ISSN: 1405-9940 • eISSN: 1665-1731

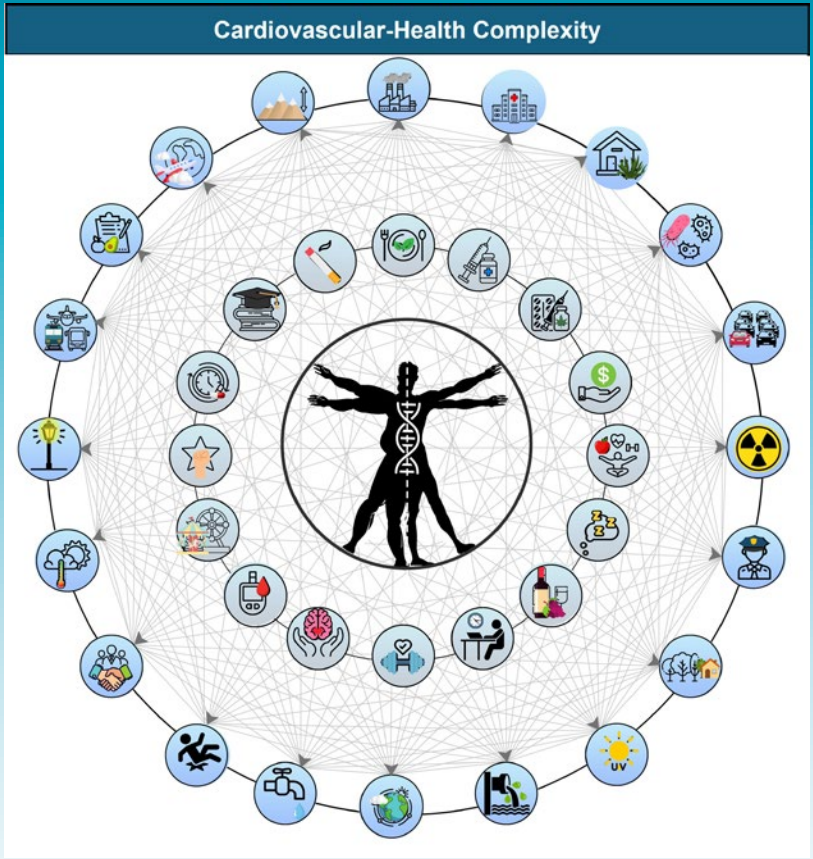
# Archivos de Cardiología de México

International journal indexed in PubMed with Open Access

Founded in 1930 – Year 95, Vol. 95 • Supplement 1 • October 2025

## 2025 Clinical Practice Guidelines of the Mexican Society for Heart Care (SOMECCOR) and the Mexican Society of Cardiology (SMC) on Cardiovascular Rehabilitation and Prevention: Therapeutic Physical Training and Heart-Healthy Lifestyle

Developed by the Task Force for Cardiovascular Rehabilitation and Prevention of the Mexican Society for Heart Care (SOMECCOR) and the Mexican Society of Cardiology (SMC)

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Órgano Oficial del Instituto Nacional de Cardiología Ignacio Chávez, a la Sociedad Mexicana de Cardiología y a SIBIC-Internacional

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**VOLUMEN 95 - Suplemento 1, 2025** – ISSN: 1405-9940
eISSN: 1665-1731



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1944 y 1961 por Instituto Nacional de Cardiología (registro 303757).

Factor de impacto: Journal Citation Reports = 0.7
Indicador de trascendencia:
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Edición impresa en México
**ISSN:** 1405-9940
**Ref.:** 11611AMEX251



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Portada: Cardiovascular-Health Complexity. Humans are immersed in a continuous interaction between their most intimate components (DNA), their decision-based behavior, and their exposure to external elements, forming a network (plexus, complexity). Cardiovascular-Health Complexity is a conceptual framework that describes the association of these interactions with potential outcomes, whether favorable or adverse. Therefore, these interactions drive our reality, whether in a vicious or virtuous cycle. p. 126.

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GUIDELINES

# 2025 Clinical practice guidelines of the Mexican Society for Heart Care (SOMECCOR) and the Mexican Society of Cardiology (SMC) on Cardiovascular Rehabilitation and Prevention: therapeutic physical training and heart-healthy lifestyle.

# Developed by the Task Force for Cardiovascular Rehabilitation and Prevention of the Mexican Society for Heart Care (SOMECCOR) and the Mexican Society of Cardiology (SMC)

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Date of reception: 01-09-2025
Date of acceptance: 24-09-2025
DOI: 10.24875/ACM.M25000099

Available online: 28-11-2025
Arch Cardiol Mex (Eng). 2025;95(Supl 1):1-178
www.archivoscardiologia.com

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## Abstract

*Comprehensive cardiovascular rehabilitation and prevention programs (CVRhP-P) are the cornerstone for improving maximum exercise tolerance, reducing mortality, improving health-related quality of life, and reducing healthcare costs in patients with cardiovascular disease (CVD). These types of programs have grown relatively slowly since their inception in the first decade of the last century, although the last 10 years have seen an increase in the number of centers, both in developing and high-income countries. In order to update and standardize scientific knowledge in this clinical area, the SOMECCOR and SMC task force developed these clinical practice guidelines based on real-world problems (PICO) and a strict, internationally approved methodology, based on AGREE-II and the Delphi method. The thematic spectrum begins with care for hospitalized and critically ill patients and continues through to long-term preventive measures, always with a focus on therapeutic physical training and a heart-healthy lifestyle. These CPGs are intended for healthcare personnel in various disciplines, as well as administrative, managerial, and government professionals. The recommendations also include a cost-benefit analysis and tips for implementation. Some topics of interest include the type of unit appropriate for patient risk, prehabilitation, telemedicine, advice on daily living for patients with heart disease (driving, air travel, etc.), dysautonomia, emergency care protocols, complexity sciences, training planning, and process management, among others.*

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***Keywords:*** *Guidelines. cardiac rehabilitation. exercise training, risk factors. coronary heart disease. heart failure. prevention. risk stratification.*

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## Abbreviations and acronyms

| | |
|---|---|
| 1RM | One-Repetition Maximum |
| 6MWT | 6-Minute Walk Test |
| 95% CI | 95% confidence interval |
| AACVPR | American Association of Cardiovascular and Pulmonary Rehabilitation |
| ABI | Ankle-Brachial Index |
| ACC | American College of Cardiology |
| ACLS | Advanced Cardiac Life Support |
| ACS | Acute Coronary Syndrome |
| ACSM | American College of Sports Medicine |
| AED | Automated External Defibrillator |
| AF | Atrial Fibrillation |
| AHA | American Heart Association |
| AMI | Acute Myocardial Infarction |
| AMPAC | Activity Measure Post-Acute Care |
| AMV | Assisted mechanical ventilation |
| ANOCA | Angina with Non-Obstructive Coronary Arteries |
| AoI | Aortic Insufficiency |
| ARA-II | Angiotensin II Receptor Antagonists |
| AS | Aortic Stenosis |
| ASCVD | Atherosclerotic Cardiovascular Disease |
| AUC | Area Under the ROC curve |
| AVB | Atrio-Ventricular Block |
| BACPR | British Association for Cardiovascular Prevention and Rehabilitation |
| BLS | Basic Life Support |
| BMI | Body Mass Index |
| BP | Blood Pressure |
| bpm | beats per minute |
| c-TNT | Cardiac Troponin T |
| CABG | Coronary Artery Bypass Graft surgery |
| CAD | Coronary Artery Disease |
| CASP-19 | Control Autonomy, Self-realization, Pleasure scale (19-item) |
| CCIS | Chronic coronary ischemic syndrome |
| CCS | Canadian Cardiovascular Society |
| CCU | Coronary Care Unit |
| Ch_A | Driver with type A driver's license |
| Ch_B-E | Drivers with type B, C, D or E driving licenses. |
| CHD | Congenital Heart Disease |
| CMAT | Continuous Moderate Aerobic Training |
| COPD | Chronic Obstructive Pulmonary Disease |
| CPET | Cardiopulmonary Exercise Testing |
| CPG | Clinical Practice Guide |
| CPR | Cardiopulmonary resuscitation |
| Cr-I | Chronotropic incompetence |
| cVCAM-1 | Vascular cell adhesion molecule 1 |
| CVD | Cardiovascular disease |
| CVRF | Cardiovascular risk factors |
| CVRhP-P | Cardiovascular Rehabilitation and Prevention Program |
| D-OAC | Direct Oral Anti-Coagulant |
| DAPT | Dual antiplatelet therapy |
| DASH | Dietary Approaches to Stop Hypertension |
| DAUCI | Acquired Weakness in Intensive Care Units |
| DBP | Diastolic blood pressure |
| DLW | Doubly labeled water |
| DmO2 | Muscle deoxygenation assessed by infrared oximetry |
| DS14 | Type D Personality Scale |
| DVT | Deep venous thrombosis |
| EACTS | European Association of Cardiothoracic Surgery |
| EAPC | European Association of Preventive Cardiology |
| EAS | European Atherosclerosis Society |
| ECG-12D | Resting 12-lead electrocardiogram |
| ECMO | Extracorporeal membrane oxygenation |
| EQ-5D | EuroQol-5D |
| ESC | European Society of Cardiology |
| ET | Exercise test or stress test |
| ExTol | Exercise Tolerance |
| FFQ | Food Frequency Questionnaire |
| FITT-VP | Frequency, Intensity, Time, Type-Volume, and Progression. |
| GAD | Generalized anxiety disorder |
| GDF 15 | Growth Differentiation Factor 15 |
| GRADE | Grading of Recommendations Assessment, Development, and Evaluation |
| HDL-C | High-Density Lipoprotein Cholesterol |
| Hedge's g | Statistic that expresses the difference of the means |
| HF | Heart Failure |
| HFpEF | Heart failure with preserved ejection fraction |
| HFrEF | Heart failure with reduced ejection fraction |
| HIIT | High-Intensity Interval Training |
| HR | Heart rate |
| HR-QoL | Quality of life associated with health |
| HRR | Heart rate recovery |
| RHR | Reserve Heart Rate |
| HRV | Heart rate variability |
| hs-CRP | Highly sensitive C-reactive protein |

| | |
|---|---|
| HVS | Heart valve surgery |
| HxTx | Heart Transplant |
| ICCPR | International Council of Cardiovascular Prevention and Rehabilitation |
| ICD | Implantable Cardioverter Defibrillator |
| ICF | International Classification of Functioning, Disability and Health |
| ICU | Intensive care unit |
| IHD | Ischemic heart disease |
| INR | International normalized ratio |
| TR | Tricuspid Regurgitation |
| LDL-C | Low-Density Lipoprotein Cholesterol |
| LVEF | Left ventricular ejection fraction. |
| MACE | Major adverse cardiovascular events |
| MacNew | The MacNew Heart Disease health-related quality of life instrument |
| MBSR | Mindfulness-based stress reduction |
| MD | Mean difference |
| MET | Metabolic unit |
| MINOCA | Myocardial Infarction with Non-Obstructive Coronary Arteries |
| MLHFQ | Minnesota Living with Heart Failure Questionnaire |
| MR | Mitral Regurgitation |
| MSC | Mitral Stenosis |
| MVC | Maximum voluntary contraction |
| MVL | Maximum Voluntary Load |
| NHS | National Health Service (UK) |
| NNT | Number needed to treat |
| NT-proBNP | N-terminal pro-B-type natriuretic peptide |
| OAC | Oral Anti-Coagulant |
| OSAHS | Obstructive sleep apnea-hypopnea syndrome |
| PADLL | Peripheral arterial disease of the lower limbs |
| PAH | Pulmonary Arterial Hypertension |
| PCI | Percutaneous coronary intervention |
| PI | Pulmonary Insufficiency |
| PS | Pulmonary Stenosis |
| PTCA | Percutaneous Transluminal Coronary Angioplasty |
| PVC | Premature Ventricular Complexes |
| RER,RQ | Respiratory Quotient |
| ResR | Respiratory rate |
| SBC | Brazilian Society of Cardiology |
| SDNN | Standard Deviation of NN intervals |
| SEC | Spanish Society of Cardiology |
| SF-36 | 36-item Short Form Health Survey |
| SFC | French Society of Cardiology |
| SIAC | Interamerican Society of Cardiology |
| SMC | Mexican Society of Cardiology |
| SMD | Standardized mean difference |
| SOMECCOR | Mexican Society for Heart Care |
| SSC | South American Society of Cardiology |
| Strgh-T | Strength Training |
| SUCRA | Area Under the Cumulative Rating Curve. |
| SYNTAX | SYNTAX score |
| TC | Total cholesterol |
| ThPhT | Therapeutic physical training |
| TS | Tricuspid Stenosis |
| VAD | Ventricular assist device |
| $VCO_2$ | Carbon dioxide production rate |
| $VE/VCO_2$-m | Ventilatory Efficiency Slope |
| VKI-OAC | Vitamin K Inhibitor Oral Anti-Coagulant |
| $VO_2$ | Oxygen uptake rate |
| VT | Ventricular tachycardia |
| VF | Ventricular fibrillation |
| WHO | World Health Organization |

# 1 Introduction

Comprehensive cardiovascular rehabilitation and prevention programs (CVRhP-P) are the cornerstone for improving maximum exercise tolerance, reducing mortality, improving health-related quality of life (HR-QoL), and reducing healthcare costs in patients with cardiovascular disease (CVD).

## *1.1 Definition*

In 1964, the World Health Organization (WHO) published Technical Report No. 270 on the rehabilitation of patients with CVD. This report was prepared by a group of experts in medicine, cardiology, occupational medicine, clinical therapy, vocational rehabilitation, cardiovascular prophylaxis, and occupational and social health. They proposed that the objective of rehabilitation should not only be to restore the patient with CVD to their previous capacity, but also to offer a broader and more comprehensive intervention that develops physical and mental functions to an optimal level. This implied starting rehabilitation early, with the aim of restoring the patient's self-sufficiency in their activities of daily living, reinstatement to work or preparation for some other full-time activity, always compatible with their work capacity, part-time employment or, if this were not possible, at least unpaid activities.[1]

In this same report, the experts list the different groups of cardiovascular pathologies that require rehabilitation, namely: congenital heart disease, rheumatic heart disease, high blood pressure, ischemic heart disease, chronic *cor pulmonale*, cardiomyopathies, and neurovegetative disorders. They also suggested the inclusion of specialists in this area, along with the training of other professionals in complementary disciplines such as education, nursing, social work, and vocational work, creating a broad network.

Three decades later, Feigenbaum E and Carter E describe that "Cardiac rehabilitation services are long-term, comprehensive programs that include a medical evaluation, exercise prescription, cardiovascular risk factor modification, education, and counseling. These programs are designed to limit the physiological and psychological impact of CVD, reduce the risk of sudden death or reinfarction, control symptoms, stabilize or reverse the atherosclerotic process, and improve patients' psychosocial and vocational status."[2]

In recent years, these programs have been conceived as a coordinated interaction of activities, which has evolved due to the problem of accessibility, relying on new technology, by developing several modes of communication with patients, which allows remote care such as telephone care protocols, synchronous in person, bidirectional real-time audiovisual, asynchronous data exchange or by text messages.[3]

## *1.2 History of the CVRhP-P*

Physical exercise has been an intentionally used intervention in cardiovascular pathologies for more than 130 years (Oertel M, Leipzig 1891), and the first structured cardiac rehabilitation program was inaugurated by Nicandro Chávez in 1944 at the National Institute of Cardiology in Mexico, where the original focus was the care of rheumatic heart disease and its sequelae. Initially, these types of programs were based exclusively on physical exercise therapy, but over the years and with the understanding of the etiological role of cardiovascular risk factors, the perspective broadened and shaped what we now know as comprehensive cardiovascular rehabilitation and prevention (CVRhP). (Fig. 1).[4,5]

## *1.3 General aspects*

The study and treatment of patients with cardiovascular diseases have evolved significantly thanks to key advances such as the design and implementation of intensive care units for myocardial infarction care, the development of various electrical therapy devices, coronary revascularization (pharmacological, mechanical, or hybrid), and even the placement or repair of prosthetic valves and the closure of congenital cardiac septal defects. These therapeutic resources have improved the survival of a large number of patients who are fortunate enough to encounter healthcare services.

However, there are significant problems that prevail today, such as the high incidence of out-of-hospital sudden cardiac death, where patients were not fortunate enough to receive medical care, which may exceed 90% of all deaths from myocardial infarction. Furthermore, there is a high incidence of adverse events and the persistent loss of health-related quality of life during the vulnerable period after hospital discharge.[6,7,8] Patients with CVD often generate high care costs and have a low return to work rate.[9]

One in three people worldwide requires rehabilitation at some point in their lives, because of congenital, acute, or chronic health conditions. Recently, the WHO developed a package of rehabilitation interventions as a substantial strategy toward its inclusion within universal health coverage and the implementation of the

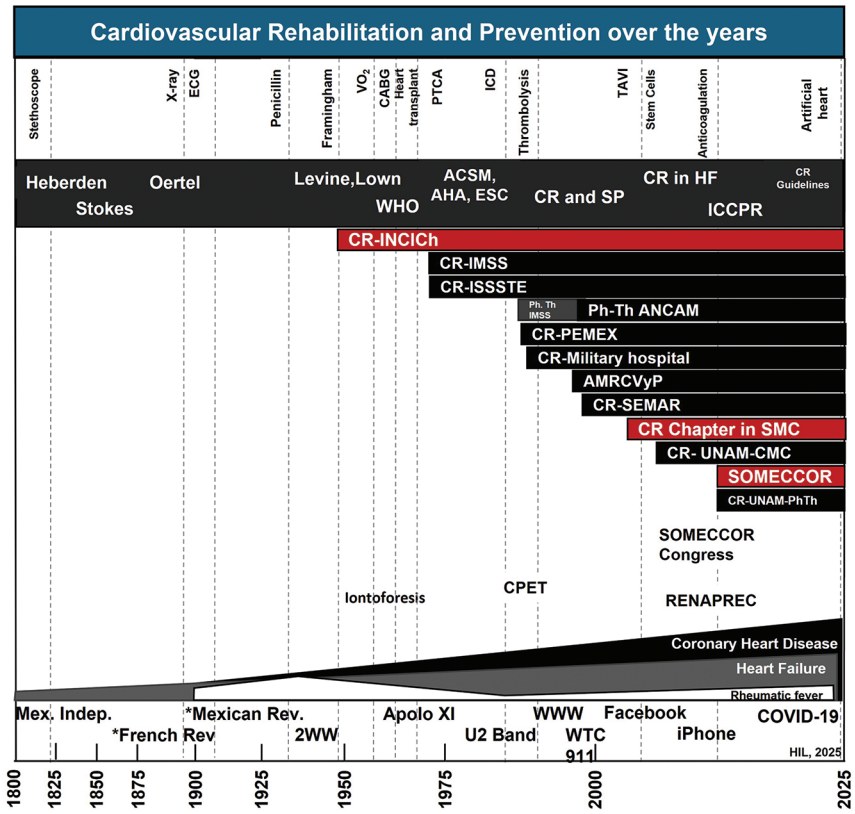


**Figure 1.** Cardiovascular Rehabilitation and Prevention over the years. Timeline of synchronous events with Cardiovascular Rehabilitation programs in Mexico and the World. Electrocardiography (ECG), oxygen uptake (VO2), coronary artery bypass grafting (CABG), percutaneous transluminal coronary angioplasty (PTCA), implantable cardioverter-defibrillator (ICD), transcatheter aortic valve implantation (TAVI), World Health Organization (WHO), American College of Sports Medicine (ACSM), American Heart Association (AHA), European Society of Cardiology (ESC), Cardiac Rehabilitation and Secondary Prevention (CRS and SP), Cardiac Rehabilitation in Heart Failure (CRS in HF), International Council of Cardiovascular Prevention and Rehabilitation (ICCPR), Ignacio Chávez National Institute of Cardiology (INCICh), Mexican Social Security Institute (IMSS), Institute of Social Security and Services for State Workers (ISSSTE), physical therapists (PhTh), National Association of Cardiologists of Mexico (ANCAM), Medical Services of Petróleos Mexicanos (PEMEX), Mexican Rehabilitation Association Cardiovascular and Pulmonary (AMRCVyP), Health Services of the Secretariat of the Navy (SEMAR), Mexican Society of Cardiology (SMC), National Autonomous University of Mexico (UNAM), Mexican Council of Cardiology (CMC), Mexican Society for Heart Care (SOMECCOR), Cardiopulmonary Test (PECP), National Registry of Cardiac Rehabilitation Programs (RENAPREC), Revolution (Rev.), World-Wide-Web (WWW), World Trade Center September 11, 2001 (WTC 911), Coronavirus Disease (COVID-19).

Rehabilitation 2030 Initiative. This document describes the essential actions for the rehabilitation of the 20 most relevant conditions in general, enabling countries to plan and budget for the integration of these services into their health systems. This document refers to the rehabilitation of patients with ischemic heart disease (module 4), with nine types of functional interventions.[10]

May GS et al. in 1982 conducted one of the first systematic reviews of six studies and 2,752 post-AMI patients. The authors found that in five studies, exercise training was associated with a 27% (20% to 37%) reduction in mortality.[11]

Research groups have confirmed that the association between CVRhP-P and reduced mortality has been maintained over the years, particularly for the most prevalent conditions such as coronary artery disease and heart failure (Fig. 2).[12,13,14,15,16,17,18,19,20,21,22,372,373]

The benefits associated with cardiovascular rehabilitation and prevention programs are a cornerstone of care for patients with heart disease and should be

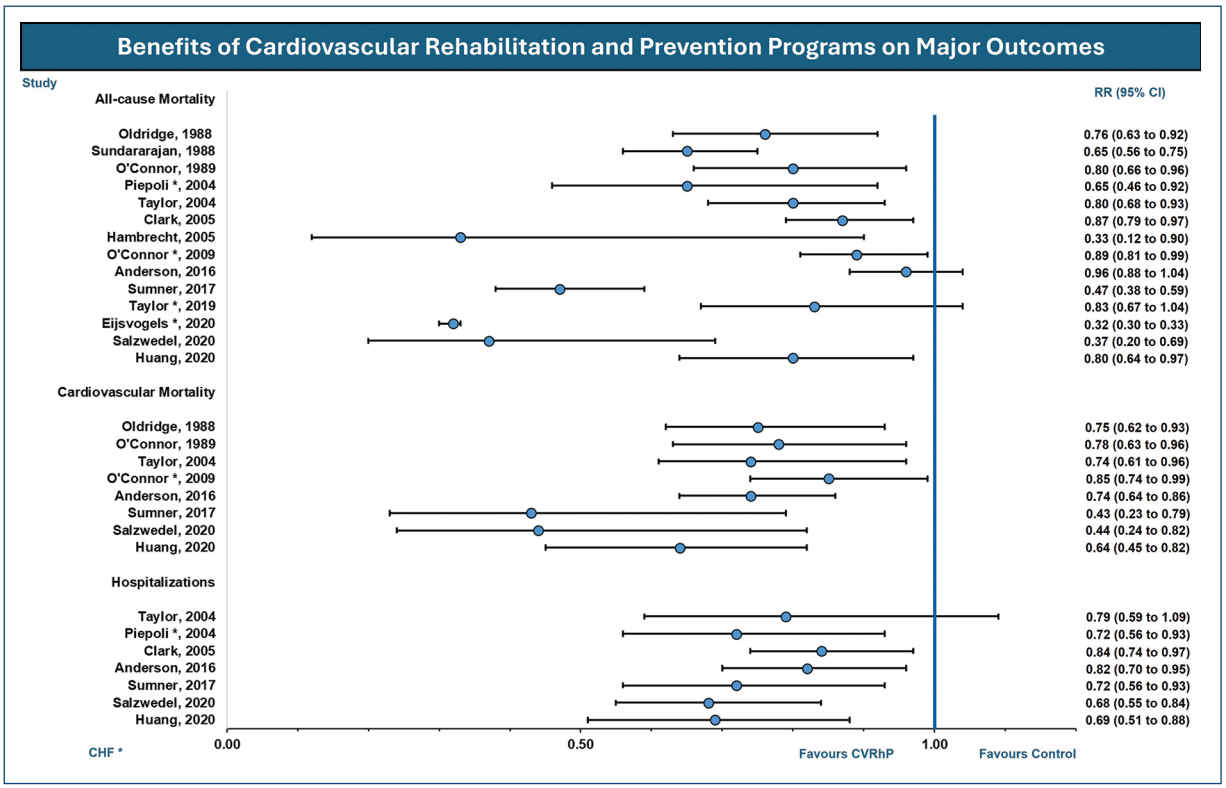


**Figure 2.** Benefits of Cardiovascular Rehabilitation and Prevention Programs on Major Outcomes. Cardiovascular rehabilitation and prevention programs (CVRhP-P) have been shown over the years to be strongly associated with survival in patients with heart disease. This Forest Plot presents some of the major studies that have demonstrated the effect of CVRhP on cardiovascular or all-cause mortality in patients with coronary artery disease or chronic heart failure (CHF). Relative Risk (RR).

linked to health strategies at the institutional, sectoral, and national levels, seeking medical, psychological, occupational, and social impact.

### *1.3.1 CVRhP-P core components*

Multilevel-multitasking processes, such as CVRhP-P, require a simplified general outline of core components, which should be versatile, with easily recognizable elements and adaptable to a variety of situations and patients.

The core components of the CVRhP-P should be associated in practice with the activities performed by the patient, preferably as a standard flowchart that integrates them into a timeline, along with the assignment of tasks for each specialist (Fig. 3).

Therapeutic physical training and the establishment of a heart-healthy lifestyle are associated with a better prognosis, provided these activities are maintained persistently and over the long term. Therefore, it is of paramount importance to establish long-term maintenance programs to promote high adherence to specific activities. It is important to note that underlying these procedures are recurring management elements such as auditing and process reengineering.[23,24,25]

The field of CVRhP involves a highly technical component that requires in-depth, specific training for staff, particularly in highly complex patients, who require close supervision and, in some cases, rapid and accurate decision-making, as in the case of a cardiovascular emergency. In other settings, the severity and risk of the patients are much lower, and less close supervision is required, along with basic training.

In the past, the CVRhP-P was largely based on the benefits associated with therapeutic physical training (exercise-based CR). In the 1990s, as cardiovascular risk factors became more important, the program's approach was expanded to systematically include risk factor screening and control, while also inviting various professionals to form a multidisciplinary task force (nutrition, psychology, etc.).

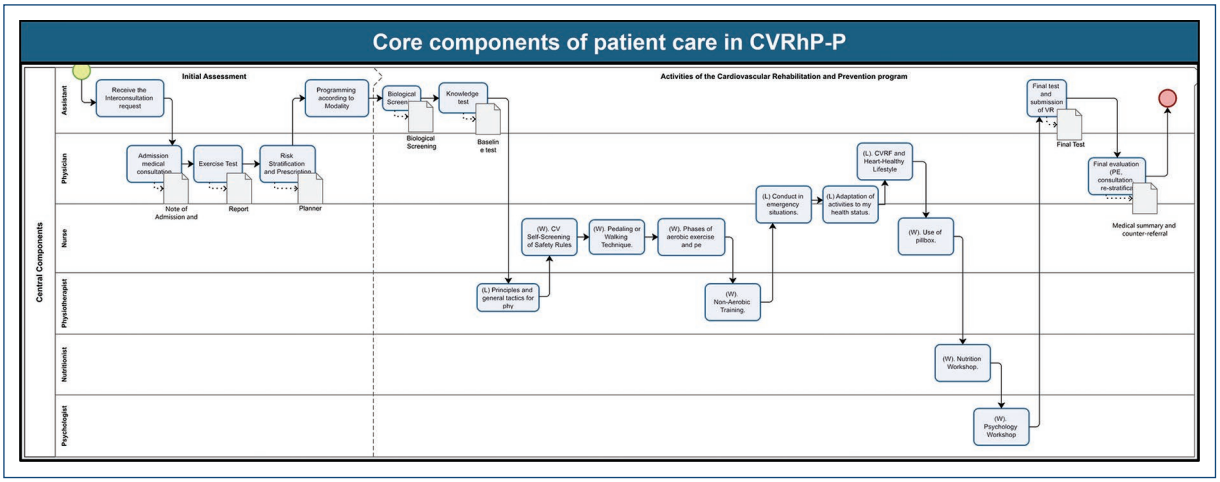


**Figure 3.** Core components of patient care in CVRhP-P. This flowchart of a typical patient highlights the main components of a standard CVRhP-P program. Patient referral initiates a process that includes multidisciplinary interventions including clinical and paraclinical assessment, risk stratification, exercise testing, training prescription and supervision, cardiovascular risk factor screening and management, nutrition, psychological aspects, health education, as well as control, regulation, and system reengineering procedures.

### 1.3.2 Indications and contraindications for CVRhP-P

Initially, the group of patients who may benefit from interventions such as CVRhP-P must be identified. These patients often have high-risk heart disease, have recently suffered a cardiovascular event, are profoundly frail, face obstacles to returning to work, or simply face a high risk of recurrent events associated with persistent risk factors. Secondly, hospital procedures should include early referrals for CVRhP-P, ideally automated, and verify that this has been done.

Nowadays, most patients can benefit from CVRhP-P. Scientific literature has shown that patients with ischemic heart disease have benefited in terms of reduced mortality, increased health-related quality of life, and reduced healthcare costs. Furthermore, available evidence shows that patients with heart conditions for whom exercise training has traditionally been contraindicated (heart failure, congenital heart disease, pulmonary arterial hypertension, etc.) can also safely benefit from modern CVRhP-P. Newer disease entities such as chemotherapy-associated heart failure and ANOCA or MINOCA syndromes have also emerged in this group. It is fair to mention the existence of cases where cardiac rehabilitation is temporarily contraindicated, and in very few cases, absolutely contraindicated (Fig. 4).

### 1.3.3 Burden of cardiovascular disease

In 2021, a total of 1,114,630 deaths from all causes were recorded in Mexico, of which 189,715 were of cardiovascular origin and 68% of these were ischemic. Worldwide, the number of deaths was 68 million, 19.4 million, and 34%, respectively. In addition to this, 566 thousand people in Mexico have some degree of disability due to HF and, globally, they add up to 45 million, all of them potentially eligible for a CVRhP-P.[26]

### 1.3.4 Current situation of CVRhP in Mexico and the World

CVRhP-P are associated with lower mortality, improved HR-QoL, higher return to work, and reduced healthcare costs. The number of CVRhP-P is increasing every day worldwide. These days, there are a wide variety of ways to implement these programs, from residential programs to remotely supervised programs using telemedicine. The number of patients referred to these programs remains very low, and the program offerings fail to meet the real needs.

