CARDIAC REHABILITATION

Abstract

Cardiac rehabilitation (CR) is an extensive program designed to manage the mortality risk associated with cardiovascular disease and enhance the overall function of the cardiovascular system while elevating the individual's quality of life. This comprehensive initiative primarily revolves around physical exercise, the cultivation of a healthy lifestyle, the incorporation of cardio-active medications, provision of educational support, and comprehensive psychical and psychological evaluations. These integrated components collectively offer safety and substantial benefits, leading to remarkable improvements in lifestyle quality, functional capacity, mortality rates, and reduced hospital readmissions. Current guidelines strongly endorse the application of cardiac rehabilitation across a wide spectrum of cardiac conditions. Notably, exercise-based CR is recognized as a pivotal element in the comprehensive management of coronary artery disease (CAD). It's imperative that exercise is tailored to each individual's unique characteristics, optimizing the rehabilitation program's effectiveness. Cardiac rehabilitation encompasses an overview of recommended components for an effective cardiac rehabilitation or secondary prevention program. It also delves into varied delivery methods for these services, suggests avenues for future research, and rationalizes each program element. Notably, exercise training is underscored as a crucial focus. The conventional challenges inherent in center-based CR could potentially be resolved through the integration of digital technology, thereby enhancing care delivery. The American Heart Association's science advisory serves as a guide for the development and implementation of digital cardiac rehabilitation interventions, specifically designed for clinical settings.

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This initiative aims to amplify health outcomes and promote health equity. However, the comprehension of these interventions as a digital approach to CR is still in its infancy, with much to explore. The realm of digital health technologies, encompassing internet-based platforms, wearable devices, and mobile applications, holds the potential to mitigate challenges associated with traditional facility-based CR programs.

Keywords: Cardiac rehabilitation, mortality risk , coronary artery disease management ,Exercise-based cardiac rehabilitation, Digital Technology

I. INTRODUCTION

Cardiac rehabilitation is a multifaceted process aimed at maintaining and restoring optimal heart function. Its primary focus is on mitigating the physical and psychological factors contributing to heart disease, reversing the atherosclerotic process, prolonging the lives of individuals with diverse heart conditions, and enhancing overall cardiovascular health. Numerous professional associations and organizations define cardiac rehabilitation as a form of secondary prevention, encompassing comprehensive and long-term programs that encompass medical evaluations, prescribed physical exercise regimens, educational interventions, and counseling support. Cardiac rehabilitation proves advantageous for a range of patients, including those who have experienced myocardial infarction and undergone procedures like coronary artery bypass graft surgery (CABG) or percutaneous coronary interventions (PCI), individuals awaiting or having received heart transplants, and those with stable chronic heart failure, peripheral arterial disease, or other cardiovascular disorders. Additionally, for patients who have undergone various cardiac surgeries such as valvular heart disease interventions, systematic reviews highlight significant reductions of 20–25% in overall and cardiovascular-related mortality [1], coupled with a substantial 38% decrease in the risk of recurrent myocardial infarctions [2]. Shepherd et al. also put forth the concept of a bidirectional relationship between improved quality of life and engagement in physical activity [3]. Notably, cardiac rehabilitation has the potential to curtail coronary artery disease (CAD) hospitalizations by up to 18%.

II. CORE COMPONENTS OF CARDIAC REHABILITATION

The fundamental elements of cardiac rehabilitation encompass physical exercise, lifestyle adjustments, cardiovascular medications, educational guidance, management of diverse anomalies (such as lipidemia, hypertension, weight issues, diabetes, and smoking) [4], comprehensive physical assessments, and counseling. Furthermore, the judicious utilization of evidence-based cardio-protective medications, known for their effectiveness in secondary prevention, constitutes a crucial aspect. For a comprehensive overview of these rehabilitation components, please refer to Table 1.

III. PATIENTS WHO GET BENEFIT FROM CARDIAC REHABILITATION

As outlined by reputable sources such as NICE, the Department of Health, BACPR (British Association for Cardiovascular Rehabilitation), and European Guidelines [5–10], cardiac rehabilitation is recommended for various patient categories including:

1. Individuals with myocardial infarction, both ST-segment elevation and non-ST-segment elevation myocardial infarction.
2. Patients recently diagnosed with heart failure.
3. Individuals who have undergone heart transplants and ventricular assist devices.
4. Those who have undergone heart valve replacement.
5. Individuals who have undergone percutaneous coronary intervention
6. Increase the working capacity of the heart and body.
7. In heart disease, CR limits unfavorable psychological and physiologic effects.
8. Stabilize or reverse the progression of atherosclerosis [11]

The Objectives of Cardiac Rehabilitation Encompass [5–10]:

- Enhancing the functional capacity of both the cardiovascular system and the body.
- Mitigating the adverse psychological and physiological impacts associated with heart disease.
- Halting or reversing the progression of atherosclerosis.

