Home-Based Cardiac Rehabilitation in Patients with Chronic Heart Failure - A Narrative Review

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Abstract

Home-based cardiac rehabilitation designs have been introduced in clinical practice to identify the weaknesses in CR services and quantify patients’ access and participation. Nonetheless, consistent variations of protocols and its effectiveness in high-risk patients remains sceptical. This narrative review aims to update the current literature on HBCR and highlight its importance in the management of chronic heart failure by addressing: (1) effectiveness of home-based versus centre-based CR; (2) structural components; (3) patient characteristics; (4) health-related factors and outcomes (5) utilisation and cost-effectiveness; (6) prognosis; (7) pros and cons. No evident differences existed in mortality, cardiac events, exercise capacity, healthcare costs, modifiable risk factors and HRQoL between home-based and centre-based CR; but HBCR had increased programme completion and adherence. HBCR is composed of patient assessment, exercise training, dietary counselling, risk factor management, and psychosocial intervention. Limited evidence of differential effects exists across patient-related outcomes which indicates
similar improvements, regardless of age, sex, current fitness or disease severity. HBCR programmes are safe, effective and affordable choice for low-to-moderate risk HF patients; yet underutilisation persists. CR provides improved health-related outcomes, reduced cardiovascular events and mortality. Nevertheless, the long-term impact of home-based CR on patients’ quality of life and clinical outcomes needs to be further evaluated.

**Keywords:** home-based, cardiac rehabilitation, heart failure, narrative review

1. **Introduction**

Cardiovascular disease (CVD) prevails as a leading contributor to mortality in western nation (1). Prevalence of CVD among adults in the United States is approximately 49.2% (126.9 million) based on the NHANES 2015-2018 report (2). Despite recent advances in the therapeutic management of patients, secondary prevention yet remains a valuable component (1). Hence, cardiac rehabilitation (CR) provides an effective approach towards cardiovascular risk reduction, long-term patient care and maintaining better quality of life (3). CR is seamlessly, a class I indication for patients with CVD (4), as recommended by the ACC/AHA (5). Existing literature confirms the utilisation of CR in several conventional indications including coronary artery disease, valvular heart diseases, heart failure and cardiac transplantation (1).
CR is a safe and effective intervention prescribed to HF patients, as it causes significant improvements in the cardiac functionality, exercise tolerance, and health-related quality of life with minimised HF-related hospitalisation rate (6). Nevertheless, most of the CR programmes are quite unevenly implemented, in terms of the structure, accessibility, and duration; while the participants’ enrolment also remained low (1).

CR programmes, traditionally, are centre-based, supervised programmes, that recruits the in-patients to specific CR groups at hospitals, sport centres, or community leisure centres (7). While, home-based CR (HBCR) designs are an alternative approach (8), incorporated into clinical practice as a key solution to overcome the weaknesses in CR services and quantifying the patients’ access, and participation to rehabilitation programmes (4); (9). Although HBCR models are safely functional, nonetheless, consistent variations of protocols and its effectiveness in high-risk patients remains sceptical (4).

Thus, this narrative review aims to update the current state of literature on HBCR and highlight its importance in the management of individuals with chronic heart failure. It addresses the following aspects of HBCR: (1) effectiveness of home-based vs. centre-based CR, (2) structural components, (3) patient characteristics, (4) health-related factors and outcomes, (5) utilisation and cost-effectiveness, (6) prognosis, (7) pros and cons.

