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REVIEW

The Effectiveness and Current Challenges of Home-Based Cardiac Telerehabilitation for Patients with Coronary Artery Disease: A Narrative Review

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Abstract: The high mortality rate associated with coronary artery disease (CAD) represents a significant global health challenge. While home-based cardiac telerehabilitation (HBCTR) has emerged as a key area of research, its clinical effectiveness remains controversial. This review aims to evaluate the effectiveness of HBCTR interventions in patients with CAD across multiple domains, including cardiovascular outcomes, cardiopulmonary function, treatment adherence, and quality of life. It also seeks to identify the key challenges impeding its widespread implementation. We searched PubMed, Web of Science, Google Scholar, and CNKI for relevant studies published between January 2015 and October 2025 using a combination of keywords and MeSH terms. The findings indicate that HBCTR effectively improves cardiovascular outcomes, cardiopulmonary function, adherence, and quality of life in CAD patients. Specifically, HBCTR programs incorporating app-based follow-up and wearable device monitoring were associated with reduced all-cause mortality and readmission rates, as well as enhanced exercise tolerance. Similarly, HBCTR protocols combined with traditional exercise regimens improved cardiovascular outcomes. At the psychological and metabolic levels, HBCTR alleviated anxiety and depression, optimized metabolic indicators, and demonstrated superior adherence compared with traditional center-based cardiac rehabilitation (CR). In conclusion, HBCTR offers comparable or even better rehabilitation outcomes to center-based CR. However, challenges related to technology adaptation, data security, and policy support remain key barriers to its broader adoption. Future research should prioritize large-scale, multi-center randomized controlled trials to verify the feasibility and long-term benefits of widespread HBCTR implementation, and to better understand how differences in technology, patient demographics, and regional resources affect intervention effects.

Keywords: home-based cardiac telerehabilitation, coronary artery disease, patient adherence, quality of life, eHealth

Introduction

The global incidence and mortality of cardiovascular disease (CVD) continue to rise, and it is currently the leading cause of death among both urban and rural residents in China.[1,2] Epidemiological data indicate that over 11.39 million people in China are diagnosed with coronary artery disease (CAD), with mortality rates having increased steadily since 2012—a trend that is particularly pronounced in rural areas.[1] Notably, approximately 43% of patients with established CAD will experience major adverse cardiovascular events, including death and nonfatal myocardial infarction, underscoring the poor prognosis in this population.[3] Cardiac rehabilitation (CR) is a clinician-supervised, evidence-based secondary prevention program for patients with cardiovascular disease. Its core components include patient assessment, exercise training, nutritional counseling, cardiovascular risk factor management, psychosocial support, and outcomes evaluation, and it can be delivered via center-based, home-based, or hybrid models. Although substantial evidence supports the effectiveness of CR in reducing mortality and improving health-related quality of life for patients with CAD, global participation in CR programs remains suboptimal.[4–6] In China, CR participation rates are below 10%, with significant geographic disparities, and are far lower than those in developed countries.[7–9]

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The COVID-19 pandemic, coupled with rapid advances in information and communication technology, has accelerated the search for novel CR delivery models. Against this backdrop, home-based cardiac telerehabilitation (HBCTR) has emerged as a promising alternative. HBCTR is a specific form of home-based CR that leverages mobile health technologies, such as smartphone applications, wearable monitoring devices, short message services, and video conferencing, to deliver comprehensive CR services remotely. The core components of HBCTR align with standard CR, integrating aerobic and resistance exercise training, remote dietary and medication adherence guidance, real-time physiological data feedback, and digital psychosocial intervention, while eliminating the geographical and time barriers associated with conventional center-based CR.[10,11] Consequently, HBCTR is now endorsed by authoritative guidelines as a valuable complement to conventional CR.[12,13] Recent statistics show that China's internet user base has reached 1.123 billion, representing an internet penetration rate of 79.7%. Furthermore, infrastructure development has achieved "gigabit connectivity in every county, 5G coverage in every township, and broadband access in every village", providing a robust technological foundation for the widespread implementation of HBCTR.[14] Despite these favorable conditions, the actual adoption rate of HBCTR in clinical practice remains low. Therefore, identifying and overcoming barriers to participation and enhancing patient engagement will be critical to the future development of this field.