There is a global underutilization of CVRhP-P due to various causes, such as the lack of patient referrals or the uneven distribution of cardiac rehabilitation units. It has been reported that only 55% of countries worldwide have CVRhP programs, of which 77% were supervised programs and 46% of units offered alternative models,

| | Diagnosis | ICD-11 | Comments |
|---|---|---|---|
| Indicated | Acute coronary ischemic Syndrome (Convalescence) | BA41 | From the subacute/post-acute phase (≥ 5-7 days) |
| | Chronic coronary syndrome | BA40.1 | If controlled and without active ischemia |
| | Coronary revascularization (PCI or CABG) | QB50.4 - QB50.1 | When the patient is hemodynamically stable |
| | Chronic heart failure (various etiologies) | BD71 | Functional class I-III (NYHA) stable |
| | Heart or Lung Transplant | QB63.1 | With stable function and no active rejection |
| | Congenital heart disease in adults | LA8Z | Evaluate on a case-by-case basis |
| | Non-Ischemic dilated cardiomyopathy | BC43.0 | Clinically stable patient |
| | Heart Valve Disease, Corrected surgically or percutaneously | BC01 | Hemodynamically stable patient |
| | Chronic Atrial Fibrillation / Arrhythmias | BC81.32 | If no decompensation or thromboembolic risk without anticoagulation |
| | Cardiac Implantable Electronic Devices (ICD, pacemaker) | QB50.00 - QB50.03 | 2-3 weeks, clinical stability |
| | Ventricular assist devices | PK91.0 - QC48.Y | With hemodynamic stability |
| | Peripheral arterial disease | BD40 | 1-2 weeks post-revascularization |
| | Pulmonary arterial hypertension | BA01.0 | Clinical stability |
| | Hypertrophic cardiomyopathy | BC43.1 | Individualized and gradual |
| | Dysautonomia | 8D84 | Individualized and gradual |
| Contraindicated | Acute coronary syndrome | BA40.0 | Temporary (until clinical stabilization) |
| | Decompensated heart failure | BD11 | Temporary (until hemodynamic stabilization) |
| | Severe and symptomatic LV outflow obstruction | BB70 | Temporary (until surgical/interventional resolution) |
| | Syncope of undetermined origin | MG45 | Temporary (until etiology is known) |
| | Uncontrolled life-threatening ventricular arrhythmia | BC82.0 | Risk of sudden death. Until stabilized |
| | Acute aortic syndrome | BD50 | Temporary (until clinical stability, depending on risk) |
| | Acute pericarditis or myocarditis | BB20 - BC42.Z | Temporary (until total remission) |
| | Deep venous or pulmonary thromboembolism | BB00.0 - BD71 | Temporary (until hemodynamic stabilization) |
| | Uncontrolled hypertension (≥180/110 mmHg at rest) | BA00 | Temporary (until blood pressure control) |
| | Hyperglycemia (> 300 mg/dL) | 5A11 | Temporary (until glycemic control) |
| | High-risk severe pulmonary arterial hypertension | BB01 | Evaluate on a case-by-case basis |
| | Thyrotoxicosis | 5A02 | Temporary (until it is under control) |

**Figure 4.** Indications and contraindications of CVRhP-P. This table lists the indications and contraindications for CVRhP-P associated with the 11th edition of the International Classification of Diseases (ICD-11) code. It recognizes that all types of heart disease can be included, while most contraindications are usually temporary. Patient enrollment in a CVRhP-P depends on several factors, both individual and methodology-specific. For example, patients with hypertrophic cardiomyopathy or those recovering from an episode of myocarditis may be disqualified for a CVRhP-P due to the increased risk of complications such as arrhythmias, syncope, or sudden death. If these patients are stratified, have a properly individualized training plan, and are provided with appropriate equipment (arrest chart), they could train and thus improve their ExTol without experiencing major adverse events.

such as home-based programs (34%), e-rehabilitation (64%), and 23% with community programs.[27]

In 2022, forty-five CVRhP units were reported to be operating in Mexico, occupying 20 of the country's 31 states, an increase of 221% since the first report in 2009. Most centers implemented the basic actions of Phase II of the programs, and the composition of the multidisciplinary team was heterogeneous. Care modalities include outpatient, home-based, telemedicine, and hybrid programs. Seventy-five percent of these units are private. This registry continues to show a low referral rate of eligible patients (9%). Care costs per program are around USD $1,200 and are covered by institutions, insurance companies, or directly by patients.[28,29]

## 2 Methodology for developing clinical practice guidelines

This clinical practice guideline (CPG) has been developed using a systematic, rigorous, and transparent methodology that seeks to provide up-to-date, valid, and relevant scientific information to support clinical decision-making related to patients participating in CVRhP-P. This figure presents the Gantt chart containing the development stages of the CPG (Fig. 5).

### 2.1 Scope and Purpose

#### 2.1.1 Objectives (1)

The CPGs on Cardiovascular Rehabilitation and Prevention (CVRhP) developed by the Mexican Society for Heart Care (SOMECCOR) and the Mexican Society of Cardiology (SMC) are intended to provide healthcare professionals responsible for the care of patients with CVD with the most up-to-date recommendations based on global scientific evidence in the field of rehabilitation, exercise therapy, and cardiovascular prevention.

The authors hope that, with the dissemination and implementation of these CPGs, the CVRhP-P will be standardized, increasing the quality, accessibility, and self-sustainability of the centers, along with an increase in the referral of eligible patients. These actions will lead, in the long term, to a decrease in fatality and an increase in HR-QoL.

#### 2.1.2 Clinical questions (2)

The group of experts who conducted these CPGs was made up of specialists from various disciplines that made up the CVRhP-P and followed the methodology

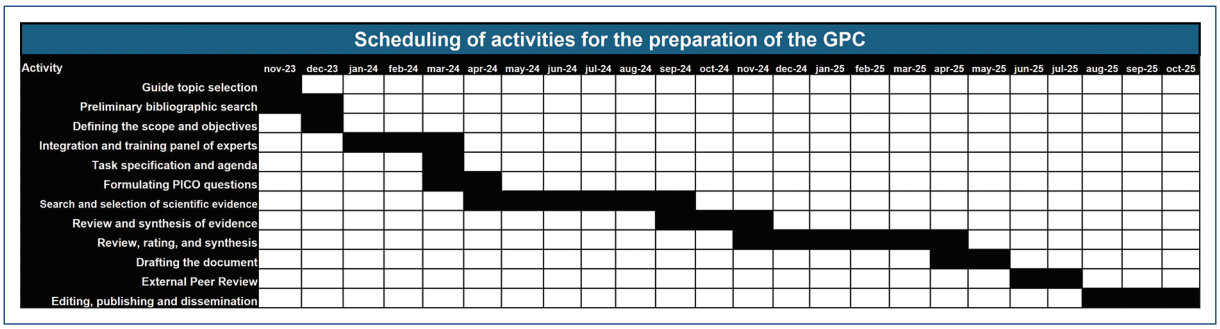


**Figure 5.** Scheduling of activities for the preparation of the CPG. This Gantt chart presents the planned schedule for completing the stages involved in developing these CPGs, in accordance with international recommendations.

established in AGREE-II and Delphi.[30,31,32] Our group of experts formulated relevant questions, focused on the patient or management, according to the PICO model, obtained directly from the problems observed in clinical practice, care work and process management (Fig. 6).[33]

The main topics were: risk assessment of patients with CVD before entering the CVRhP program, ways to offer physical exercise therapy, intervention in emergency situations, comprehensive preventive measures, establishment of a heart-healthy lifestyle and prescription of specific treatments, in the search to improve HR-QoL, reduce mortality, morbidity and healthcare expenditures in this population, at the different levels and modalities of healthcare.

### 2.1.3 Population (3)

This CPG focuses on patients requiring cardiovascular rehabilitation and prevention, all genders, pediatric, adult, and elderly, who suffer from various types of CVD such as ischemic, valvular, congenital, cardiomyopathies, HF, or peripheral arterial disease, among others. It also seeks to cover the full spectrum of disease severity and include specific aspects of some comorbidities such as diabetes, COPD, chronic kidney disease, dyslipidemia, high blood pressure, obesity, and sleep disorders, for example. This document will present recommendations for patients in various settings, from outpatient care to those admitted to intensive care units.

## 2.2 Stakeholders involved

### 2.2.1 Working groups (4)

The members of the working group were selected based on their professional training, experience, teaching, and research in the field of cardiovascular prevention and rehabilitation. Overall, the calculated expertise coefficient was 8.1 ± 1.1 (mean ± SD), and the level of motivation was 9.52 ± 0.68 (both on a scale of 0 to 10).[34,35] Representatives from various academic disciplines and major public and private health institutions were also present. The following table summarizes the information provided by the contributors to these guides (Fig. 7).

### 2.2.2 Target population, preferences, and opinions (5)

Assessment of patient values and preferences. To ensure that the recommendations included in this CPG consider patients' values, preferences, and priorities, a direct consultation process was conducted through the application of a face-to-face survey. This was intended to gather patients' opinions on the topics addressed in the guideline, identify the health outcomes they consider most relevant, and explore their preferences regarding how they receive clinical information and participate in therapeutic decision-making.

The survey included three sections: 1) Rating of the topics included in the guide, using a 5-point Likert-type scale. 2) Selection of the most important outcomes for their recovery (maximum three). 3) Preferences regarding clinical decision-making and information format.

The survey was administered to patients with a history of acute myocardial infarction, heart failure, valvular heart disease, or recent cardiac surgery, all of whom were participants in the CVRhP-P. Data collection was conducted in person and voluntarily. Each patient was interviewed individually by a cardiologist, who explained all the clinical recommendations included in the guideline in a clear and understandable manner, ensuring

| Recommendation | Chapter | PICO Clinical Questions | Outcome | MeSH search terms | Platform | Ref. (n) |
|---|---|---|---|---|---|---|
| G2-R4 | CR Generalities | What is the optimal duration and frequency of the different phases of the physical training program, among the other prescription variables? | Critical | Cardiac Rehabilitation AND Exercise Therapy AND Time Factors AND Exercise Prescription AND Exercise Intensity; Cardiac Rehabilitation AND Exercise Tolerance AND Physical Endurance AND Patient Compliance AND Quality of Life; Cardiac Rehabilitation AND Physical Conditioning AND Oxygen Consumption AND Treatment Outcome AND Mortality | PubMed | 7 |
| G2-R6 | CR Generalities | What are the goals a patient should meet at a CR? | Critical | (Cardiac Rehabilitation) OR (Cardiovascular Diseases/rehabilitation) AND (Treatment Outcome) OR (Patient Compliance) OR (Health Behavior) AND (Exercise Tolerance) OR (Muscle Strength) OR (Postural Balance) OR (Smoking Cessation) OR (Body Composition) AND (Prognosis) OR (Survival Rate) OR (Recurrence) OR (Hospitalization) AND (Humans) AND (Adult) | PubMed | 9 |
| G2-R2 | CR Generalities | How can we improve the referral rate for patients with CVRhP-P? | Critical | (Cardiac Rehabilitation) AND (Referral and Consultation) AND (Health Policy); (Cardiac Rehabilitation) AND (Enrollment) AND (Education) AND (referral and consultation) | PubMed | 5 |
| G2-R1 | CR Generalities | How can long-term participation and adherence to cardiac rehabilitation programs be promoted? | Critical | (cardiac rehabilitation) AND (Adherence) | PubMed | 7 |
| G3-R2 | Modalities | What is the effect of telerehabilitation in terms of safety and efficacy? | Important | ("Cardiac Rehabilitation"[MeSH] OR "Cardiovascular Rehabilitation"[Title/Abstract]) AND ("Telerehabilitation"[MeSH] OR "Telemedicine"[MeSH] OR "Remote Rehabilitation"[Title/Abstract] OR "Telehealth"[Title/Abstract]) AND ("Patient Compliance"[MeSH] OR "Adherence"[Title/Abstract]); Cardiac Rehabilitation AND Telehealth OR Telemedicine AND Cardiovascular disease AND Mortality NOT Cancer; Cardiac Telerehabilitation and Mortality | PubMed | 6 |
| G4-R4 | Prevention | How to manage smoking in patients with heart disease? | Critical | "Smoking Cessation"[Mesh] OR "Tobacco Use Cessation"[Mesh] OR "smoking cessation" OR "tobacco cessation" OR "quit smoking") AND ("Cardiovascular Diseases"[Mesh] OR "cardiac rehabilitation" OR "heart disease" OR "myocardial infarction" OR "coronary artery disease") AND ("Randomized Controlled Trial"[pt] OR "meta-analysis"[pt] OR "systematic review"[pt]); ("Smoking Cessation"[Mesh] OR "tobacco cessation") AND ("Bupropion"[Mesh] OR "Varenicline"[Mesh] OR "Nicotine Replacement Therapy" OR "nicotine patch" OR "pharmacotherapy") AND ("Cardiovascular Diseases"[Mesh] OR "heart disease" OR "post-myocardial infarction") AND ("Randomized Controlled Trial"[pt] OR "clinical trial"[pt]) | PubMed | 4 |
| G4-R2 | Prevention | What are the lipid control goals in patients with ischemic heart disease? | Critical | (cardiac rehabilitation) OR (cardiac) AND (rehabilitation) OR (cardiac rehabilitation) AND (cholesterol) OR (cholesterol) OR (cholesterol) OR (cholesterole) OR (cholesterols); (cardiovascular risk) AND (atherosclerotic cardiovascular disease) | PubMed | 3 |
| G4-R1 | Prevention | What is the recommended vaccination schedule for patients with heart disease? | Critical | (immunization) AND (heart disease); (immunization) AND (heart disease) AND (CDC) | PubMed, Google Scholar | 2 |
| G4-R3 | Prevention | What is the importance of evaluating periodontal disease in patients with heart disease? | Important | [Periodontal disease] AND [cardiovascular disease]; [oral health] AND [Cardiovascular disease]; [chronic periodontitis] AND [coronary artery disease] | PubMed | 7 |
| G4-R5 | Prevention | How can cardiovascular risk factors be controlled in children and adolescents? | Important | ((cardiovascular) AND (risk factors)) AND (children), ((cardiovascular disease) AND (children)) | PubMed | 3 |
| G5-R2 | Infrastructure | What regulations must be followed to establish a cardiac rehabilitation unit in Mexico? | Critical | Health normativity and cardiac rehabilitation ((health norms) OR (normativity)) AND (cardiac rehabilitation); [normativity] and [consultation room] and [mexico] | PubMed | 5 |
| G5-R4 | Infrastructure | What is the recommended physical area for training gyms at CR? | Important | [cardiac rehabilitation] AND [infrastructure]; [cardiac rehabilitation] AND [gym] | PubMed | 3 |
| G5-R3 | Infrastructure | What equipment is needed for the different levels of monitoring (control) of patients in cardiac rehabilitation according to their characteristics? | Critical | Cardiac Rehabilitation and statements; cardiac Rehabilitation and guidelines; cardiac Rehabilitation and monitoring; cardiac Rehabilitation and devices; cardiac Rehabilitation and electrocardiogram; cardiac Rehabilitation and exercise | PubMed | 2 |
| G5-R1 | Infrastructure | Is an emergency care cart required during CR sessions? | Critical | (Cardiac rehabilitation) and (equipment); (cardiac rehabilitation) and (guidelines); (cardiac rehabilitation) and (materials resources); rehabilitación cardiaca y seguridad; rehabilitación cardiaca y pruebas de esfuerzo; rehabilitación cardiaca y calidad. | PubMed | 9 |
| G6-R1 | Management | What to do when a cardiac rehabilitation center is inoperative? | Important | [CARDIAC REHABILITATION] AND [PROCESS MANAGEMENT]; [CARDIAC REHABILITATION] AND [RE-ENGINEERING]; [APPLY] AND [PROCESS MANAGEMENT AND HEALTH];[cardiac rehabilitation] AND [quality improvement] | PubMed | 4 |
| G6-R2 | Management | How to ensure quality in the operation of CR units? | Important | [CERTIFICATION] AND [CARDIAC REHABILITATION]; [QUALITY EVALUATION] AND [CARDIAC REHABILITATION]; [QUALITY EVALUATION] NOT [QUALITY OF LIFE] AND (CARDIAC REHABILITATION). (cardiology) and (measurement) AND (improvement) | PubMed | 8 |
| G6-R3 | Management | What CR staff training strategies can be implemented, and what is the ideal professional profile? | Important | [Cardiac Rehabilitation] AND [Professional Competence] | PubMed | 5 |
| G6-R4 | Management | How to identify successes or failures in the care or administration processes of a CR center? | Important | ("Integrated Advanced Information Management Systems/organization and administration"[Mesh]) AND "Cardiology Service, Hospital/organization and administration"[Mesh]) OR "Cardiac Rehabilitation"[Mesh] ("Cardiology"[Mesh]) AND "Quality Improvement"[Mesh] process[All Fields] AND ("organization and administration"[MeSH Terms] OR "disease management"[MeSH Terms] OR management[Text Word]) | PubMed | 2 |
| G6-R6 | Management | How to ensure proper referral of patients by treating physicians? | Critical | "Referral and Consultation"OR "Referrals" OR "Consultation"AND "Quality of Health Care" OR "Patient Care Management" OR "Continuity of Patient Care" OR "Health Services Accessibility" and "cardiac rehabilitation" | PubMed | 6 |
| G7-R3 | Therapeutic Physical Exercise | When should training begin for different types of patients: post-surgical, pacemaker, interventional, post-hospitalization, post-AMI, etc.? | Important | (Cardiac Surgical Procedures) AND (rehabilitation); (myocardial infarction) AND (rehabilitation); (Implantable cardioverter-defibrillator) AND (exercise) | PubMed | 6 |
| G7-R7 | Therapeutic Physical Exercise | What should be taken into account when planning a patient's CR program? | Important | (Planning) AND (cardiac rehabilitation) | PubMed | 4 |
| G7-R4 | Therapeutic Physical Exercise | How to correctly prescribe and supervise training in patients with CVD? | Critical | #exercise prescription# and #cardiac rehabilitation#; #Safety# and #cardiac rehabilitation# and #medically supervised#; #Resistance exercise# and #cardiac rehabilitation# | PubMed | 5 |
| G7-R1 | Therapeutic Physical Exercise | What is the usefulness of different aerobic (treadmill, cycle ergometry, dance) and non-aerobic training modalities in CR? | Important | [Dance] AND [cardiac rehabilitation]; [Treadmill] and [Cycle Ergometer] and [Cardiac Rehabilitation]; [Resistance exercise] and [cardiac rehabilitation]; [physical training] AND [cardiac rehabilitation] | PubMed | 4 |
| G7-R8 | Therapeutic Physical Exercise | What is the level of monitoring (control) of patients in cardiac rehabilitation according to their characteristics? | Important | (cardiac rehabilitation) AND (exercise training) AND (activity) AND (functional status);(Cardiac rehabilitation) AND (Coronary heart disease) AND (Exercise training) OR (Physical activity Prevention) | PubMed, EBSCO | 3 |
| G7-R12 | Therapeutic Physical Exercise | What is the importance of patients self-assessing safety measures before performing physical training? | Critical | (Cardiac rehabilitation) AND (self-efficacy) AND (Exercise);(self-efficacy) AND (coronary heart disease) AND (cardiac rehabilitation); (cardiac rehabilitation) and (education) and (acute coronary syndrome) | PubMed | 3 |
| G7-R2 | Therapeutic Physical Exercise | What is the importance of teaching exercise technique? | Important | (Exercise techniques education) AND (cardiac rehabilitation); (Cardiac rehabilitation AND (patient education) | PubMed | 4 |
| G7-R10 | Therapeutic Physical Exercise | How can the intensity of physical training be prescribed or established in different populations? | Critical | (cardiac rehabilitation) AND (prescription) | PubMed | 2 |
| G7-R5 | Therapeutic Physical Exercise | How to establish an adequate respiratory pattern in patients with cardiovascular disease? | Important | (Respiratory muscle training) AND (heart disease) | PubMed | 4 |
| G7-R6 | Therapeutic Physical Exercise | What is the most efficient and safe way to advance the training of patients in a physical training program? | Important | (Cardiac Rehabilitation) AND (Exercise Therapy) AND (Exercise) AND (Time Factor) | PubMed | 1 |
| G7-R11 | Therapeutic Physical Exercise | Is it necessary to have an emergency care program (for pediatric and adult patients) and conduct drills within CR? | Critical | ((exercise[MeSH Terms]) AND (safety[MeSH Terms])),(aid, first[MeSH Terms]) AND (Emergency Cardiovascular[MeSH Terms]); (exercise) and (cardiovascular events) | PubMed | 5 |
| G8-R6 | Nutrition | How is nutritional assessment and intervention performed in adults with heart disease admitted to a CR? | Important | nutrition and Cardiac rehabilitation; Evaluación nutricional en rehabilitación cardiaca;(cardiac rehabilitation) AND (nutritional advice) | PubMed, Google Scholar | 4 |
| G8-R3 | Nutrition | How is nutritional assessment and intervention performed in children with congenital heart disease admitted to CR? | Important | (Congenital heart defects) AND (Nutritional assessment); (Cardiorespiratory rehabilitation) AND (Congenital heart diseases); (Crecimiento) AND (desarrollo) AND (cardiopatias congénitas) | PubMed, Google Scholar | 3 |
| G8-R2 | Nutrition | How to measure food and nutrient intake in patients with CVD? | Important | Food intake not animals | PubMed | 2 |

*(Continues)*

**Figure 6.** Clinical questions in PICO format. This table presents the PICO questions that form the backbone of this CPG, giving it its strength by supporting the set of recommendations on problems in everyday clinical practice *(continuation)*.

| Recommendation | Chapter | PICO Clinical Questions | Outcome | MeSH search terms | Platform | Ref (n) |
|---|---|---|---|---|---|---|
| G8-R4 | Nutrition | How to improve adherence to nutritional plans in patients undergoing cardiovascular rehabilitation? | Important | (diet adherence) AND (cardiac rehabilitation) clinical trial; (diet compliance) AND (cardiac rehabilitation) | PubMed | 2 |
| G8-R5 | Nutrition | What is the usefulness of the Mediterranean diet in the nutritional counseling of patients with heart disease? | Important | (Mediterranean Diet) and (cardiovascular disease) | PubMed, LILACS | 5 |
| G8-R7 | Nutrition | Is the cornfield diet an alternative for patients with cardiovascular disease? | Important | (Mexican Diet) and (risk factor); (dieta de la milpa) | PubMed, Google Scholar | 5 |
| G8-R1 | Nutrition | What are the nutritional recommendations for patients with stress, anxiety, or depression, and for patients who have quit smoking? | Important | (Behavior therapy) AND (weight loss); (Diet) AND (body weight) AND (risk); (Nicotine) AND (flavors);(Smoking) AND (Antidepressive Agents);(Smoking) AND (reduction interventions); (Addiction) AND (withdrawal) AND (Obesity); (Tobacco) AND (withdrawal) | PubMed, NIH | 10 |
| G9-R3 | Psychology | What is the importance of psychotherapy after a cardiovascular event? | Important | (psychologic) and (cardiovascular disease);(depression) and (cardiovascular disease) | PubMed, Google Scholar | 5 |
| G9-R7 | Psychology | How does psychological intervention in CR improve the quality of life in patients with heart disease? | Important | (psychological intervention) and (heart disease) and (quality of life) | PubMed, Google Scholar | 2 |
| G9-R4 | Psychology | What is the usefulness of using psychological or neuropsychological tests or self-examination in patients with cardiovascular disease? | Important | (Psychosocial Evaluation) AND (Psychosocial Intervention) AND (Quality of Life) AND (Mental Health); (Cognitive behavior therapy) AND (Psychological health) AND (Quality of Life) AND (Depression); (Psychosocial Evaluation) AND (Mortality) NOT cancer | PubMed, LILACS, Scielo | 2 |
| G9-R8 | Psychology | What is the best way to assess health-related quality of life in patients with heart disease? | Important | (Cardiac Rehabilitation) AND (Heart Failure) AND (Quality of Life) AND (Biophysiological Parameters); (Cardiac Rehabilitation) AND (Mental Health) AND (Depression) AND (Anxiety) AND (Quality of Life); (Cardiac Rehabilitation) AND (Acute Coronary Syndrome) AND (Exercise) AND (Health-Related Quality of Life); (HeartQoL) AND (Heart Disease) AND (Quality of Life) AND (Psychometric Evaluation); Google Scholar: "Emotional Evolution" AND "Quality of Life" AND "Cardiac Rehabilitation" AND "Acute Coronary Syndrome" | PubMed, Google Scholar | 11 |
| G9-R5 | Psychology | What is the use of teaching relaxation techniques to patients with heart disease within CR? | Important | (depression) and (education) and (cardiac rehabilitation program); (depression) and (cardiac rehabilitation program);(cardiovascular disease) and (mindfulness) | PubMed, SciELO | 3 |
| G9-R1 | Psychology | What is the effect of providing patients with information about psychological risk factors for cardiovascular disease? | Important | (Psychological stress) and (cardiovascular) | PubMed, Google Scholar | 2 |
| G9-R6 | Psychology | What is the use and how to offer family, couple, and/or group psychotherapeutic support after a cardiovascular event? | Important | "emotional impact"+ "heart disease" | PubMed, Google Scholar | 4 |
| G9-R2 | Psychology | How important are comprehensive support networks for patients with CVD? | Important | (Social Support) and (social integration) and (mortality) and (cardiovascular disease);(Risk factor) and (mortality) AND (Myocardial Infarction) AND (Social Support) | PubMed, Google Scholar | 2 |
| G10-R4 | Critically ill patient | What are the indications and contraindications for rehabilitation treatment in critically ill patients? | Critical | (Early Mobilization) AND (Critical Care) OR (Intensive Care Units) AND (Physical Therapy Modalities);(Early physical) AND (occupational therapy) AND (mechanically ventilated); (Safety criteria) AND (mechanically ventilated) AND (Physical therapy) AND (critically ill) AND (ICU) | PubMed | 4 |
| G10-R5 | Critically ill patient | What is the usefulness of ventilatory exercise in patients in the intensive care unit? | Critical | search("Intensive Care Units"[MeSH] AND "Respiratory Therapy"[MeSH] AND ("Pneumonia"[MeSH] AND ("Exercise Therapy"[MeSH] OR "Physical Therapy Modalities"[MeSH] OR "Pulmonary Rehabilitation"[MeSH]) AND ("Artificial Respiration"[MeSH] OR "Ventilator Weaning"[MeSH]) AND "Cardiovascular Diseases"[MeSH] | PubMed, Google Scholar | 8 |
| G10-R1 | Critically ill patient | What is the effect of mobilization and aerobic exercise on patients in the intensive care unit? | Critical | ("Cardiovascular Disease" AND "Intensive Care Units") AND ("Exercise" OR "Exercise Therapy" OR "Physical Therapy ") AND ("Length of Stay" OR "Hospitalization" OR "Complications" OR "Patient Safety") ("Cardiovascular Disease" AND "Intensive Care Units") AND ("early mobilization "); ("Cardiovascular Disease" AND "Intensive Care Units") AND ("mobilization" OR X50"Exercise"); ("Intensive Care") AND ("Heart Disease") ("mobilization" OR "Exercise" OR "Rehabilitation"); ("Cardiovascular Disease" AND "Intensive Care") AND ("rehabilitation"); "Cardiovascular Intensive Care Unit" AND "Early Mobilization" OR "Aerobic Exercise" AND "Length of Stay" OR "Complications"; "cardiac rehabilitation" AND "cardiovascular intensive care unit" AND "clinicaltrials" | PubMed, Google Scholar | 7 |
| G10-R2 | Critically ill patient | What is the usefulness of aerobic exercise in patients in the intensive care unit? | Important | (critical care) AND (extracorporeal membrane oxygenation) AND (intensive care unit) AND (multidisciplinary team) AND (rehabilitation); (postoperative cardiac surgery) AND (aerobic exercise) AND (critical care) AND (cardiac rehabilitation) (extracorporeal membrane oxygenation) AND (aerobic exercise); ECMO AND extracorporeal membrane oxygenation AND mobilization AND rehabilitation | PubMed | 5 |
| G10-R3 | Critically ill patient | What points should be addressed during rehabilitation in patients with ventricular assist devices (ECMO, HeartMate, BIAC, etc.) | Important | (cardiac rehabilitation) AND (ExtraCorporeal Membrane Oxygenation) | PubMed | 2 |
| G11-R1 | Health Education | What is the recommendation regarding weight lifting for patients with heart disease, including those after sternotomy surgery? | Critical | Resistance training and cardiac surgery; Resistance training and sternotomy | PubMed, Google Scholar | 5 |
| G11-R2 | Health Education | What is the comprehensive advice on sexual activity in patients with cardiovascular disease? | Important | (Sexual activity) AND (post cardiovascular disease); (Sexual activity) AND (cardiovascular disease) | PubMed, Ovid | 4 |
| G11-R3 | Health Education | What is the recommendation for patients with heart disease regarding driving various types of motor vehicles? | Important | (coronary) and (driving); (heart) and (driving) | PubMed, Google Scholar | 11 |
| G11-R5 | Health Education | What is the recommendation for patients with heart disease regarding air travel? | Important | (air travel) and (cardiovascular disease) | PubMed, Ovid | 6 |
| G11-R6 | Health Education | What is the recommendation for cold water immersion baths and sauna use in patients with heart disease? | Important | (cold water immersion) AND (heart disease); (cold water immersion) ND (cardiovascular disease) | PubMed | 5 |
| G11-R4 | Health Education | What is the recommended alcohol intake for patients with cardiovascular disease? | Important | Alcohol Drinking AND Cardiovascular Diseases AND Risk Assessment AND Diet AND Primary Prevention; Cardiovascular disease AND Drinking Habits AND Alcohol Consumption; Prevención de la enfermedad cardiovascular y bebidas alcohólicas fermentadas" Prevención de la enfermedad cardiovascular y bebidas alcohólicas fermentadas" "Guías alimentarias saludables y sostenibles para la población mexicana | PubMed, Google Scholar | 8 |
| G12-R6 | Paraclinical tests | What information is important to gather during the patient's first consultation, in anticipation of the next steps (stratification, monitoring, etc.)? | Important | Cardiac rehabilitation AND quality AND ischemic heart disease AND Patient evaluation, Pre-participation screening AND Exercise Therapy | PubMed, Google Scholar | 3 |
| G12-R7 | Paraclinical tests | What is the usefulness of laboratory studies in the initial evaluation of patients admitted to the cardiac rehabilitation program? | Important | cardiac rehabilitation and "Clinical evaluation"; "Clinical evaluation" and cardiac rehabilitation; cardiac rehabilitation and risk stratification | PubMed, Google Scholar | 4 |
| G12-R3 | Paraclinical tests | What is the usefulness of knowing biomarker values in later stages (stratification, prescription, exercise monitoring, etc.) in patients admitted to the cardiac rehabilitation program? | Important | (Biomarkers) and (outcome) and (cardiac rehabilitation); (Biomarkers) and (cardiac rehabilitation) and (risk stratification) | PubMed, Google Scholar | 4 |
| G12-R2 | Paraclinical tests | What physical tests do patients require before entering CR? | Important | Cardiac Rehabilitation AND Physical Examination AND Physical Fitness NOT Cancer NOT Stroke; Cardiac Rehabilitation AND Physical performance AND Physical functions AND Risk Assessment AND Tinetti mobility test NOT Stroke NOT Cancer; Cardiac Rehabilitation AND Muscle Strength AND Physical Examination AND cardiovascular disease NOT Stroke NOT Cancer | PubMed | 7 |
| G12-R5 | Paraclinical tests | How and why to measure muscle strength in patients with heart disease? | Important | muscle strength and heart; physical therapist and heart failure; resistance training and heart;exercise training and cardiac rehabilitation | PubMed, Google Scholar | 10 |
| G12-R1 | Paraclinical tests | What is the importance of assessing body composition and dietary recall in patients with cardiovascular disease? | Important | (cardiac rehabilitation) and (anthropometric); (24 hour) and (diet recalls) | Google Scholar | 6 |
| G12-R4 | Paraclinical tests | What is the importance of assessing psychological cardiovascular risk factors (depression, anxiety, personality) in patients with cardiovascular disease? | Important | Intervenciones psicológicas en Rehabilitación Cardiaca, Psicopatología y personalidad de pacientes cardiópatas, Factores de Riesgo e Intervenciones Psicológicas, Síndrome Depresivo y Ansiedad, Aspectos Psiquiatricos y conductuales de enfermedades Cardiovasculáres | PubMed, Google Scholar | 10 |
| G13-R3 | Exercise test | What is the patient's maximum exercise tolerance capacity to estimate future survival? | Critical | Exercise capacity and mortality and cardiovascular disease; VO2max and predictor;Cardiorespiratory Fitness and All-Cause Mortality | PubMed | 3 |
| G13-R1 | Exercise test | What is the usefulness of chronotropic response variables and HR recovery in risk prediction? | Important | chronotropic response AND exercise test AND risk prediction OR stratification AND cardiac rehabilitation; heart rate recovery AND exercise test AND risk prediction OR stratification; chronotropic incompetence and prognostic; chronotropic incompetence and risk | PubMed, Google Scholar | 7 |