2. **Effectiveness of HBCR versus CBCR**

Home based CR designs have demonstrated both effectiveness and benefits, and also addressed the barriers in accessing rehabilitation programmes (1). Though, majority of the evidence collected through randomised controlled trials were related to HF patients undergoing CR at a supervised centre-based setting, such as the outpatient department in hospitals or community leisure centres (6).
Systematic reviews and meta-analyses have identified and compared the differences between home- based CR versus centre- based cardiac rehabilitation (CBCR) based on previously published studies and clinical trials. Existing literature validates the effectiveness of home-based versus centre-based CR programmes in regards to patients’ health outcomes, and reported several inconsistencies in protocols mainly among the higher CVD risk population (4). Majority of these studies (9); (7); (10); (8) found no evident differences in cardiac events, mortality, exercise- capacity, healthcare costs, modifiable risk factors (i.e., smoking, total cholesterol, low-density lipoprotein, systolic blood pressure) and HRQoL; but reported marginally decreased high-density lipoprotein cholesterol among CBCR participants, with increased programme completion and adherence among HBCR groups. A current systematic review and meta-analysis (11) reported that utilising HBCR and hybrid CR (i.e., short-term combination of CBCR with HBCR) significantly improved the patients’ functional capacity, while an improved HRQoL was observed among the HBCR group. Furthermore, a recent study in the United States found that HBCR patients achieved higher 3- month functional gains and QoL than those in facility-based CR (12).

Overall, both these CR models appear to be tremendously effective in improving the health outcomes in low-risk HF patients even after critical events such as myocardial infarction or revascularisation (7).
3. **Structural components of HBCR**

CR implements education of patients, modification of health behaviour, and exercise training to improve secondary prevention outcomes in CVDs (13). Primarily, HBCR is built on 5 main principles: patient assessment, exercise training, dietary counselling, risk factor management, and psychosocial intervention (13); which conjunctly helps to strengthen its structural core and functions (Figure 1).

![Diagram of HBCR components](image)

**Figure 1:** Five Core components of Home-based Cardiac Rehabilitation and their functions
In 2010, the Veterans Affairs office of Rural Health in the US., initiated the HBCR programme to enhance accessibility to CR services for rural veterans. The intervention included nutrition and stress management, risk factor modification, medication adherence and exercise prescription (4). Exercise training can be performed alone, or in conjunction to educational and/or psychological interventions, while resistance training is additional to aerobic exercises (14). Magnitude of exercise training varied across studies, with a prescribed period of 8 weeks to 12 months and 2-5 sessions per week (duration: 10-60 minutes; target intensity: 40-80% of maximal heart rate) (6); (15).

Patients are often advised to self-monitor their target exercise intensity using objective or subjective measures (e.g., pedometers and Borg scale) (6). Home based CR programmes also involve professional contact by CR specialist through phone calls, tele-monitoring or home visits. Regular follow-up of health status and vitals screening leads to necessary alterations in the educational content, for better understanding and healthier lifestyle; while, exercise prescriptions are standardised and individually tailored, based on patients’ lifestyle and home environment (4).

4. Patient characteristics

HBCR is an effective choice specifically for clinically stable or low-to-moderate risk HF patients who are eligible but yet unable to join CBCR programme (13). HF symptoms such as fatigue, dyspnoea and exertion, can make daily activities difficult and intolerable; while aggravation of these symptoms may often lead to anxiety, depression, and reduced QoL (16). Although, current evidence suggests increased number of female patients being recruited in the clinical trials, yet, majority of the CR participants are males (6); and the participation rate is much lower among low-and middle-income populations (17).
The NIHR study (18) evaluated if individual patient characteristics might affect the exercise-based CR effectiveness and summarised the clinical outcomes of patients with HF. There were notable improvements in exercise-capacity and HRQoL, regardless of the patient characteristics (age, sex, ethnicity, ischaemic aetiology, NYHA functional class, EF and exercise capacity at baseline) (19). While, no relevant differences in the patient outcomes were present based on the location of ExCR interventions (centre versus home-based) (20). Another recent study validated the individual participant data report and found no strong evidence of differential effects across the patient-related outcomes(21). The HF-ACTION study also showed similar findings based on gender-related clinical outcomes, whereas, the European HF Training Group study reported an increased peak VO₂ in women (22).