In this review, we aim to provide a comprehensive overview of the clinical efficacy of HBCTR in patients with CAD, analyze current implementation challenges and potential solutions, and explore the role of hybrid CR models in the future management of cardiovascular disease.

Methods

Search Strategy

A comprehensive literature search was conducted on PubMed, Web of Science, Scopus, Cochrane Library, Google Scholar, and CNKI for studies published between January 2015 and October 2025. The search strategy employed a combination of keywords and MeSH terms, including "coronary disease", "coronary heart disease", "coronary artery disease", "remote rehabilitation", "home-based rehabilitation", "telerehabilitation", "hybrid cardiac rehabilitation", and "cardiac rehabilitation". Boolean operators ("AND", "OR") were used to combine search terms appropriately in a logical manner. The reference lists of included studies and relevant clinical guidelines were also screened to ensure comprehensiveness. The full search strategy for PubMed, Web of Science, Scopus, Cochrane Library, and Google Scholar is provided in Table S1.

Eligibility Criteria

Studies were eligible if they met the following criteria: (1) Study design: We included randomized controlled trials or prospective cohort studies reporting complete data on baseline characteristics and outcome indicators; (2) Population: Adult patients with a confirmed diagnosis of CAD undergoing Phase II cardiac rehabilitation; and (3) Intervention: Studies employing at least one HBCTR technology. In addition, relevant systematic reviews, meta-analyses, and surveys were consulted for contextual information.

Studies were excluded if they: (1) were conference abstracts, commentaries, or non-full-text articles; (2) included patients with severe heart failure (NYHA class IV) or exercise contraindications; or (3) lacked sufficient clinical relevance or outcome data.

Study Selection and Data Extraction

The lead author initially screened all titles and abstracts for relevance. Full texts of potentially eligible studies were then retrieved and assessed. The screening process was independently cross-checked by co-authors to ensure consistency. Any disagreements were resolved through discussion until a consensus was reached.

Evidence Synthesis

Findings were categorized by HBCTR model type: (1) remote digital programs and (2) hybrid approaches integrating HBCTR with center-based cardiac rehabilitation. We then descriptively synthesized and compared key variables across

these categories, including adherence rates, exercise capacity, quality of life, cardiovascular outcomes, and implementation barriers. A narrative synthesis was used to summarize patterns and gaps in the evidence.

Results

A total of 328 records were identified from the database search, including 79 Chinese articles and 249 in English. Following the removal of duplicates, the titles and abstracts of the remaining records were screened using the eligibility criteria. Articles deemed potentially relevant were then retrieved for full-text review. Ultimately, 121 relevant studies were included.

Discussion

The technological approaches used in HBCTR are diverse across the included studies. Common methods include: (1) smartphone applications that deliver exercise prescriptions, track adherence, and provide motivational feedback.[15,16] (2) Wearable devices, such as heart rate monitors and fitness trackers, for real-time or offline monitoring of exercise intensity and physical activity.[16,17] (3) Text messaging interventions for behavioral reinforcement.[18,19] (4) Video conferencing platforms, including Tencent Meeting and WeChat, for supervised remote exercise sessions or educational sessions.[17,20] In addition, some studies have integrated HBCTR with traditional exercise therapies, such as Tai Chi and Baduanjin, delivered via social media platforms like WeChat groups.[21,22] Given this diversity of available approaches, the optimal combination of these technologies should be determined collectively based on patient preferences, technological literacy, and local infrastructure availability.