*(Continues)*

**Figure 6.** Clinical questions in PICO format. This table presents the PICO questions that form the backbone of this CPG, giving it its strength by supporting the set of recommendations on problems in everyday clinical practice *(continuation)*.

| Recommendation | Chapter | PICO Clinical Questions | Outcome | MeSH search terms | Platform | Ref (n) |
|---|---|---|---|---|---|---|
| G13-R2 | Exercise test | What is the usefulness of assessing systolic blood pressure, during exercise and recovery, for risk prediction in patients with heart disease? | Important | Systolic blood pressure AND exercise test AND risk prediction; systolic blood pressure recovery AND ischemic heart disease; Systolic blood pressure AND exercise test AND risk prediction | PubMed, Google Scholar | 4 |
| G13-R4 | Exercise test | What is the usefulness of exercise testing to predict future ischemia in the patient, particularly during physical exercise? | Critical | (Stress electrocardiography testing in coronary artery disease) AND (exercise capacity on treadmill with future cardiac events); (Exercise capacity) AND (treadmill) AND (cardiac events) AND (Prognostic value) | PubMed, Science Direct | 2 |
| G13-R6 | Exercise test | What is the usefulness of exercise testing to predict arrhythmias in the patient's future, particularly during physical exercise? | Critical | (Exercise testing) AND (cardiovascular disease) AND (arrhythmias) AND (cardiovascular risk); (Exercise testing) AND (cardiovascular disease) AND (risk arrhythmias) AND (cardiovascular risk) NOT (athletes) NOT (Healthy)<br>(Risk of arrhythmia) AND (exercise testing) AND (ventricular extrasystole) NOT (asymptomatic) AND (exercise testing) | PubMed | 7 |
| G13-R5 | Exercise test | What is the usefulness of exercise testing for calculating risk in pediatric patients with heart disease? | Important | peak oxygen uptake and predictor and children | PubMed | 5 |
| G14-R3 | Other paraclinical tests | What is the usefulness of evaluating the glycemic profile, lipid profile, and purine metabolism in patients admitted to a cardiovascular rehabilitation program? | Critical | 1)("Cardiac Rehabilitation"[Mesh] OR "Cardiac Rehabilitation"[Title/Abstract] OR "Rehabilitation, Cardiac"[Title/Abstract]) AND ("Blood Glucose"[Mesh] OR "Blood Glucose"[Title/Abstract] OR "Glycemic Control"[Mesh] OR "Glycemic Control"[Title/Abstract] OR "Diabetes Mellitus"[Mesh] OR "Diabetes Mellitus"[Title/Abstract]). 2)Cardiac Rehabilitation"[Mesh] OR "Cardiac Rehabilitation"[Title/Abstract] OR "Rehabilitation, Cardiac"[Title/Abstract]) AND ("Lipids"[Mesh] OR "Lipids"[Title/Abstract] OR "Lipid Profile"[Mesh] OR "Lipid Profile"[title/Abstract | PubMed, biblioteca cochrane, tripdatabase | 11 |
| G14-R5 | Other paraclinical tests | What is the usefulness of assessing the degree of ventricular damage in patients with cardiovascular disease, particularly post-infarction? | Important | (myocardial damage) AND (cardiac rehabilitation); (myocardial injury) AND (cardiac rehabilitation); (left ventricle function) AND (risk stratification); (echocardiography) AND (risk stratification); (left ventricular ejection fraction) AND (risk stratification) | PubMed | 6 |
| G14-R1 | Other paraclinical tests | What is the usefulness of evaluating the presence of residual ischemia using perfusion studies? | Important | Residual ischemia and diagnosis; Chronic ischemic and nuclear imaging | PubMed | 4 |
| G14-R2 | Other paraclinical tests | What is the usefulness of assessing the arrhythmogenic state of patients with cardiovascular disease, particularly post-infarction? | Important | (Holter monitoring) AND (Post-myocardial infarction arrhythmia) AND (Heart rate variability) AND (Cardiovascular risk); (24-hour ECG monitoring) AND (Premature ventricular contractions) AND (prognosis); (Arrhythmia assessment) AND (cardiac rehabilitation) AND (cardiovascular disease) AND (myocardial infarction); Arrhythmia AND (cardiovascular disease) AND (Telemedicine) OR (Remote Consultation) AND (Exercise Therapy) AND (Electrocardiography Ambulatory Monitoring) OR (Holter Monitoring) | PubMed, SciELO | 6 |
| G14-R4 | Other paraclinical tests | What is the usefulness of assessing the inflammatory status of patients with cardiovascular disease, particularly post-infarction? | Important | (Platelet Activation) AND (Inflammation Mediators) AND (ST Elevation Myocardial Infarction); (Biomarkers) AND (Cardiovascular Diseases) AND (Stable Coronary Artery Disease) AND (Vascular Inflammation) (Biological Markers) AND (Risk Assessment) AND (Interleukin-6) AND (Cytokines) AND (Cardiovascular Diseases); (Ventricular Remodeling) AND (Biomarkers) AND (Myocardial Infarction); (Inflammation) AND (No-Reflow Phenomenon) AND (Percutaneous Coronary Intervention); (Coronary Flow Reserve) AND (Inflammation) AND (Myocardial Strain); (Ferritins) AND (Myocardial Infarction) AND (Genetic Association Studies) | PubMed | 9 |
| G15-R4 | Risk stratification | ¿Cual es la utilidad del proceso de estratificación de riesgo en pacientes con ECV dentro de un PRHCV? | Critical | (("cardiovascular risk" OR "cardiac risk") AND ("risk stratification" OR "risk calculators" OR "risk assessment tools" OR "risk classification")) OR ("cardiac rehabilitation" AND ("risk prediction" OR "risk protocols" OR "complications")) OR ("physical activity" AND ("mortality" OR "cardiovascular disease") AND ("global" OR "multi-country" OR "cohort")) OR ("coronary atherosclerosis" AND "natural history" AND "high-risk plaque"); CARDIAC RISK STRATIFICATION AND CARDIAC REHABILITATION | PubMed, Google Scholar | 7 |
| G15-R1 | Risk stratification | How is cardiovascular risk assessed? | Critical | (cardiovascular risk score) AND (secondary prevention)) AND (cardiac rehabilitation) NOT (primary prevention); (cardiac risk stratification) AND (cardiac rehabilitation programs) | PubMed, Google Scholar | 11 |
| G15-R3 | Risk stratification | In relation to risk stratification, what is the usefulness of the scales designed for risk estimation in long-term secondary prevention? | Critical | risk stratification AND exercise and heart disease; puntuaciones de riesgo AND cardiovascular AND mexico; cardiac rehabilitation AND guidelines | Google Scholar | 15 |
| G15-R2 | Risk stratification | How to perform the risk stratification process in the pediatric population? | Critical | (Cardiac Rehabilitation) AND (Risk) AND (Child); (Congenital heart disease) AND (cardiac rehabilitation) AND (risk stratification) | PubMed | 5 |
| G16-R4 | Ischemic Heart Disease | What are the components of CR for patients with ischemic heart disease? | Critical | (coronary artery disease[Title/Abstract] OR ischemic heart disease[Title/Abstract] OR coronary heart disease[Title/Abstract]) AND (cardiac rehabilitation[Title/Abstract] OR rehabilitation program[Title/Abstract]) AND (components[Title/Abstract] OR patient education[Title/Abstract] OR exercise training[Title/Abstract] OR psychosocial support[Title/Abstract] OR return to work[Title/Abstract] OR risk factor modification[Title/Abstract]) | PubMed | 3 |
| G16-R1 | Ischemic Heart Disease | What is the usefulness of PRHC in patients with ischemic heart disease? | Critical | Cardiac rehabilitation and coronary heart disease and Mortality and Quality of life | PubMed | 4 |
| G16-R2 | Ischemic Heart Disease | What is the usefulness of CR programs in patients with ischemic heart disease? | Critical | (("cardiac rehabilitation"[MeSH Terms] OR "cardiac rehabilitation" [Title/Abstract] OR "exercise-based rehabilitation" [Title/Abstract]) AND ("ischemic heart disease"[MeSH Terms] OR "ischemic heart disease"[Title/Abstract] OR "coronary artery disease"[Title/Abstract] OR "coronary heart disease"[Title/Abstract]) AND ("mortality"[MeSH Terms] OR "mortality"[Title/Abstract] OR "survival"[Title/Abstract] OR "major adverse cardiovascular events"[Title/Abstract] OR "MACE"[Title/Abstract] OR "quality of life"[MeSH Terms] OR "quality of life"[Title/Abstract]) AND ("cohort studies"[MeSH Terms] OR "prospective studies"[MeSH Terms] OR "meta-analysis"[Publication Type] OR "systematic review"[Publication Type])).<br>(Cardiovascular disease) AND (Sexual activity) AND (Sexual health) AND (Patients) AND (Cardiovascular rehabilitation) | PubMed | 8 |
| G16-R5 | Ischemic Heart Disease | What are the physical training modalities used in patients with ischemic heart disease? | Critical | exercise modalities for CHD | PubMed | 4 |
| G16-R8 | Ischemic Heart Disease | Is it useful to train angina patients through physical exercise? | Critical | ("Angina Pectoris"[MeSH Terms] OR angina[Title/Abstract] OR "stable angina"[Title/Abstract] OR "chronic coronary syndrome"[Title/Abstract]) AND ("Exercise Therapy"[MeSH Terms] OR "Exercise"[MeSH Terms] OR exercise[Title/Abstract] OR "physical activity"[Title/Abstract] OR "cardiac rehabilitation"[Title/Abstract]) AND ("Randomized Controlled Trial"[Publication Type] OR "Clinical Trial"[Publication Type] OR "Meta-Analysis"[Publication Type] OR "systematic review"[Title/Abstract]) | PubMed | 5 |
| G16-R6 | Ischemic Heart Disease | What are the nutritional goals for patients with ischemic heart disease in a CR program? | Critical | Dyslipidaemias OR Lipid Modification AND management AND treatment | PubMed | 4 |
| G16-R3 | Ischemic Heart Disease | What is the usefulness of CR in patients with ischemic heart disease in relation to their return to work? | Critical | Cardiac rehabilitation and return to work | PubMed | 4 |
| G17-R11 | Post-surgical | What is the usefulness of pre-surgical programs (Prehabilitation) in patients scheduled for surgery? | Important | ("prehabilitation"[Title/Abstract] OR "prehabilitation program"[Title/Abstract] OR "preoperative rehabilitation"[Title/Abstract] OR "preoperative exercise"[Title/Abstract] OR "preoperative care"[MeSH Terms] OR "preoperative program"[Title/Abstract]) AND ("surgery"[Title/Abstract] OR "surgical procedure"[Title/Abstract] OR "surgical patient"[Title/Abstract] OR "elective surgery"[Title/Abstract] OR "preoperative period"[MeSH Terms]) AND ("outcomes"[Title/Abstract] OR "postoperative complications"[MeSH Terms] OR "length of stay"[Title/Abstract] OR "functional capacity"[Title/Abstract] OR "functional recovery"[Title/Abstract] OR "quality of life"[Title/Abstract]) AND (cardiovascular disease) NOT cancer | PubMed | 4 |
| G17-R1 | Post-surgical | What care should be taken with surgical wound scars? | Important | (surgical wound management[MeSH Terms]) AND (cardiac rehabilitation[MeSH Terms]); (surgical wound management) AND (cardiac rehabilitation); (cardiothoracic surgery wound care[MeSH Terms]) AND (cardiac rehabilitation[MeSH Terms]); (cardiac incition[MeSH Terms]) AND (cardiac rehabilitation[MeSH Terms]); (cardiac surgical incision[Title/Abstract]) AND (rehabilitation[Title/Abstract]); ((cardiac surgical procedure[MeSH Terms]) AND (dehiscence, surgical wound[MeSH Terms])) AND (cardiac rehabilitation[MeSH Terms]); (postoperative care) AND (cardiac rehabilitation). Filters applied: Meta-Analysis; (cardiovascular scar) AND (physical therapy);(median sternotomy[MeSH Terms]) AND (cardiac rehabilitation[MeSH Terms]);<br>(scar manipulation) AND (manual therapy); (physical therapy) AND (scar);(Scar rehabilitation) AND (cardiovascular surgery); (early mobilization) AND (sternotony scar));(cardiac wound dehiscence) AND (cardiac rehabilitation) | PubMed, Google Scholar | 7 |
| G17-R2 | Post-surgical | When should strength training be started in MSTs for patients with thoracotomy? | Critical | ("cardiac surgery" or "heart surgery") and ("exercise" or "Physical activity" or "Resistence") and ("upper body");("cardiac surgery" or "heart surgery") and ("exercise" or "mobilization" or "Resistence") and ("upper body" or "Upper Limb");("sternotomy") and ("exercise" or "mobilization" or "Resistence") and ("upper body" or "Upper Limb"); ("cardiac surgery") and ("mobilization") and ("Upper Limb") | PubMed, Google Scholar | 7 |
| G17-R3 | Post-surgical | What precautions are required regarding invasive devices in the postoperative patient (cannula, catheters, probes, MC electrodes, etc.)? | Critical | (surgical wound management[MeSH Terms]) AND (cardiac rehabilitation[MeSH Terms]);(surgical wound management) AND (cardiac rehabilitation); (cardiothoracic surgery wound care[MeSH Terms]) AND (cardiac rehabilitation[MeSH Terms]); (cardiac incition[MeSH Terms]) AND (cardiac rehabilitation[MeSH Terms]);(cardiac surgical incision[Title/Abstract]) AND (rehabili) | PubMed, Google Scholar | 4 |

*(Continues)*

**Figure 6.** Clinical questions in PICO format. This table presents the PICO questions that form the backbone of this CPG, giving it its strength by supporting the set of recommendations on problems in everyday clinical practice *(continuation)*.

| Recommendation | Chapter | PICO Clinical Questions | Outcome | MeSH search terms | Platform | Ref (n) |
|---|---|---|---|---|---|---|
| G17-R4 | Post-surgical | What is the recommended intervention for children post-cardiac surgery? | Critical | Postoperative Rehabilitation[MeSH Terms]) AND (congenital heart surgery[MeSH Terms]); (Cardiac rehabilitation) AND (postoperative) AND (heart) AND (pediatric) | PubMed | 4 |
| G17-R7 | Post-surgical | What is the ideal anticoagulation regimen for a POP patient who has undergone valve replacement or biologic/mechanical valve replacement? | Critical | (Antithrombotic therapy after heart valve intervention) OR (Antithrombotic Treatment After Surgical and Transcatheter Heart Valve Repair and Replacement) OR (Guidelines for the management of valvular heart disease) NOT (mechanical valve) | PubMed | 3 |
| G17-R6 | Post-surgical | What is the ideal anticoagulation regimen for a postoperative patient undergoing TAVI? | Critical | (Antithrombotic therapy after heart valve intervention) OR (Antithrombotic Treatment After Surgical and Transcatheter Heart Valve Repair and Replacement) OR (Guidelines for the management of valvular heart disease) NOT (mechanical valve) | PubMed | 3 |
| G18-R13 | Heart failure | What are the indications and contraindications for physical training in patients with heart failure? | Critical | Heart failure and exercise | PubMed, Google Scholar | 4 |
| G17-R8 | Post-surgical | What is the ideal anticoagulation regimen for a POP patient requiring Mitraclip placement? | Critical | Antithrombotic drug management after valvular heart repair mechanical and bioprosthetic | PubMed, Google Scholar | 3 |
| G18-R10 | Heart failure | How to supervise the physical training of patients with heart failure? | Critical | Training supervision and heart failure; Training hybrid, home and heart failure; Safety training and heart failure | PubMed, Google Scholar | 5 |
| G18-R11 | Heart failure | What is the usefulness of strength (counter-resistance) training in patients with HF? | Critical | Resistance training and heart failure; Heart failure and myokines | PubMed, Google Scholar | 6 |
| G18-R8 | Heart failure | What are the advantages and disadvantages of using high-intensity interval therapy (HIIT) in patients with HF? | Critical | ("Heart Failure"[MeSH] OR "heart failure"[tiab]) AND ("High-Intensity Interval Training"[MeSH] OR "high intensity interval training"[tiab] OR "HIIT"[tiab] OR "interval training"[tiab]); Insuficiencia cardiaca, HIIT, VO2máx, fracción de eyección | PubMed, LILACS | 3 |
| G18-R1 | Heart failure | What is the nutritional intervention in patients with heart failure in CR? | Critical | "diet, sodium-restricted" AND "heart failure" | PubMed, SciELO | 6 |
| G18-R3 | Heart failure | What is the nutritional intervention in patients with heart failure in CR? | Important | Food drug interactions AND heart failure | PubMed, SciELO | 2 |
| G18-R4 | Heart failure | What is the nutritional intervention in patients with heart failure in CR? | Important | ("Heart Failure"[MeSH Terms] OR "Cardiomyopathies"[MeSH Terms]) AND ("Cachexia"[MeSH Terms] OR "Sarcopenia"[MeSH Terms] OR "Muscle Weakness"[MeSH Terms] AND ("Nutritional Status"[MeSH Terms] OR "Nutrition Therapy"[MeSH Terms] OR "Dietary Supplements"[MeSH Terms] OR "Diet, Mediterranean"[MeSH Terms]) AND ("Exercise Therapy"[MeSH Terms] OR "Cardiac Rehabilitation"[MeSH Terms]); ("Heart Failure"[MeSH] OR "heart failure"[tiab] OR "chronic heart failure"[tiab]) AND ("Cachexia"[MeSH] OR "Sarcopenia"[MeSH] OR "sarcopenia"[tiab] OR "cachexia"[tiab] OR "muscle loss"[tiab]) AND ("Nutrition Therapy"[MeSH] OR "Nutritional Status"[MeSH] OR "Diet, Mediterranean"[MeSH] OR "dietary supplements"[MeSH] OR "nutrition"[tiab] OR "nutritional intervention"[tiab] OR "oral supplements"[tiab]) AND ("Exercise Therapy"[MeSH] OR "Cardiac Rehabilitation"[MeSH] OR "physical activity"[tiab] OR "exercise"[tiab]) | PubMed | 6 |
| G18-R12 | Heart failure | What is the usefulness of home programs in patients with HF? | Critical | HOME PROGRAMMES AND HEART FAILURE AND CARDIAC REHABILITATION | PubMed | 17 |
| G18-R9 | Heart failure | What is the CR prescription to follow in patients undergoing transplant protocol? | Critical | Heart transplant and cardiac rehabilitation; Cardiac rehabilitation pre transplant; Prehabilitation in heart transplant | PubMed | 2 |
| G19-R1 | Ventricular assist devices | What are the indications and contraindications for physical training in patients with ventricular assist devices? | Critical | ventricular assist device and cardiac rehabilitation; ventricular assist device and cardiac rehabilitation | PubMed, Google Scholar | 3 |
| G19-R4 | Ventricular assist devices | What is the usefulness of the CR program in patients with ventricular assist devices? | Critical | ("Heart-Assist Devices"[Mesh]) AND "Cardiac Rehabilitation"[Mesh] | PubMed | 2 |
| G19-R3 | Ventricular assist devices | What physical therapy is generally indicated for patients with ventricular assist devices? | Important | Ventricular Assist Device and Cardiac Rehabilitation; Ventricular Assist Device and Cardiac Rehabilitatio | PubMed, Google Scholar | 6 |
| G19-R2 | Ventricular assist devices | What is the appropriate physical therapy for an ECMO patient? | Important | ("Extracorporeal Membrane Oxygenation"[MeSH] OR ECMO OR "extracorporeal life support") AND ("Physical Therapy Modalities"[MeSH] OR "Early Mobilization"[MeSH] OR "Exercise Therapy"[MeSH] OR "Rehabilitation"[MeSH] OR "Physical Therapy" OR "physiotherapy" OR "mobilization") AND ("2019"[Date - Publication] | PubMed | 6 |
| G20-R4 | Heart transplant | What is the usefulness of the CR program in heart transplant patients? | Critical | ("Heart Transplantation"[Mesh]) AND "Cardiac Rehabilitation"[Mesh] | PubMed | 1 |
| G19-R5 | Ventricular assist devices | What specific care is required for patients with ventricular assist devices in the CR program? | Critical | Ventricular assistance and cardiac rehabilitation; ventricular assistance and cardiac rehabilitation; Cuidados de dispositivos de asistencia ventrcular | PubMed, Google Scholar | 6 |
| G20-R1 | Heart transplant | What are the indications and contraindications for physical training in post-heart transplant patients? | Critical | Cardiac transplant. PubMed; Cardiac transplant and cardiac rehabilitation; Cardiac transplant and cardiac rehabilitation. | PubMed, Google Scholar | 8 |
| G20-R2 | Heart transplant | What are the physical training modalities for heart transplant patients? | Critical | ("Heart Transplantation"[MeSH Terms]) AND ("Exercise"[MeSH Terms]); (("Heart Transplantation"[MeSH Terms]) OR ("Cardiac Transplantation"[MeSH Terms])) AND ("Exercise Therapy"[MeSH Terms]. ("Heart Transplantation"[MeSH Terms] OR "Cardiac Transplantation"[MeSH Terms]) AND ("Exercise"[MeSH Terms] OR "Physical Activity"[MeSH Terms])) AND ("Exercise Therapy"[MeSH Terms] OR "Rehabilitation"[MeSH Terms]) AND ("Systematic Review"[Publication Type] OR "Meta-Analysis"[Publication Type]) AND ("Humans"[MeSH Terms]); (("Heart Transplantation"[MeSH Terms]) AND ("Exercise"[MeSH Terms] OR "Physical Activity"[MeSH Terms])) AND ("Rehabilitation"[MeSH Terms]) AND ("Meta-Analysis"[Publication Type] OR "Randomized Controlled Trial"[Publication Type]) AND ("Humans"[MeSH Terms]) AND (English[lang]) | PubMed | 9 |
| G20-R3 | Heart transplant | How to prescribe training intensity in post-HT patients? | Critical | exercise prescription and cardiac transplant; cardiac rehabilitation an cardiac transplantation | PubMed | 2 |
| G21-R2 | Peripheral arterial disease | What is the usefulness of aerobic training in patients postoperatively with valve surgery? | Important | Aerobic excercise AND post operated cardiac valvulopathy; Heart valve surgery AND cardiacc rehabilitation | PubMed, Ovid | 9 |
| G21-R3 | Peripheral arterial disease | What is the usefulness of non-aerobic training in patients postoperatively with valve surgery? | Important | Ejercicio anaerobico post operados valvulares; Guía actividad física cardiópata; Athlets with heart deseases and sports | Google Scholar | 3 |
| G21-R4 | Peripheral arterial disease | How to train a patient with mitral valve disease? | Critical | Mitral stenosis and exercise; Atrial fibrillation and mitral valve and rehabilitation; Mitral valve and exercise training;Mitral valve and exercise training and sport; Exercise program and mitral; Mitral valve surgery and exercise training resultados; Mitral valve replacement and exercise resultados;<br>Mitraclip and rehabilitation | PubMed, LILACS | 16 |
| G21-R1 | Peripheral arterial disease | How to train a patient with tricuspid or pulmonary valve disease | Critical | "Heart Valve Diseases"[Mesh]) AND "Exercise"[Mesh] | PubMed, Google Scholar | 4 |
| G22-R1 | Peripheral arterial disease | What are the indications and contraindications of RC in patients with peripheral arterial disease (PAD)? | Important | Exercise modalities training AND peripherial artery disease; Cardiac rehabilitation programs excercise training peripherial arterial disease; PubMed Advanced: exercise training modalities AND peripherial artery disease | PubMed, Google Scholar | 4 |
| G22-R4 | Peripheral arterial disease | What is the usefulness of measuring the ankle-brachial index during assessment in RHC programs? | Important | Ankle-brachial index peripheral arterial disease; ankle brachial index ischemic cardiopathy | PubMed, NIH | 10 |
| G22-R2 | Peripheral arterial disease | How to train a patient with peripheral arterial disease in the lower limbs? | Important | Peripheral arterial disease and exercise; Peripheral arterial disease and training; Peripheral arterial disease training and claudication | PubMed, Google Scholar | 8 |
| G22-R3 | Peripheral arterial disease | What is the usefulness of performing carotid Doppler ultrasound in patients admitted to a CR? | Important | Detection of carotid atheromatosis using Doppler ultrasound; Carotid Doppler ultrasound rehabilitation; Correlation between Carotid Artery Atherosclerosis cardiac Infarction | PubMed, NIH | 9 |
| G23-R1 | Arrhythmias and sudden death | Which patients should be monitored (ECG) for arrhythmias during training? | Critical | ecg monitoring "during exercise" and "Cardiac rehabilitation"; ecg monitoring "during exercise" and "Cardiac rehabilitation" and care | PubMed, Google Scholar | 5 |
| G23-R3 | Arrhythmias and sudden death | How to determine exercise intensity in patients with atrial fibrillation? | Important | Exercise intensity in patients with atrial fibrillation and cardiac rehabilitation; Clinical guidelines for physical training in patients with atrial fibrillation;Meta-analysis of physical training in patients with atrial fibrillation<br>Seguridad del entrenamiento físico en pacientes con fibrilación auricular; physical training in patients with "atrial fibrillation"; Exercise intensity in patients with atrial fibrillation | PubMed, Google Scholar | 6 |
| G23-R2 | Arrhythmias and sudden death | What kind of movements should a patient not make when a pacemaker has been inserted? | Critical | ("Pacemaker, Artificial"[Mesh] OR pacemaker* OR "cardiac pacing") AND ("Postoperative Complications"[Mesh] OR "Movement" OR "Range of Motion, Articular"[Mesh] OR restriction* OR "Physical Activity" OR "Exercise"[Mesh] OR "Upper Extremity"[Mesh]) AND ("Rehabilitation"[Mesh] OR "Patient Education as Topic"[Mesh] OR "Postoperative Period"[Mesh] OR precaution* OR limitation* OR contraindication*) | PubMed | 6 |

*(Continues)*

**Figure 6.** Clinical questions in PICO format. This table presents the PICO questions that form the backbone of this CPG, giving it its strength by supporting the set of recommendations on problems in everyday clinical practice *(continuation)*.

