercise training, health behaviour modification, medication adherence and psychological counselling to improve secondary prevention outcomes in patients with cardiovascular disease. CR programs reduce morbidity and mortality rates in adults with ischemic heart disease, following coronary intervention, heart failure, or cardiac surgery. These are significantly underused, with only a minority of eligible patients participating in CR in India. Novel delivery strategies and CR endorsement by healthcare organizations are urgently needed to improve participation. One potential strategy is home-based CR (HBCR). Differing from centre-based CR services, which are provided in a medically supervised facility, HBCR relies on remote coaching with indirect exercise supervision. It is provided mostly or entirely outside of the traditional centre-based setting and could be facilitated by the aid of technology and web based applications. The purpose of this appraisal is to identify the core components, efficacy, strengths, limitations, evidence gaps, and research necessary to guide the future delivery of HBCR. This appears to hold promise in expanding the use of CR to eligible patients. Additional research and demonstration projects are needed to clarify, strengthen, and extend the HBCR evidence base for key subgroups, including older adults, women, underrepresented minority groups, and people in remote and rural areas. HBCR may be a reasonable option for a selected group of patients and could be a game changer in low- and middle-income countries who are eligible for CR.

1. Introduction

Worldwide, Coronary Heart Disease is the main cause of death, around 75% of these deaths occur in developing countries and are increasing with high mortality rate and increasing burden.[1–3] The Registrar General of India reported that cardiovascular disease (CVD) led to 17% of total deaths and 26% of adult deaths in 2001–2003, which then increased to 23% of total and 32% of adult deaths in 2010–2013. The World Health Organization (WHO) and Global Burden of Disease Study have also highlighted increasing trends in years of life lost (YLLs) and disability-adjusted life years (DALYs) from CHD in India. In India, studies have reported increasing CHD prevalence over the last 60 years, from 1% to 9%–10% in urban populations and <1% to 4%–6% in rural populations.

In India the age-adjusted CVD mortality rates are 349/100,000 in men and 265/100,000 in women. These rates are >2–3 times greater than in the United States, where rates are 170/100,000 in men and 108/100,000 in women.[1]

There has been considerable implementation of expensive acute coronary care units and revascularisation centres in many metros and large cities in India and other middle- and low-income countries. Research suggests that proven, low-cost secondary prevention strategies such as cardiac rehabilitation (CR) are not widely implemented.[4,5] To our knowledge, CR is only available at a few centres in the Indian subcontinent.[6] There are multiple reasons for low uptake in CR, these include healthcare budgetary issues, inadequate legislation, lack of trained healthcare providers, no structured pathways and most centrally lack of clinical practice

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guidelines on how CR can be implemented in low-resource settings.[7,8]

1.1. Essential components of cardiac rehabilitation

Cardiac rehabilitation (CR) is provided through its multi-pronged approach of risk reduction therapies, promotion of physical activity, nutrition advice, tobacco cessation, medication adherence and psychological counselling. This forms an important component in primary and secondary prevention of future cardiac events. Essential components of CR are shown in Fig. 1.

2. Benefits of cardiac rehabilitation

2.1. Mortality

The benefits of cardiac rehabilitation for individuals after myocardial infarction, revascularisation and heart failure have been extensively reviewed in several meta-analyses.[9–15] Cardiac Rehabilitation, delivered to patients with stable angina, myocardial infarction, coronary intervention and coronary artery bypass surgery, reduces cardiovascular mortality by 26% and rehospitalisation by 18%.[16] Cochrane review and meta-analysis of 47 randomized controlled trials, including 10,794 patients, showed that cardiac rehabilitation reduced overall mortality (relative risk 0.87; 95% CI: 0.75 to 0.99), and cardiovascular mortality (relative risk 0.74 (CI:0.63–0.87), ARR 1.6%, NNT 63). This benefit was limited to studies with a follow-up of greater than 12 months,[17] except one large UK based trial that showed little effect of cardiac rehabilitation on mortality at two years (relative risk 0.98 (0.74–1.30)).[18] Findings from meta-analyses and observational studies support a mortality benefit.[19] Another systematic review and meta-analysis of 34 randomized controlled trials, including 6111 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 (0.58–0.95)).[20]

Fig. 1. Essential components of cardiac rehabilitation.