Cumulatively, this justifies the NICE 2018 recommendations and it further validates that all individuals can benefit from rehabilitation, in spite of their age, gender, current fitness status or severity of disease (19). NICE 2018 guidelines also recommends individualised exercise-based CR programmes for HF patients, and advised pre-assessment check-up before programme enrolment to ensure the patients’ safety and suitability (23).

5. Health-related factors and outcomes

5.1 Self-care

Self-care is an effective factor in the maintenance of physiological stability and improvement of health outcomes in chronic heart failure (22). Home-based CR emphasises self-care by actively educating the patients and their caregivers. Patients’ responsibility is the core element in self-management and thereby, it plays an important role in a productive HBCR (17).
Multiple studies have associated patients’ self-care with reduced symptom burden, healthcare cost, hospitalisation and mortality; alongside an increased quality of life and functional status (17). REACH-HF study found better patient ratings using Self-Care of Heart Failure Index based on their self-care regimen such as regular monitoring of weight, performing the prescribed exercises, identifying signs of fluid retention and remembering daily intake of medications (24). Self-care has been mostly highlighted in centre-based settings as CR programmes facilitated an ideal opportunity to support the CHF self-care, and provided an integrative team of doctors, nurses, dieticians, exercise physiologists, physical therapists, etc., to monitor all patients on a regular basis (22).

5.2 Adherence

In most cases, hospital readmissions due to CHF exacerbations are attributable to poor self-management, non-adherence to drugs, exercise, diet, and delayed response in the management of worsening symptoms (22); while an observed effect exists between higher adherence and improved clinical outcomes (25). Hence, adherence to prescribed treatment regimen, involving medications and behavioural recommendations is mandatory. Some studies found reduced compliance to HBCR as compared to supervised CBCR; while others reported an increased rate of adherence to the home-based, tele-monitored CR programmes in HF patients (26). Few studies have in fact associated HBCR with better adherence (8).

The differences in adherence could be due to variations in home-based training strategies and the reported adherence measures. Self-motivation of patients, increased family support and active health-related education could be useful strategies in improving the adherence towards HBCR (26). The rate of adherence across HBCR interventions was reportedly high and varied from 110% to 54%, according to a recent meta-analysis (6). Setting goals, prescribing exercises, solving problems, providing positive reinforcement
and feedback, performing inspirational interviews and group interactions have all demonstrated evident improvements in adherence among patients suffering with CHF (22).

5.3 Physical activity

Physical exercise is a major component of CR as it improves the cardiac functioning. Exercise training could improve the functional parameters in patients with HF, regardless of the coronary versus non-coronary aetiology (27). Despite the noted benefits of ExCR, unsupervised or unmonitored, and inappropriately performed exercises may often lead to adverse cardiovascular events, including MI, arrhythmias and sudden death (25).

The Active-at-Home-HF study conducted a 12-week, home-based intervention to improve physical activity by daily increase in the number of steps, and found that the average steps count/day was significantly increased from baseline to 12th week. This demonstrated a greater exercise tolerance among the participants (28). A meta-analysis reported increased exercise duration (by 1.94 min), and greater distance on 6-minute walk test (by 30.4 m) in the home-based CR (15). Quite a few studies measured the distance on 6-minute walk or incremental shuttle walk test as a study outcome in the home-based CR, and found significant improvements (6); (16); (24). As compared to facility-based CR, patients undergoing HBCR achieved higher 3- month gains in the 6MWT. Overall, HBCR participants reported with greater improvements in their physical activity but had reduced exercise self- efficacy (12).

5.4 Aerobic capacity

Several studies reported an increment in the peak oxygen uptake (VO$_2$) after HBCR (6); (11); (16). One study reported improvements in the mean peak oxygen consumption by 2.86 ml/kg per min (15). While, another study found an increase of 19% in the peak exercise
stroke volume, and the cardiac index increased by 12%. Furthermore, there was a noted rise in the workload and O₂ consumption at anaerobic threshold (28).