Furthermore, a Cochrane review indicates that cardiopulmonary rehabilitation can lead to a reduction in hospital admissions and an improvement in all-cause mortality rates for heart failure patients by maintaining ejection fraction. However, this effect on overall mortality might not be immediately observed within the short term (less than 12 months) [12].

Table 1: Core Components of Cardiac Rehabilitation

S.no	Core Components
1	Counseling on nutrition
2	Weight management
3	Hypertension management
4	Diabetes management
5	Psychological management
6	Lifestyle changes: exercise training, physical activity counseling Smoking cessation
7	Heart valve repair
8	• Audit and evaluation Delivery of the core components requires expertise from a range of different professionals. • The team may include: • Cardiologist, community cardiologist, physician, or general practitioner • Physiotherapist • Dietitian • psychologist and exercise specialist

IV. CONTRAINDICATIONS TO CARDIAC REHABILITATION

1. Crescendo angina
2. Acute Congestive heart failure
3. Complex ventricular arrhythmia
4. Severe pulmonary hypertension
5. Inflammation in the wall of vein with associated thrombosis
6. Obstructive cardiomyopathy
7. Severe or symptomatic aortic stenosis
8. Uncontrolled inflammatory or infectious pathology

V. EXERCISE-BASED CARDIAC REHABILITATION (CR)

It is suitable for individuals diagnosed with cardiovascular diseases (CVD) and heart failure with a reduced ejection fraction measuring below 40%, as it results in notable enhancements in exercise capability. The advantages of exercise-focused cardiac

rehabilitation encompass enhanced functionality of vascular endothelial cells, restoration of normal cardiac output, amelioration of left ventricular function, and a decrease in mortality rates. However, while rehabilitation primarily centers around exercise-based training, its scope extends beyond mere physical activity and encompasses a multidisciplinary approach. (Refer to Figure 1)

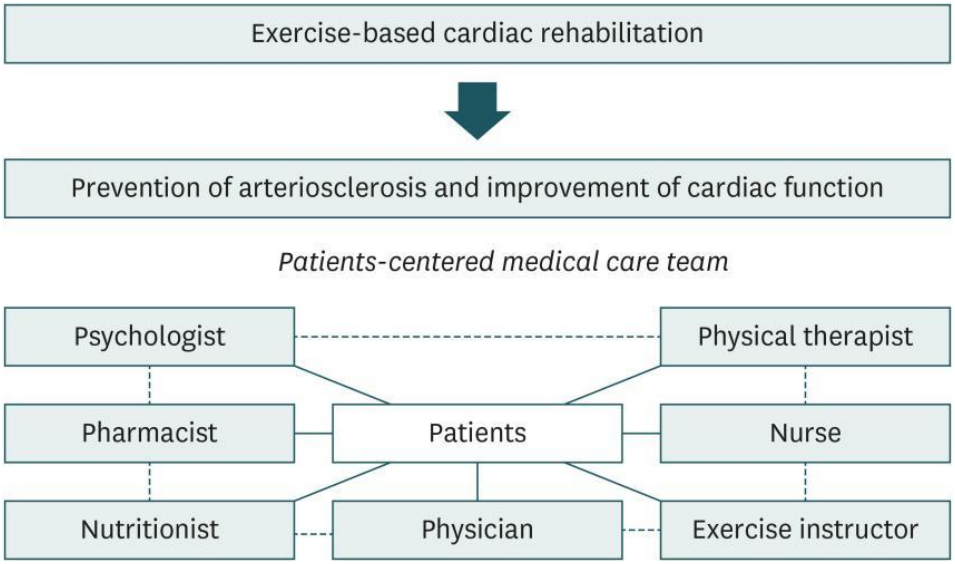

Figure 1: Exercise- Based Cardiac Rehabilitation

Exercise training is categorized as a subset of physical activity characterized by planned, structured, and repetitive bodily movements aimed at preserving or enhancing various facets of physical fitness. It constitutes a methodical intervention carried out over a predefined timeframe [13]. This form of training should be seamlessly integrated into the broader physical activity regimen. Several key points are universally acknowledged and applicable to exercise training across various clinical conditions, as outlined below (Refer to Table 2).

1. Exercise entails stress testing, often performed on a treadmill or bicycle, involving progressively challenging levels of intensity. However, this testing is unsuitable for individuals with specific cardiovascular anomalies like left ventricular dysfunction (ejection fraction <40%), neuromuscular dysfunction, or those who have recently undergone cardiac interventions.