2.2. Reduced hospital admissions

One Cochrane review, performed in 2015 on patients with 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), yet there was a reduced risk of hospital admission (from 30.7% to 26.1%, NNT 22).[10] In another Cochrane review of 33 randomized controlled trials, including 4740 patients with heart failure, exercise based cardiac rehabilitation reduced the risk of overall hospitalisation (relative risk 0.75 (0.62–0.92), ARR 7.1%, NNT 15) and hospitalisation for heart failure (relative risk 0.61 (0.46–0.80), ARR 5.8%, NNT 18).[21]

2.3. Psychological wellbeing and quality of life

A US observational study, consisting of 635 patients with coronary heart disease, reported improvements in depression, anxiety, and hostility scores after cardiac rehabilitation.[22] Significant ($P < 0.01$) improvements in anxiety and depression scores were reported in one randomized controlled trial of 210 men with myocardial infarction undergoing gym based exercise training.[23]

Furthermore, a meta-analysis of 23 randomized 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).[24]

Some other studies have reported improvement in psychological stress in patients with coronary heart disease who have attended cardiac rehabilitation. One recent US observational study, consisting 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%, $P < 0.0001$).[25] Depressed patients, who also completed their cardiac rehabilitation, had a 59% lower mortality (44% *v* 18%, $P < 0.05$) compared with depressed patients who did not undergo cardiac rehabilitation.[25] A Cochrane review of exercise-based rehabilitation for coronary heart disease showed that seven out of ten randomized 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.[17] 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 randomized controlled trials that used this validated quality of life measure.[21]

2.4. Cardiovascular 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.[26,27] The findings of a small case series of 18 patients prescribed a low cholesterol diet and daily exercise for 30 min 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.[27]

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 a US observational study from

the 1990s involving 313 cardiac patients.[26] 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.[28] Ades et al conducted a randomized 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 min 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 min. 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.

3. Risks of cardiac rehabilitation

A French observational study of more than 25,000 patients undergoing cardiac rehabilitation reported one cardiac event for 50,000 h of exercise training, equivalent to 1.3 cardiac arrests per million patient-hours.[29] 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.[30] 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, and formal risk stratification should be conducted by an experienced clinician before they engage in the exercise component of the cardiac rehabilitation.[31] 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 patients with stable chronic heart failure (NYHA level 1–3).[13]

4. Barriers of 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%.[31,32] Currently, there is limited evidence, conducted in India, demonstrating CR efficacy. Moreover, there is currently limited availability of outpatient CR programs in India. In a landmark cross-sectional study, conducted by International Council of Cardiovascular Prevention and Rehabilitation (ICCPR) an online survey was administered to CR programs, identified in India by CR champions and through snowball sampling.[15] CR density was computed using Global Burden of Disease study ischemic heart disease (IHD) incidence estimates. In this survey Twenty -three centres were identified, of which18 (78.3%) responded, from 3 southern states. There was only one spot for every 360 IHD patients/year, and estimated 3,304,474 more CR spaces needed each year. They also concluded that greater need for CR exists in India, particularly in the North. Despite the availability of CR in India (given the high burden of CVD), the unmet need for CR is highest in India of any country in the world.[33] The programs that are available were clustered in the southern states of India, leaving major gaps in services in the North, East and West. Based on the evidence, CR is also recommended in clinical guidelines for CVD in India.[34,35] Therefore, efforts are needed to continue CR research in India and facilitate clinical implementation.[36]

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, lack of resources, capacity, and funding. Adherence to cardiac rehabilitation programmes is also affected by factors such as psychological wellbeing, geographical location, access to transport, and a dislike of group-based rehabilitation sessions.[9–15,17–30,34,35]

5. Alternate approaches to centre based cardiac rehabilitation

The most effective way to increase uptake and optimise adherence and secondary prevention is for clinicians to endorse cardiac rehabilitation. This can be facilitated by inviting patients while 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.[37] Novel ways of providing cardiac rehabilitation are emerging using the internet and mobile phones.[38,39] A recent systematic review has evaluated alternative models of delivery[40] that can be provided via secondary prevention clinics.[41] 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.[42–44]