NYHA class improved significantly with aerobic training by 0.5 class as reported by the European Heart Failure Training Group, and it was proportional to the peak VO₂ improvement (22). Some recent studies indicated that HF patients with reduced EF have significantly higher peak VO₂ levels after exercise training as compared to those with preserved EF (11); (29).

5.5 Quality of life

Previously, most of the studies have associated cardiac rehabilitation programmes with increased functional status and quality of life, along with improved MLHFQ and/or HRQoL scores (11); (30); (28); (12); (27); (18). The HF-ACTION study revealed that 30% of the participants in exercise group improved remarkably by 1 full NYHA class or more. Greater improvements were observed for physical limitations, HF symptoms and quality of life in the exercise arm (22). Furthermore, QoL has been strongly associated with increased exercise tolerance (16).

The REACH-HF study reported significant differences in the MLHFQ physical scores, with no differences in the emotional score. Although, post-hoc analysis revealed greater improvements among participants in the HBCR intervention group (52%) than those undergoing usual care (33%), with a clinically proven reduction of ≥5 points in the total MLHFQ score (24).

HBCR has a lesser effect on the patient’s daily routine and can be easily integrated unlike facility-based CR, which explains the better functional state and QoL among cardiac patients (16).
5.6 Depression and anxiety

The prevalence of mental health issues among cardiac patients are at least 4 times higher than the general population (31). Depression and anxiety are predominant among heart patients; yet often remains unidentified. They are linked to poor clinical outcomes (32), and greater long-term mortality (33).

Home-based CR has yielded significant results in improving the mental health of cardiac patients. Systematic reviews indicate that HBCR has effectively improved HF patients’ QoL and psychological wellbeing (8). A recent study that incorporated e-Health support system in patients’ care found improved anxiety, depression and QoL scores, except for bodily pain dimension; and showed higher anxiety score in HBCR (30). HF-ACTION study also demonstrated a reduction in the depression scores post exercise training (22).

It appears HBCR has a positive impact on patients’ self-efficacy, which consequently leads to increased motivation, and reduced feelings of helplessness, anxiety and depression (34). The active involvement between patients and caregivers during HBCR might further enhance the emotional support and psychological wellbeing (17).

5.7 Rehospitalisation and Mortality

Cardiac rehabilitation reduces the progression of HF, minimises recurrent hospitalisations, and sudden mortality (29). Many studies (22); (28); (35); (36) reported significant effects of CR on the hospital readmission and mortality rates, and with no severe heart-related complications (37). Nevertheless, the long-term outlook of home-based CR in improving these outcomes is still limited, as most of the evidence has been derived from hospital or
centre-based models (24). In addition, there has been also some heterogeneity regarding the effects of exercise training on the HF clinical outcomes (29).

A study reported significant reduction (28%) in the hospitalisation rate and mortality (35%) among exercise trained patients (22). In 2019, the Cochrane systematic review and meta-analysis reported no significant reductions in all-cause mortality but stated fewer all-cause hospitalisations and HF-related hospitalisations (20). While, another recent study found no sudden deaths and/or cardiac-cause hospitalisations (12).

The EXTRAMATCH II study found that ExCR had no effect on mortality and hospitalisation rate (38). Although moderate-to-good correlation was noted between VO₂ or the 6MWT with mortality and HRQoL. Hence, VO₂ peak and 6MWT might serve as surrogate end points in demonstrating the ExCR treatment effect on mortality in patients with HF (18).