Efficacy of HBCTR Model Conclusion

Cardiovascular Outcomes and Cardiopulmonary Function

Recent evidence has demonstrated that HBCTR significantly improves cardiovascular outcomes and cardiopulmonary function in patients with CAD. For instance, research focusing on patients with myocardial infarction without obstructive coronary artery disease found that a long-term home-based exercise training program substantially reduced all-cause mortality and major adverse cardiovascular events (MACEs).[23] In a randomized controlled trial by Lunde et al, 113 patients undergoing cardiac rehabilitation were assigned to either an intervention or a control group.[15] The intervention group received personalized follow-up via a smartphone application for one year. This digital tool enabled patients to set personal goals, self-determine the frequency and timing of task reminders, and receive one to three brief, tailored motivational feedback messages per week. The control group received conventional care. Results showed significant improvements in peak oxygen consumption in the intervention group, along with notable gains in exercise performance metrics such as time to exhaustion, peak workload, and peak walking velocity. Participants also reported enhanced self-efficacy in goal achievement, suggesting that personalized management optimizes cardiovascular health through multiple pathways. Similarly, a study involving Chinese CAD patients revealed that smartphone-based interaction combined with HBCTR effectively reduces cardiovascular risk.[24] This intervention model streamlined the implementation of exercise prescriptions and enabled real-time monitoring of exercise intensity, thereby enhancing both intervention safety and patients' health status. In another study, Xia et al used wearable heart rate monitoring devices connected to a smartphone application to track exercise intensity, while the same application provided video demonstrations of the prescribed exercises.[16] After 12 weeks, this approach led to significant improvements in maximal oxygen uptake and peak metabolic equivalents in patients with stable CAD. Collectively, these findings indicate that HBCTR contributes to improved cardiopulmonary function and favorable cardiovascular outcomes in this population.

Traditional exercise therapies integrated with telehealth technology have also demonstrated positive effects in CAD management. For example, a six-week Tai Chi-based HBCTR intervention delivered via WeChat group chats to 90 low-risk patients with stable CAD resulted in significant improvements in peak exercise workload and other measures of exercise capacity.[21] Similarly, Wu et al reported comparable outcomes using a Baduanjin exercise intervention for CAD patients following percutaneous coronary intervention.[22] During the COVID-19 pandemic, Zhang et al conducted a study in which 70 home-based CAD patients were divided into three groups: Tai Chi cardiac rehabilitation, conventional rehabilitation, and a control group. The "hospital + home" model comprised 10 weeks of in-hospital instruction followed by 26 weeks of HBCTR delivered via Tencent Meeting and WeChat groups. The Tai Chi cardiac rehabilitation protocol

included mental preparation, practice of the eight methods and five steps of Tai Chi, and Tai Chi elastic band exercises. In contrast, the conventional rehabilitation group performed aerobic exercises and elastic band resistance training. Results demonstrated that the Tai Chi cardiac rehabilitation group exhibited the greatest improvement in quality of life, with superior outcomes in physical functioning, social functioning, and emotional role performance compared to the other two groups. While these findings are promising, the current evidence base remains limited by the relatively small number of studies and variable methodological quality.[20]

In summary, HBCTR—by integrating technological tools, traditional therapeutic approaches, and remote management strategies—not only enhances cardiopulmonary function and promotes healthier behaviors in CAD patients but also reduces all-cause mortality and other cardiovascular outcome measures, underscoring its substantial clinical value. As technology continues to advance and intervention models are optimized, HBCTR holds considerable promise for further enhancing cardiovascular outcomes and expanding the scope of comprehensive CAD management.

Psychological Effects and Metabolic Outcomes

Depression has been identified as an independent risk factor for poor prognosis and increased mortality in patients with CAD.[25,26] Epidemiological data indicate that the incidence of depression after percutaneous coronary intervention (PCI) is increasing in patients with CAD. In China, the prevalence of depression in this population is approximately 19.8%—markedly higher than that observed in the general population.[27] Contemporary CR programs have increasingly emphasized the importance of psychosocial interventions, because depressive symptoms significantly reduce rehabilitation participation and adherence.[28,29] Consequently, effectively addressing psychological barriers such as depression, anxiety, and kinesiophobia is crucial for the successful delivery of HBCTR.[30,31]

HBCTR offers significant advantages in improving the psychological status of patients with CAD. In a randomized controlled trial, Jin et al enrolled 90 patients with acute myocardial infarction and assigned them to either standard care alone or standard care augmented with HBCTR. After six months of follow-up, the intervention group showed significantly greater reductions in Self-Rating Anxiety Scale (SAS) and Self-Rating Depression Scale (SDS) scores compared to the control group. These findings indicate that HBCTR not only enhances cardiac structure and function but also effectively alleviates anxiety and depression, while improving patients' self-management capabilities and treatment satisfaction.[32] Xia et al further confirmed these psychological benefits, reporting significant improvements in depressive and anxiety symptoms alongside gains in cardiopulmonary function.[16] Collectively, these studies suggest that by providing personalized exercise guidance and real-time physiological monitoring, HBCTR effectively reduces psychological burden and promotes mental health in this population.