6. Home based cardiac rehabilitation

One potential approach is alternative site- or home-based CR (HBCR), which can be carried out in a variety of settings, including the home or other nonclinical settings such as community centres, health clubs, and parks. In concept, HBCR could help overcome some of the barriers that Centre-based CR (CBCR) programs face, including geographic, logistical, and other access related barriers. Although home-based exercise training is commonly recommended by CBCR staff for their patients on days when they are not physically present in the CBCR centre, "stand-alone" HBCR programs are still in their infancy. However, the European guidelines on CVD prevention state that "home-based rehabilitation with and without telemonitoring holds promise for increasing participation and supporting behavioural change"[45]; In addition, Cochrane collaborative reviews have compared CBCR and HBCR and concluded that there is low-to moderate-strength evidence that HBCR and CBCR have similar effects on quality of life and cost among patients with recent MI or coronary revascularization.[11,16,46]

The use of HBCR, either alone or in combination with CBCR (i.e., a hybrid approach to CR), represents a possible alternative that may improve the delivery of CR to eligible patients. HBCR has been incorporated into the healthcare systems of several countries, including Australia, Canada, and the United Kingdom and could be a game changer in low- and middle-income countries. The British Heart Foundation recently reported that in the United Kingdom >50% of eligible patients are now participating in CR after a cardiac event or procedure.[47] Table 1 lists potential advantages and disadvantages of HBCR, including the possibility that HBCR could help to overcome some of the logistical barriers (e.g., transportation and scheduling barriers) that patients in CBCR programs face. In addition, HBCR has the potential to expand the breadth and depth of educational, counselling, and monitoring options for patients.

Table 1
Benefits and disadvantages of HBCR over CBCR.

Benefits of HBCR	Potential disadvantages of HBCR
Individual patient tailored program	Less intensive exercise training
Increased access and capacity	Less accountability
Reduced delay in enrolment	Less face to face interaction
Reduced Travel and Transportation	Less patient accountability
Greater Privacy	Safety concerns in patients at high risk
Integration into home routine	
Cost effective	

HBCR services can potentially be used 24 h a day, 7 days a week, whereas most CBCR programs are usually limited to the 3–4 h of weekly in-person contact between patients and staff. As most patients with CVD spend >5000 waking hours each year independent of medical providers,[48] it is critically important to arm them with behavioural change strategies that can be implemented in their home, work, or community environments. Unfortunately, HBCR faces substantial challenges for implementation in some countries, most notably a lack of reimbursement by the Centres for Medicare & Medicaid Services and other third-party payers in USA. In a recent study of CR-eligible patients, when given the option to receive CR through a home-based or a centre-based approach, nearly half preferred a home-based approach.[49] Both CBCR and HBCR include a number of components that overlap with usual care, including management of lipids, blood pressure, diabetes mellitus, and cardioprotective medications (such as antiplatelet agents, b-blockers, angiotensin inhibitors, and statins). However, both types of CR are differentiated from usual care by their multidisciplinary, systematic, and team-based approach to patient-centred care that includes patient activation and behavioural changes, which are promoted through multiple, individualized tailored interactions with patients over time. CR services empower patients to meet the goals of increased physical activity, improved dietary habits, optimal adherence to prescribed medications, smoking cessation, and optimal psychosocial well-being, thereby helping them to reduce their risk of future CVD events.

7. Evidence from published studies comparing HBCR and CBCR

7.1. Mortality and Re-hospitalization

Several small studies reported all-cause mortality data after the intervention and revealed no statistically significant differences between CBCR and HBCR up to 12 months.[50–57] It is difficult to ascertain from published studies whether there are trends over time in the comparative effectiveness of HBCR and CBCR, especially taking into consideration temporal trends in secondary prevention efforts in clinical practice (usual care) settings. Among the studies that examined morbidity data beyond 1 year, Smith and colleagues[58] reported no significant between-group differences in clinical events at the 6-year follow-up. A total of 46 of 74 patients participating in CBCR (62%) experienced a rehospitalization during the follow-up period compared with 35 of 70 patients participating in HBCR (50%), and the median time to first rehospitalization was similar for both groups (4.49 years). However, the total number of rehospitalizations was higher in patients participating in CBCR (n ¼ 79) compared with patients participating in HBCR (n ¼ 42). Two other studies reported no difference in revascularization or recurrent MI events between HBCR and CBCR programs.[56,59]