| Recommendation | Chapter | PICO Clinical Questions | Outcome | MeSH search terms | Platform | Ref (n) |
|---|---|---|---|---|---|---|
| G23-R4 | Arrhythmias and sudden death | How to train a patient with a pacemaker or implanted cardioverter-defibrillator? | Important | "Pacemaker, Artificial"[Mesh] OR "Defibrillators, Implantable"[Mesh]) AND ("Exercise Therapy"[Mesh] OR "Exercise"[Mesh] OR "Physical Fitness"[Mesh]) AND ("Rehabilitation"[Mesh] OR "Cardiac Rehabilitation"[Mesh]) | PubMed | 5 |
| G24-R2 | Congenital Heart Disease | How to train children with congenital heart disease? | Critical | ((cardiac rehabilitation[MeSH Terms]) AND (congenital heart disease[MeSH Terms])) NOT (adults[MeSH Terms]); ((exercise[MeSH Terms]) AND (children[MeSH Terms])) AND (congenital heart disease[MeSH Terms]) ((exercise) AND (children)) AND (heart); guidelines congenital heart disease exercise: guidelines congenital heart disease exercise | PubMed, Google Scholar | 12 |
| G24-R1 | Congenital Heart Disease | In which patients with congenital heart disease is strength training beneficial? | Important | Congenital cardiopathy; Congenital cardiopathy and cardiac rehabilitation; Congenital cardiopathy and physioterapy; Cardiac rehabilitation and congenital heart disease; Cardiac rehabilitation and congenital heart disease and muscular strength; Cardiac rehabilitation and congenital heart disease and muscular strength. | PubMed, Google Scholar | 7 |
| G24-R3 | Congenital Heart Disease | At what age and how should aerobic training be performed in children with congenital heart disease? | Important | PubMed (Exercise / physiology[MeSH Terms]) AND (child[MeSH Terms]); PubMed (aerobic exercise[MeSH Terms]) AND (congenital heart defect[MeSH Terms]);Google Academic: age + onset + aerobic training + children | PubMed, Google Scholar | 6 |
| G24-R4 | Congenital Heart Disease | What is the effect of early initiation of feeding on the outcome of children with critically ill congenital heart disease? | Important | "Heart Defects, Congenital" [Mesh]Nutrition in children with heart disease | PubMed | 2 |
| G25-R1 | Pulmonary arterial hypertension | What effect does physical training have on pulmonary artery pressure? | Critical | PULMONARY HYPERTENSION AND EXERCISE; PULMONARY HYPERTENSION AND HEMODYNAMICS; PULMONARY HYPERTENSION AND MORTALITY | PubMed, Google Scholar | 4 |
| G25-R2 | Pulmonary arterial hypertension | Is muscle strength training recommended for patients with PAH? | Important | ("Hypertension, Pulmonary"[MeSH] OR "pulmonary arterial hypertension"[Title/Abstract]) AND ("Resistance Training"[MeSH] OR "High-Intensity Interval Training"[MeSH] OR "anaerobic exercise"[Title/Abstract]) ("Pulmonary Hypertension"[MeSH] OR "pulmonary arterial hypertension"[tiab] OR "PAH"[tiab]) AND ("Exercise"[MeSH] OR "exercise training"[tiab] OR "physical training"[tiab] OR "whole-body vibration"[tiab]) OR ("Muscle Dysfunction"[MeSH] OR "skeletal muscle dysfunction"[tiab] OR "muscle protein metabol*"[tiab])) | PubMed | 4 |
| G25-R4 | Pulmonary arterial hypertension | Which PAH patients are eligible for an exercise program? | Critical | ("pulmonary hypertension"[MeSH Terms] OR "pulmonary hypertension"[Title/Abstract]) AND ("exercise training"[Title/Abstract] OR "physical training"[Title/Abstract] OR "exercise therapy"[MeSH Terms]) AND ("randomized controlled trial"[Publication Type] OR "systematic review"[Publication Type] OR "meta-analysis"[Publication Type] OR "clinical trial"[Publication Type]); ("pulmonary hypertension"[MeSH Terms] OR "pulmonary hypertension"[Title/Abstract]) AND (("exercise training"[Title/Abstract] OR "physical training"[Title/Abstract] OR "exercise therapy"[MeSH Terms]) OR ("oxygen supplementation"[Title/Abstract] OR "oxygen therapy"[MeSH Terms])) AND ("randomized controlled trial"[Publication Type] OR "systematic review"[Publication Type] OR "meta-analysis"[Publication Type] OR "clinical trial"[Publication Type]) | PubMed | 3 |
| G25-R3 | Pulmonary arterial hypertension | What exercise protocol should be performed in patients with PAH? | Critical | ("Hypertension, Pulmonary" OR "Pulmonary Arterial Hypertension") AND ("aerobic exercise" OR "endurance training"); ("Hypertension, Pulmonary" OR "Pulmonary Arterial Hypertension") AND ("rehabilitation"); ("Hypertension, Pulmonary" OR "Pulmonary Arterial Hypertension") AND ("strength training" OR "resistance training"); ("Hypertension, Pulmonary" OR "Pulmonary Arterial Hypertension") AND ("respiratory training" OR "pulmonary exercise" OR "inspiratory muscle training" or "breathing exercise"); ("Hypertension, Pulmonary" OR "Pulmonary Arterial Hypertension") AND ("interval exercise" or "interval training");("Hypertension, Pulmonary" OR "Pulmonary Arterial Hypertension") AND ("yoga" OR "tai-chi" OR "dance");"pulmonary arterial hypertension" and "exercise training" and "meta analysis" | PubMed, Google Scholar | 9 |
| G26-R4 | Dysautonomia | What is the benefit of high salt and fluid intake in patients with dysautonomia? | Important | ("Dietary Sodium"[MeSH Terms] OR "Sodium, Dietary"[All Fields] OR "salt intake"[tiab] OR "salt supplementation"[tiab]) AND ("Orthostatic Intolerance"[MeSH Terms] OR "orthostatic hypotension"[tiab] OR "orthostatic intolerance"[tiab] OR "postural tachycardia syndrome"[tiab] OR "vasovagal syncope"[tiab] OR "autonomic nervous system diseases"[MeSH Terms]) | PubMed | 3 |
| G26_R2 | Dysautonomia | What role does strength training play in patients with dysautonomia? | Important | ("Autonomic Nervous System Diseases"[MeSH] OR dysautonomia OR "Postural Orthostatic Tachycardia Syndrome"[MeSH] OR POTS OR "Orthostatic Hypotension"[MeSH]) AND ("Exercise Therapy"[MeSH] OR "Resistance Training"[MeSH] OR "Strength Training"[MeSH] OR "Resistance Exercise" OR "Exercise"[MeSH]); ("Autonomic Nervous System Diseases"[MeSH] OR dysautonomia OR "Postural Orthostatic Tachycardia Syndrome"[MeSH] OR POTS OR "Orthostatic Hypotension"[MeSH]) AND ("Exercise Therapy"[MeSH] OR "Resistance Training"[MeSH] OR "Strength Training"[MeSH] OR "Resistance Exercise" OR "Exercise"[MeSH]) AND ("Adolescent"[MeSH] OR "Aged"[MeSH] OR "Older Adults" OR elderly OR "Young Adult"[MeSH]) AND ("Quality of Life"[MeSH] OR "Exercise Tolerance"[MeSH] OR "Venous Return"[MeSH] OR "Syncope"[MeSH] OR "Muscle Strength"[MeSH] OR functional improvement) | PubMed, Google Scholar | 6 |
| G26-R1 | Dysautonomia | What role does aerobic exercise play in patients with dysautonomia? | Important | aerobic training AND dysautonomia; Excercise training AND dysautonomia; aerobic training OR Excercise training AND syncope prevention; aerobic training OR Excercise training AND dysautonomia AND quality of life; aerobic training OR Excercise training AND neurocardiogenic syncope AND quality of life; aerobic training OR Excercise training AND vasovagal syncope AND quality of life | PubMed, Google Scholar | 12 |
| G26-R3 | Dysautonomia | What is the use of orthostatic challenge training? | Important | Tilt test. Syncope, vasovagal | Google Scholar | 5 |
| G26-R5 | Dysautonomia | What is the usefulness of psychological intervention in patients with dysautonomia? | Important | "Dysautonomia"+ Psychological disorder";"Dysautonomia"+ "Anxiety"; "Dysautonomia"+ "Depression" | PubMed, Google Scholar | 7 |
| G27-R1 | Athletes with heart disease | Which athletes are eligible to return to their sport after a cardiovascular diagnosis? | Important | Athletes AND (cardiovascular disease OR coronary artery disease OR heart valve disease OR cardiomyopathies) AND (return to sports OR return to high intensity sports) | PubMed, Ovid | 14 |
| G27-R2 | Athletes with heart disease | How to perform risk stratification in athletes with heart disease? | Critical | [Athlete with cardiopathy] AND [risk stratification]; [Athletes] AND [ECG] AND [Predictors] AND [Ventricular arrhythmias];[Athletes] AND [Sudden Cardiac Death] AND [Cardiovascular Diseases] AND [Coronary Artery Disease] AND [Risk Assessment]; [Athlete with coronary heart disease] AND [risk stratification]; [Arrhythmias] AND [cardiac] AND [athletes] AND [cardiomyopathy] AND [hypertrophic] AND [death] AND [etiology] | PubMed | 9 |
| G27-R3 | Athletes with heart disease | How can we investigate and treat the grief of an athlete with heart disease who will be unable to return to competition? | Important | grief] AND [athlete] AND [injury]; [depresión] AND [athlete] AND [injuries];[depressión] AND [athlete] AND [injuries] | PubMed, Google Scholar | 7 |
| G28-R5 | Co-morbidity | How can various chronic conditions such as high blood pressure, diabetes mellitus, thyroid dysfunction, or hyperuricemia be managed in patients with heart disease undergoing a CR program? | Important | (allopurinol[Title/Abstract]) AND (hyperuricemia[Title/Abstract]) AND (cardiovascular[Title/Abstract]) (SGLT2 inhibitors[MeSH Terms]) AND (cardiovascular disease[MeSH Terms]) AND (diabetes mellitus, type 2[MeSH Terms]) (levothyroxine treatment) (subclinical hypothyroidism AND (risk of adverse cardiovascular events) (Blood pressure management) AND (type 2 diabetes) AND (treatment) | Pubmed | 6 |
| G28-R1 | Co-morbidity | How to provide nutritional counseling within a CR program to overweight and obese patients? | Important | ("Cardiac Rehabilitation"[MeSH]) AND ("Behavior Therapy"[MeSH] OR "Behavioral Therapy"[MeSH]) AND ("Overweight"[MeSH] OR "Obesity"[MeSH])); ("Cardiac Rehabilitation"[MeSH]) AND ("Nutrition therapy"[MeSH] OR "Behavioral Therapy"[MeSH]) AND ("Overweight"[MeSH] OR "Obesity"[MeSH]) AND ("Body Weight Changes"[MeSH]) | PubMed | 13 |
| G28-R4 | Co-morbidity | How to physically train a patient with lung disease? | Important | "Respiratory Therapy"[Mesh]) AND "Exercise"[Mesh] | PubMed | 2 |
| G28-R2 | Co-morbidity | How to train patients with kidney problems within a CR program? | Important | ((renal function) AND (physical activity)) AND (lifestyle)) AND (kidney function)) AND (glomerular filtration rate)) AND (Dialysis)) OR (Chronic kidney disease) NOT Children) AND (physical training) | PubMed | 6 |
| G29-R1 | Atherosclerosis | How to properly prescribe available drugs for the treatment of hypercholesterolemia and keep the patient at their goals? | Critical | Dyslipidemia; Cardiac rehabilitation and dyslipidemia;Dyslipidemia guidelines | PubMed, Google Scholar | 4 |
| G29-R2 | Atherosclerosis | What are the main pillars of dietary prescription in patients with atherosclerosis? | Critical | ((diet) AND (coronary artery disease); ((dietary pattern) AND (coronary artery disease)); (( fatty acids) AND (coronary artery disease)) | PubMed | 6 |
| G29-R4 | Atherosclerosis | How to plan a cardiovascular health education program for patients with heart disease? | Critical | PUBMED: [Secondary prevention] AND [cardiovascular health]; [Preventive education] AND [cardiac rehabilitation]; [Cardiac patients] AND [educational programs];Google Scholar: Programas educativos y prevención cardiovascular | PubMed | 5 |
| G29-R3 | Atherosclerosis | How effective is anti-smoking therapy in quitting smoking? | Critical | (anti-smoking) AND (efficacy) AND (treatment) AND (tobacco) AND (therapies) OR (cessation); Google Academics: Anti smoking AND therapies AND efficacy AND treatment | PubMed, Google Scholar | 3 |
| G30-R2 | Heart valve disease | How can we identify and prescribe foods that may interact with anticoagulation therapy for patients with valvular heart disease? | Critical | Vitamin K AND Dietary Intake OR Diet AND Anticoagulants OR Vitamin K Antagonists OR Warfarin AND Drug Interactions OR Food-Drug Interactions AND Heart Valve Diseases OR Valvular Heart Disease; Vitamin K OR Dietary Supplements AND Anticoagulants OR Warfarin AND Patient Compliance OR Dietary Management AND Heart valve disease; Vitamin K OR Dietary Supplements AND Anticoagulants OR Warfarin AND Patient Compliance OR Dietary Management AND Heart disease; Nutrition AND Vitamin K antagonists AND anticoagulation AND warfarin; Diet AND Interaction AND Vitamin K AND warfarin; Ambulatory care AND medication safety AND warfarina | PubMed | 6 |

*(Continues)*

**Figure 6.** Clinical questions in PICO format. This table presents the PICO questions that form the backbone of this CPG, giving it its strength by supporting the set of recommendations on problems in everyday clinical practice *(continuation)*.

| Recommendation | Chapter | PICO Clinical Questions | Outcome | MeSH search terms | Platform | Ref (n) |
|---|---|---|---|---|---|---|
| G30-R3 | Heart valve disease | How to prevent falls and secondary complications in patients with valvular heart disease on anticoagulation? | Critical | "prevention of falls in anticoagulated valve patients"; "prevention of falls + valve patients; "secondary complications in valve patients with anticoagulation"; "cardiac rehabilitation + valve patients + anticoagulation"; "cardiac rehabilitation in patients with valve disease"; "fall prevention"; "fall prevention and cardiac"; "cardiac rehabilitation" | PubMed, Google Scholar | 3 |
| G30-R4 | Heart valve disease | How to prevent bacterial endocarditis in patients with prosthetic valves? | Critical | Infective endocarditis AND antibiotic prophylaxis | PubMed | 3 |
| G31-R1 | Arrhythmias and sudden death | At what point should the person (nurse, physical therapist) supervising an ECG monitor notify the physician? | Critical | (Cardiac rehabilitation) AND (Safety) | PubMed, Google Scholar | 3 |
| G31-R2 | Arrhythmias and sudden death | How to approach a patient with exercise-related EVs? | Important | (Premature ventricular contraction) AND (Exercise); (Premature ventricular contraction) and (Management) | PubMed | 2 |
| G31-R3 | Arrhythmias and sudden death | What dietary precautions should patients with cardiac arrhythmias or who are taking antiarrhythmics take? | Critical | (Arritmia Cardiaca) y (Potasio) | Google Scholar | 3 |
| G31-R5 | Arrhythmias and sudden death | What are the indications for referral to electrophysiology consultation in patients admitted to CR? | Important | (arrhythmia) AND (cardiac rehabilitation) | PubMed, Google Scholar | 9 |

**Figure 6.** Clinical questions in PICO format. This table presents the PICO questions that form the backbone of this CPG, giving it its strength by supporting the set of recommendations on problems in everyday clinical practice.

that the language was adapted to each patient's level of understanding. During this interaction, it was verified that the patients understood the content of each recommendation and were able to express their agreement regarding its application in their clinical situation.

Ninety percent of patients rated topics related to improving exercise capacity, managing symptoms such as dyspnea or weakness, reducing the risk of new cardiovascular events, and receiving education about their disease and nutritional support as "very important." The outcomes of greatest interest to patients were avoiding hospitalizations (70%), having energy for daily activities (60%), and clinical and emotional management (50%).

Regarding clinical decision-making, 100% of patients expressed a desire to be considered, and 80% of them expressed a preference for receiving clear and direct recommendations from healthcare personnel.

### 2.2.3 Clinical practice guidelines users (6)

This CPG aims to provide the most up-to-date information on the rehabilitation and prevention of patients with cardiovascular disease and to support clinical decision-making by healthcare professionals involved in these processes. It includes specialists in cardiology, rehabilitation medicine, internal medicine, pediatrics, family medicine, sports medicine, geriatrics, psychiatry, physical therapy, nursing, nutrition, psychology, and social work. It also contains information of interest to leaders in health service policy and administration. As this is a rapidly growing specialty, this document can assist in the standardization of corresponding healthcare.

## 2.3 Rigor in development

### 2.3.1 Search method (7)

The panel of experts held 16 videoconference sessions using Zoom (20 hours of online work) to formulate a total of 154 PICO questions. The sessions were recorded. The working group established the following components in each question: the problem, the target population, the intervention, and the alternative (Fig. 6). When developing the PICO question, outcomes were categorized as critical, important, and unimportant. The most common outcomes were mortality, MACE, morbidity, HR-QoL, and adverse events. Each recommendation must answer a PICO question.

| Name | Profession | Institution | Member of Societies | Geographical location | Type of Collaboration | Conflict of interest |
|---|---|---|---|---|---|---|
| Alonso Sánchez Jesús | Cardiology – Cardiac Rehabilitation | Private | SOMECCOR, SMC, ESC, SEC, ANCAM, CCJ, | Guadalajara, Jalisco | Collaborator | None |
| Álvarez Jaramillo Karen | Nutrition – Cardiac Rehabilitation | INCICh | SOMECCOR | CDMX | Coordinator | None |
| Aranda Ayala Zulema | Cardiology – Cardiac Rehabilitation | Private | SOMECCOR | Cuenavaca, Morelos | Collaborator | None |
| Arteaga Martínez José Rodolfo | Rehabilitation Medicine – Cardiac Rehabilitation | CMN-20Nov, ISSSTE | SOMECCOR, SMMFR | CDMX | Collaborator | None |
| Ávila Estrada Ángel | Cardiology – Cardiac Rehabilitation | Private | SOMECCOR, ESC | Mérida, Yucatán | Collaborator | None |
| Avilés Rosales Jorge | Cardiology – Cardiac Rehabilitation | Private | SOMECCOR | Cuenavaca, Morelos | Collaborator | None |
| Cámara Beltrán Russel | Psychology – Cardiac Rehabilitation | Private | SOMECCOR | Mérida, Yucatán | Collaborator | None |
| Cassaigne Guasco María Elena | Cardiology – Cardiac Rehabilitation | Private | SOMECCOR, SMC, ANCAM, AMERECAP, AACVPR, ESC, EAPC | Estado de México | Collaborator | None |
| Cerón Enriquez Norma | Cardiology – Cardiac Rehabilitation | Private | SMC, SOMECCOR | Puebla, Puebla | Collaborator | None |
| Flores Carrillo Saray | Pediatric Cardiology – Cardiac Rehabilitation | Private | SOMECCOR, SMC, AMECC, SOMEIC | Guadalajara, Jalisco | Collaborator | None |
| Flores Morales Abelardo | Cardiology – Cardiac Rehabilitation | IMSS-CMNsXXI | SOMECCOR, SMC, ANCAM, SEC, SEIC, FMND, GREHTA | CDMX | Collaborator | Speaker SERVIER |
| Franco Ojeda María Esther | Physiotherapy – Cardiac Rehabilitation | INCICh | SOMECCOR, SMC | CDMX | Collaborator | None |
| García Hernández Nayelli | Cardiology – Cardiac Rehabilitation | IMSS_Private | SOMECCOR | CDMX | Collaborator | None |
| García Saldivia Marianna Andreína | Cardiology – Cardiac Rehabilitation | INCICh | SOMECCOR, SMC, AMEHCARDIO CMNSXXI, SIBIC, ESC | CDMX | Editor | None |
| González Bonilla Meztli Berenice | Physiotherapy – Cardiac Rehabilitation | CMN-20Nov, ISSSTE | SOMECCOR, AMEFI | CDMX | Collaborator | None |
| Hernández González Pedro Alejandro | Cardiology – Cardiac Rehabilitation | Private | SOMECCOR, SMC, ANCAM, CCC, ACC | Saltillo, Coahuila | Collaborator | None |
| Hernández Rodríguez Nancy | Nursing – Cardiac Rehabilitation | INCICh | SOMECCOR, SMC. | CDMX | Collaborator | None |
| Ilarraza-Lomelí Hermes | Cardiology – Cardiac Rehabilitation | INCICh | SOMECCOR, SMC, ANMM, CMC, ESC, SIBIC | CDMX | Editor | None |

*(Continues)*

| Name | Profession | Institution | Member of Societies | Geographical location | Type of Collaboration | Conflict of interest |
|---|---|---|---|---|---|---|
| Jiménez Campos Cecilia | Rehabilitation Medicine – Cardiac Rehabilitation | Hospital Regional de Alta Especialidad de Oaxaca | SOMECCOR, SOC, CMMEMFR | Oaxaca, Oaxaca | Collaborator | None |
| Ku González Andrés | Cardiology – Cardiac Rehabilitation | Hospital Regional de Alta Especialidad de la Península de Yucatán/Private | SOMECCOR | Mérida, Yucatán | Collaborator | None |
| Lara Vargas Jorge Antonio | Cardiology – Cardiac Rehabilitation | CMN-20Nov, ISSSTE | SOMECCOR, SMC, ANCAM, ESC | CDMX | Collaborator | None |
| Leyva Valadez Eduardo Alfonso | Physiotherapy – Cardiac Rehabilitation | CMN-20Nov, ISSSTE | SOMECCOR | CDMX | Collaborator | None |
| López García Ariadna | Pediatric Cardiology – Cardiac Rehabilitation | Hospital General de México | SOMECCOR, SMC | CDMX | Coordinator | None |
| López Huerta Doris | Physiotherapy – Cardiac Rehabilitation | Hospital Regional de Alta Especialidad de Oaxaca | SOMECCOR, ASOTFFI, AMEFI | Oaxaca, Oaxaca | Collaborator | None |
| Navarrete De la O Dulce | Nutrition – Cardiac Rehabilitation | Private | SOMECCOR | CDMX | Collaborator | None |
| Palillero Santos Lilia | Nursing – Cardiac Rehabilitation | INCICh | SOMECCOR, SMC | CDMX | Collaborator | None |
| Pichardo González Gabriela | Nursing – Cardiac Rehabilitation | INCICh | SOMECCOR, SMC | CDMX | Coordinator | None |
| Pineda García Alfredo D | Cardiology – Cardiac Rehabilitation | Hospital Civil de Guadalajara Juan I Menchaca | SOMECCOR | Guadalajara, Jalisco | Collaborator | None |
| Pineda Juárez Juan Antonio | Nutrition – Cardiac Rehabilitation | CMN-20Nov, ISSSTE | SOMECCOR, SMC, SCM | CDMX | Collaborator | None |
| Piña Carrillo Karla Itzi | Nutrition – Cardiac Rehabilitation | INCICh | SOMECCOR | CDMX | Collaborator | None |
| Reza Orozco Marco | Cardiology – Cardiac Rehabilitation | Private | SOMECCOR | Chihuahua | Collaborator | None |
| Ríos Martínez Blanca | Psychology – Cardiac Rehabilitation | Private | SOMECCOR, SMC, CMCOEM, IFSO, | CDMX | Coordinator | Speaker MEDIX |
| Rius Suárez María Dolores | Physiotherapy – Cardiac Rehabilitation | INCICh | SOMECCOR, SMC, AMERECAP, AACVPR, AMEFI, ESC, CNFTF | CDMX | Coordinator | None |
| Rivera Parra Nayeli | Physiotherapy – Cardiac Rehabilitation | SEMAR | SOMECCOR | CDMX | Collaborator | None |

*(Continues)*

| Name | Profession | Institution | Member of Societies | Geographical location | Type of Collaboration | Conflict of interest |
|---|---|---|---|---|---|---|
| Rojano Castillo Jessica | Cardiology – Cardiac Rehabilitation | INCICh | SOMECCOR, SMC, ESC, EAPC, SHC, SONECOM, SIBIC | CDMX | Coordinator | None |
| Rojas López María del Pilar | Nursing – Cardiac Rehabilitation | CMN-20Nov, ISSSTE | | CDMX | Collaborator | None |
| Romo Escamilla Ricardo Evaristo | Cardiology – Cardiac Rehabilitation | IMSS_Private | SOMECCOR, ANCAM, CCG | León, Guanajuato | Collaborator | None |
| Segoviano Mendoza Georgina | Cardiology – Cardiac Rehabilitation | IMSS_Unidad Norte | ANCAM, SISIAC, ESC, EAPC, EACVI, SEC, SEIC | CDMX | Collaborator | None |
| Solache Carranco Ángela | Rehabilitation Medicine – Cardiac Rehabilitation | INR | SOMECCOR, SMMFR, AMMD | CDMX | Collaborator | None |
| Tovar Hernández María de la Luz | Nutrition – Cardiac Rehabilitation | INCICh | SOMECCOR | CDMX | Collaborator | None |
| Tovar Mondragón Adela Mariel | Nutrition – Cardiac Rehabilitation | Private | SOMECCOR | Estado de México | Collaborator | None |
| Vázquez Palafox Sara | Physiotherapy – Cardiac Rehabilitation | INCICh | SOMECCOR, AMEFI | CDMX | Collaborator | None |
| Vergara Guzmán Jessica | Rehabilitation Medicine – Cardiac Rehabilitation | SEDENA | SOMECCOR, SMMM, SMMFR | CDMX | Collaborator | None |
| Zavala Ramírez Juana | Rehabilitation Medicine – Cardiac Rehabilitation | INR | SOMECCOR, AMEFI, COMEFYR | CDMX | Collaborator | None |

**Figure 7.** List of CPG participants. This table concentrates on the academic and professional information of the group of the forty-four collaborators (alphabetic order), along with the type of participation they had in the development of this CPG. Abbreviations. AACVPR: American Association of Cardiovascular and Pulmonary Rehabilitation; ACC: American College of Cardiology; AMECC: Mexican Association of Congenital Heart Disease Specialists; AMEFI: Mexican Association of Physical Therapy - National College of Physiotherapy and Physical Therapy; AMEHCARDIO CMNSXXI: Medical Association of the Cardiology Hospital, Siglo XXI National Medical Center; ANMM: National Academy of Medicine of Mexico; ANCAM: National Association of Cardiologists of Mexico; ASOTFFI: Oaxacan Association of Physical Therapy and Physiotherapy; CCG: College of Cardiologists of Guanajuato; CCC: Coahuilense College of Cardiology; CMC: Mexican Council of Cardiology; CMCOEM: Mexican College of Surgery for Obesity and Metabolic Diseases; COMEFYR: Mexican College of Physiotherapy and Physical Therapy; CNFTF: National College of Physiotherapy and Physical Therapy; EACVI: European Association of Cardiovascular Imaging; EAPC: European Association of Preventive Cardiology; ESC: European Society of Cardiology; FMND: Mexican Federation of Sports Nutrition; GREHTA: Group of Experts in Hypertension; IFSO: International Federation for the Surgery of Obesity; INCICH: Ignacio Chávez National Institute of Cardiology; IMSS: Mexican Social Security Institute; ISSSTE: Institute of Security and Social Services for State Workers; SIBIC: Society of Medical Interns and Fellows of the National Institute of Cardiology; SCM: Society of Cardiologists of the State of Morelos; SEC: Spanish Society of Cardiology; SEIC: Spanish Society of Cardiac Imaging; SHC: Hidalgo Society of Cardiology; SISIAC: Ibero-American Society of Cardiovascular Imaging; SMC: Mexican Society of Cardiology; SMMFR: Mexican Society of Physical Medicine and Rehabilitation; SMMM: Mexican Society of Military Physicians; SOMECCOR: Mexican Society for Heart Care; SOMEIC: Mexican Society of Echocardiography and Cardiovascular Imaging; SONECOM: National Society of Echocardiography of Mexico; SOC: Oaxacan Society of Cardiology.

The collaborators conducted searches on digital platforms such as PubMed, LILACS, Scielo, OVID, and Google Scholar. The search languages were English, Spanish, Portuguese, French, and German. The recommended search period was 5 years from the current date (Fig. 8).

The search terms and connectors were described in detail by each expert in their recommendation development sheets. In general, research was based on MeSH terms and the Boolean connectors "*and*", "*or*", or "*not*".

### 2.3.2 Evidence Selection Criteria (8)

To select relevant scientific evidence, the target population was considered: patients of all genders, of all ages, with CVD of any severity, and eligible for participation in CVRhP-P. First, the "results" obtained by the platform were received according to the search criteria. Second, articles of interest were preliminarily selected based on their titles. A second evaluation was then conducted by reading the abstracts of the preselected articles. Finally, the selected articles were fully evaluated and included if they adequately answered the corresponding PICO question (Fig. 9).

Evidence was classified from highest to lowest level into meta-analyses/systematic reviews/clinical practice guidelines, controlled clinical trials, uncontrolled clinical trials, cohort studies, case-control studies, cross-sectional studies, narrative review articles, case series, opinion articles, and case reports. Reviewers were encouraged to include only manuscripts belonging to the first five categories. Each selected article was then evaluated using the GRADE system (Fig. 10).

### 2.3.3 Strengths and limitations of the evidence (9)

The main strength of these guidelines lies in the fact that the recommendations were developed and focused on the clinical problems identified by the expert group through the development of the PICO questions, as well as the transparency in the development and publication of the guidelines. The group of collaborators represented the country's main regions, public and private institutions, and the disciplines involved in the CVRhP-P. When validating the recommendations, Lynn's proposal regarding the minimum percentage of agreement among experts on each item was followed.[36] The main weakness is the heterogeneous certainty of the topics investigated. References were occasionally published more than 5 years prior, and they included manuscripts with a low level of evidence, primarily narrative reviews. Many of the studies were rated as having a lower level of evidence due to the lack of adverse event reporting (Fig. 11).

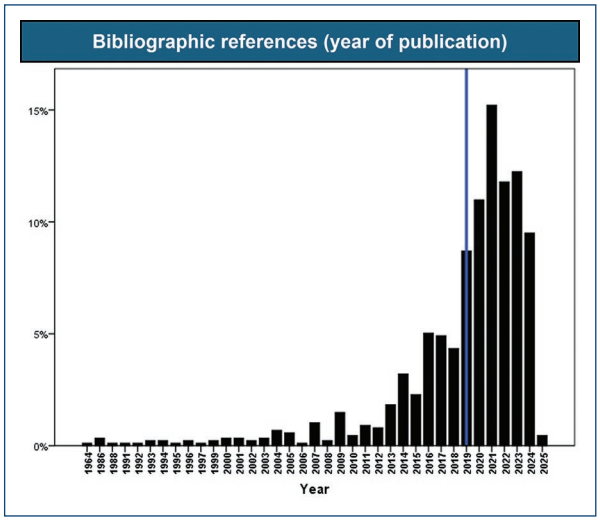


**Figure 8.** Bibliographic references (year of publication). This graph shows the distribution of the articles selected for the preparation of these CPG, according to the publication date.

Most of the studies report results in the same direction, so they are not considered contradictory. Most of the recommendations can, in theory, be put into practice.

### 2.3.4 Formulation of recommendations (10)

Initially, collaborators were trained in literature search and selection based on PICO questions, as well as in the preparation of recommendation forms. In the Delphi-1 stage, with a total of 62 videoconference sessions (74 hours), the group of experts presented their recommendations for the first time, based on the reviewed literature, which were subsequently put into debate. The articles were reviewed again by the editorial group, and, if necessary, an adjustment to the recommendation was proposed. The working group then conducted a second review of the recommendations (19 sessions equivalent to 25 hours) and provided its opinion (Delphi-2 phase). Approval of a recommendation required a majority vote in the first round and a unanimous vote in the second. If necessary, a third Delphi meeting was being held. In the absence of clear evidence in the literature, recommendations were developed based on the consensus of expert opinion (EO). The approved recommendations were then incorporated into the manuscript, which was then submitted for external peer review.[36]

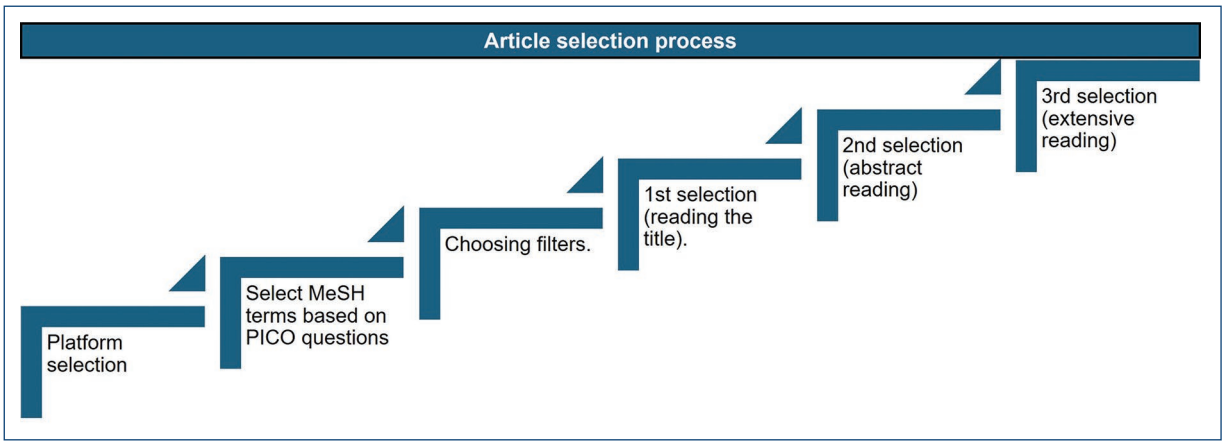


**Figure 9.** Article selection process. This diagram shows the sequence used to scan and select the most appropriate scientific evidence to answer clinical questions (PICO).

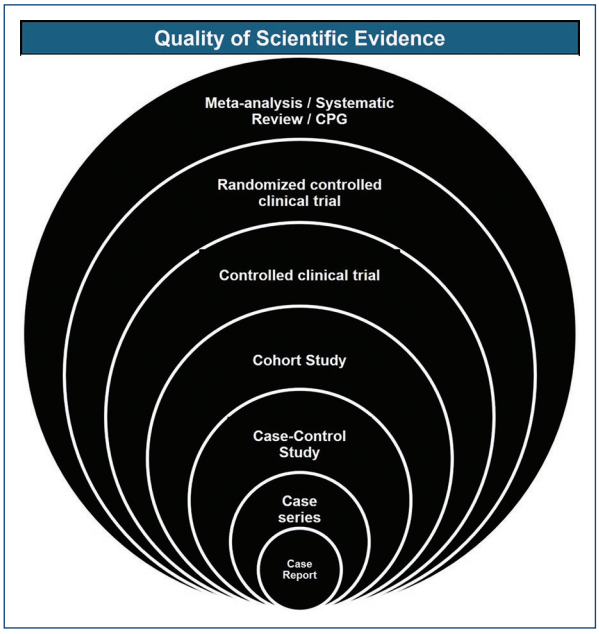


**Figure 10.** Quality of Scientific Evidence. Level of Scientific Evidence. The selected articles were stratified according to the level of scientific evidence related to their methodology, using the GRADE method.

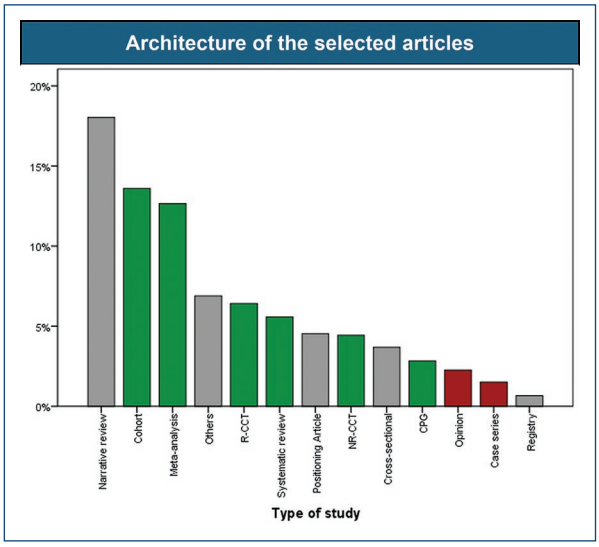


**Figure 11.** Architecture of the selected articles. This graph shows the percentage of each type of article selected for the development of the CPGs. The green bars represent information with the strongest scientific evidence, while the red bars represent the lowest quality.