In addition to its psychological benefits, HBCTR also exerts favorable effects on metabolic parameters. Taylor et al evaluated the metabolic outcomes of a 12-month high-intensity interval training (HIIT) program in patients with coronary artery disease.[33] The study employed a three-phase design: Phase 1 (weeks 1–4) involved supervised training; Phase 2 (months 2–3) transitioned to home-based training with partial supervision; and Phase 3 (months 4–12) comprised fully independent home-based training. Results showed that telemonitored HIIT significantly reduced visceral adiposity and hepatic fat content in patients with coronary artery disease, while effectively addressing traditional safety concerns associated with high-intensity training in home settings. A meta-analysis by Hu et al further confirmed that HBCTR significantly reduces total cholesterol (TC), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C), while increasing high-density lipoprotein cholesterol (HDL-C).[34] Additionally, this approach was associated with reductions in body mass index (BMI), systolic blood pressure, and diastolic blood pressure. In summary, these findings suggest that through integrated interventions—including exercise training, nutritional counseling, and risk factor modification—HBCTR effectively improves metabolic profiles and thereby reduces cardiovascular event risk.[35]

Adherence

Low adherence among patients with CAD is influenced by multiple factors, including health literacy, disease burden, economic constraints, healthcare system barriers, and technological adaptability.[36,37] Multi-regional surveys conducted in China have demonstrated a significant positive correlation between patients' awareness of CR and their level of adherence.[38–40] Furthermore, additional barriers exist in the Chinese context, such as limited health literacy among

middle-aged and older adults and the influence of family members or caregivers on treatment decisions—all of which can affect patient adherence to some extent.[41]

Patients receiving HBCTR generally exhibit superior adherence rates and clinical outcomes compared to those in traditional outpatient settings. Research indicates that HBCTR interventions incorporating smartphone applications not only significantly improve patient adherence but also enhance clinical health outcomes.[42,43] In a randomized controlled trial, Xu et al assigned 147 patients with CAD to either an experimental group or a control group.[17] The experimental group received exercise rehabilitation promotion strategies based on a structured model called "SCeiP" (Self-Evaluation /Condition of Exercise—Effect Perception—Internal Drive—Persistence Behavior), delivered via the WeChat platform and wearable exercise devices. The intervention comprised three phases: Phase 1 (in-hospital) involved comprehensive self-assessment, including evaluation of exercise capacity, dietary habits, and sleep quality; Phase 2 (post-discharge transition) assessed patients' home rehabilitation environments, established personalized exercise programs based on individual preferences, and created WeChat groups facilitated by professional medical teams; and Phase 3 (HBCTR) required patients to execute customized exercise regimens at home, upload exercise records to the WeChat groups, and receive regular telephone follow-ups or home visits. The control group received conventional disease education and rehabilitation guidance during hospitalization, followed by periodic telephone follow-ups after discharge. Results showed improved exercise adherence in both groups, but the experimental group demonstrated significantly greater improvements in adherence metrics and disease knowledge.

Beyond comprehensive interventions, even simple digital approaches can effectively improve adherence. One study focusing on patients with ischemic heart disease found that an intervention combining text messages and video reminders significantly increased patients' physical activity time at 24 weeks and improved self-efficacy; however, improvements in exercise capacity, such as the 6-minute walk test, did not reach statistical significance compared to the conventional care group.[18] Another study reported that text message reminders effectively enhanced adherence to lifestyle recommendations among patients with CAD during the 3-month intervention period, but this effect was not sustained at the 6-month follow-up after the intervention had ceased.[19] These inconsistent findings may be attributed to methodological limitations, including the use of non-blinded assessors, a lack of personalized intervention strategies, insufficient attention to dynamic changes in patients' psychological states, and inadequate follow-up duration, among other confounding factors.