7.2. Exercise capacity

Most studies comparing outcomes in individuals participating in HBCR and CBCR reported data on exercise capacity, including gas exchange in most cases.[52–56,58–74] Some of these studies reported data on changes in peak oxygen uptake among these clinical trial participants.[52–55,58,60–63,65,67,69–71,73,74] In almost all of these studies, the improvement in peak oxygen uptake and other exercise parameters were observed in those individuals assigned to HBCR was similar to that in patients assigned to CBCR. Improvement in the distance achieved on an incremental shuttle walk test was evaluated in two studies and was similar in HBCR participants and CBCR participants.[59,68] The improvement in distance achieved on a 6-min walk test was analyzed in two studies and was found to be similar in those participating in HBCR and patients participating in CBCR.[54,61] Improvements in the peak metabolic equivalent tasks achieved on an exercise test,[50,56,75] peak exercise duration,[53] and work capacity on a cycle ergometer[66] were also similar in those assigned to HBCR and those assigned to CBCR. In general,[64] the magnitude of improvement in exercise capacity across all studies appeared to be similar in HBCR and CBCR settings.

7.3. Effect on modifiable risk factors

Multiple studies have examined the differential effect that HBCR and CBCR have on participant weight, blood pressure, lipid values, and tobacco use. Collectively, changes in these modifiable risk factors were similar between HBCR and CBCR participants selected for these clinical trials. Outcomes for weight were specifically reported in 4 of these studies,[38,54,58,62] and in all 4 studies, there was no difference in the change in weight between the HBCR and CBCR participants. Similarly, blood pressure changes were specifically reported in 6 of these studies.[38,54,56,59,64,76] Most of these studies reported a similar effect on blood pressure in HBCR and CBCR participants. The effects on lipids were reported in some of these clinical trials.[38,52,54,59,64] Although there were some isolated differences in the response of individual lipid parameters in HBCR versus CBCR, the remainder of the studies reported similar changes between HBCR and CBCR.[52,54,59] Some other studies found no difference in tobacco use/smoking behaviours between CBCR and HBCR interventions.[51,54,56]

7.4. Adherence to the program

An important potential benefit of HBCR is that its flexibility may help improve the low levels of CR participation and adherence that have been reported in many CBCR studies. In general, majority of the studies report that patient adherence strategies for HBCR appear to be comparable to those observed in CBCR. A recent Cochrane review by Taylor et al[33] was not able to pool adherence data results because of substantial variation in the way that adherence was reported. However, 7 of the studies in that report, and in the studies that we reviewed, found no evidence of a significant difference in the level of adherence between HBCR and CBCR. This potentially was due to small number of patients in each study and variation in the way adherence was defined.

Three other studies showed a higher level of adherence with HBCR than with CBCR. In addition, the rate with which patients attended all prescribed CR sessions (i.e., completion or graduation rates) was slightly higher among the HBCR participants compared with CBCR participants (relative risk: 1.04 [95% CI: 1.01–1.05]; p 0.009). Longer-term adherence after the initial phase of HBCR or CBCR, a critically important issue, was not reported in any of the studies reviewed. In addition, it is unclear how much the use of HBCR might improve the CR participation gap that currently exists. A recent study from the Veterans Health Administration found that patients offered referral to HBCR or facility-based CR were 4 times more likely to participate than those offered referral to facility-based programs alone,[77] and a study from Kaiser Permanent in Colorado found that 41% of eligible patients participated in their HBCR program.[78] However, another study from Toronto, ON, Canada, reported that only 10% of eligible patients receiving CR elected to participate in HBCR, despite it being covered by the local insurance provider.[79] In general, there was higher adherence to the HBCR as compared to CBCR.