The recommendations were adjusted and graded using the traditional method of American and European guidelines.[37] Although the recommendations were also stratified using the GRADE method, the editorial committee agreed to only report one grading system. Each recommendation was presented in a standardized format that included: code for the corresponding PICO question, class of recommendation, level of evidence, cost-benefit balance, and implementation tips. This method is described in detail in the corresponding figure (Fig. 12).

### 2.3.5 Consideration of benefit or harm (11)

Recommendations are categorized using the Classes and Levels of Evidence system according to the balance of benefits and harms reported in the literature. Classes I and II reflect interventions that are beneficial to the patient. Class III is subdivided into: (1) a

**Guidelines for classifying Recommendations (Class and Level of Evidence)**

| Class of Recommendation (Strength) | Level of evidence (quality) | Cost / Benefit | Tips for implementation |
|---|---|---|---|
| **Class I (Strong)**<br>• Highly recommended<br>• It is indicated/useful/effective/beneficial<br>• It should be put into practice<br>• It is preferable to other options | **Level A**<br>• High-quality evidence<br>• High-quality RCTs<br>• Meta-analyses with high-quality RCTs<br>• One or more RCTs corroborated by high-quality registries. | **$C^-/B^+$**<br>• Inexpensive and very beneficial | **1.-** Integrate into the Procedures Manual |
| **Class IIa (Moderate)**<br>• Reasonable<br>• May be indicated/useful/effective/beneficial<br>• It is probably the best option | **Level B-R (Randomized)**<br>• One or more RCTs of moderate quality of evidence<br>• Meta-analyses of this type of studies | **$C^+/B^+$**<br>• Expensive, but beneficial | **2.-** Preparation of instructions<br>**3.-** Acquisition of equipment, personnel and areas |
| **Class IIb (Weak)**<br>• It may be reasonable to use it<br>• It could be considered<br>• Doubtful indication, usefulness/effectiveness, or benefit | **Level B-NR (NO – Randomized)**<br>• One or more well-designed NoA-RCTs, observational studies, or registries<br>• Meta-analyses of these types of studies | **$C^-/B^-$**<br>• Inexpensive, but poor benefits | **4.-** Specific staff training |
| **Class III-NB (No benefit)**<br>• Not recommended<br>• Not indicated/useful/effective/beneficial | **Level C-LD (Limited Data)**<br>• RCT-A or RCT-NoA, observational studies or registries with methodological limitations<br>• Meta-analyses of this type of study<br>• Physiological or mechanistic studies in humans | **$C^+/B^-$**<br>• Very expensive and poor benefits | **5.-** Progressive implementation of the process/procedure/task |
| **Class III-H (Harmful)**<br>• Potentially harmful.<br>• Associated with morbidity/mortality<br>• Should not be performed | **Level C-EO (Expert Opinion)**<br>• Consensus of expert opinion based on their clinical experience | | **6.-** Establishment of indicators and process monitoring. |

**Figure 12.** Guidelines for classifying Recommendations (Class and Level of Evidence). The recommendations will initially be graded on two widely used axes: Class and Level of Evidence. In addition, based on AGREE-II, these CPGs incorporate two other concepts: cost-benefit balance and advice for implementation.

recommendation with no demonstrable benefits or (2) a recommendation strongly associated with harm (Fig. 12).

Twenty-five percent of the included literature specifically reported the incidence or absence of adverse events associated with the intervention. The remaining articles did not clearly describe the safety level of the interventions.

### 2.3.6 Link between recommendations and evidence (12)

Each group of recommendations includes a summary description of the information supporting them in an attached paragraph, and the corresponding bibliographic reference is cited. At the end of the CPGs, all the recommendations are summarized in a table (Fig. 32).

### 2.3.7 External peer review (13)

An external peer review was conducted to improve the quality of the document, provide qualified feedback on the recommendations, assess applicability and feasibility, and disseminate the evidence. The external reviewers were asked to assess the quality of these guidelines using the 23-point AGREE-II checklist, along with the general article review format. The editorial committee evaluated the comments, and adjustments were made.

### 2.3.8 Clinical practice guidelines update process (14)

The SOMECCOR statutes contemplate the development and updating of CPGs as part of the academic committee's responsibilities. In this case, this CPG will be updated every 5 years, and if new evidence of great relevance arises, the CPGs will be reviewed before.

An *ad-hoc* working group (transdisciplinary, with a high level of expertise and motivation) will be appointed to review and update the document. The number of contributors will be assigned by the academic committee, and efforts will be made to retain the group of experts who have already participated. Initially, an assessment of the current guidelines will be conducted, including both the PICO questions and recommendations, as well as the supporting references. With this information, the editorial committee will decide which PICO questions and recommendations should be renewed and which ones will be ratified.

The committee will evaluate all recommendations and verify the consistency between the PICO question and the recommendation, ratify or modify the recommendation's rating, select the PICO questions that require new systematic search, and eliminate irrelevant or outdated recommendations. Changes must be supported by relevant justification. The recommended methods are AGREE-II and Delphi. The updated CPG will include a summary of the changes made compared to the previous version.

The editorial committee must establish the appropriate strategy to evaluate whether the recommendations were effectively implemented by the users of these CPGs and, if not, establish the appropriate strategy for this purpose.

## 2.4 Clarity of presentation

### 2.4.1 Specific and unambiguous recommendations (15)

The recommendations were drafted by the editorial committee and operational collaborators, seeking to ensure clear and concise statements. Standardization of the recommendations includes the integration of the recommended action, the purpose of the intervention, the target population, and the specific circumstances of each case.

### 2.4.2 Handling options (16)

The paragraph corresponding to each recommendation describes the different options for evaluation and treatment, characterizing population variants and clinical situations according to each case.

### 2.4.3 Key recommendations identified (17)

The CPG includes a comprehensive table of recommendations, with those considered key highlighted in bold.

## 2.5 Applicability

### 2.5.1 Facilitators and barriers to implementation (18)

Each collaborator was asked to write a succinct suggestion on the form for implementing the recommendation, which was discussed in the Delphi meetings. The most frequently used suggestions were coded as follows: integrate the recommendation into the procedure's manual (1), prepare instructions (2), acquire equipment and areas (3), specific training (4), progressive implementation of the process (5) and establish goals as well as supervise processes (6). The corresponding code was included in each recommendation and, if necessary, these suggestions were written in the reference paragraph. When updating the CPG, feedback information from end users should be collected and analyzed to corroborate whether the recommendations were effectively implemented.

### 2.5.2 Tools and tips for implementation (19)

These comprehensive CPGs contain several algorithms and explanatory figures throughout the manuscript to facilitate their implementation. Additional materials were also developed, including various communication methods such as an executive summary, pocket guides, tutorial videos, and clinical scenarios, among others.

### 2.5.3 Implication on resources (20)

The cost-benefit ratio was assessed for each recommendation and graded with the following codes: low cost and high benefit (C-/B+), high cost and high benefit (C+/B+), high cost and low benefit (C+/B-), or low cost and low benefit (C-/B-). These assessments were made by expert consensus unless specific studies were published. Further developments in this area will be continued in the next update of this CPG.

### 2.5.4 Provision of monitoring or audit criteria to measure the implementation of the guide recommendations (21)

To investigate the degree of user implementation of the guidelines, a biennial review of the implementation of the recommendations in the various CVRhP units will be conducted. This information will be used to inform the next update.

The points included in this review will be the level of implementation and adherence to the recommendations, as well as the evaluation of the effect of having implemented the recommendation.

## 2.6 Editorial independence

### 2.6.1 Financing (22)

The guidelines was supported by an unrestricted educational grant from Baxter Mexico and the Facultad de Ciencias de la Salud, Universidad Anáhuac México. The sponsors had no role in the study design, data collection, analysis, or interpretation, nor in the decision to publish the results.

### 2.6.2 Conflicts of interest (23)

The editorial team requested that each contributor complete a form specifically for declaring conflicts of interest. This information is included in the corresponding table (Fig. 7).

## 3 Recommendations

This section of the CPG contains the set of recommendations issued by the task force. The reader will find a table corresponding to each subsection of the document and a table with the total number of recommendations (Fig. 32). The presentation format and grading details of the set of recommendations can be found in sections 2.3.4 and 2.3.5 of this document.

At the end of each section, key messages from the most important points covered are presented **(KM)**.

### 3.1 Common elements of cardiovascular rehabilitation and prevention

Over several decades, it has been scientifically proven that CVRhP-P has a beneficial effect on patients with heart disease, both in increasing survival and in HR-QoL.

### 3.1.1 General effects of CVRhP-P

This section presents the general effects of CVRhP-P, which benefit most patients, regardless of their clinical characteristics and type of heart disease.

Cardiovascular rehabilitation and prevention programs, both those based exclusively on physical training and comprehensive rehabilitation, have proven beneficial in terms of mortality, morbidity, reduction in the rate of re-hospitalizations, quality of life, and reduction of healthcare costs.

The general and specific results depend on the patient's adherence to the CVRhP-P and its persistence in the medium and long term.

Staff responsible for establishing overall CVRhP-P strategies should systematically identify indicators of program performance and patient clinical response, which will be associated with long-term outcomes. Some of the most relevant clinical indicators that clearly identify a patient's response to CVRhP-P and, consequently, its impact on prognosis include: degree of program adherence, identification and control of cardiovascular risk factors, changes in ExTol, health-related quality of life (HR-QoL), and the rate of adverse events.

Świątkiewicz I et al. published a cohort analysis, where they observed the beneficial effect of CVRhP-P on indicators such as re-hospitalization for HF, evaluation of body composition (fat and muscle) and ergometric performance in patients with high cardiovascular risk in CVRhP-P. (GRADE: moderate $_{\text{G2-R6_Ref_5}}$).[218]

**Recommendation Table 1.** Common elements of CVRhP

| PICO | 3.1 Common elements of cardiovascular rehabilitation and prevention | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G2-R1 | It is recommended that the benefits associated with the CVRhP-P be widely disseminated among healthcare providers and the general population, in an effort to increase patient referrals to these programs. This will include the impact on survival, quality of life, and reduction in healthcare costs. | I | A | C-/B+ | Disseminate guides, establish interactions with stakeholders, public policies and advocacy. |
| G2-R2 | It is recommended that patients with CVD, whether post-PCI or post-surgical, be referred to the CVRhP-P through optimized strategies, such as electronic referral, the use of liaison managers, and explicit physician recommendation, in order to increase their participation rate. | I | B-NR | C-/B+ | Disseminate guides, establish interactions with stakeholders, public policies and advocacy. |
| G3-R2 | It is recommended that patients at low cardiovascular risk who participated in the initial part of the in-person CVRhP-P continue with a distance rehabilitation program in order to maintain their adherence. | IIa | B-R | C-/B+ | 1 to 6 |
| G2-R6 | It is recommended that the CVRhP-P leader establish precise, patient-centered indicators and goals, both at the clinical and technical levels, in order to ensure adequate quality control of interventions based on patient outcomes. | IIa | C-EO | C-/B+ | 1,2,6 |

A randomized clinical trial evaluated the effect of an intensive prevention program in patients after an acute myocardial infarction. The results showed that improved risk factor control was associated with a reduction in clinical events in the intervention group (12.5% vs. 20.9%, p=0.06). Prognostic indicators included smoking, LDL-C levels, physical activity level, BMI, and blood pressure. Furthermore, this program was shown to be cost-effective, at €1,070 per patient, compared to €1,170 for standard care (GRADE: moderate $_{G2\text{-}R6_Ref_8}$).[38]

### 3.1.1.1 Exercise tolerance (ExTol)

Exercise tolerance is a person's ability to perform physical activity, sometimes at a maximum level, and requires the harmonious participation of the entire body, predominantly the cardiovascular, pulmonary, and musculoskeletal systems. The assessment of maximum exercise tolerance shows overall physical reserve, both in health and in illness.

The gold standard for assessing maximum ExTol is the cardiopulmonary exercise test (CPET), which directly measures the oxygen used for energy transformation in the body ($VO_2$). This indicator is strongly associated with major adverse cardiovascular events, such as mortality or the presence of coronary syndromes. ExTol can be assessed using several surrogate methods (standard PE, 6MWT, etc.) and is used to dose therapeutic exercise training (ThPhT) and assess the body's adaptation to it.

In a retrospective study, each 1 $mlO_2$/kg/min increase in $VO_2$peak after CVRhP-P was found to be associated with an 11% decrease in all-cause mortality (HR=0.89; 95% CI 0.84 to 0.95, p=0.001) and a 24% lower risk of hospital readmission for CVD (HR=0.76; 95% CI 0.68 to 0.85, p<0.001) (GRADE: low $_{G2\text{-}R4_Ref_4}$).[39]

Bjarnason-Wehrens B et al. published a meta-analysis analyzing the effects of exercise-based CVRhP-P in patients with heart failure and reduced LVEF. They report a substantial improvement in their exercise capacity and HR-QoL. No significant differences were observed in mortality or hospitalization compared to the control group. (GRADE: moderate $_{G2\text{-}R6_Ref_2}$).[40]

Yamamoto S et al. published a meta-analysis of patients with heart failure, where they compared the effects of a CVRhP-P vs. a control group. Results showed an improvement in exercise tolerance and HR-QoL. Furthermore, the intervention was associated with a decrease in the rate of rehospitalization for any cause (RR = 0.80; 95% CI 0.70 to 0.92) No significant differences in mortality reduction were observed between groups. No adverse events were reported in this study (GRADE: high $_{G2\text{-}R6_Ref_3}$).[184]

Regarding ThPhT, a 2020 meta-analysis examined the effect of combined aerobic and resistance training in patients with coronary artery disease. The indicators evaluated were oxygen uptake ($VO_2$peak), muscle strength by dynamometry, maximum isokinetic voluntary contraction, and the degree of muscle hypertrophy. Sessions were generally 2 to 3 times per week, with 50 minutes of aerobic training and three sets of 10 to 12 repetitions of resistance exercises, for 14 weeks. This training modality was associated with an increase in $VO_2$peak, strength, and the degree of muscle hypertrophy. Adverse events were recorded, most of which were mild, and there were two cases of cardiovascular events that led to withdrawal from the study (GRADE: high $_{G2\text{-}R6_Ref_9}$).[41]

ExTol can be improved with physical training, but this effect is quickly lost if the individual does not have good medium- and long-term adherence. Eser P et al. published that, particularly in older patients with diabetes, although rehabilitation improved $VO_2$peak (HR=1.15; 95% CI 1.02 to 1.30, p=0.03), the benefit was low and was lost over time (HR=0.92, 95% CI 0.85 to 0.99, p=0.04) (GRADE: low $_{G2\text{-}R4_Ref_6}$).[42]

New CVRhP-P modalities, such as home-based programs or remote options (telemedicine), have been designed to increase patient participation in ThPhT programs, overcoming barriers such as distance and accessibility.

In a 2020 study, a randomized clinical trial evaluated the effects of telemedicine cardiovascular rehabilitation using smartphones in patients with stable coronary artery disease. This strategy was found to significantly improve $VO_2$peak, and exercise adherence compared to the control group. No adverse events were reported (GRADE: high $_{G2\text{-}R6_Ref_1}$).[43]

Lee JJ et al., published in 2021 that CVRhP-P performed in specialized centers show a statistically significant increase in $VO_2$peak and cardiopulmonary function, compared to home-based programs (GRADE: low $_{G2\text{-}R4_Ref_5}$). [44]

### 3.1.1.2 Major adverse cardiovascular events

A major adverse cardiovascular event (MACE) outcome is a composite, medium- to long-term endpoint in cardiovascular studies that combines several serious events, such as myocardial infarction, stroke, and death, to evaluate the effectiveness of treatments or interventions.

Hiruma T et al. published the results of a cohort of 610 patients who suffered an acute myocardial infarction and evaluated the effect of a CVRhP-P for 150 days. These researchers found that, during follow-up (6.1 ± 4.0 years), the CR group had a lower incidence of MACE (log-rank p = 0.002). They identified predictive indicators of MACE associated with the maneuver as: age, diabetes, chronic kidney disease, atrial fibrillation, Killip-Kimbal classification, HDL-C levels, diuretic use, left atrial diameter, left ventricular end-diastolic and end-systolic diameters, LVEF, and RV systolic pressure. (GRADE: low $_{G2\text{-}R6_Ref_7}$).[45]

MACE assessment is not systematically performed within CVRhP-P because these are long-term outcomes and are usually evaluated in research studies. However, rehabilitation center staff should be aware of these indicators, as they are the best way to provide feedback on processes and staff engagement.

#### *3.1.1.3 Health-related quality of life (HR-QoL)*

Health-related quality of life is an indicator that has gained importance over the years and is a primary goal in virtually any healthcare activity. Currently, most studies systematically publish the effect of CVRhP-P on HR-QoL as an outcome indicator.

HR-QoL is an indicator that cannot be missing in the evaluation of CVRhP-P. In 2024, the relationship between ExTol and HR-QoL was studied in older adults included in a CVRhP-P. It was found that the increase in $VO_2$peak was associated with better HR-QoL and a reduction in anxiety and depression in men (p<0.001), while in women it was related only to the physical component of HR-QoL (GRADE: moderate $_{G2\text{-}R6_Ref_6}$).[46]

#### *3.1.1.4 Health care costs*

Healthcare costs are a factor that has become increasingly important in a highly technological world with very expensive consumables. Therefore, any initiative proven to have a favorable clinical effect and generate savings for the healthcare system is welcome.

Over the past few decades, several studies have been published that have demonstrated the adequate cost-benefit effect of CVRhP-P, showing savings in monetary terms and in QALYs or DALYs (GRADE: moderate $_{G3\text{-}R2_Ref_7,\ G2\text{-}R6_Ref_8,\ G3\text{-}R2_Ref_4}$).[47,38,59].

Although various cost-benefit analyses associated with CVRhP-P have been published, a study, either at the individual or large-scale level on healthcare costs remains a pending task in our country.

**(KM)** The CVRhP-P includes a series of general effects common to most patients with heart disease (ExTol, HR-QoL, reduction in care costs), which are directly associated with major short-, medium-, and long-term outcomes.

### *3.1.2 Referral of patients to CVRhP-P*

Patient referral and participation in cardiovascular rehabilitation and prevention programs is a crucial step in the continuum of care for patients with heart disease. However, this approach is often suboptimal in most health care systems.

The low referral rate of patients to CVRhP-P is one of the problems most in need of resolution. It is clear that, to the extent that patients are not referred to the programs, participation will be reduced, and they will not receive the associated benefits.

A 2021 observational study of patients undergoing PCI at Michigan hospitals showed that although 76.3% of patients received a hospital referral to CVRhP-P, only 27.1% attended within the following 90 days, with significant variability across institutions and providers (GRADE: moderate $_{G2\text{-}R2_Ref_1}$).[48]

A cohort study evaluated the impact of a referral strategy mediated by a liaison manager versus written referral alone in post-PCI patients. This intervention significantly increased the rate of participation in CVRhP-P (43.1% vs. 32.4%) and reduced the time to first session (28 vs. 33 days) (GRADE: moderate $_{G2\text{-}R2_Ref_2}$).[49]

A 2021 cohort study found that patients referred to CVRhP-P with an electronic referral and a clear medical recommendation had higher attendance at these programs (GRADE: low $_{G2\text{-}R2_Ref_3}$). [50]

### *3.1.3 Barriers in CVRhP-P*

Over the past few decades, various barriers have been identified that prevent patients from accessing, participating in, and adhering to CVRhP-P. These barriers range from clinical to social and financial issues.

There is a low number of patients eligible for CVRhP-P who participate in them, either due to a low referral or poor adherence (GRADE: low $_{G2\text{-}R1_Ref_8}$).[51]

The presence and type of barriers to the implementation of CVRhP-P have been documented in low- and middle-income countries, where the lack of referrals, the perception of low utility of the program,

and deficiencies in infrastructure and human resources limit access to these services. Babu AS et al. proposed strategies to counteract this effect, such as improving the training of health personnel, optimizing task distribution, and strengthening the presence of CVRhP-P in hospital care (GRADE: very low $_{G2\text{-}R2_Ref_4}$).[52]

In the post-surgical setting, a cross-sectional study in patients undergoing cardiac surgery found that although the referral rate to CVRhP-P was 84% and the enrolment rate was 87%, there were groups that were less likely to be admitted such as: women, older people, patients living alone and those with low incomes (GRADE: very low $_{G2\text{-}R2_Ref_5}$).[53]

A systematic review of 29 articles found that authors agreed that patients with the lowest participation in CVRhP-P were the elderly, women, patients with comorbidities, the unemployed, individuals with low educational levels, low incomes, and single individuals. Other factors related to program adherence were distance from the CVRhP centers, lack of transportation, or inability to drive. (GRADE: low $_{G2\text{-}R1_Ref_2}$).[54]

In 2022, a cohort of 214 patients with HF and reduced ejection fraction showed that CVRhP-P remains underutilized. Initially, the authors observed that only 35% of these patients were enrolled in CVRhP-P, and they had a higher prescription rate for sacubitril/valsartan (34% vs. 19%; p=0.01), mineralocorticoid receptor antagonists (84% vs. 72%; p=0.04), ICDs (41% vs. 20%; p<0.01), and resynchronization therapy (21% vs. 10%; p=0.03). On the other hand, the variables associated with the non-inclusion of these patients in CVRhP-P were: age (OR= 1.04; 95% CI 1.01 to 1.07), higher educational level (OR= 3.31; 95% CI 1.63 to 6.70), having suffered a stroke (OR= 3.29; 95% CI 1.06 to 10.27), chronic obstructive pulmonary disease (OR= 4.82; 95% CI 1.53 to 15.16), and patients without an ICD (OR= 2.68; 95% CI 1.36 to 5.26). The main reasons for patients not participating in CVRhP-P were lack of medical referral (31%), comorbidity (28%), patient refusal (11%), and geographical distance to the hospital (9%). Adverse events were not assessed (GRADE: moderate $_{G2\text{-}R1_Ref_1}$).[55]

**(KM)** There are multiple barriers to referral, participation, and adherence to CVRhP-P, which must be identified and specific plans established to overcome them.

### 3.1.4 Modalities of CVRhP-P

Today, there are several ways to deliver CVRhP-P, ranging from in-patient interventions known as Phase I, through in-person Phase II (outpatient or residential) and home-based (Phase III) variants, telerehabilitation, and even hybrid programs. Most of the activities take place here, including rehabilitation, therapeutic physical training, prevention, mental health, nutrition, and health education.

Each modality can be delivered singly or in a combination, usually sequential. At the end of the CVRhP-P, a comparative evaluation is required, highlighting whether the established goals were achieved.

The level of expertise of each unit allows for the development of exercise plans ranging from least to most complex, along with the ability to identify and resolve complications. In addition, other modalities based on telemedicine or hybrid programs are currently available.

The AHA and AACVPR issued a position paper on CVRhP-P in 2024, stating that these should not be restricted to offering a single format. Currently, there are various modalities, ranging from in-person and telemedicine models to hybrid virtual (synchronous) or remote (asynchronous) programs. This diversity can help overcome frequently observed barriers such as lack of access due to geography, transportation, and competing priorities, and consequently improve adherence. There is evidence to suggest that these types of programs are as effective and safe as traditional programs, particularly in low- to moderate-risk patients. (GRADE: moderate $_{G2\text{-}R1_Ref_4}$).[23]

#### 3.1.4.1 Standard modality

The way CVRhP-P are offered has changed significantly over time. Historically, these programs were composed exclusively of therapeutic physical training in a hospital-based format, and the most widely used form of physical exercise has been continuous moderate aerobic training (CMAT), usually on a stationary bicycle or treadmill.

Today, standard programs are in-person and transdisciplinary, including various forms of physical training (moderate continuous aerobic training (HITT), strength, or circuit training), as well as complementary preventive activities such as nutrition, psychology, and the systematic identification and management of cardiovascular risk factors.

#### 3.1.4.2 Telerehabilitation

Telemedicine is the remote delivery of medical care using telecommunications and digital technologies such as video calling and messaging to connect patients with physicians even when they are physically separated.

Telemedicine has been around for years and began simply with phone calls to patients for follow-up care. Nowadays, sophisticated monitoring systems have been developed, such as those that use T-shirts with built-in electrodes that send the electrocardiographic signal to a smartphone app. Furthermore, some of these apps even make decisions and suggest training adjustments based on specific algorithms (AI). Several studies have demonstrated its efficacy in improving exercise tolerance, increasing adherence, and optimizing HR-QoL.

Ramachandran HJ et al. recently published a meta-analysis with 14 studies and 2,869 patients with ischemic heart disease. The authors found that the cardiac telerehabilitation protocol was associated with improvement in ExTol (6-min walk distance, MD= 25.58 m; 95% CI 14.74 to 36.42), daily step count (MD = 1.05 mil; 95% CI 0.36 to 1.75), exercise habits (OR = 2.28; 95% CI 1.30 to 4.00), depression score (SMD = -0.16; 95% CI -0.32 to 0.01), and HR-QoL in mental role (MD= 2.63, 95% CI 0.06 to 5.20) and physical role (MD = 1.99; 95% CI 0.83 to 3.16). Adverse events not assessed (GRADE: moderate $_{G2\text{-}R1_Ref_3}$).[56]

Su JJ et al. developed a randomized clinical trial with 146 patients hospitalized with coronary artery disease, where nursing-led telerehabilitation through an eHealth platform was shown to increase physical activity and reduce sedentary time. After performing a generalizability estimated equations (GEE) model, it was observed that, at 6 and 12 weeks, patients increased their number of daily steps ($\beta$ = 2520 to 2628, p = 0.006), reduced sitting time ($\beta$ = -640.30 to -719.73 min/week, p = 0.004) and reported higher self-efficacy ($\beta$ = 0.61, p = 0.005) and HR-QoL (MD = 0.56, p < 0.001) (GRADE: moderate $_{G3\text{-}R2_Ref_2}$).[57]

A meta-analysis of 46 studies confirmed that telerehabilitation significantly improves exercise adherence and tolerance, with a combination of wearable devices and mobile apps proving most effective at improving $VO_2$ peak (SUCRA = 86.8%) and instant communication the best strategy to encourage adherence (SUCRA = 74.2%) (GRADE: moderate $_{G3\text{-}R2_Ref_3}$).[58]

From a financial perspective, a cohort study demonstrated that telerehabilitation following a coronary event has a significantly higher completion rate than in-center rehabilitation (80% vs. 50%) and similar total costs, although with a significant reduction in rehabilitation-specific costs (USD $1,377/patient, p=0.002) (GRADE: moderate $_{G3\text{-}R2_Ref_4}$).[59]

For some experts, one aspect that remains unclear is the level of safety associated with this type of program, where the provider does not have direct access to the patient in case of a complication.

### *3.1.4.3 Hybrid programs*

A hybrid model is a healthcare approach that combines traditional facility-based rehabilitation with remote, home-based, or technology-enabled components, such as supervised virtual sessions and telehealth.

Currently, the most promising CVRhP-P format is the hybrid model, as it is an adaptable and versatile model that offers several solutions to patient needs, including barriers to referral and participation.

Keteyian SJ et al. conducted a randomized clinical trial comparing hybrid rehabilitation (synchronous telemedicine) with traditional outpatient rehabilitation. They found that both strategies achieved equivalent improvements in peak $VO_2$ and 6MWT, with no differences in the number of sessions completed (29±12 vs 28±12, p=0.94). One major adverse event was reported after a virtual session (non-fatal CVE) (GRADE: high $_{G3\text{-}R2_Ref_5}$).[60]

**(KM)**. CVRhP-P should not be restricted to a single presentation, and today we have various modalities ranging from traditional and telemedicine, to versatile hybrid formats, always ensuring effectiveness and safety.

## *3.2 General Interventions*

The interventions performed in a CVRhP-P can be divided into general interventions, which are applied to most patients, complemented by patient-specific maneuvers that are tailored to each case. This section presents the first type.

**Clinical Evaluation.** It is essential that healthcare team understand the details of the patient's case from the first contact, including the patient's medical history, specific assessments such as frailty, anxiety, depression, HR-QoL, physical attributes, and the results of laboratory and imaging studies. The initial evaluation of each patient is usually conducted during a medical consultation and focuses on obtaining the information needed to plan the CVRhP-P activities. This is done to identify the patient's clinical, personal, occupational, and cultural problems, as well as to prepare information for risk stratification. Occasionally, it will be necessary to expand this information with further studies or consultations.

**Risk stratification.** Every convalescent patient remains at some level of risk for a new cardiovascular event or potentially serious complications during ThPhT sessions. One of the cornerstones is the calculation and stratification of this risk to identify those patients who require closer, more technical monitoring than those with a lower likelihood of complications. The

method and tools used for this purpose are associated with the complexity of each case.

**Therapeutic physical training**. The changes in the body associated with physical training have been studied for centuries, from the training of the armed forces to patient care. The cause of these changes, both structural and functional, is the teleological process of stimulus-adaptation, where specially designed routines lead to specific bodily changes, many of them in pursuit of specific goals, such as increasing survival, improving HR-QoL, or optimizing physical performance for work or athletic purposes.

**Physical qualities**. Muscle strength, elasticity, aerobic power, balance, and coordination, among others, can be modified through targeted training programs, seeking harmony in the complex network of organs and body systems. The prescription of ThPhT is based on general scientific principles that give it properties analogous to pharmacological ones.

**Heart-healthy lifestyle**. A fundamental goal of CVRhP-P is the degree to which each patient achieves adequate cardiovascular risk factor modification and the achievement of health determinants, integrated into what we call a heart-healthy lifestyle. This includes basic elements such as chronic disease control, adequate nutritional status, cessation of harmful habits, and good mental health.

Finally, CVRhP unit team members should discuss this information together to establish goals and identify barriers to achieving them in each case.