2. Patients should be comprehensively briefed on the procedure and associated risk factors before initiating the exercise stress test.

3. Sub-maximal exertion is generally recommended (as specified in Table 2).

4. Patients should be educated about recognizing symptoms triggered by physical effort, practicing appropriate conduct, and avoiding undue physical strain during treadmill sessions.

5. Expected outcomes of training encompass heightened cardio-respiratory fitness, improved flexibility, and enhanced muscular strength.

6. Thorough physical examinations, encompassing continuous monitoring of heart rate and blood pressure prior to, during, and after exercise sessions, are imperative.

7. **Program Parameters:** During Phase 1, it is advisable to prescribe supervised hospital-based exercise training regimens for high-risk cardiovascular patients with compromised systolic left ventricular function. This approach ensures the assessment of individual responses and tolerability within a secure clinical environment, enabling the prompt identification of any indications necessitating program adjustments or termination.

Table 2: Exercise Training Prescription Guidelines

Mode	Continuous endurance: walking, jogging, cycling, swimming,aerobic training, etc.
Duration	20-30 minutes
Frequency	6-7 days per week, or may extend over several weeks
Intensity	50–80% of peak oxygen consumption close to anaerobic |threshold or peak heart rate: 40–60%
Progression	Gradually increase the intensity and duration of training over time
Follow-up	Regular follow-up for a minimum of 3-6 months
Physiological Test	Peak oxygen consumption measured by cardiopulmonary exercise testing is a recommended indicator of proper intensity

VI. PHASES OF THE CARDIAC REHABILITATION PROGRAM

1. **Phase 1: Inpatient**
   Patients with cardiac disease in acute condition, e.g., those recovering from a cardiovascular event or who have completed the procedure, may be referred for cardiac rehabilitation. The duration of this phase 1 may last between 2 and 5 days. During this phase, relaxation, breathing exercises, and simple range of motion exercises like ankle, foot, finger, and wrist movements are performed by the patients three times a day. The therapist ensures that the level of aerobic and strength training is appropriate to the patient's current status and progressively increases their therapeutic exercise [14][15].

2. **Phase 2: Outpatient Cardiac Rehab (Post-discharge, Pre- Exercise Period)**
   This phase focuses on closely monitoring patients and identifying any limitations in physical function or participation due to comorbidities. It usually begins with an intake assessment that includes measuring cardiac risk factors such as lipid levels, blood pressure, body composition, depression or anxiety, and tobacco use [16]. A functional capacity test is conducted to ensure safe physical activity and tailor an individualized exercise program [17]. Phase 2 lasts for 4 to 6 weeks after cardiac surgery.

3. **Phase 3: Intensive Outpatient rehabilitation**
   Exercise sessions in Phase 3 are similar to those in Phase 2. This phase involves self-monitoring and record-keeping of exercise progress. It consists of three exercise sessions per week, with continuous monitoring of heart rate and blood pressure. Cardiac rehabilitation therapists provide practical, heart-healthy information during sessions. Weekly educational therapy sessions are also conducted in Phases 2 and 3, emphasizing the program's benefits.

   The duration of cardiac rehabilitation varies across programs, ranging from six weeks to several years. On average, worldwide, about 24 sessions are offered [18]. Long-term maintenance programs are available for interested patients upon completing the primary rehabilitation program [19].

VII. VIRTUAL TECHNOLOGY IN CARDIAC REHABILITATION AND SECONDARY PREVENTION

The integration of advanced technology has gained widespread usage and demonstrates its potential to effectively handle the complexities within center-based cardiac rehabilitation (CBCR) while enhancing overall care. The American Heart Association's science advisory aims to provide guidance for the development and implementation of virtual cardiac rehabilitation (CR) interventions that can seamlessly transition into clinical practice, leading to improved health outcomes and equitable healthcare delivery [20] [21].

Digital Technology in CR represents a comprehensive, medically supervised program that encompasses the essential components of guideline-based therapy. These components include initial patient assessment, nutritional guidance, monitoring and management of various health parameters (such as lipids, blood pressure, weight, diabetes, and smoking), psychosocial interventions, exercise training, and physical activity promotion. The rapidly advancing landscape of CR technology has the potential to overcome the challenges associated with traditional facility-based CR programs, offering patients personalized assistance within the comfort of their own homes [22].

Digital health interventions harness various technologies, including internet connectivity, AI advancements, wearable devices, and mobile applications, to facilitate the delivery of CR services. This approach is poised to revolutionize the way healthcare is provided and accessed, ensuring tailored support and engagement for patients in their home environments.