8. Key factors associated with successful implementation of HBCR

8.1. Patient-level factors

Patient motivation, self-efficacy, and engagement are the most important predictors of healthy long-term lifestyle changes and adherence to prescribed drug therapies. However, the likelihood of success increases when counselling messages are tailored to an individual patient's goals and readiness to make specific changes.[80] The 6-stage Transtheoretical Stages of Change Model[81] can be used to evaluate a patient's stage of readiness to change a lifestyle habit before being counselled to change a specific behaviour. For example, providing perception alteration or a critical analysis of the pros and cons of changing behaviour may be required for the precontemplator and contemplator, respectively. Although most people believe that a single behaviour change is preferred at any given time, multiple simultaneous changes may be easier to adopt and sustain because they quickly yield perceptible benefits.[82] Successful approaches to behavioural activation include the provider conveying understanding, acceptance, and interest in the patient as an individual; expressing empathy for unhealthy lifestyle practices; helping the patient understand and accept the need for change; identifying the patient's stage of readiness to change; encouraging patients to hear themselves express why they want to change; and helping patients to identify, understand, and work through the barriers, challenges, and opportunities that influence their health-related behaviours (e.g., job-related stressors, financial challenges).[83] Additional steps involve helping patients overcome inertia and gain momentum with small serial successes over time, which should be viewed as an ally to successful lifestyle modification and a tool for dealing with inevitable recidivism.[84,85] Clinicians should be aware of time-related challenges for patients and ensure the availability of convenient hours of operation for "real-time" (synchronous) HBCR, as well as for asynchronous HBCR. Technological advancements, including physical activity tracking, web-based and mobile applications, handheld computer technologies, the internet, and various wearable devices,[86] may be helpful in this regard. Clinicians should also discuss other practical issues with patients who participate in HBCR, including their access to exercise equipment and facilities, availability of support systems (including family members and friends), and relevant comorbidities (e.g., balance in older adults).

The core of effective counselling is a patient-centred approach in which providers work with their patients to create and implement an action plan to achieve their self-determined goals, resulting from questions carefully posed by the provider.[87] The underlying power of this therapeutic approach, known as motivational interviewing, is that patients, with support from others, convince themselves to change behaviour rather than rely exclusively on suggestions or advice from others.[84,85,88] Specific strategies to circumvent or attenuate common CR barriers and to enhance patient referral, participation, and adherence to secondary prevention therapies, which clearly improve patient outcomes.[89,90]

8.2. Health care provider-level factors

The referring provider has 3 vital roles in the implementation of CR: referring eligible patients, encouraging patient participation, and communicating the importance of long-term lifestyle changes. CR is not intended to provide a short-term therapy but rather to help patients make essential lifestyle changes (e.g., walking for 30 min/d) that will influence the long-term course of their disease. Greater emphasis on personal accountability on the part of the patient, adherence to prescribed cardioprotective medications, and ongoing engagement in health care reduce the potential for recidivism. Finally, the antedated mentality that CR is a time-limited intervention delivered in a supervised medical setting must be expanded to help empower patients to continue with their secondary prevention treatment plan in the longer term wherever they live, work, worship, or play.

8.3. System-level factors

Endorsement of HBCR and reimbursement at the health system level are by far the most critical factors influencing the success or failure of HBCR programs. Some countries, including the United Kingdom, Canada, and Australia, have national healthcare coverage policies that endorse and cover either CBCR or HBCR for patients with various cardiac conditions. In the United States, insurance carriers, including the Centres for Medicare & Medicaid Services, have coverage policies that endorse and cover up to 36 sessions of CBCR; however, coverage does not generally include HBCR.[91]

In Indian subcontinent, health care services are provided by the combination of national healthcare and private healthcare services. HBCR could be of immense value in these settings as cost effective preventive approach particularly if endorsed by national healthcare schemes.

Practical Considerations Roles and Competencies of Personnel Traditional CBCR is implemented with the knowledge, skills, and certifications of a multidisciplinary team of healthcare professionals. In the studies reviewed, nurses and exercise physiologists supervised most HBCR programs. In this scenario, it is feasible to triage medical problems that arise to appropriate physicians, dietitians, pharmacists, psychologists, and related specialty programs (e.g., smoking cessation clinics).