### 3.2.1 First evaluation of the patient

The first contact with the patient is crucial. At this point, the precise indication for program entry will be verified, any contraindications will be identified, the patient will be informed about the characteristics of the

**Recommendation Table 2.** First evaluation of the patient

| PICO | 3.2.1 Patient First Evaluation | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G12-R6 | It is recommended that a comprehensive assessment be performed at the start of a CVRhP-P, including a detailed medical history, functional physical, nutritional, and psychosocial assessment. This will provide the information necessary to stratify the patient's risk, design a training plan, assign the level of supervision, and establish goals for each case. | I | A | C+/B+ | 1 to 6 |
| G12-R1 | It is recommended that patients' nutritional status and body composition be assessed in order to establish an appropriate nutritional diagnosis and treatment. This assessment may include anthropometry or more sophisticated techniques. | I | B-R | C-/B+ | 1 to 6 |
| G12-R4 | It is recommended to assess the mental health status (depression, anxiety, or personality disorder) of patients in CVRhP-P, in order to identify psychological risk factors and establish appropriate interventions that contribute to improving treatment adherence, HR-QoL, and reducing cardiovascular mortality. | I | B-R | C-/B+ | 1,2,4 and 6 |
| G12-R2 | It is recommended to perform a comprehensive functional assessment prior to enrollment in cardiac rehabilitation, including objective tests of exercise tolerance (such as the 6-minute walk test or cardiopulmonary exercise testing), muscle strength (e.g., handgrip strength or one-repetition maximum tests), balance (tandem stance or the Tinetti test), and mobility (gait speed or the Timed Up & Go test). The purpose of this assessment is to identify relevant functional limitations, personalize the CR intervention, establish a baseline to evaluate progress, and detect conditions such as frailty or fall risk that may require specific adaptations to the program | I | B-NR | C+/B+ | 1,2,4 and 6 |
| G12-R5 | It is recommended that grip and quadriceps muscle strength be assessed in patients participating in a CVRhP-P, in order to establish an initial diagnosis and prognosis, as well as to prescribe ThPhT in a targeted manner. | I | B-NR | C-/B+ | 1 to 6 |
| G12-R7 | It is recommended to evaluate coronary anatomy, presence of ischemia, ventricular function, electrical stability, as well as ergometric response in patients in a CVRhP-P, in order to perform a comprehensive risk stratification. | I | C-EO | C+/B+ | 1 to 6 |
| G12-R3 | It is recommended to evaluate biomarkers such as NT-proBNP, hs-CRP, and troponins in patients in a CVRhP-P, according to the physician's clinical judgment, in order to establish a prognosis and evaluate the achievement of goals during follow-up. | IIa | B-NR | C+/B+ | 1 to 6 |

CVRhP-P, and the necessary information will be collected for risk stratification and ThPhT planning.

### *3.2.1.1 Initial approach*

Upon admission to the CVRhP-P, a plan of activities is established that includes the preparation of a medical history and evaluation of physical qualities, analysis of paraclinical studies that include an exercise test (ideally CPET), risk calculation and stratification, prescription and supervision of therapeutic physical training, as well as the establishment of a heart-healthy lifestyle.

Clinical and paraclinical information contributes to case knowledge, risk stratification, and the prescription and monitoring of ThPhT in patients participating in CVRhP-P.

### *3.2.1.2 Clinical Evaluation*

The systematic collection of clinical information at the start of CVRhP-P in patients with CVD is essential to ensure adequate risk stratification and individualized monitoring throughout their care.

The initial interview with the patient gives us the opportunity to receive and analyze the clinical summary sent by the attending physician and begin compiling the medical record.

Through the anamnesis, we corroborate the data recorded in the clinical summary and inquire about the patient's symptoms, adherence to prescribed medication, and expectations, among other items.

The patient's physical examination completes the initial clinical evaluation and should include, at a minimum, vital signs, data on cardiopulmonary stability, the condition of wounds and scars, and the presence of invasive devices (hospitalized patients).

#### 3.2.1.2.1 Medical record review and anamnesis

Initially, all patients will be interviewed by each professional on the CVRhP staff, with the goal of obtaining relevant information for comprehensive program planning, from risk stratification to goal assessment.

Several CPGs recommend including a complete evaluation of the clinical history from the first consultation, with emphasis on cardiovascular history and the presence of comorbidities. They also establish the need to identify modifiable risk factors, such as smoking and sedentary lifestyle, as well as to document adherence to pharmacological treatment and the patient's specific needs regarding physical, occupational, or nutritional rehabilitation.

Thus, the medical history compiled by the attending physician must include, in addition to conventional data (such as age, gender, etc.), information about the characteristics of their cardiovascular diagnosis (history, etiology, severity, paraclinical studies performed, type of treatment received, complications, etc.), cardiovascular risk factors (diabetes, smoking, dyslipidemia, hypertension, sedentary lifestyle, etc.), and comorbidities. In addition, the consolidated medication intake must include all current medication use (medications, supplements, etc.), vaccination schedule, physical activity or sedentary lifestyle, sleep pattern, substance abuse (smoking or vaping, alcohol use, soft or hard drugs), and any special patient preferences.

Cardiorespiratory fitness, considered a vital sign, can now be assessed indirectly using clinimetric instruments such as the Duke Activity Status Index (DASI) or NYHA functional class. The gold standard for this assessment is exercise testing (see below).

One aspect that cannot be overlooked is the evaluation of the patient's sleep habits; due to the inherent cardiovascular risk they entail (Fig. 13).

#### 3.2.1.2.2 Pharmacological treatment

It is important to accurately record a patient's drug treatment, largely because CVRhP-P generates physiological changes that often require adjustments in treatment titration and optimization, ideally in conjunction with the treating physician. Polypharmacy and potential drug interactions should always be considered.

Depending on the patient's clinical status, it is common to adjust antihypertensives, beta-blockers, diuretics, antiarrhythmics, hypoglycemic agents, lipid-lowering agents, and anticoagulants, among others. The timing of CVRhP-P is an excellent opportunity to adjust doses in outpatients (real life), reduce the number and severity of medication-related incidents, and promote practices that increase treatment adherence.

Staff should keep in mind that the use of medications, particularly those with negative chronotropic effects (beta-blockers, antiarrhythmics, etc.), can reduce exercise tolerance by decreasing heart rate and cause symptoms such as fatigue or dyspnea. Furthermore, the use of diuretics and vasodilators can be associated with postural hypotension in certain patients, causing dizziness, fainting, or syncope.

| Sleep and Subclinical Atherosclerosis | |
|---|---|
| **Variable** | **Effect** |
| **Sleep Duration**<br>**<6 h**<br>**>8 h** | **Increased subclinical atherosclerosis:**<br>**Adjusted Δ: +0.067 mm (p<0.001)**<br>**Adjusted Δ: +0.054 mm (p<0.001)** |
| **Healthy Sleep Score (HSS)** | **For each additional unit in HSS, the risk of CVD decreased by 16% (HR 0.84, 95% CI: 0.73–0.97), 2–5 years of follow-up.** |
| **Poor Cardiovascular Health (AHA's Life's Simple 7)**<br><br>**• Short sleep duration**<br>**• High night-to-night variability in sleep duration**<br>**• Irregular sleep timing**<br>**• Moderate to severe obstructive sleep apnea** | **Associated with poor cardiovascular health (AHA's Life's Simple 7):**<br><br>**OR = 1.25; 95% CI: 1.01–1.55**<br>**OR = 1.24; 95% CI: 1.02–1.51**<br>**OR = 1.31; 95% CI: 1.04–1.64**<br>**OR = 2.21; 95% CI: 1.78–2.73** |
| **Sleep <6 h vs 7–8 h**<br><br><br>**Sleep fragmentation** | **Higher subclinical atherosclerosis burden (based on non-invasive vascular imaging):**<br>**Adjusted OR = 1.33; 95% CI: 1.02–1.73**<br><br>**Greater non-coronary plaque burden (p < 0.05)** |

**Figure 13.** Sleep disorders and subclinical atherosclerosis. An association is observed between sleep duration and subclinical atherosclerosis burden. Poor sleep quality, irregular sleep patterns, and obstructive sleep apnea are linked to worse overall cardiovascular health, increased plaque burden, and a higher risk of cardiovascular events, even after adjustment for traditional risk factors. Abbreviations: HSS: Healthy Sleep Score; CVD: cardiovascular disease; HR: hazard ratio; 95% CI: 95% confidence interval; AHA: American Heart Association; OR: odds ratio; Δ: adjusted change or difference.

### 3.2.1.2.3 Physical examination

The physical examination should include information on anthropometry, vital signs, general examination, neurological evaluation, cardiovascular and pulmonary evaluation, ankle-brachial index, presence of edema, condition of scars, wounds, and vascular bundles in the areas of cardiovascular procedures (particularly sternal stability in post-surgical patients), and the presence of implanted devices (cannulas, electrodes, probes, etc.).

The physician will request any morpho-functional studies deemed necessary to adequately stratify the patient's risk (see below).

In addition to a medical evaluation, clinical review by specialists in physical therapy, nursing, nutrition, psychology, and social work is required. Thus, clinical tools such as visual and auditory acuity, the falls risk scale, evaluation of physical qualities (strength, coordination, elasticity, balance), the degree of general frailty, nutritional evaluation and dietary recall, screening for anxiety, depression and health-related quality of life (HR-QoL), mental state, socio-economic evaluation, educational level, employment status, identification of social support networks will be obtained The elderly group requires a specific assessment to determine the level of physical and cognitive decline in various areas (Fig. 14) (GRADE: high $_{G12\text{-}R6_Ref_4}$).[61]

### 3.2.1.2.4 Nutritional status

The nutritional status of patients with CVD is a clinical indicator with a significant prognostic impact. Nutritional advice should include a recommendation for a heart-healthy diet along with other specific items aligned with the clinical status of the cardiovascular disease and the patient's comorbidity. Initially, a complete nutritional assessment should be performed, including food recall, weight status, and body composition. In patients with heart disease, in addition to calculating the BMI, the level of adiposity and sarcopenia must be assessed. Indicators of centripetal obesity, such as waist circumference or the waist-hip ratio, are associated with the case fatality rate.

Vaquero-Cristóbal R describes the pros and cons of various methods for assessing body fat. Dual-energy X-ray absorptiometry (DEXA) is considered the gold standard, although it requires specialized equipment and software. Hydrodensitometry and plethysmography are based on the displacement of a liquid or gas caused by a body (Archimedes' principle) to assess fat mass.

**Clinical Evaluation of the Elderly**

| Principle | Items |
|---|---|
| Mental processes | Dementia, memory loss, delirium, depression |
| Mobility | Disorders of gait, balance, and fall prevention |
| Medications | Polypharmacy, reduction of medications and side effects |
| High complexity | Multi-morbidity. Complex bio-psycho-social disorders. |
| Priorities | Individualized goals and preferences |

**Figure 14.** Clinical Evaluation of the Elderly. Key domains in the comprehensive assessment of older adults, including mental status, mobility, medication use, complexity of conditions, and individualized care priorities. These elements are essential for tailoring CVRhP-P, as they help identify risks, guide safe exercise prescription, and align interventions with patient-centered goals.

Both are accurate methods, but little used due to their high cost, discomfort, and logistics. Electrical bioimpedance is a widely used method with favorable characteristics such as speed, very low invasiveness, portability, economy, and low complexity. However, the subject's hydration status greatly affects the measurements, which decreases its validity, particularly in athletes. On the other hand, anthropometry has the advantages of being inexpensive, noninvasive, requiring minimal equipment, being portable, and offering the clinician various supplementary variables. However, it is a complex evaluation that requires a long acquisition time, making it operator dependent. Ultrasonography is a valid and accurate method, but at the same time it is expensive, less portable, and operator dependent. The 2D/3D/4D scanner is an avatar performed using visible light and infrared, still under investigation (GRADE: very low $_{\text{G12-R1_Ref_1}}$).[62]

A 2023 expert consensus concluded that, although BMI is easy to calculate and widely used, it has several limitations. The need to know the type of weight distribution, whether centripetal or centrifugal, makes other clinical methods for specifically measuring visceral fat (waist-hip ratio, waist circumference) more accurate in predicting pathology or mortality. The most novel methods described are CT, MRI, anthropometry, bioelectrical impedance, ultrasound, and DEXA (GRADE: very low $_{\text{G12-R1_Ref_2}}$).[63]

Alaminos Torres A et al. compared various body composition diagnostic methods with 5,225 individuals who attended a nutritional clinic in a pharmacy. The methods compared were weight, height, waist index, BMI, roundness index, body silhouette, and waist-to-height ratio. The area under the ROC curve was calculated for each method, and then the methods were compared. The roundness and waist-to-height indices showed the best diagnostic accuracy for hypertension (ROC = 0.710), hyperglycemia (ROC = 0.710), and hypercholesterolemia in both genders (ROC = 0.650), as well as hypertriglyceridemia in men (ROC = 0.710) (GRADE: moderate $_{\text{G12-R1_Ref_3}}$).[64]

A meta-analysis of 32 studies showed that both BMI and waist circumference are not sensitive enough to be used in the diagnosis of obesity, but in the absence of a more effective method, they remain valid. BMI in women has a sensitivity of 51.4% (95% CI, 38.5% to 64.2%) and a specificity of 95.4% (95% CI, 90.7% to 97.8%); in men, a sensitivity of 49.6% (95% CI, 34.8% to 64.5%) and a specificity of 97.3% (95% CI, 92.1% to 99.1%). Waist circumference in women had a sensitivity of 57.0% (95% CI: 32.2 to 79.0%) and specificity of 94.8% (95% CI: 85.8 to 98.2%) and in men a sensitivity of 62.4% (95% CI: 49.2 to 73.9%) and specificity of 88.1% (95% CI: 77.0 to 94.2%). There was no significant evidence in the waist-to-hip or waist-to-height indices (GRADE: moderate $_{\text{G12-R1_Ref_4}}$).[65]

### 3.2.1.2.5 Psychological evaluation

Psychological assessment should be systematically performed on any patient entering a CVRhP-P, and at least the presence and extent of depression, anxiety or stress, and health-related quality of life (HR-QoL) should be evaluated.

The presence of anxiety, depression, and type D personality has been consistently associated with a worse prognosis in patients with CVD. A recent narrative review indicates that approximately 50% of patients with CVD have elevated levels of anxiety, which negatively affects their treatment adherence, health behaviors, and HR-QoL. Evidence suggests that interventions such as cognitive-behavioral therapy and psychoeducation improve these clinical outcomes and are essential for optimizing cardiovascular health (GRADE: very low $_{\text{G12-R4_Ref_1}}$).[66]

Pedersen SS et al. support the use of validated instruments such as the PHQ-9 (Patient Health Questionnaire-9), GAD-7 (Generalized Anxiety Disorder-7), HADS (Hospital Anxiety and Depression Scale), and DS14 (Type D Scale-14) to identify psychological risk factors in clinical practice. This assessment has been

linked to increased therapeutic adherence, improved HR-QoL, and reduced readmissions and mortality. They also emphasize the need to integrate psychological management with physical therapy for CVD to maximize clinical benefits (GRADE: low $_{G12\text{-}R4_Ref_3}$).[67]

In the context of heart failure, a cohort study in 148 patients found that while depression and anxiety were not directly correlated with the risk of rehospitalization, other dimensions such as vitality, social functioning, and general health were significant in predicting events. General health was the best predictor of rehospitalization (AUC = 0.665, p = 0.002), which underscores the value of assessing psychological well-being as a complement to conventional clinical markers (GRADE: moderate $_{G12\text{-}R4_Ref_2}$).[68]

From an epidemiological perspective, depression has been associated with a 30% increased risk of coronary heart disease (RR=1.30; 95% CI 1.22 to 1.40) and myocardial infarction (RR=1.30, 95% CI 1.18 to 1.44), according to a meta-analysis with more than 893,000 patients. In follow-up periods of less than 15 years, the risk was higher (RR=1.36; 95% CI 1.24 to 1.49). These findings highlight the clinical relevance of evaluating and treating depression as part of a comprehensive cardiovascular approach (GRADE: high $_{G12\text{-}R4_Ref_5}$).[69]

Batelaan NM et al. published a meta-analysis and observed that anxiety is associated with a 52% increase in the incidence of CVD (HR = 1.52; 95% CI: 1.36 to 1.71), independent of traditional risk factors and depression. This positions anxiety as an independent risk factor in cardiovascular pathophysiology (GRADE: high $_{G12\text{-}R4_Ref_6}$).[70]

In patients with heart failure, depression is also an adverse prognostic marker. A meta-analysis of nine studies reported that depression was associated with a 51% increase in all-cause mortality (HR = 1.51; 95% CI: 1.19 to 1.91), with a diagnosis of major depression being the highest risk (HR = 1.98; 95% CI: 1.23 to 3.19). Cardiovascular mortality was also significantly increased (HR = 2.19; 95% CI: 1.46 to 3.29) (GRADE: high $_{G12\text{-}R4_Ref_7}$).[71]

A meta-analysis of 8,473 patients with heart failure found an association between depression and overall mortality (HR = 1.39; 95% CI 1.27 to 1.52), particularly in older adults and with shorter follow-up periods. However, no significant association with cardiovascular mortality was observed in multivariate analyses (HR = 1.22; 95% CI 0.91 to 1.63) (GRADE: high $_{G12\text{-}R4_Ref_8}$).[72]

Even in patients who will undergo coronary artery bypass grafting, preoperative depression increases the risk of long-term mortality (HR = 1.46, 95% CI 1.23 to 1.73), justifying its systematic evaluation as part of the presurgical approach (GRADE: high $_{G12\text{-}R4_Ref_9}$).[73]

Psychological factors such as work-related stress, post-traumatic stress, and emotional stress in childhood negatively impact cardiovascular function and promote disease progression. Early identification allows for the design of more effective prevention and intervention programs (GRADE: low $_{G12\text{-}R4_Ref_4}$).[74]

Finally, a 2018 systematic review and meta-analysis with over 10,000 patients showed that psychological interventions significantly reduced cardiovascular mortality (RR= 0.79; 95% CI 0.63 to 0.98), in addition to improving symptoms of depression (SMD= -0.27; 95% CI -0.39 to -0.15), anxiety (SMD= -0.24; 95% CI -0.38 to -0.09), and stress (SMD= -0.56; 95% CI -0.88 to -0.24). From an economic perspective, an average savings of $1,229 USD per patient was observed due to a 46% reduction in hospital readmissions (GRADE: high $_{G12\text{-}R4_Ref_10}$).[75]

**(KM).** The patient's clinical assessment is the cornerstone of the program. A review of the clinical record, along with a targeted history and physical examination, is essential to confirm the number and severity of pathologies and the patient's current stability. This will also guide the request for further information required for risk stratification and establish the basis for prescribing the activities included in the program.

### *3.2.1.3 Paraclinical studies*

The history and physical examination, which provide this initial assessment of the case, will be expanded and refined using various paraclinical studies, ranging from general (complete blood count, blood chemistry, glycosylated hemoglobin, lipid profile, urinalysis, chest X-ray, and electrocardiogram) to more sophisticated studies such as cardiopulmonary exercise testing, echocardiography, 24-hour Holter ECG, biomarkers, etc. This strategy allows for safe and realistic adjustment of therapeutic goals and supervision levels in subsequent stages (GRADE: very low $_{G12\text{-}R6_Ref_2}$).[685]

Furthermore, in studies conducted among healthcare professionals who care for active populations or those with special needs, it has been observed that more than 60% use tools such as echocardiography from the first clinical consultation to complement cardiovascular assessment. This practice reinforces the usefulness of integrating functional and structural imaging tests as part of the initial approach, especially in those with symptoms or high-risk factors. It is also highlighted that periodic and targeted assessments allow for adapting

follow-up and timely detection of any relevant clinical changes (GRADE: very low $_{G12\text{-}R6_Ref_1}$).[76]

The number and type of studies will be ordered based on each individual patient.

### 3.2.1.3.1 Exercise test

Exercise testing (ET) is a tool for assessing physical performance during exercise and can be obtained with the help of various instruments such as continuous ECG tracing, echocardiography, radionuclide imaging, or expired gas analysis (Cardiopulmonary Exercise Testing, CPET).

ET is performed using a standardized protocol, and indications and contraindications are clearly identified beforehand. Test supervision and criteria for discontinuing exercise are precisely described, and a complete final report signed by the attending physician must be obtained.

Exercise testing is very versatile and can be performed in children, adults, and the elderly, as well as in the entire spectrum of heart disease, from coronary artery disease to adult-onset congenital heart disease (GUCH). Naturally, the findings will depend on everyone's pathophysiology and should be considered when stratifying risk and planning ThPhT.

One of the most relevant indicators recorded in the ET report (ideally CPET) is exercise tolerance, an expression of cardiorespiratory fitness as a vital sign.

Similarly, it is recommended that an assessment of ExTol (METs, $VO_2$ peak) through exercise testing be integrated into the initial consultation, which is key to establishing safe ThPhT levels and assessing cardiovascular prognosis. In specific contexts, such as evaluation for participation in sports activities, this assessment is combined with risk stratification, analysis of residual ischemia, and the type of sport to be performed, thus allowing for personalized decisions regarding patient eligibility and follow-up. This information facilitates continuous adjustments in training and improves the safety of physical participation during CVRhP-P (GRADE: low $_{G12\text{-}R6_Ref_3}$).[77]

In a position document of the European Society of Preventive Cardiology in 2021, as part of the evaluation of the patient entering CVRhP-P, office studies such as: 12D surface electrocardiogram, echocardiography, exercise test, and chest X-ray in postoperative patients are included (GRADE: low $_{G12\text{-}R7_Ref_1}$).[678]

Stress testing allows us to assess overall body performance and identify abnormalities such as ischemia or arrhythmias. It is the primary method in CVRhP-P, combining diagnostic and prognostic approaches and providing essential information for prescribing ThPhT.

### 3.2.1.3.2 Functional assessment

Several studies support the clinical utility of a comprehensive functional assessment in patients with CVD before starting cardiac rehabilitation, particularly through objective tests of exercise tolerance, muscle strength, balance, and mobility, both for their prognostic value and their ability to detect relevant functional conditions.

In a cohort study of 160 men in the maintenance phase of CVRhP-P, a significant increase in ExTol ($VO_2$peak) was documented, ranging from +0.33% to +3.23% annual increase during the first three years after the program ($p < 0.05$), followed by a progressive decline. In parallel, muscle strength was measured using the one-repetition maximum (1RM) method in different muscle groups and observed a similar behavior to ExTol, i.e., an initial improvement followed by a subsequent decline ($p < 0.05$). In this study, strength tests such as knee extension, chest press, and rowing were used as functional indicators (GRADE: moderate $_{G12\text{-}R2_Ref_1}$).[78]

In a cohort of women in the CVRhP-P program, gains in ExTol (+1.8% annually) and muscle strength (between 0.6% and 2.1% annually) were observed at six years of follow-up. This highlights the importance of assessing these indicators over the long term, particularly in populations that tend to have lower participation in these programs. (GRADE: low $_{G12\text{-}R2_Ref_2}$).[79]

Furthermore, in a cohort of 243 older adults classified according to frailty, Phase II CVRhP-P was associated with significant functional improvement across all physical indicators assessed, including gait speed, Timed Up & Go (TUG), tandem stand balance, handgrip strength, and 6MWT, even in the most frail groups ($p < 0.001$), supporting the use of these tests as sensitive tools to identify the need to tailor intervention to a patient's baseline condition (GRADE: low $_{G12\text{-}R2_Ref_3}$).[80]

Itagaki A et al, published a multicenter cohort with 523 older adults undergoing cardiac surgery and observed that the lower the preoperative performance in gait speed, the greater the functional deterioration at hospital discharge (OR= 0.01; 95% CI 0 to 0.08, $p< 0.001$) (GRADE: moderate $_{G12\text{-}R2_Ref_4}$).[81]

The Tinetti mobility test correlated significantly with muscle mass ($r= 0.48$, $p= 0.024$) and handgrip strength ($r= 0.39$, $p= 0.046$) in a cross-sectional study with 337 older adults, indicating its usefulness in identifying risk of sarcopenia and falls (GRADE: low $_{G12\text{-}R2_Ref_5}$).[82]

On the other hand, the Short Physical Performance Battery, which includes tests of balance, gait speed, and rising from a chair, has demonstrated structural validity and acceptable reliability in a study of 637 older adults, although its individual-level accuracy is limited. This finding highlights the importance of combining multiple objective functional tests to achieve a more accurate and personalized assessment in clinical practice (GRADE: low $_{G12\text{-}R2_Ref_7}$).[83]

Resistance training in patients with CVD has gained renewed interest in recent years, as has the assessment of muscle strength, both as a prognostic parameter and as the basis for individualized exercise prescription. Muscle strength is an indicator of medium- and long-term survival. Although muscle strength cannot be defined with a single measure, it is widely assessed using handgrip strength (HGS) using dynamometry, which is easily applicable and recommended for use in clinical, research, or community settings. It is a practical, safe, noninvasive, and reliable method, and does not require intensive training for its application and interpretation.

Shoemaker MJ et al. proposed that muscle strength measurement in patients with HF be performed using the percentage of one-repetition maximum (1RM) and used for resistance training prescription (GRADE: high $_{G12\text{-}R5_Ref_1}$).[84]

Tomkinson GR et al. recently published a systematic review and meta-analysis of 100 studies and 2,405,863 individuals from the general population where they presented data distribution tables in relation to the assessment of handgrips throughout life and according to gender (GRADE: high $_{G12\text{-}R5_Ref_9}$).[85]

Adachi T et al. conducted a validation study with 60 patients in CVRhP-P (inpatients and outpatients) of a method to assess the rate of force development (RFD) of the quadriceps and showed high reproducibility, with intraclass correlation coefficients of 0.742 to 0.930 (GRADE: moderate $_{G12\text{-}R5_Ref_10}$).[86]

### 3.2.1.3.3 Biomarkers

The use of biomarkers has significantly improved the evaluation and monitoring of patients with cardiovascular disease, including natriuretic peptides in patients with HF and troponins for the assessment of myocardial damage.

Although many biomarkers exist, few have reached clinical application, as they must meet a series of requirements to be considered relevant and significant. Nowadays, biomarkers can be divided into 7 groups: myocardial injury (troponins, cardiac-type fatty acid-binding proteins and cardiac myosin-binding protein-C), myocardial stress (natriuretic peptides, pro-adrenomedullin and co-peptin), inflammation (C-reactive protein, interleukin 6, growth differentiation factor 15, soluble suppressor of tumorigenicity 2 and galectin-3), platelet activation (soluble CD40 ligand and P-selectin), plaque instability (lipoprotein-associated phospholipase A2, matrix metalloproteinase-9), systemic stress (catecholamines and granin proteins), calcium homeostasis (secretoneurin) (GRADE: low $_{G12\text{-}R3_Ref_3}$).[87]

Acanfora D et al. mention in their review that physical exercise has been positively and significantly associated with some biomarkers such as BNP, NT-proBNP, hs-CRP, IL-6, cVCAM-1, pentraxin (PTX3), homocysteine, and ApoA1. There are other substances where the results are ambiguous or even contrary, such as the ST2 suppressor, MR-ProADM, and CT-proAVP. The authors do not report adverse events (GRADE: low $_{G12\text{-}R3_Ref_1}$).[88]

Oemrawsingh RM et al. published a case-control study with 844 patients surviving an acute coronary syndrome, showed that hs-cTnI levels were associated with the occurrence of a new CV event (HR= 1.87; 95% CI 1.27 to 2.72) for NT-proBNP (HR= 2.38; 95% CI 1.41 to 4.33) and hs-CRP (HR= 1.46; 95% CI 0.82 to 2.62). A single spike in hs-cTnI was significantly associated with the outcome (HR = 2.90; 95% CI, 1.04 to 7.27; p = 0.045), as was a spike in hs-CRP (HR = 2.92; 95% CI, 1.13 to 7.00; p = 0.023). Adverse events were not assessed (GRADE: moderate $_{G12\text{-}R3_Ref_2}$).[89]

Pearson MJ et al published a meta-analysis with 27 studies and 641 HF patients, which showed that there was a significant improvement in NT-proBNP levels associated with conventional ThPhT (MD= -32.80; 95% CI -56.19 to -9.42, p= 0.006) and BNP (MD= -17.17; 95% CI -29.56 to -4.78, p= 0.007) (GRADE: high $_{G12\text{-}R3_Ref_4}$).[90]

A biomarker-based cardiovascular mortality prediction model was developed in a cohort of 13,164 patients with stable coronary artery disease. Patients were followed for 3.7 years, and 591 deaths were recorded. Biomarkers associated with outcome were pro-BNP, highly sensitive cTNT, and LDL-C. The model included the following variables: age, biomarkers, and clinical variables (smoking, diabetes, peripheral arterial disease), with a C statistic = 0.81 (GRADE: high $_{G31\text{-}R1_Ref_3}$).[91]

**(KM).** The clinical evaluation of each patient is expanded and complemented using paraclinical studies that provide information from physiological, imaging, and biochemical perspectives. Exercise testing (ideally CPET) is particularly notable for its diagnostic and prognostic utility and is considered the basis for prescribing physical training. Recently, the use of biomarkers indicates the degree of tissue dysfunction or the

**Recommendation Table 3.** Risk Stratification

| PICO | 3.2.2 Risk stratification | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G13-R3 | It is recommended that maximum exercise tolerance be assessed in all patients with CVRhP-P, in order to predict long-term survival and guide follow-up. | I | A | C-/B+ | 1 to 6 |
| G13-R1 | It is recommended to evaluate the chronotropic response and HR recovery in patients in a CVRhP-P, in order to stratify the risk of overall mortality, cardiovascular mortality, the incidence of acute coronary syndromes or atrial fibrillation. | I | A | C+/B+ | 1 to 6 |
| G14-R1 | It is recommended to use some method of assessing myocardial perfusion in patients with symptomatic coronary artery disease in CVRhP-P, in order to identify the presence of ischemia. | I | A | C+/B+ | 1,6 |
| G14-R5 | An exercise test is recommended upon admission of patients with congenital heart disease, in order to assess their exercise tolerance, hemodynamic abnormalities or arrhythmias. | I | A | C+/B+ | 1,6 |
| G14-R2 | It is recommended that the arrhythmogenic status of patients participating in CVRhP-P be assessed through appropriate studies, in order to identify the risk of developing arrhythmias associated with a poor prognosis. | I | B-R | C+/B+ | 1,6 |
| G15-R4 | It is recommended to stratify the risk of patients in CVRhP-P, in order to identify those who have a higher probability of complications during training and consequently, adjust the exercise plan, prescription, and assign monitoring. | I | B-NR | C-/B+ | 1,2,4 and 6 |
| G15-R1 | It is recommended to systematically include the main risk indicators for each patient in the CVRhP-P, preferably using scales validated for the target population, in order to calculate the probability of experiencing adverse events associated with ThPhT, assign the appropriate level of supervision, and prescribe individually. | I | B-NR | C-/B+ | 1,2,4 and 6 |
| G13-R2 | It is recommended to evaluate the response of systolic blood pressure during exercise testing and recovery in patients in a CVRhP-P, in order to calculate the risk of cardiovascular events and mortality. | I | B-NR | C-/B+ | 1 to 6 |
| G13-R6 | Exercise testing is recommended for patients in a CVRhP-P to assess the risk of potentially lethal exercise-induced arrhythmias. | I | B-NR | C-/B+ | 1 to 6 |
| G13-R4 | Exercise testing is recommended for patients with coronary artery disease to estimate the risk of ischemia and other adverse events associated with therapeutic physical training. | I | B-NR | C-/B+ | 1 to 6 |
| G13-R5 | An exercise test is recommended upon admission of patients with congenital heart disease to assess their ExTol, hemodynamic abnormalities, or arrhythmias. | I | B-NR | C-/B+ | 1 to 6 |
| G14-R3 | It is recommended to evaluate metabolic indicators such as blood glucose, cholesterol, LDL-C, HDL-C, and triglycerides before and after a CVRhP-P, in order to identify goal attainment and audit the program's results. | I | B-NR | C-/B+ | 1,6 |
| G15-R2 | It is recommended to perform a risk stratification process in the pediatric population with congenital heart disease, with a comprehensive assessment of anatomical, functional, hemodynamic, and electrophysiological parameters, for the purpose of planning and supervising physical training in CVRhP-P. This information also supports the recommendation or disqualification for sports participation. | I | C-EO | C-/B+ | 1,2,4 and 6 |
| G14-R4 | It is recommended to request inflammatory markers in patients in a CVRhP-P, particularly post-infarction, in order to assess the risk of future acute coronary events. | IIb | B-NR | C+/B- | 1,6 |

presence of myocardial damage from a cellular perspective.