Quality of Life

HBCTR has demonstrated significant efficacy in improving quality of life among patients with CAD. Zheng et al found that patients with CAD who had undergone PCI showed significantly improved Short Form-12 (SF-12) scores and enhanced quality of life following a three-month HBCTR program.[44] Similarly, Bernal-Jiménez et al evaluated the effectiveness of an interactive mobile health application (EVITE) as an intervention for patients with CAD.[45] Their results showed that following the intervention, patients' SF-12 scores improved significantly, indicating enhanced health-related quality of life. The application also promoted healthier lifestyle behaviors and achieved high patient satisfaction ratings, suggesting that remote cardiac rehabilitation can serve as an effective supplement to traditional center-based programs—particularly in enhancing patients' quality of life.

HBCTR interventions offer multidimensional benefits in promoting lifestyle modifications and improving quality of life. A systematic review by Zhou et al confirmed that eHealth interventions effectively increase patients' engagement in healthy lifestyle behaviors, improve dietary patterns, reduce total cholesterol and low-density lipoprotein cholesterol levels, and significantly decrease readmission rates.[46] In addition, Su and Yu implemented a six-week nurse-led eHealth CR system for patients with CAD and demonstrated significant improvements in quality of life, with benefits sustained through the 12-week follow-up period.[47] Their study also found that providing personalized feedback and peer support mechanisms through remote rehabilitation may help improve patients' emotional and social well-being, thereby enhancing overall quality of life. Collectively, this evidence indicates that HBCTR offers clinical value in enhancing quality of life for patients with CAD and represents a promising intervention approach for this population.

Patient Selection for HBCTR

Based on recent evidence, certain patient subgroups may be particularly suitable for HBCTR. A 2025 systematic review and meta-analysis by Li et al, which included 13 randomized controlled trials with 1508 patients, demonstrated that mHealth-delivered home-based cardiac rehabilitation is effective for patients with myocardial infarction, stable angina, heart failure, or post-revascularization status.[12] The RESILIENT randomized clinical trial further underscored the importance of risk stratification by showing that among 400 older adults (≥65 years) hospitalized for ischemic heart disease, mHealth-CR was feasible and safe, with no deaths during the 3-month follow-up.[48]

Common inclusion criteria across studies include clinically stable status, possession of a smartphone with internet connectivity, ability to perform independent ambulation, absence of significant cognitive impairment, and willingness to comply with remote monitoring protocols. Conversely, patients with certain high-risk features generally require careful evaluation before participation in HBCTR or may be better suited for center-based programs. These features include: unstable angina; New York Heart Association class III–IV heart failure or left ventricular ejection fraction ≤35% without an implantable cardioverter-defibrillator; Canadian Cardiovascular Society angina class >2; recent acute coronary syndrome or cardiac surgery within 30 days; severe arrhythmias; advanced age (>75 years) with significant functional impairment; moderate-to-severe cognitive impairment; non-ambulatory status; and lack of digital literacy or necessary equipment.

Assessment Methods in HBCTR

Assessment methods for CAD patients undergoing HBCTR vary across studies. Generally speaking, patient clinical response is commonly evaluated using core cardiac rehabilitation outcomes, including exercise capacity measured by the 6-minute walk test or cardiopulmonary exercise testing, as well as cardiovascular risk factors and health-related quality-of-life questionnaires. Patient satisfaction is typically assessed through validated instruments, such as the Patient Satisfaction Questionnaire, or through custom-designed surveys. Patient engagement and contribution are often measured using objective data from digital platforms, including login frequency, session completion rates, message response times, and exercise adherence recorded by wearable devices or smartphone applications.