Exercise training can be achieved with activities that do not require specialized exercise equipment, home-based exercise equipment can be an important part of HBCR programs if available to patients. Such equipment includes treadmills, elliptical trainers, exercise pedalers, or stationary bicycles for aerobic training, pedometers or accelerometers for activity tracking.

Heart rate monitors can help patients maintain fidelity to exercise prescriptions but often require out-of-pocket payments that are not feasible for many patients. Other items such as blood pressure monitors, bathroom scales, glucometers, and pill organizers can also be used as an important part of the patient's follow-up care.[92]

9. Technology tools and HBCR

Technology-facilitated HBCR has the potential to expand the reach of CR, to promote patient engagement, and to enable patient-provider communication. Many technology tools can play a role in the delivery of HBCR, including websites, mobile phone applications, text messaging, and sensors for monitoring physical activity, heart rate, ECG, and other health measures.[36] Some studies have shown feasibility and efficacy of technology-aided interventions.[38,55] The devices included wearable heart rate monitors; a mobile telemonitoring system that recorded ECGs and transmitted data via a mobile phone and smartphone applications, website tools, and text messaging communications. In each case, adherence, exercise capacity, and HRQOL with HBCR was equal to or better than with CBCR.

Other studies have reported more limited information about the use of technology in HBCR interventions, including heart rate monitors, ambulatory electrocardiographic monitoring, and trans telephonic electrocardiographic monitoring. Although most studies did not report technical details, few studies reported that no arrhythmia or ischemia events were noted.[55,60,63] All of these

interventions included both technology and provider facilitated HBCR, and many interventions reported additional features beyond the technology itself such as training on the use of the technology and the use of technology as a tool for patient provider communication. Long-term impact on important patient-centred outcomes, including cardiovascular events are unknown. Additionally, because none of these studies directly compared HBCR with technology tools and HBCR without technology tools, we cannot conclude whether the effects of the interventions were the result of the delivery of HBCR or the inclusion of technology in the interventions.

Technology tools incorporated into HBCR delivery models have the potential to expand the reach of CR by improving uptake and adherence compared with CBCR approaches. More research is needed to assess whether technology aided HBCR has a lasting favourable impact on program enrolment, adherence, and outcomes.

10. Role of yoga in cardiac rehabilitation

Yoga is traditional Indian mind-body practice and combines gentle physical exercises (physical functioning) with breathing and meditation (psychological functioning), and promotes healthy lifestyle (secondary prevention), thereby inherently addressing the key objectives of CR. A randomized controlled trial looking at yoga based cardiac rehabilitation after myocardial infarction has found to be safe and effective in improving quality of life and return to pre-infarct activities after myocardial infarction.[93] This trial recruited 3959 patients with acute myocardial infarction across 24 medical centres in India and the patients were randomized to Yoga-Care group and enhanced standard care group. MACE occurred in 131 (6.7%) patients in the Yoga-CaRe group and 146 (7.4%) patients in the enhanced standard care group (hazard ratio with Yoga-CaRe: 0.90; 95% confidence interval [CI]: 0.71 to 1.15; p ¼ 0.41). Self-rated health was 77 in Yoga-CaRe and 75.7 in the enhanced standard care group (baseline-adjusted mean difference in favour of Yoga-CaRe: 1.5; 95% CI: 0.5 to 2.5; p ¼ 0.002). The Yoga-CaRe group had greater return to pre-infarct activities, but there was no difference in tobacco cessation or medication adherence between the treatment groups. Few other small-scale trials of yoga-based cardiac rehabilitation have shown improvements in functioning, quality of life, and recurrent cardiac events.[94,95]

Yoga- CaRe has the potential in meeting the unmet need of the disadvantaged groups world-wide. In India, conventional exercise-based CR programs are lacking, and Yoga based programs could meet the entire rehabilitation needs. This could be incorporated into HBCR with the guidance from the Yoga teacher.