VIII. DIGITAL HEALTH IN CARDIAC REHABILITATION AND SECONDARY PREVENTION

Current care for patients with cardiac disease involves risk stratification, risk factor management, patient education, pharmacological treatment, increased physical activity, and psychosocial support [23]. Psychosocial management often includes techniques like breathing exercises and meditation [24]. These aspects are integral to cardiac rehabilitation programs, which encompass core components (as outlined in Table 1). While telemedicine and telerehabilitation aren't yet considered standard practice, existing sensors present opportunities for implementation in various aspects of secondary prevention.

Emerging technologies, including wearable devices and smartphones, have prompted healthcare professionals and researchers to explore their integration into innovative cardiac rehabilitation initiatives to enhance engagement and participation. Wearable activity monitors (WAMs) and mobile apps on smartphones and tablets (mHealth) provide avenues for delivering proper interpretation and results to patients outside of hospital settings [25]. Different modes of cardiac rehabilitation delivery through digital technologies include real-time audio, virtual, asynchronous, and in-person approaches (Figure 2). This evolving landscape holds promise for transforming the delivery of cardiac rehabilitation services and improving patient outcomes.

Figure 2: Digital Technology and Modes of CR Delivery

1. **Hypertension:** High blood pressure is one of the main causes of cardiac disease. Before digital BP apparatus was introduced, a manually cuffed sphygmomanometer was used, but now current practice has largely evolved to a digital sphygmomanometer. These digital BP monitors work on the oscillometric method, in which pressure is measured by the principle of the automatic cuff. Some devices for measuring BP in the wrists or fingers using oscillometry are commercially available, but in 2020, the American Heart Association Guidelines on Hypertension recommend an upper arm blood pressure monitor [26]. Photoplethysmography (PPG) is a non-invasive technique used to detect volumetric changes in blood in peripheral circulation.

2. **Smoking Cessation:** Quitting smoking is the most effective way to prevent cardiovascular disease. Modern cessation strategies encompass psychological tools like cognitive-behavioral therapy, coupled with pharmacotherapy (nicotine alternatives, varenicline, bupropion) [23]. Integrating smartphone apps with exhaled carbon monoxide (CO) sensors has proven effective in behavior modification [27]. An emerging sensor type involves portable "hand-to-mouth" motion sensors to detect smoking gestures [28]. Artificial intelligence supports outcome prediction and is harnessed in AI-based chats to facilitate behavior change.

3. **Sensors in Heart Failure:** Telemonitoring, exemplified by Cardio MEMS, an implantable wireless device, tracks pulmonary artery pressure. The LINK-HF study employed a multi-sensor patch, measuring ECG, skin resistance, temperature, and acceleration to capture heart rate, arrhythmia strain, respiratory rate, activity levels, sleep, and movement [29]. Telemonitoring, aided by cardiac implantable electronic devices (CIEDs), further enhances heart failure management. The IN-TIME study demonstrated the enhanced clinical outcomes of heart failure patients through multi-parameter telemonitoring with implantable cardioverter defibrillators (ICD) and cardiac resynchronization defibrillators (CRT-D) [30]. Ongoing developments, including sensor advancements and widespread 5G internet, hold promise for acute heart failure care, encompassing both hospitalization and home-based intensive care.

4. **Sensors for Detection and Monitoring of Arrhythmia:** Untreated ventricular malignant arrhythmias pose sudden cardiac death risks. Cardiac implantable electronic devices (CIEDs) play a recognized role in ventricular arrhythmia detection, monitoring, and treatment through ICDs. Current analytical wristwatch ECGs aren't ideal for ventricular arrhythmia diagnosis, but isolated case reports of ventricular tachycardia (VT) exist [32]. Microelectromechanical sensors (MEMS) are employed in single-lead ECGs using smartwatches or smartphone-compatible devices, detecting cardiogenic motion upon chest contact. These methods demonstrate sufficient sensitivity and specificity, with FDA approval for PPG- and ECG-based devices like the Apple Watch for medical use [33].

X1. CONCLUSIONS

The physical, mental, and emotional well-being of a person is significantly impacted by heart disease. Each part of the person's life is impeded by limits. Cardiac rehabilitation is a sophisticated, multifaceted strategy tailored to the specific needs of individuals with heart disease. It entails physical activity promotion, health education, cardiovascular risk management, and psychological support. According to an assessment and evaluation of India's worldwide cardiac rehabilitation (CR) data conducted by the International Council on Cardiovascular Prevention and Rehabilitation (ICCPR) in April 2020, India has the greatest need for CR due to a lack of patient referrals and financial support. Government funding assistance and training of healthcare professionals can both enhance the delivery of CR in India [34].

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