Challenges and Solutions in Implementing HBCTR

HBCTR also has several inherent disadvantages that should be considered. First, the lack of direct in-person supervision may increase safety risks, particularly for patients at higher baseline risk or those with complex medical needs. Second, HBCTR requires patients to have adequate digital literacy and access to reliable internet and devices, which may exclude elderly or socioeconomically disadvantaged individuals. Third, the remote nature of HBCTR reduces opportunities for peer support and social interaction that naturally occur in center-based programs. Fourth, data security and privacy concerns are amplified in digital health platforms. Fifth, the initial costs of purchasing wearable devices or subscribing to applications may be prohibitive for some patients. These disadvantages should be carefully considered when prescribing HBCTR.

Technological and Equipment Limitations

Despite the significant potential of HBCTR to improve patient outcomes and enhance service accessibility, technological and equipment limitations remain major barriers to its widespread adoption.[49] According to the 56th Statistical Report on China's Internet Development, issued by the China Internet Network Information Center (CNNIC), there are 286 million non-internet users in China, predominantly adults aged 60 years and above.[14] Although internet penetration rates have exceeded 50% in both urban and rural areas, this level of connectivity does not necessarily ensure that patients can access and effectively utilize telehealth services—a challenge that is particularly pronounced among the elderly population.[50] A 2023 study conducted in Qingdao revealed that older adults with CAD face significantly greater challenges with internet usage compared to their younger counterparts.[51] Consequently, developing a digitally inclusive intervention framework tailored to the needs of technologically disadvantaged patients has become a critical pathway for optimizing the effectiveness of HBCTR.

For device-dependent CR programs that utilize cardiopulmonary exercise testing systems to monitor real-time exercise data, enhancing rehabilitation safety is feasible. However, the installation requirements, clinical operational thresholds, and procurement costs associated with these systems collectively present significant obstacles to the widespread implementation of home-based cardiac telerehabilitation. An analysis based on the Technology Acceptance Model suggests a correlation between patients' technology-related anxiety and the ease of interaction with smart medical devices; simplified interaction processes can reduce anxiety and promote the use of these technologies.[52] Therefore, to achieve broader adoption of HBCTR devices, it is essential to lower technological barriers while incorporating multidimensional considerations, including health economic evaluations and patient acceptance.

To overcome existing technological hurdles and equipment limitations, structured health education initiatives should be implemented for patients with CAD. These initiatives may include virtual reality simulations for device operation training, guided tutorials delivered via mobile health applications, and round-the-clock clinical decision support systems. In addition, developing multimodal human-computer interaction systems could provide screen-reading functionalities for visually impaired patients and reduce cognitive barriers for those with cognitive impairments. This comprehensive approach aims to ensure equitable access to and usability of home-based cardiac telerehabilitation for all patients with CAD, regardless of their technological proficiency or physical limitations.

Safety and Privacy Protection

Safety and privacy protection are critical prerequisites for the clinical application of HBCTR.[53] According to the newly released Cybersecurity Observation Report for Digital Healthcare, China's healthcare sector currently maintains an overall cybersecurity risk level classified as "moderate", indicating that while basic protective capabilities exist, persistent vulnerabilities remain. Although this represents an improvement of one level compared to the previous year, nearly half of China's provinces are still classified as being at "significant risk" or "critical risk", posing substantial challenges for the implementation of home-based cardiac telerehabilitation programs.[54] During telehealth service delivery, data security is influenced by multiple factors, including data collection devices, home network environments, transmission platforms and software, and healthcare personnel operations—factors that collectively necessitate higher standards for data protection. For technology and device vendors, future efforts should focus on optimizing technologies for the secure transmission, storage, and protection of patient data in order to enhance patients' trust in remote rehabilitation.