6. Utilisation and Cost-effectiveness

Although CR is an effective strategy, yet underutilisation of these services remain in practice (4). Many clinicians are thoughtful on the use of HBCR in patients with higher CVD risks and clinical complexities (4). One study identified that physician-related barriers could affect the CR referral rates so increased awareness and educational interventions may improve the overall CR referral rates (39). HBCR has been successfully incorporated in United Kingdom, Canada, Australia (40), and other countries, yet most US healthcare organizations have limited or no experience regarding HBCR programmes (13). Cardiac tele-rehabilitation using monitoring devices and remote communication is being highly utilised for long-term CVD management outside the hospital premises (25).
HF-related medical expenditure leads to massive economic burden upon the patients and healthcare system (16). Multiples cost-effective strategies have been adopted to provide improved HBCR services and quality (17). Furthermore, one study also revealed that HBCR is associated with higher patient satisfaction since it is more cost-effective compared to CBCR (41). In the United States, CBCR costs were apparently higher than some of the recently published HBCR cost reports, thus, home-based CR models appear to be financially attractive and affordable (11); (24).

7. Prognosis

Evidence suggests that CR programmes are both safe and effective in improving the QoL and functional capacity, as well as reducing hospital readmission and all-cause mortality rates in HF (16). A Taiwanese study reported significant improvements in the quality of life, aerobic capacity and hospital readmission rate with no adverse events after HBCR (16).

The HF-ACTION study found that exercise-training induced greater peak VO₂ and also correlated with better prognosis in participants (22). A home-based pilot study discovered that exercise training (3-5 MET hours/week) was significantly associated with 37% and 64% reductions in the adjusted risks for death/hospitalisation (p=0.03); and cardiovascular death/heart failure hospitalisation (p=0.001) (25). Thus, adherence to the exercise prescription is essential, to improve the long-term outcomes in patients (22).

Providing objective feedback data and letting patients track their own progress may lead to improved self-management skills and better adherence. Furthermore, cardiac tele-rehabilitation may be a convenient method in reducing anxiety, improving the patients’ QoL and prognosis with minimal healthcare costs (25).
8. Pros and cons

HBCR is a potential solution towards addressing the logistic impediments (e.g., traveling distance, transportation, scheduling, and availability issues) in accessing centre/facility-based programmes (4). Certainly, CR interventions are highly beneficial in reducing the morbidity and mortality rates among patients with heart failure, ischemic heart disease, or cardiac surgery (13).

Home-based CR could help overcome geographic, logistical, and other access-related barriers to promote improved participation rate and behavioural changes (40). Some of the major pros and cons related to HBCR has been listed (Table 1).

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td>Integrated with patients’ daily life routine</td>
<td>Insufficient published standards or guidelines for HBCR</td>
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<tr>
<td>Flexibility and feasibility</td>
<td>Reduced intensive exercise training</td>
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<td>Personalised/tailored programmes based on specific patient needs and suitability</td>
<td>Presence of safety issues primarily among higher-risk patients</td>
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<tr>
<td>No limited time restrictions as practiced in CBCR programmes</td>
<td>Reduced face-to-face communication</td>
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<tr>
<td>Lesser transportation and availability issues</td>
<td>Patient accountability is low</td>
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<td>More convenient and comfortable</td>
<td>Reimbursement issues</td>
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<td>Higher accessibility and privacy</td>
<td>Lesser monitoring by medical providers in comparison to facility-based CR</td>
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<td>Affordability and cost-effectiveness</td>
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Table 1: Pros and Cons of Home-based Cardiac Rehabilitation
9. Conclusion

Cardiac rehabilitation is AHA recommended class 1 guideline in improving the physical and emotional wellbeing of patients with heart diseases (5). Despite well-established benefits, inadequate participation of the patients still persists (17). CR programmes can facilitate better management of patients with CHF by exercise training, education, promotion and monitoring of self-management skills (22).

Previous studies have significantly associated CR with improved health outcomes, and reduced cardiovascular events and mortality (29). Nevertheless, the long-term impact of home-based CR on patients’ QoL and the clinical outcomes need to be further evaluated. More evidence or published data on the home-based cardiac rehabilitation standards and patient monitoring system is highly recommended. Future studies should aim to address the effectiveness of different HBCR models and the patient-related outcomes.

Abbreviations

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