### 3.2.2 Risk stratification

Risk stratification is a process that calculates the probability of a patient experiencing an adverse outcome in the future, either due to the natural history of their cardiovascular disease or a complication during exercise training, and classifies this chance as low, moderate, or high. This process includes the identification and classification of prognostic variables that influence the outcome and can range from empirical evaluation to the use of sophisticated mathematical risk calculation models.

On the one hand, patients with indicators of poor long-term cardiovascular prognosis will require stricter goals, such as lower LDL-C levels, among others. On the other hand, risk stratification indicates the degree of supervision required during exercise sessions, allowing for planning the ThPhT and implementing intervention measures in the event of an exercise-related cardiovascular emergency in high-risk patients.

In a publication on CVRhP-P from the SEC, the following basic points to be evaluated in a standard risk stratification are established: 1) Coronary risk factors and the progression of the atherosclerosis process. 2) Presence of ischemia. 3) Coronary anatomy. 4) Ventricular function. 5) Electrical stability. 6) Ergometric response. 7) Biomarkers (GRADE: low $_{G12\text{-}R7_Ref_4}$).[92]

#### 3.2.2.1 Exercise tolerance

Maximum exercise tolerance (ExTol) assesses an individual's level of aerobic reserve for physical activity and is the primary indicator considered during the risk stratification process. ExTol is a recognized general indicator of survival and, given its importance, it is considered a vital sign.

ExTol can be assessed directly using CPET (Gold standard) or can be inferred with surrogate indicators, both clinical (Duke Activity Status Index) or paraclinical (6MWT).

Myers J et al. evaluated a cohort of 6,213 healthy subjects or those with known cardiovascular disease over a 6-year follow-up period. The results recorded an incidence of 1,256 deaths and observed that maximum exercise tolerance (METs) was associated with a reduction in mortality in patients with CVD (HR=0.91; 95% CI: 0.88 to 0.94, p<0.001), while this association was even stronger in apparently healthy subjects (HR=0.84; 95% CI: 0.79 to 0.89, p<0.001). After several statistical models, it was inferred that for each MET increase, long-term survival increased by 12% (GRADE: high $_{G13\text{-}R3_Ref_1}$).[93]

In a cohort of 57,284 subjects referred to exercise testing, it was observed that on average, men performed 2 more METs than women. At 10 years of follow-up, 6,402 deaths were recorded and a reduction in mortality risk was observed proportional to the increase of one MET in the ExTol, with no differences by sex: men (HR = 0.84; 95% CI: 0.83 to 0.85) and women (HR = 0.83; 95% CI: 0.81 to 0.84) (GRADE: high $_{G13\text{-}R3_Ref_3}$).[94]

There is a group of patients who, after completing a CVRhP-P, did not show an increase in their exercise tolerance and are classified as non-responders. A risk re-stratification process allows us to identify these patients, who are more likely to experience adverse events.

De Schutter A et al. published a cohort study that included 1,171 patients with coronary heart disease undergoing phase II cardiac rehabilitation where they evaluated the response to training through changes in exercise tolerance ($VO_2$) and the associated prognosis. Mortality was significantly higher in the non-responder group (22%) compared to those who improved their exercise tolerance in a low (17%) or high (8%) manner (p< 0.001). Non-responders had an increased risk of long-term mortality compared to high responders (HR= 4.32; 95% CI from 2.64 to 7.06, p< 0.001) as well as low responders (HR= 2.29; 95% CI from 1.46 to 3.59, p< 0.001). Independent variables associated with non-response were female gender (OR=1.15; 95% CI from 1.08 to 1.22, p< 0.001), older age (OR=1.01; 95% CI from 1.00 to 1.01, p< 0.001), diabetes mellitus (OR=1.06; 95% CI from 1.01 to 1.11, p= 0.01), hostility score (OR=1.01; 95% CI from 1.00 to 1.02, p= 0.003), and higher baseline $VO_2$ (OR=1.01; 95% CI from 1.01 to 1.02, p< 0.001). No adverse events attributable to training were reported. (GRADE: low $_{G15\text{-}R5_Ref_1}$).[95]

Witvrouwen I et al. performed a subanalysis of the SAINTEX-CAD clinical trial in patients with coronary artery disease and preserved ejection fraction (n= 167) to identify predictors of non-response to aerobic training (interval vs continuous). Twenty-four patients (14%) were non-responders, and associated variables included older age (OR= 1.11; 95% CI from 1.04 to 1.18, p=0.001), elective PCI (OR= 3.31; 95% CI from 1.12 to 9.76, p= 0.03), and higher baseline $VO_2$ peak (OR= 1.16; 95% CI from 1.06 to 1.27; p=0.001). Low

training intensity (β= 0.447, p= 0.008) and lower baseline physical activity (β= 0.014, p= 0.003) were associated with a lower response. No exercise-related adverse events were reported. (GRADE: moderate $_{G15\text{-}R5_Ref_2}$).[96]

In a cross-sectional study (16 centers and 24,572 subjects), patient-reported predictors of non-response were identified, specifically the MacNew health-related quality of life questionnaire in heart disease. Variables associated with non-response included female gender (OR= 1.22; 95% CI from 1.14 to 1.30, p< 0.001), age (OR= 1.02; 95% CI from 1.02 to 1.02, p< 0.001), lack of supplementary insurance (OR= 1.49; 95% CI from1.39 to 1.59, p< 0.001), foreign language (OR= 6.94; 95% CI from 6.03 to 7.99; p< 0.001), admission from acute care hospital (OR= 1.23; 95% CI from 1.10 to 1.38, p< 0.001), discharge to acute care hospital (OR= 4.14; 95% CI from 3.12 to 5.50, p< 0.001), higher rate of comorbid burden (OR= 1.05 per point; 95% CI from 1.04 to 1.05, p< 0.001), longer length of stay (OR= 1.01 per day; 95% CI from 1.00 to 1.01, p= 0.008) and the presence of other associated heart diseases (OR= 1.25; 95% CI from 1.13 to 1.38, p< 0.001). Non-rheumatic mitral valve disease was associated with a lower risk (OR = 0.85, 95% CI from 0.75 to 0.96, p= 0.010). No adverse events attributable to exercise were reported. (GRADE: low $_{G15\text{-}R5_Ref_3}$).[97]

In 2022, a cohort study of 671 patients evaluated the outcomes of phase II outpatient cardiac rehabilitation, combining aerobic and resistance exercise with nutrition education, stress management, and medication adherence. Overall, 78% of patients improved their exercise tolerance ($VO_2$peak), with a mean gain of 17%. Variables that were associated with a higher likelihood of improved exercise tolerance were: higher session attendance (OR= 1.04; 95% CI from 1.02 to 1.05, p< 0.001), younger age (OR= 0.96; 95% CI from 0.94 to 0.98, p< 0.001), lower baseline $VO_2$peak (OR= 0.92; 95% CI from 0.89 to 0.95, p< 0.001), and absence of peripheral arterial disease (OR= 0.47; 95% CI from 0.28 to 0.78, p= 0.004). No exercise-related adverse events were reported. (GRADE: low $_{G15\text{-}R5_Ref_4}$).[98]

**(KM)**: A risk **re-stratification** process allows for the identification of patients with low exercise tolerance who did not improve with the CVRhP-P (non-responders). This group of patients has a higher risk of mortality and a deteriorated quality of life. Several factors, such as advanced age, gender, and poor adherence to the program, among other variables, have been associated with this lack of response.

### *3.2.2.2 Heart rate performance*

For years, heart rate behavior—both the chronotropic response and heart rate recovery—has been associated with maximum oxygen consumption and has played a role in the prognosis of patients with cardiovascular disease.

In a cohort of 120 patients with HF and sinus rhythm, the presence of a group of patients classified as non-responders to CVRhP-P was observed, and the variables associated with this poor adaptation were the recovery of heart rate (AUC-ROC = 0.757; 95% CI from 0.661 to 0.853), peak HR (AUC-ROC = 0.715, 95% CI from 0.540 to 0.804) and HR reserve (AUC-ROC = 0.713, 95% CI from 0.596 to 0.829) (GRADE: moderate $_{G13\text{-}R1\text{-}Ref_2}$).[99]

O'Neal WT et al. published data from a cohort of 57,402 individuals showing that those with chronotropic incompetence during exercise testing were at increased risk of atrial fibrillation, either through the percentage of maximum theoretical HR achieved <85% (HR= 1.33; 95% CI 1.22 to 1.44) or chronotropic index <80% (HR= 1.28; 95% CI 1.19 to 1.38) (GRADE: high $_{G13\text{-}R1\text{-}Ref_3)}$.[100]

In a cohort of 1,910 veterans without heart disease, 70 cardiovascular deaths were recorded over a 10-year period, and the three variables that were strongly associated with the risk of mortality were: Duke score (HR = 3.0; 95% CI: 1.9 to 4.9, p < 0.0001), chronotropic incompetence (HR = 2.8; 95% CI: 1.7 to 4.8, p < 0.0001), and poor heart rate recovery (HR = 2.0; 95% CI: 1.1 to 3.5, p = 0.02) (GRADE: high $_{G13\text{-}R1\text{-}Ref_4}$).[101]

Magrì D et al. published a cohort study with 864 patients with HF and moderately decreased ejection fraction, recording 84 deaths in 5 years. Chronotropic incompetence was associated with an increased risk of cardiovascular mortality, either as maximum HR (HR = 0.97; 95% CI 0.95 to 0.99, p < 0.05) or HR reserve (HR = 0.98, 95% CI 0.96 to 0.99, p < 0.01) (GRADE: moderate $_{G13\text{-}R1\text{-}Ref_5}$).[102]

A cohort of 2,428 individuals without known heart disease recorded 213 deaths over 6 years and showed that poor HR recovery within 1 minute of stopping exercise (<12 bpm, at a speed of 2.4 km/h and an incline of 2.5°) was associated with an increased risk of mortality (RR=2.0; 95% CI 1.5 to 2.7, p<0.001) (GRADE: high $_{G13\text{-}R1\text{-}Ref_6}$).[103]

Within the Framingham cohort, 1,575 subjects were studied by exercise testing, and at 7.7 years, chronotropic response was associated with a higher risk of overall mortality, HR at 85% of theoretical HRmax (HR=1.07; 95% CI 0.59 to 1.94, p= ns), heart rate reserve (HR=1.23; 95% CI 1.01 to 1.48, p= 0.04), and

chronotropic index (HR=1.27; 95% CI 1.01 to 1.60, p< 0.05). In relation to the presence of non-fatal coronary events (n=95), the indicators were: HR <85% of HRmax-theoretical (HR=1.75, 95% CI 1.11 to 2.74, p=0.02), heart rate reserve (HR=1.31, 95% CI 1.13 to 1.52, p=0.0003) and the chronotropic index (HR=1.35, 95% CI 1.13 to 1.61, p<0.001) (GRADE: high $_{G13\text{-}R1\text{-}Ref_7}$).[104]

### 3.2.2.3 Blood pressure performance

Systolic blood pressure in the exercise test increases with workload (pressor response), decreases during the post-exercise period (SBP recovery) and has been shown to be a useful tool for risk stratification in patients with CVD.

Irving JB and Bruce RA, decades ago, showed that the hypotensive response to exercise was directly associated with serious adverse outcomes such as ventricular fibrillation (GRADE: very low $_{G13\text{-}R2_Ref_5}$).[105]

A meta-analysis of 19 studies and a total of 45,895 patients with various heart diseases (coronary artery disease, heart failure, hypertrophic cardiomyopathy, or peripheral arterial disease) found that an abnormal SBP response during exercise—defined as a drop below baseline, an increase of less than 10 mmHg, or belonging to the lowest reported quartile—was significantly associated with an increased risk of fatal and non-fatal cardiovascular events, as well as all-cause mortality (HR = 2.01; 95% CI 1.59 to 2.53; p < 0.001). Furthermore, it was observed that for every 10 mmHg decrease in SBP during exercise, the risk increased significantly (HR= 1.13; 95% CI 1.06 to 1.20; p< 0.001) (GRADE: high $_{G13\text{-}R2_Ref_1}$).[106]

Additionally, another cohort study with 672 patients with a positive exercise stress test and subsequent coronary angiography showed that paradoxical elevation of SBP during recovery—defined as higher SBP at three minutes compared with the first minute post-exercise—was associated with a higher prevalence of coronary artery disease (CAD), especially in its severe form. Independent predictors of CAD in these patients were male gender (OR: 7.36) and hyperlipidemia (OR: 2.58). Similarly, shorter exercise time and a lower maximum heart rate were also associated with severe CAD (GRADE: moderate $_{G13\text{-}R2_Ref_4}$).[107]

On the other hand, abnormal SBP recovery has also been linked to an increased likelihood of coronary artery disease. A cohort study of 493 patients who underwent exercise testing followed by coronary angiography within 90 days showed that a delay in SBP decline at three minutes post-exercise, compared with one minute after recovery, was independently associated with significant coronary artery disease, even adjusted for exercise-induced blood pressure changes (adjusted OR = 2.22; 95% CI 1.27 to 3.87; p = 0.005) (GRADE: moderate $_{G13\text{-}R2_Ref_3}$).[108]

Finally, in normotensive subjects, an exaggerated SBP response during exercise has also been associated with the future development of hypertension and cardiovascular events. A systematic review that included 31 studies with a total of 78,163 normotensive patients identified the association of exaggerated SBP response with both the development of hypertension (18 studies, 35,151 individuals) and the occurrence of cardiovascular events (11 studies, 43,012 subjects). This finding suggests that an excessive blood pressure response to exercise could be a subclinical manifestation of vascular dysfunction or arterial stiffness, which would justify its monitoring in clinical practice (GRADE: low $_{G13\text{-}R2_Ref_2}$).[109]

### 3.2.2.4 Evaluation of myocardial ischemia

In the risk stratification process, it is essential to systematically assess the presence of ischemia in patients with coronary artery disease, many of whom have undergone some type of revascularization. There are several methods for assessing this phenomenon, ranging from the presence of symptoms to sophisticated imaging methods.

Several studies have documented the clinical utility of exercise stress testing with electrocardiographic (ET) recording as a diagnostic and prognostic tool in patients with suspected coronary artery disease (CAD). Despite the increasing use of advanced cardiac imaging techniques such as coronary computed tomography, SPECT, and stress echocardiography, ET remains widely used due to its low cost, accessibility, and safety, especially in resource-limited regions.

ET remains current in clinical practice, highlighting its usefulness in the initial evaluation of patients with suspected exercise-induced ischemia. Although its lower sensitivity and specificity compared to advanced modalities are recognized, it is emphasized that ET retains prognostic value and may be the only viable diagnostic option in certain clinical settings (GRADE: low $_{G13\text{-}R4_Ref_1}$).[110]

Another useful tool for assessing myocardial ischemia is ergospirometry, which allows us to simultaneously identify the integrated response of the cardiovascular, respiratory, and muscular systems

during exercise. Peak $VO_2$ is an indirect indicator of ventricular function. The $\Delta VO_2/\Delta$Watts slope assesses the response of oxygen utilization to changes in workload. Thus, if this curve flattens after reaching the anaerobic threshold, it could indicate an inadequate response of cardiac output to increasing metabolic demand. On the other hand, if anaerobic metabolism increases early in a patient with ischemia (anaerobic threshold at low $VO_2$ values), it could indicate insufficient oxygen delivery to the myocardium. Another indicator of myocardial ischemia obtained in CPET is the ratio of $VO_2$ to heart rate ($VO_2$/HR or oxygen pulse), which correlates directly with stroke volume. Thus, the presence of plateaus or decreases in oxygen pulse during CPET indicates ischemia-induced myocardial dysfunction. On the other hand, ventilatory efficiency, assessed by the $VE/VCO_2$ slope, shows the ventilation-perfusion adaptation capacity and its relationship with the physiological dead space. This indicator is also altered in ischemic heart disease. The kinetics of $VO_2$ recovery reflects the capacity of the cardiopulmonary system to compensate for the oxygen deficit experienced during intense exercise, and its delay constitutes a marker of ischemia and restriction in ExTol. (GRADE: low $_{G14\text{-}R1_Ref_5}$).[111]

Additionally, exercise tolerance measured during exercise testing has been shown to be a robust predictor of adverse cardiovascular events. In a prospective cohort study of 9,191 patients referred for PE, an ExTol less than 85% of predicted METs was associated with a significant increased risk of non-fatal cardiac events and mortality: acute myocardial infarction (HR=2.36; 95% CI 1.55 to 3.60; p<0.001), unstable angina (HR=2.39; 95% CI 1.78 to 3.21; p<0.001); coronary revascularization (HR= 1.75; 95% CI 1.46 to 2.08; p< 0.001) and all-cause mortality (HR= 2.90; 95% CI 1.88 to 4.47; p< 0.001) (GRADE: moderate $_{G13\text{-}R4_Ref_2}$).[112]

Coronary computed tomography angiography can provide information on atherosclerotic plaque stenosis, its composition, and the possible assessment of myocardial ischemia through fractional flow reserve or perfusion by coronary computed tomography angiography. Magnetic resonance imaging can be used to assess cardiac function, as well as the presence of residual ischemia and to characterize the myocardial tissue at risk. Stress echocardiography is the most widely used technique to obtain information on myocardial function and wall motion abnormalities during induced ischemia. Nuclear medicine studies can be used to assess perfusion, qualitatively or quantitatively (GRADE: very low $_{G14\text{-}R1_Ref_4}$).[113]

Coronary angiography is a method that offers high diagnostic accuracy, and prognostic tools such as the SYNTAX score have been developed based on it.

Kovach CP et al. published a cohort study of 57,476 patients with coronary artery disease who had undergone PTCA and evaluated the risk of MACE in those subjects with incomplete revascularization compared to those with a residual SYNTAX score = 0. They found that the highest tertile of SYNTAX score had a higher risk for MACE (HR = 2.06; 95% CI 1.98 to 2.15) and specifically for case fatality (HR = 1.50; 95% CI 1.41 to 1.59) in the following 3 years (GRADE: high $_{G14\text{-}R1_Ref_1}$).[114]

In a cohort of 293 patients undergoing PTCA, the cutoff point of the SYNTAX score and the percentage of ischemia by nuclear medicine (SDS%) were evaluated to discriminate the risk for MACE. Thus, the cutoff points were for SYNTAX = 12 (AUC of 0.748) and $\Delta$SDS% > 5% (AUC = 0.648). The incidence of MACE was directly associated with $\Delta$SDS% (HR = 0.9437; 95% CI: 0.8950 to 0.9949, p = 0.0317) and with the residual SYNTAX (HR = 1.1079; 95% CI: 1.0633 to 1.1543, p < 0.0001) (GRADE: moderate $_{G14\text{-}R1_Ref_2}$).[115]

Gould KL et al. published a study of a cohort of 6,979 patients with coronary artery disease that had a case fatality rate of 364 patients and showed that coronary flow reserve measurement by PET was associated with a greater decrease in post-revascularization mortality when flow reduction was severe (HR= 0.50; 95% CI 0.32 to 0.76, p= 0.0015) as opposed to the group without significant reduction (HR= 0.71; 95% CI 0.19 to 2.63, p=ns) (GRADE: moderate $_{G14\text{-}R1_Ref_3}$).[116]

### *3.2.2.5 Electrical stability assessment*

The assessment of the arrhythmogenic state in patients with cardiovascular disease has proven to be a fundamental strategy for identifying potentially life-threatening arrhythmias, especially in the post-infarction and heart failure population.

Several studies have shown that the presence of exercise-induced arrhythmias identified in the exercise test, particularly frequent PVC, can have significant prognostic value for the future occurrence of adverse cardiovascular events, making it a fundamental tool for risk stratification.

In a prospective study of 1,442 patients with coronary artery disease or idiopathic cardiomyopathy, those with exercise-induced PVC were found to have

a significantly higher risk of developing life-threatening ventricular arrhythmias (RR = 2.81; 95% CI 1.9 to 4.3, p < 0.001) and all-cause mortality (RR = 2.1; 95% CI 1.2 to 3.4, p < 0.01). This risk was even higher in patients who developed serious arrhythmia during follow-up (RR=5.7; 95% CI 3.4 to 9.4, p<0.001) (GRADE: moderate $_{G13\text{-}R6_Ref_6}$).[117]

A recent meta-analysis including 5,284 patients, both asymptomatic and with established heart disease, showed that exercise-induced PVC was associated with an increased risk of long-term cardiovascular events, both in asymptomatic patients without structural disease (RR = 1.82; 95% CI 1.44 to 2.30) with a mean follow-up of 16 years, and in patients with symptomatic CVD (RR = 1.36; 95% CI 1.18 to 1.57) over 5.4 years. PVC during the recovery phase was found to have a superior prognostic value, reflecting underlying autonomic dysfunction (GRADE: high $_{G13\text{-}R6_Ref_7}$).[118]

Consistently, a cohort study in 5486 asymptomatic patients without structural heart disease documented that the presence of high-grade PVC during recovery from ET was significantly associated with an increased risk of cardiovascular mortality (HR = 1.68; 95% CI 1.09 to 2.60, p = 0.02), whereas the presence of PVCs during exercise was not associated with an increased risk (GRADE: moderate $_{G13\text{-}R6_Ref_2}$).[119]

In patients with genetic channelopathies such as Brugada syndrome, exercise-induced PVC has also been shown to be an important risk marker. A cohort study in 307 patients with this syndrome revealed that the presence of PVC in the early recovery phase was significantly associated with future ventricular fibrillation (VF) events, with an increased risk (HR = 4.45; 95% CI 1.60 to 10.68, p = 0.0062). Furthermore, an elevated risk of serious adverse events was observed in patients with syncope or a history of VF (HR = 12.24; 95% CI 5.46 to 31.18, p < 0.0001), as well as those with spontaneous type 1 ECG pattern (HR = 4.69; 95% CI 1.62 to 19.89, p = 0.0028) (GRADE: moderate $_{G13\text{-}R6_Ref_3}$).[120]

In patients with CVD, a study of 6,415 patients developed and validated a prediction model for serious exercise-induced ventricular arrhythmias, finding an 8.5% incidence of such events. Predictive factors included advanced age, heart failure, use of digoxin, nitrates, and antiarrhythmic medications. This model reinforces the role of exercise testing as a tool for predicting potentially lethal arrhythmias (GRADE: moderate $_{G13\text{-}R6_Ref_4}$).[121]

Calo' L et al. highlighted that PVC occur in up to 75% of healthy individuals; however, the presence of complex PVC during exercise could indicate the existence of occult myocardial fibrosis or genetic burden for cardiomyopathies or sudden death. The morphology, origin, and complexity of PVC are key elements for adequate risk stratification, which reinforces the clinical value of exercise in prognostic assessment (GRADE: low $_{G13\text{-}R6_Ref_5}$).[122]

Beyond its diagnostic and prognostic value, exercise testing has also been shown to be useful in assessing response to ThPhT. In a cohort study of patients with heart disease undergoing cardiac rehabilitation, a significant reduction in the occurrence of exercise-induced arrhythmias was observed after the training program (RR=0.49, 95% CI: 0.35 to 0.67, p<0.001), with no adverse events reported (GRADE: moderate $_{G13\text{-}R6_Ref_1}$).[123]

During exercise sessions in a CVRhP-P, continuous ECG monitoring is an additional tool that allows real-time surveillance of the electrical response to exercise. A sub analysis of a randomized clinical trial with 386 patients with heart failure (NYHA I-III, LVEF ≤ 40%), comparing hybrid telerehabilitation with ECG telemonitoring versus standard care, showed an incidence of PVC in 76.4% of patients, premature atrial contractions in 27.7%, NSVT in 2%, and paroxysmal AF in 1%. No symptomatic arrhythmias requiring training discontinuation occurred, demonstrating the safety of monitoring during supervised exercise (GRADE: high $_{G14\text{-}R2_Ref_1}$).[124]

Exercise testing also provides key information by reproducing physiological stress conditions that can induce complex ventricular arrhythmias. A cohort study investigated the association between patients with cardiovascular disease and the presence of potentially life-threatening exercise-induced ventricular arrhythmias. The generated predictive model identified associated factors such as heart failure (RR= 2.70; 95% CI 2.26 to 3.22, p< 0.001), digoxin use (RR= 2.55; 95% CI 2.10 to 3.10, p< 0.001), nitrates (RR= 0.73; 95% CI 0.58 to 0.93, p= 0.01) and antiarrhythmic drugs (RR= 2.64; 95% CI 2.10 to 3.32, p< 0.001), with robust statistical significance ($X^2$ = 283.987; p < 0.001). This allows for better risk stratification before indicating or intensifying rehabilitation programs (GRADE: moderate $_{G14\text{-}R2_Ref_5}$).[121]

Franklin BA et al conclude that moderate-intensity exercise and good cardiorespiratory fitness have cardioprotective effects by reducing the incidence of arrhythmias, whereas non-habitual intense exercise in sedentary individuals may increase the risk of AF and adverse events (GRADE: low $_{G14\text{-}R2_Ref_2}$).[125]

The benefits of arrhythmogenic assessment also apply to populations with implantable cardiac devices. A consensus document emphasizes that ThPhT in these patients is safe, and that close monitoring allows for adaptation of exercise intensity, optimization of device programming, and prevention of arrhythmic events and sudden cardiac death. Emphasis is placed on an individualized approach and psychological support (GRADE: low $_{G14\text{-}R2_Ref_3}$).[126]

Twenty-four-hour Holter monitoring offers diagnostic advantages by detecting arrhythmias not evident on the baseline ECG or during conventional clinical examination, such as the burden of premature ventricular contractions (PVC), non-sustained ventricular tachycardia (VT) or sustained VT, silent episodes of atrial fibrillation (AF), and prolonged sinus pauses.

In a cohort study of 172 post-STEMI patients undergoing percutaneous coronary intervention, 24-hour Holter-based parameters such as heart rate variability (HRV), heart rate deceleration capacity, and the presence of PVC were evaluated, and a significant association was observed between these markers and the occurrence of MACE and cardiac death during a 3-year follow-up. Each 1 ms increase in HRV was associated with a 2% reduction in the risk of MACE (OR=0.980; 95%CI 0.967 to 0.994, p=0.005) and a 4.3% reduction in the risk of cardiac death (OR=0.957; 95%CI 0.933 to 0.981; p=0.001). Lower SDANN index values also significantly increased the risk of MACE (OR= 0.982; 95% CI 0.969 to 0.996, p= 0.009), while a higher minimum heart rate was associated with a higher risk of MACE (OR= 1.075; 95% CI 1.022 to 1.131, p= 0.005). Furthermore, patients with frequent PVC had a 2.7-fold higher risk of MACE (OR = 2.685; 95% CI: 1.204 to 5.987; p = 0.016), and deceleration capacity showed an inverse association with cardiac death (OR = 0.702; 95% CI: 0.526 to 0.938; p = 0.017), with DC4 being the most notable (OR = 0.020; 95% CI: 0.001 to 0.664; p = 0.029). ROC analysis showed that SDNN was a moderate predictor of major cardiovascular events (AUC = 0.688; 95% CI: 0.601 to 0.776) and cardiac death (AUC = 0.752; 95% CI: 0.625 to 0.879). No adverse events attributable to Holter use were reported, which supports its safety profile (GRADE: moderate $_{G14\text{-}R2_Ref_6}$).[127]

The ESC guidelines recognize the value of continuous surveillance of the arrhythmic state, noting that its monitoring contributes to preventing future cardiac events, within the framework of a comprehensive approach that includes the control of comorbidities and the prescription of structured exercise (GRADE: high $_{G14\text{-}R2_Ref_4}$).[286]

### *3.2.2.6 Exercise testing in congenital heart disease*

Congenital heart disease has a wide variety of presentations, which, in the case of the most complex ones, pose a challenge in understanding its cardiopulmonary physiology and, therefore, interpreting dynamic studies such as CPET.

Measuring oxygen uptake using cardiopulmonary exercise testing is the gold standard for assessing aerobic capacity and currently has applications from patients with cystic fibrosis to those with congenital heart disease (GRADE: very low $_{G13\text{-}R5_Ref_3}$).[128]

Cardiopulmonary evaluation of patients with heart disease requires a control group for comparison, and there are several articles in the literature that show us the values of the variables obtained in the CPET, as well as regression models that allow us to calculate the theoretical values in this population, particularly in children (GRADE: moderate $_{G5\text{-}R1_Ref_8)}$.[216]

Von Sanden F et al. evaluated a cohort of 1,194 patients with congenital heart disease of diverse etiologies. Their results showed that both age and ExTol were predictive variables for the incidence of serious arrhythmias (n=97) during 3 years of follow-up: age (OR=1.029; 95% CI 1.009 to 1.049, p=0.004) and reduction in $VO_2$peak (OR=1.052; 95% CI 1.018 to 1.086, p=0.002) (GRADE: moderate $_{G13\text{-}R5_Ref_1}$).[129]

A cohort of 40 children with tetralogy of Fallot was studied with CPET. The results showed that both the oxygen consumption efficiency slope (OUES) and the percentage of predicted VO2peak achieved appear to have a predictive value two years after hospitalization, with an area under the ROC curve for OUES (AUC = 0.700, p = 0.03) and for VO2peak (AUC = 0.720, p = 0.02) (GRADE: low $_{G13\text{-}R5_Ref_2}$).[130]

Recently, a cross-sectional study with 1,208 children with different congenital heart diseases, showed the epidemiological data of more than 1,300 cardiopulmonary tests, with the purpose of describing the behavior of peak oxygen uptake ($VO_2$ peak) and other indicators such as workload (W) and heart rate during exercise (GRADE: moderate $_{G13\text{-}R5_Ref_4}$).[131]

A cross-sectional study evaluated variables obtained from cardiopulmonary exercise testing in children with HF and compared them with children without heart disease. Oxygen uptake was lower in children with HF compared with the control group (27 ± 10 $mlO_2$/min vs 37 ± 10 $mlO_2$/min, p < 0.001) and the $VE/VCO_2$ slope was greater in patients than in controls (31 ± 4 vs 28 ± 6, p < 0.001) (GRADE: low $_{G13\text{-}R5_Ref_5}$).[132]

### 3.2.2.7 Biochemical profile

The initial assessment of biochemical parameters in patients participating in a CVRhP-P allows the clinical team to identify abnormalities that may require specific treatment or increase the risk of adverse events during training sessions. Furthermore, they are useful for establishing goals during medium- and long-term follow-up, based on what we now call precision medicine.

Wu G et al. published a meta-analysis of 51 studies and 10,286 patients with several heart conditions that evaluated the effect of CVRhP-P, particularly on lipid control. Thus, it was observed that after CVRhP-P there was a significant decrease in LDL-C levels (SMD = -0.23; 95% CI -0.38 to 0.08, p< 0.001), triglycerides (SMD = -0.17; 95% CI -0.28 to -0.06, p < 0.001), total cholesterol (SMD = -0.30; 95% CI -0.43 to -0.16, p < 0.001) and was associated with a decrease in HDL-C levels (SMD = 0.19; 95% CI -0.10 to 0.29, p< 0.001). Adverse events were not assessed (GRADE: moderate $_{G14\text{-}R3_Ref_2}$).[133]

A randomized clinical trial with 56 patients compared the changes observed in the lipid profile in patients who participated in telerehabilitation (T-Rh) versus in-person (P-Rh) for 10 months. In the T-Rh group, glycoprotein A decreased (p = 0.007). LDL-C particles decreased in both groups, but in the P-Rh group it was at the expense of small LDL (p = 0.012). Triglycerides in IDL-C increased only in the P-Rh group (p = 0.043), while the TG/HDL ratio decreased only in T-Rh (p = 0.006). Adverse events were not evaluated (GRADE: very low $_{G14\text{-}R3_Ref_3}$).[134]

In addition to the lipid profile, it is extremely important to assess renal function (creatinine, urea, albumin), glycemic control (fasting blood glucose, HbA1C), fluid and electrolyte balance (sodium, potassium, chloride, calcium, and magnesium), and in certain patients, liver or thyroid function should also be assessed. In some cases, the determination of specific biomarkers of inflammation or ventricular damage is recommended (see section 3.2.1.3.3).