In addition, because patients do not have direct contact with healthcare professionals during home-based cardiac telerehabilitation, this modality may potentially increase the risk of falls or injuries. Studies have shown that the incidence of major cardiovascular complications during supervised exercise training for patients with cardiovascular disease is extremely low. A 2022 systematic review of 9 high-quality RCTs (n=808) confirmed 1 exercise-related serious adverse event per 23,823 patient-hours of HBCR exercise, with no exercise-related deaths or hospitalizations across all risk strata.[55] This finding was further supported by a 2024 systematic review, which reported an even lower rate of 1 event per 53,770 patient-hours of remote CR, with zero exercise-related mortality.[56] Consistent evidence also comes from a 42-month Chinese cohort study of PCI-treated patients, which found a 1.5% major adverse cardiovascular event rate in the HBCTR group, significantly lower than the 8.9% in controls, with no cardiovascular deaths.[24] Despite this low event rate, to ensure absolute safety during care delivery, careful safety measures must still be implemented when conducting home-based cardiac telerehabilitation.[57]

To mitigate these risks and enhance patient safety, several strategies can be employed. First, regular assessments and equipment checks should be conducted to evaluate patients' functional status through self-uploaded data, video conferencing, and online surveys, while also ensuring alignment with traditional cardiac rehabilitation processes and verifying equipment functionality. Second, real-time monitoring with wearable devices—equipped with heart rate, oxygen saturation, blood pressure, glucose monitoring, and fall detection capabilities—can facilitate immediate communication via video conferencing and enable rapid response to emergencies through established protocols. Third, comprehensive cardiac rehabilitation education is essential. Health education and health promotion interventions have been shown to effectively enhance health literacy and improve treatment adherence among patients with CAD.[58] Therefore, personalized CR education should be delivered through methods tailored to patients' information reception

capabilities, such as combining online and offline approaches, offering both group and individual sessions, and utilizing diverse educational tools—including action demonstrations, pamphlets, videos, and telephone consultations—to meet patients' needs and enhance their self-awareness and safety consciousness.[59]

Industry and Policy Support

In March 2018, at the American College of Cardiology (ACC) Annual Scientific Session, a research team led by Professor Dayi Hu presented survey results on the current state of CR development in China. The survey revealed that only 13% of hospitals provide Phase I CR services, 17% offer Phase II CR services, and merely 8% deliver both Phase I and Phase II programs.[60] In addition, the shortage of specialized CR professionals remains a significant barrier to the effective implementation of HBCTR.

Cardiac rehabilitation initiatives in China originated in the 1960s and expanded to incorporate chronic CAD rehabilitation programs in the 1980s. However, public awareness of CR—including among patients with CAD themselves—remains low, and patients often demonstrate limited self-efficacy. Along with insufficient policy support for this long-term therapeutic service, the implementation of HBCTR continues to face substantial obstacles.[61,62] Furthermore, inadequate insurance reimbursement represents another critical constraint. In the Chinese context, despite patients' willingness to participate in CR, many discontinue treatment prematurely due to the persistent financial burden associated with long-term therapeutic interventions, ultimately impairing treatment outcomes.

To further promote the development of HBCTR, several strategies are recommended. First, medical insurance payment mechanisms should be reformed by appropriately increasing reimbursement rates for CR services, thereby reducing patients' financial burden and improving long-term adherence. Second, health literacy can be enhanced through systematic health education programs based on the Health Belief Model, delivered in diverse formats, alongside the development of an integrated hospital-community-family linkage mechanism to strengthen patients' self-efficacy. Third, standardized guidelines should be developed to establish protocols for remote assessment, exercise prescription formulation, and emergency management of adverse events, ensuring service quality and safety across diverse healthcare settings. Fourth, advancing the digital transformation of healthcare institutions through infrastructure investment and technical support will facilitate broader implementation and improved accessibility of telehealth services across diverse populations. Fifth, strengthening professional talent development by expanding the tiered training system for CR professionals—incorporating specialized modules on telehealth technologies—will provide the workforce support needed for high-quality development of the field.

Integration of HBCTR with Center-Based Cardiac Rehabilitation

The imbalance between limited medical resources and the public's growing demand for high-quality CR services highlights the promise of hybrid cardiac rehabilitation models in China.