11. Potential measures to increase participation in cardiac rehabilitation in indian population

1. Strong endorsement of outpatient CR by referring physicians and hospital administration by incorporating it into the hospital discharge plan and automatic referral.[92,96]
2. Provide CR information and education to inpatients before discharge
3. Provide patients with contact information for outpatient CR programs in close proximity to their home.
4. Utilize CR enrolment appointments via the patient's preferred communication mode (telephone call, text message, email, or regular mail).
5. Develop the HBCR services and provide the option to patients at the time of discharge.
6. Develop a series of integrated practice units, staffed by allied health professionals, that can provide counselling via in-person visits or through web-based and mobile applications, telephonic coaching, handheld computer technologies, or the internet.
7. Development of web-based delivery of HBCR including all components of exercise, medications adherence, risk factor modification and psychological counselling.
8. Incorporation of Yoga based care in the HBCR and CBCR protocols.

These alternative approaches have the potential to address the unmet need of cardiac rehabilitation in the disadvantaged groups worldwide particularly in low- and middle-income countries, such as India.

11.1. Suggestions for healthcare organizations

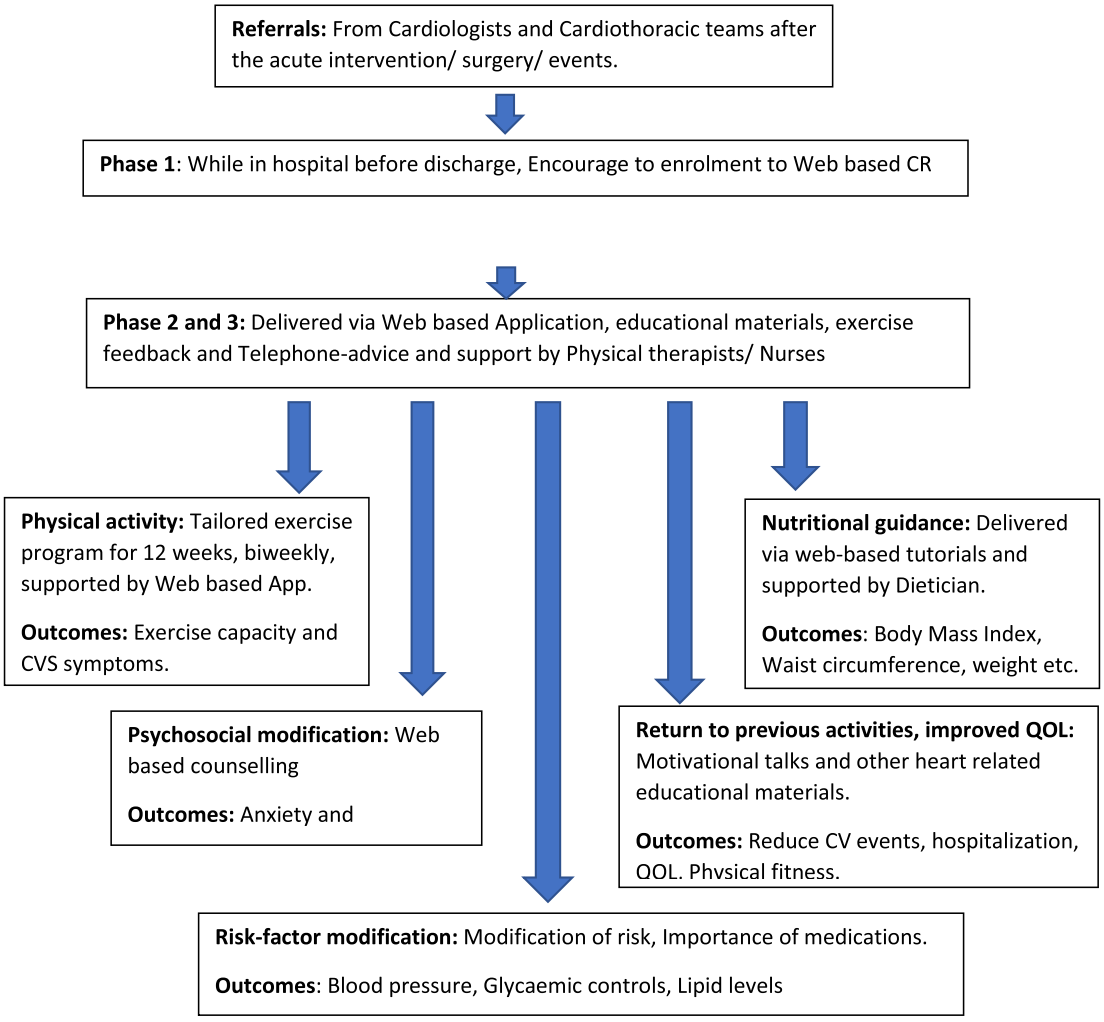
1. Efforts to maximize CR referral and entry through systematic approaches such as automatic referral systems and patient liaisons.
2. High-quality programs of CBCR and HBCR that optimize delivery of CR services to their patients by using evidence-based standards and guidelines, strategies to maximize patient adherence in both the shorter and longer term, and outcome tracking methods that help promote continuous quality improvement.
3. Testing and implementation of evidence-based hybrid approaches to CR that combine the positive and complementary aspects of both CBCR and HBCR to personalize and optimize CR services for each patient and to promote long-term adherence and favourable behavioural change.
4. CR professionals must work with other healthcare professionals and policymakers to implement additional research and demonstration projects to expand the evidence base for HBCR and to inform HBCR related policy decisions.[97]
5. Public private partnership could bridge the gap between consumers and service providers and adoption of CR services by national health care schemes.