Hybrid cardiac rehabilitation represents an integrated approach that combines center-based cardiac rehabilitation (CBCR) with HBCTR. Its core objective is to meet the diverse needs of patients through flexible service delivery models, offering an alternative for individuals who are unable to fully participate in CBCR. This hybrid model has gained support from both research evidence and professional organizations.[63,64] Studies demonstrate that hybrid approaches significantly improve patient participation rates and yield favorable outcomes in terms of cardiovascular endpoints and functional capacity among patients with CAD.[65]

Marzuca-Nassr et al conducted a study involving 42 patients diagnosed with coronary artery disease, stratified by age (<60 years, n=22; ≥60 years, n=20). Both groups received a 12-week exercise-based hybrid CR program consisting of six weeks of face-to-face rehabilitation followed by six weeks of remote monitoring, with the aim of evaluating improvements in muscle strength and functional exercise capacity.[66] Results showed significant improvements in both parameters across age groups, suggesting the applicability of hybrid CR across different age demographics. Similarly, Seron et al found that hybrid CR was as effective as traditional CBCR in preventing cardiovascular events in patients with coronary artery disease.[64] Comparable findings were also reported in a study conducted in France.[67]

Another key advantage of hybrid CR is its cost-effectiveness. Compared to CBCR, the hybrid model demonstrates significant benefits in reducing rehabilitation costs. For instance, Saeidi et al reported substantially lower per-patient costs

in the hybrid group, a finding corroborated by a study conducted in Poland.[68,69] However, a study in Australia reported higher costs for hybrid CR compared to conventional programs, suggesting that such differences may be related to national economic development levels, healthcare policy support, and other contextual factors.[70] This heterogeneity in cost-effectiveness outcomes underscores the need for larger-scale, multicenter studies that take into account local healthcare systems, economic conditions, and policy environments in order to validate the generalizability of hybrid CR models.

Limitation

This review focused on patients with CAD. Other cardiac populations that could potentially benefit from HBCTR, such as patients with heart failure, valvular heart disease, or congenital heart disease, were not included. The generalizability of our findings to these populations is therefore unknown. Future reviews should specifically examine the effectiveness of HBCTR in these patient groups. In addition, a small number of the cited references are Chinese-language publications or official reports. Readers should consider contextual differences when generalizing our findings to other healthcare settings.

Future Directions

As an emerging paradigm in cardiac rehabilitation, HBCTR demonstrates substantial potential for the secondary prevention of CAD. Compared to conventional CBCR, HBCTR exhibits comparable or superior efficacy in improving cardiovascular outcomes, enhancing psychological well-being, and increasing patient adherence, while hybrid CR models also warrant significant attention. Building on the current evidence base, future research should prioritize multicenter, large-sample, cross-regional randomized controlled trials with long-term follow-up to evaluate the durability and stability of intervention effects. Particular emphasis should be placed on assessing applicability and safety in high-risk populations and specific demographic subgroups in order to generate higher-level evidence. In addition, the clinical significance of investigating integrated intervention models—such as combining HBCTR with psychological therapy, nutritional counseling, and cognitive behavioral therapy—and comparing the differential efficacy of various combinatorial approaches merits thorough exploration. Further research into the psychological mechanisms underlying patient adherence also remains imperative to ensure safe and effective implementation across diverse age groups and risk strata.[71] As China deepens its commitment to the "Internet + Healthcare" policy framework and continues to improve its digital infrastructure, HBCTR is well positioned to expand its role in CAD rehabilitation. This approach holds promise for significantly improving the accessibility, continuity, and overall quality of cardiac rehabilitation services, ultimately contributing to optimized population health outcomes through evidence-based clinical implementation.

Conclusion

Current research has demonstrated favorable therapeutic outcomes of HBCTR in patients with CAD, with exercise-centered CR programs exhibiting particularly pronounced efficacy.[56,72] However, the existing evidence base for HBCTR is derived largely from pilot studies and feasibility assessments, underscoring the need for consolidation through larger-scale investigations with higher levels of evidence.[73,74] Furthermore, the effectiveness of HBCTR may vary according to intervention components and target populations, and comprehensive cost-benefit analyses specifically for HBCTR in Chinese CAD populations remain underexplored and require systematic investigation.[8,75,76]

Abbreviations

CAD, coronary artery disease; HBCTR, home-based cardiac telerehabilitation; CR, cardiac rehabilitation; CBCR, center-based cardiac rehabilitation.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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