12. Setting up and essential components of HBCR program

Essential components of HBCR could be categorized as following:

1. Initial baseline assessment: Includes patient medical history including diagnosis and risk factors, current symptoms, and lifestyle habits. Physical examination, baseline fitness levels, psychosocial factors (HAD score), frailty and patient reported quality of life.
2. Exercise training: Exercise protocols involving mainly walking and jogging with variable support via telephone calls and home visit by the physical therapists and or nurses. Monitoring of home exercise via diaries and heart rate, BP and weight monitoring. Tailored exercise prescription and tele/and or device-based monitoring.
3. Dietary and weight management: Dietary counselling with educational sessions via teleconsultation, web based, app based and or input from dietician.
4. Psychological support and management: Stress management and counselling.
5. Medication adherence: Education on medications via web-based sessions.
6. Risk factor management: Lifestyle modifications, smoking cessation, education about cardiac symptoms etc.

12.1. Proposed CR/HBCR deliver model for India with monitored outcomes



13. Conclusions and future directions

With a growing realization that CR services are both lifesaving and underused, there is a stark need to find new methods to augment the delivery of CR services to the >80% of eligible patients who do not participate in traditional programs. The focus of this review, HBCR, may provide such an alternative method of CR. The decades old evidence behind CBCR is convincing but limited by patient-, provider-, and system-based barriers to participation. Although the evidence behind HBCR is relatively new and less developed, its findings are generally consistent with those reported for CBCR. Available evidence suggests that HBCR may provide an alternative option for CR services for stable low-to moderate-risk patients with CVD who lack available CBCR and very relevant and appropriate in Indian subcontinent.

Shorter-term improvements in functional capacity, HRQOL, and CVD risk factor control and impact on mortality and hospitalization are similar in HBCR and CBCR. Adherence to CR therapy appears to be better in HBCR compared with CBCR, a result of the greater flexibility and convenience for patients who use HBCR services. Additional safety data are needed for HBCR, particularly in higher-risk groups. The core components of HBCR are similar to those that have been recommended for CBCR: patient assessment, exercise training, dietary counselling, and risk factor control (e.g., lipid abnormalities, hypertension, obesity, diabetes mellitus) through optimal adherence to medication, behavioural activation (e.g., smoking cessation, healthy eating habits, physical activity), and psychosocial interventions. The primary difference between HBCR and CBCR is that CBCR programs require direct face-to-face observation of patients, whereas HBCR programs do not. Quality metrics for HBCR, when developed, should focus on key structure, process, and outcome metrics. Technology tools are advancing at a rapid pace and will help improve communication between patients and providers, improve the efficiency of patient monitoring for safety and effectiveness, and expand the reach of CR professionals beyond the typical reach of CBCR services and into a more home-based setting. HBCR may be an alternative option to recommend for selected clinically stable low-to moderate-risk patients who cannot attend CBCR.[97]

Conflicts of interest

All authors have none to declare.

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