### 3.2.2.8 Evaluation of ventricular function

The severity and extent of myocardial damage is an indicator that has been increasingly studied and may be associated with patient function and survival.

A published meta-analysis with 45 studies and 6,088 patients with non-ischemic dilated cardiomyopathy (LVEF 30.6 ± 11.4%), showed a significant association between low LVEF and the incidence of sudden death or potentially lethal cardiac arrhythmias (RR = 2.34; 95% CI 1.85 to 2.96, p < 0.001) (GRADE: high $_{G14\text{-}R5_Ref_6}$).[135]

A meta-analysis of 6 studies and 536 post-myocardial infarction patients showed that abnormal myocardial viability was found by contrast echocardiography, resulting in an increased risk of MACE (RR=2.09; 95% CI 1.14 to 3.81) and cardiovascular mortality (RR=2.48; 95% CI 1.03 to 5.96) (GRADE: high $_{G14\text{-}R5_Ref_4}$).[136]

Sud K et al published a meta-analysis of 8 studies and 4,462 patients with exertional dyspnea, where they showed that the predictive capacity of exercise-induced diastolic dysfunction was associated with a higher incidence of mortality or hospitalizations (HR= 1.32; 95% CI 1.02 to 1.63, p< 0.05) (GRADE: high $_{G14\text{-}R5_Ref_5}$).[137]

Buckert D et al. evaluated a cohort of 2,422 patients with coronary artery disease studied by magnetic resonance imaging (MRI) in search of indicators associated with mortality or non-fatal myocardial infarction. A total of 187 outcomes were recorded, and the multivariate model showed that LVEF (35% and 50%) was associated with the incidence of outcomes (HR = 2.92; 95% CI 1.54 to 5.5, p = 0.001). The detection of necrotic tissue by late gadolinium enhancement was associated with the outcome (HR = 3.29; 95% CI 2.35 to 4.60, p< 0.0001) (GRADE: high $_{G14\text{-}R5_Ref_3}$).[138]

One way to assess the severity of myocardial damage is through biomarkers such as cardiac troponin T (cTNT), cardiac troponin I (cTNI), creatine kinase (CK), myocardial creatine kinase (CK-MB), and myoglobin. Some other biomarkers are still under investigation, such as high-sensitivity troponin assays, high-sensitivity C-reactive protein (HSRP), urocortin, CK-MB isoforms, and B-type natriuretic peptide (BNP). Lactate dehydrogenase (LDH) and aspartate transaminase (AST) are practically obsolete. The elevation of biomarkers can have a diverse origin, such as primary myocardial ischemia, alteration between oxygen supply and demand, related to the heart in the absence of coronary artery disease or multifactorial or undetermined cause (GRADE: very low $_{G14\text{-}R5_Ref_1}$).[139]

In a controlled clinical trial, 186 patients with HF participated in a CVRhP-P and compared the effect of specific training therapy (HIIT or continuous exercise) against a control group that received the usual advice on physical activity for 12 weeks. High sensitivity cTnI levels decreased in both groups: training group (median Δ=11.9 ng/L; interquartile range 7.1 to 21.8) vs control group (median Δ=11.5 ng/L; interquartile range 7.0 to 20.7), with no differences observed between them (p=0.116). In the group of patients without comorbidities, a significant reduction in hs-cTNI was observed

between groups: training (median Δ = -1.2 ng/L, IQR -2.7 to 0.1, p = 0.002) versus control group (median Δ = -0.1 ng/L, IQR = -0.4 to 0.7, p = 0.64), p between groups = 0.007. hs-cTNI levels were significantly associated with LV end-diastolic diameter, peak $VO_2$, and NT-proBNP (GRADE: moderate $_{G14\text{-}R5_Ref_2}$).[140]

### *3.2.2.9 Assessment of inflammatory status*

The assessment of inflammatory status in patients with heart disease, particularly those who have suffered an acute myocardial infarction, has been shown to have significant prognostic value in predicting MACE. Recently, the use of anti-inflammatory medications has been proposed as part of the treatment in these types of cases.

In a cohort study of 541 patients with ST-segment elevation acute myocardial infarction, the combination of three biomarkers—high-sensitivity C-reactive protein (hs-CRP), neutrophil-lymphocyte ratio (NLR), and platelet reactivity—was significantly associated with MACE at both 30 days (HR = 3.73; 95% CI 1.69 to 8.27, p < 0.001) and 12 months (HR = 3.85, 95% CI 1.72 to 8.60, p < 0.001), with better predictive capacity than the TIMI score alone (net reclassification index: 0.296, p < 0.001). These findings support the joint use of these biomarkers for early risk stratification in this population, although it should be noted that individual markers, such as platelet reactivity and hs-CRP, had more limited predictive value in isolation, and NLR was not an independent predictor (GRADE: high $_{G14\text{-}R4_Ref_1}$).[141]

A meta-analysis of 39 studies with 175,778 patients without known CVD demonstrated that the inclusion of inflammatory biomarkers such as hs-CRP and interleukin-6 (IL-6) increased the prognostic value of risk assessment performed with traditional clinical factors. The risk for CV events and mortality was increased (c-score = 2.9%; 95% CI 1.7 to 4.1%) and for MACE (c-score = 3.1%; 95% CI 1.8 to 4.5%) (GRADE: high $_{G14\text{-}R4_Ref_2}$).[142]

In patients with a history of acute myocardial infarction, the assessment of inflammatory biomarkers such as hs-CRP and biomechanical stress markers such as growth differentiation factor-15 have also shown potential to predict adverse cardiac remodeling and heart failure, according to a narrative review. These biomarkers were able to identify patients at higher risk of poor recovery after coronary angioplasty (GRADE: very low $_{G14\text{-}R4_Ref_3}$).[143]

From a pathophysiological perspective, IL-6 has been identified as a key mediator of vascular inflammation, with causal implications for atherosclerosis, based on genetic and experimental analyses. A review of IL-6 inhibitors highlighted their potential to reduce residual cardiovascular risk, particularly in patients with chronic kidney disease and elevated inflammation, such as ziltivekimab (GRADE: very low $_{G14\text{-}R4_Ref_6}$).[144]

Romero-Cabrera JL et al. performed a meta-analysis of 25 studies in 287,020 asymptomatic middle-aged adult patients with no prior history of CVD, evaluating advanced serum biomarkers (including hs-CRP, NT-proBNP, fibrinogen, and GGT) to predict CVD incidence. They found that elevated hs-CRP levels were associated with an increased risk of cardiovascular events (HR = 1.19; 95% CI 1.09 to 1.30, p < 0.05), and NT-proBNP also showed a strong association with CVD (HR = 1.22; 95% CI 1.13 to 1.32, p < 0.05) (GRADE: high $_{G14\text{-}R4_Ref_7}$).[145]

Likewise, the relationship between systemic inflammation and microvascular dysfunction has been demonstrated in patients with a history of infarction and diabetes. In a cohort of 3,482 patients, the reduced coronary flow reserve was significantly associated with elevated IL-6 (r= -0.44, p= 0.002) and a trend toward hs-CRP (r= -0.25, p= 0.092) (GRADE: high $_{G14\text{-}R4_Ref_8}$).[146]

### *3.2.2.10 Risk stratification scales*

Risk calculation and stratification can be addressed in two ways: the first focuses on the likelihood of developing general cardiovascular outcomes in the medium or long term, while the second focuses on the likelihood of a patient experiencing a complication associated with exercise or during a stress test. The approach has evolved over the years from an assessment based on personal experience to the development of complex multivariate risk models.

Risk stratification is based on the prediction of adverse outcomes associated with a CVRhP-P, in relation to independent indicators. These indicators are recorded through clinical history and laboratory and imaging tests. (GRADE: high $_{G15\text{-}R3_Ref_2}$).[147]

Traditionally, risk stratification scales have been used based on expert opinions, where three levels are usually assigned based on various variables: low, moderate, and high. Most of these scales have not been statistically validated (GRADE: very low $_{G15\text{-}R3_Ref_3}$).[148]

When searching for stratification scales used in CVRhP-P, it is observed that their development is very heterogeneous, and most models are based on expert consensus. However, they are a fundamental activity in patient assessment (Grade: very low $_{G15\text{-}R1_Ref_4}$).[166]

| Tool | Year | Study | Variables included | Outcomes | References |
|---|---|---|---|---|---|
| Duke (coronary arteries)[162] | 1994 | Patients with symptomatic coronary artery disease. Duke Heart Center. | Coronary anatomy, LVEF, mitral regurgitation. | Cardiovascular Mortality | G15-R3_ Ref_11 |
| SEC[164] | 2000 | Adult patients undergoing cardiovascular rehabilitation. Expert consensus | Hospital course, presence of ischemia, functional capacity, LVEF and arrhythmias | Complications during the RHC program | G15-R3_ Ref_10 |
| Duke (revasc)[163] | 2005 | Patients with coronary artery disease undergoing revascularization. Duke Clinical Research Institute | Coronary anatomy and number of protected territories (revascularization) | All-cause mortality | G15-R3_ Ref_12 |
| Framingham ATP-III[152] | 2005 | Adults without diagnosed cardiovascular disease (30 to 74 years of age). Framingham Cohort | Age, HDL-C, SBP, hypertension treatment, smoking, and diabetes | Onset of coronary artery disease, stroke, peripheral arterial disease, or heart failure | G15-R3_ Ref_7 |
| ASCVD[153] | 2013 | Adults without diagnosed cardiovascular disease (40–79 years of age). ARIC Study, Cardiovascular Health Study, Coronary Artery Risk Development in Young Adults Study, Framingham Cohort | Age, gender, diabetes, smoking, total-C, HDL-C, SBP, hypertension treatment, race. | Cardiovascular event at 10 years. non-fatal myocardial infarction (heart attack), coronary heart disease death, or stroke. | G15-R3_ Ref_8 |
| SYNTAX[165] | 2014 | Patients with coronary artery disease. SYNTAX TRIAL | Coronary anatomy | Major cardiovascular events, stroke at 12 months | G15-R3_ Ref_13 |
| Arrhythmias_ ET[121] | 2016 | Patients with cardiovascular disease within a cardiac rehabilitation and secondary prevention program. | Heart failure, use of antiarrhythmics, inferior infarction, age, use of digoxin, use of nitrates, use of diuretics, presence of valvular disease, anterior infarction, double product, diastolic blood pressure, BMI, use of ACEIs-ARAII | Exercise-induced arrhythmias. | G13-R6_ Ref_4 |
| ABC_CHD[91] | 2017 | Patients with stable coronary artery disease. Subanalysis of the STABILITY study | Age, NT-ProBNP, highly sensitive troponin T, LDL-C, smoking, diabetes, peripheral arterial disease | Cardiovascular mortality | G15-R3_ Ref_14 |
| Arrhythmias Kinesiotherapy[169] | 2017 | Patients with cardiovascular disease. Cardiac rehabilitation and secondary prevention service. | Exercise-induced arrhythmias (ST), peak VO2, diuretic use. | Arrhythmias during physical training sessions | G31-R1_ Ref_3 |
| EXERISK[171] | 2019 | Patients with cardiovascular disease. Cardiac rehabilitation and secondary prevention service. | (Arrhythmias) LVEF, maximum METs, and the presence of ventricular ectopy. (Ischemia) History of angina, METs, and SYNTAX | Arrhythmias or ischemia induced by physical training | G15-R3_ Ref_1 |
| INCICh[168] | 2019 | Patients with cardiovascular disease. Cardiac rehabilitation and secondary prevention service. INCICh cohort | Clinical indicators, ATP-III, SCORE, LVEF, Exercise test. | Complications in RHC | G15-R1_ Ref_8 |

*(Continues)*

| Tool | Year | Study | Variables included | Outcomes | References |
|---|---|---|---|---|---|
| AACVPR[147] | 2021 | Adult patients undergoing cardiovascular rehabilitation. Expert consensus | Arrhythmias, angina, chronotropic incompetence, pressor response, blood pressure recovery, exercise tolerance, LVEF, history of CPR, clinical depression, ICD use. | Adverse events during exercise and progression of atherosclerotic disease | G15-R3_ Ref_2 |
| SCORE[154] | 2021 | Adults without diagnosed cardiovascular disease or DM (40–69 years of age). Group of 45 cohorts, 677,684 individuals. | Gender, smoking, SBP, non-HDL-C | Fatal and non-fatal CVD at 10 years | G15-R3_ Ref_9 |
| AHA-Prevent[157] | 2024 | Adults without diagnosed cardiovascular disease (30–79 years of age). Multiple cohort studies. | Gender, age, total-C, HDL-C, SBP, BMI, GFR, diabetes, smoking, anti-hypertensive medication, lipid-lowering medication, albumin-creatinine ratio, HbA1C, postal code. | Cardiovascular events. Heart failure. | G15-R3_ Ref_15 |

**Figure 15.** Risk stratification tools. Risk stratification tools are commonly used in cardiovascular disease prevention and rehabilitation programs. These instruments vary according to the specific risk factors, outcomes assessed, and methods of evaluation, and are derived from expert consensus and cohort studies. Accurate risk stratification is essential to prevent adverse events and to allocate preventive strategies and healthcare resources effectively.

A cross-sectional study that applied eight different stratification protocols (ACSM, SBC, AHA, Pashkow, AACVPR, SFC, SEC) to 50 patients undergoing cardiovascular rehabilitation found that 21 comparisons between protocols, 12, were statistically significant. However, none showed excellent agreement; nine showed moderate agreement, and three showed low agreement (GRADE: low $_{\text{G15-R4_Ref_2}}$).[149]

Risk stratification must be approached from a hybrid perspective, both scientific and philosophical, in relation to the usefulness of certification models, the way of using them and their reliability (Fig. 15) (GRADE: low $_{\text{G15-R3_Ref_5}}$).[150]

### 3.2.2.10.1 Stratification of long-term general cardiovascular risk

Stratification of the risk of cardiovascular outcomes in the medium or long term allows for the targeting of both primary and secondary prevention measures. Over the years, various risk scores have been published for primary prevention, and very few have been designed specifically for secondary prevention.

The outcomes of interest are overall mortality, cardiovascular mortality, rehospitalizations, the need for further revascularization, adverse events during ThPhT (cardiorespiratory arrest, arrhythmia, ischemia, blood pressure changes), atherosclerosis progression, deterioration of ventricular function, falls, and HR-QoL. Cardiovascular risk stratification has proven to be a valuable tool for guiding clinical decision-making, especially in the context of cardiovascular prevention and rehabilitation.

In the field of primary prevention, an ACC/AHA narrative review indicated that risk stratification using pooled cohort equations is essential to identify patients at higher risk of cardiovascular events and thus optimize the use of statins and antihypertensives. Although these tools are widely used, they have been observed to tend to underestimate or overestimate risk in certain population subgroups. In patients at intermediate or borderline risk, the inclusion of additional techniques such as coronary calcium measurement may increase prognostic accuracy (GRADE: very low $_{\text{G15-R4_Ref_4}}$).[151]

In 2008, a risk prediction model was published based on a cohort (Framingham) with 8,491 subjects in primary prevention, with a 12-year follow-up. The independent variables selected were gender, age, HDL-C, SBP, treatment for hypertension, smoking, and diabetes. Over 12 years, 1,174 adverse cardiovascular events occurred for the first time. The proposed algorithm presented an adequate level of discrimination (C statistic = 0.763 -men- and 0.793 -women-). This multivariate, gender-specific algorithm can be used to

calculate overall and individual risk for CVD (GRADE: high $_{G15\text{-}R3_Ref_7}$).[152]

The ACC and AHA presented CPGs based on the risk calculation model (ASCVD-Risk), useful for subjects in primary prevention of CVD, of both sexes, aged 29 to 79 years, which used the following independent variables: age, total cholesterol, HDL-C, systolic blood pressure (under treatment or not), diabetes mellitus and smoking status. The databases that gave rise to the risk model were the following: ARIC (Atherosclerosis Risk in Communities), Cardiovascular Health Study, CARDIA (Coronary Artery Risk Development in Young Adults) and the original Framingham cohort and its offspring (GRADE: high $_{G15\text{-}R3_Ref_8}$).[153]

The AHA-ACC guidelines for the management of patients with chronic coronary artery disease recommend stratifying patients according to their risk to guide therapy. This process should use all available information, including the results of diagnostic cardiovascular tests, invasive or not, and use validated risk scores to classify patients as being at low (<1%), intermediate (1 to 3%), or high (>3%) risk of cardiovascular death or non-fatal myocardial infarction per year (GRADE: high $_{G15\text{-}R1_Ref_1}$).[601]

The ESC published the 10-year risk prediction model (SCORE2), for individuals without previous CVD, aged 40 to 69 years, where 45 cohorts in 13 countries were studied (n = 677,684 individuals) and the independent variables of age, sex, smoking status, systolic blood pressure, total cholesterol, and HDL-C were used. Four risk zones within the European continent were defined in relation to the incidence of CVD or regional mortality in a population of 10,776,466 individuals. External validation was performed with populations from 15 countries, 1,133,181 individuals and 43,492 cardiovascular events, with a C statistic that ranged from 0.67 (0.65 to 0.68) to 0.81 (0.76 to 0.86) (GRADE: high $_{G15\text{-}R3_Ref_9}$).[154]

Currently, there are study groups proposing a new risk category, “extremely high.” This would include the population with a SCORE greater than 25%, a history of a cardiovascular event in the last 2 years, acute coronary syndrome with multivascular disease, acute coronary syndrome with multivessel coronary artery disease, acute coronary syndrome with familial hypercholesterolemia, acute coronary syndrome, diabetes, and another risk factor present (GRADE: very low $_{G15\text{-}R1_Ref_2}$).[155]

Kaasenbrood L et al. published the results of a multicenter cohort study (SMART-REACH) with 40,338 patients with CVD, where a multivariate model was developed for the prediction of risk of cardiovascular events and non-cardiovascular mortality, which included independent variables such as gender, smoking, diabetes, systolic BP, total cholesterol, creatinine, presence of two- or three-vessel disease, history of atrial fibrillation and HF. The C statistic for the total cohort was significant (C = 0.68; 95% CI 0.67 to 0.70) (GRADE: high $_{G15\text{-}R1_Ref_3}$).[156]

Kahn SS et al. published a risk calculation model with 3,281,919 individuals without CVD, aged 30 to 79 years, which was developed and validated from the PREVENT score for the primary prediction of CVD or HF in American patients. The independent risk variables that comprised the model were smoking status, systolic blood pressure, cholesterol levels, use of antihypertensive drugs, presence of diabetes, and glomerular filtration rate. A total of 211,515 outcomes were recorded (in more than 6 million patients). The C statistic was 0.794 (0.763 to 0.809) in women and 0.757 (0.727 to 0.778) in men (GRADE: high $_{G15\text{-}R3_Ref_15}$).[157]

Stone GW et al studied 697 patients with acute coronary syndrome and identified that untreated, high-anatomical-risk lesions were significantly associated with major cardiovascular events: plaque burden ≥70% (HR= 5.03; 95% CI 2.51 to 10.11; p< 0.001), luminal area ≤ 4.0 mm² (HR= 3.21; 95% CI 1.61 to 6.42; p= 0.001), and thin-cap fibroatheromas (HR= 3.35; 95% CI 1.77 to 6.36; p< 0.001) (GRADE: high $_{G15\text{-}R4_Ref_7}$).[158]

A systematic review of 25 studies found that, when different risk calculators were applied to 128 hypothetical patients, 41% were simultaneously classified into all three risk categories (low, medium, and high), and the average agreement between tools was only 67%, with a discrepancy of up to 13.3 times between estimates. Thus, considerable variability in risk classification in patients with heart disease is evident, underscoring the need for standardized and consistent protocols in clinical settings such as cardiovascular rehabilitation (GRADE: low $_{G15\text{-}R4_Ref_1}$).[159]

In 2022, a cohort of 238 patients in CVRhP-P was published, where a multivariate adjusted for age, gender, diabetes, and exercise was constructed that predicted a higher risk for rehospitalization (HR = 3.83; 95% CI from 1.51 to 9.68) (GRADE: moderate $_{G15\text{-}R1_Ref_6}$).[160]

The benefit of appropriate risk-based exercise prescription is also reflected in cardiovascular prevention studies. In a cohort study of 130,843 patients without prior CVD, a significant reduction in mortality was observed in relation to physical activity, whether at a moderate (HR = 0.80; 95% CI, 0.74 to 0.87) or high level (HR = 0.65; 95% CI, 0.60 to 0.71). A reduction in major cardiovascular events was also observed (HR = 0.86; 95% CI, 0.78 to 0.93) (GRADE: high $_{G15\text{-}R4_Ref_6}$).[161]

Mark DB et al., in a non-randomized, controlled clinical trial with 9,263 patients with symptomatic coronary artery disease who underwent cardiac catheterization, studied the association of therapy with the incidence of cardiovascular mortality (PTCA n=2,788 or CABG n=3,422). A prognostic index was designed between the severity of coronary artery disease and survival. The effects of revascularization depended on the severity of coronary artery disease, where the greater the pathology, the greater the benefit of the intervention compared with medical treatment (GRADE: moderate $_{G15\text{-}R3_Ref_11}$).[162]

A cohort study of 3,178 individuals at Duke University developed a risk score for patients with coronary artery disease undergoing revascularization surgery, ranging from the presence of trivascular coronary artery disease with obstructed blood ducts (score of 100) to the presence of patent blood ducts (score = 0) and was directly associated with all-cause mortality ($p < 0.001$) and maintained its prognostic value after analyses that included other predictive variables (GRADE: high $_{G15\text{-}R3_Ref_12}$).[163]

The SEC published a set of CPGs to standardize the CVRhP-P. This document highlights the importance of creating specific cardiovascular prevention groups based on their health status and risk. It also establishes various scientifically based recommendations for reducing cardiovascular risk, particularly in relation to the control of traditional risk factors, using interventions such as smoking cessation, monitoring blood glucose, blood pressure, and lipids, as well as the use of cardiovascular rehabilitation programs (GRADE: moderate $_{G15\text{-}R3_Ref_10}$).[164]

In 2014, a narrative review on the various uses of the SYNTAX score mentioned that it is an anatomical tool to objectively determine the complexity of coronary artery disease, with the aim of assisting in decision-making regarding the type of revascularization, whether through CABG surgery or coronary intervention. Several studies have been published to validate this score and identify high-risk patients. It is currently included in coronary revascularization guidelines in both the United States and Europe. This score is the result of an analysis of the different segments of coronary anatomy, dominance, level of occlusion, presence of bifurcations or trifurcations, aorto-ostial disease, severe tortuosity, length and calcification of lesions, presence of thrombi, and small vessel disease. This score can be enriched with clinical data (SYNTAX - clinical), ACEF score, global risk (Euro-SCORE), SCORE punctuation - residual or non-invasive SYNTAX (Angio-CT) or functional data (SYNTAX and non-invasive FFR) (GRADE: low $_{G15\text{-}R3_Ref_13}$).[165]

**(KM)** Predicting general, medium- and long-term cardiovascular outcomes is the foundation of preventive measures.

### 3.2.2.10.2 Risk of complications associated with physical exercise

Risk stratification scales, although still subject to improvement, constitute the cornerstone of prescribing therapeutic physical training and assigning levels of patient supervision, according to the likelihood of experiencing an adverse event associated with exercise. (GRADE: very low $_{G15\text{-}R4_Ref_3}$).[166]

The main elements to be evaluated are: 1) coronary risk factors and the progression of the atherosclerosis process, 2) presence of ischemia, 3) coronary anatomy, 4) ventricular function, 5) electrical stability, 6) ergometric response, 7) biomarkers. Risk stratification is also performed in other modalities such as daily pre-exercise screening or patient re-stratification at different times during their evolution. In addition to preventing adverse outcomes, stratification allows us to direct therapeutic prescription specifically and establish different levels of supervision of training sessions (GRADE: low $_{G15\text{-}R1_Ref_7}$).[92]

In a cohort study of 76 patients in the CVRhP-P group, the ability of different stratification protocols to predict simple exercise-related complications (angina, dizziness, arrhythmias, fatigue, muscle pain) was evaluated. Although none of the participants experienced serious events, 524 simple complications were documented. The AACVPR protocol showed a significant association between risk classification and the occurrence of these complications ($p = 0.046$), although with limited sensitivity, specificity, and accuracy (accuracy = 0.53; 95% CI 0.40 to 0.65; sensitivity = 0.53; 95% CI 0.34 to 0.7; and specificity = 0.52, 95% CI 0.36 to 0.69) (GRADE: moderate $_{G15\text{-}R4_Ref_5}$).[167]

A risk stratification model based on a cohort of 639 patients with heart disease integrates various risk indicators, both clinical and laboratory and image, which establishes, through a scale, the global risk score of arrhythmias or ischemia during the sessions of a CVRhP-P (GRADE: low $_{G15\text{-}R1_Ref_8}$, $_{G15\text{-}R1_Ref_9}$).[168,25]

Rius MD and collaborators published a prediction model for arrhythmias during training in 412 patients in CVRhP-P and showed that the presence of rhythm disorders in the exercise test was associated with an increase in arrhythmias during kinesiotherapy

sessions (RR = 1.89; 95% CI 1.25 to 2.86) and the regression model showed that the predictive variables were: the presence of ventricular ectopy during PE, peak oxygen uptake ($VO_2$ peak) and use of diuretics (GRADE: high $_{G15\text{-}R1_Ref_10}$).[169]

A cohort published in 2021 with 76 patients within a CVRhP-P showed that traditional scales were associated with the occurrence of simple complications (angina, BP alterations, arrhythmias, fatigue, muscle pain, pallor), with low sensitivity (0.53), specificity (0.52) and accuracy (0.53) (GRADE: very low $_{G15\text{-}R1_Ref_5}$).[170]

The EXERISK study was based on a cohort of 639 patients at CVRhP-P, in which the objective was to identify risk factors for developing arrhythmias or angina during exercise. Seventy-six patients with exercise-induced arrhythmia were registered, and 32 showed ischemia. No major adverse events were observed. The multivariate model showed that significant prognostic factors for arrhythmias were LVEF, maximum METs, and the presence of ventricular ectopy in the exercise test (AUC 0.730). On the other hand, prognostic variables for ischemia were a history of angina, METs, and the SYNTAX score (AUC = 0.856) (GRADE: high $_{G15\text{-}R3_Ref_1}$).[171]

In the CPG (ESC, 2020) on the evaluation of sports participation in patients with heart disease, it is recommended that it be systematically studied and that exercise prescription be based on the SCORE scale and on various specific criteria for each morbid state (GRADE: high $_{G15\text{-}R3_Ref_4}$).[172]

**(KM).** Assessing the risk of complications during ThPhT sessions is useful for assigning the level of supervision and equipment in each case.

### *3.2.2.11 Risk stratification in the pediatric population*

Adequate risk stratification in pediatric patients with congenital heart disease is essential for personalizing therapeutic recommendations, particularly regarding sports participation and cardiovascular rehabilitation.

The 2021 position paper of the European Society of Cardiology (ESC) and the European Association for Preventive Cardiology (EAPC) emphasizes that purely anatomical classification is insufficient to predict risk in this population. Instead, a systematic assessment is proposed that includes functional and hemodynamic parameters such as ventricular function, pulmonary artery pressure, aortic characteristics, the presence of resting or exercise-induced arrhythmia, and oxygen saturation levels. This approach allows patients to be categorized into risk levels (A to D) based on the severity of the findings, facilitating safer and more accurate clinical decisions about their participation in physical activities (GRADE: very low $_{G15\text{-}R2_Ref_1}$).[173]

A recent cohort study, conducted in 63 patients under 22 years of age with congenital heart disease, evaluated the utility of the FORCE tool for risk stratification in pediatric cardiovascular rehabilitation programs. This tool is based on easily accessible clinical data, including cardiac function, oxygenation level, rhythm considerations, coronary or complex risk, and hemodynamic overload. The application of FORCE allowed complete classification in 98% of cases, and patients classified in the FORCE 3 group were identified as more frequently presenting with serious arrhythmias or cardiomyopathies. Despite this greater clinical complexity, no adverse events were reported during 958 rehabilitation sessions, supporting the safety and applicability of this approach in clinical practice (GRADE: moderate $_{G15\text{-}R2_Ref_2}$).[174]

On the other hand, a review published in 2012 proposes a comprehensive assessment model that goes beyond traditional cardiological variables, incorporating psych pedagogical, orthopedic, neurological, and nutritional aspects, as well as laboratory and exercise testing. This multidimensional approach allows for the detection of specific limitations that should be considered in the design of rehabilitation programs. Its objective is to improve HR-QoL through individualized interventions that include physical guidance, secondary prevention, reproductive and genetic counseling, and educational and professional planning for the patient (GRADE: low $_{G15\text{-}R2_Ref_3}$).[175]

Finally, the 2024 Inter-American Society of Cardiology (SIAC) guidelines integrate modern tools such as the FORCE scale with traditional clinical methods and functional tests, such as the six-minute walk and exercise stress testing with gas analysis, to construct an individualized risk profile in children and adolescents with congenital heart disease. They highlight the systematic use of HR-QoL questionnaires such as the PedsQL and ConQol, as well as the implementation of hybrid programs (hospital- and home-based), which have been shown to improve adherence. This structured and validated approach promotes safe and controlled physical participation and contributes to better clinical and psychosocial outcomes in this population (GRADE: high $_{G15\text{-}R2_Ref_4}$).[211]

Risk stratification is a process that calculates an individual's probability of suffering an adverse outcome, using inferential statistics from various cohorts, case-control, and other studies.

**Recommendation Table 4.** Therapeutic physical training

| PICO | 3.2.3 Therapeutic physical training (ThPhT) | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G7-R1 | It is recommended that patients in a CVRhP-P perform ThPhT, at least aerobic and strength training, in order to increase their exercise tolerance and quality of life. | I | A | C+/B+ | 1 to 6 |
| G7-R4 | It is recommended that therapeutic physical training be prescribed for patients in a CVRhP-P, based on the principles of physical exercise and risk stratification, with the goal of safely improving their exercise tolerance and quality of life. | I | B-R | C-/B+ | 1 to 6 |
| G16-R5 | It is recommended that patients with ischemic heart disease perform ThPhT (aerobic and resistance training) in order to increase their exercise tolerance. | I | B-R | C+/B+ | 1 to 6 |
| G7-R5 | It is recommended to train the respiratory muscles of patients in CVRhP-P, in order to improve their inspiratory strength, minute volume, forced inspiratory volume, exercise tolerance and HR-QoL. | I | B-R | C-/B+ | 1 to 6 |
| G7-R10 | It is recommended that the intensity of physical training be prescribed for patients in a CVRhP-P based on ergometric assessment and non-aerobic physical qualities, so that ThPhT sessions generate an effective and safe stimulus. | I | B-NR | C-/B+ | 1 to 6 |
| G2-R4 | It is recommended to develop a comprehensive and individualized plan with 36 ThPhT sessions, in order to increase exercise tolerance, increase HR-QoL and reduce all-cause mortality in patients participating in a CVRhP-P. | I | B-NR | C+/B+ | 1,2,6 |
| G5-R1 | It is recommended that all CVRhP-P have an emergency care protocol, a properly equipped area, and personnel trained in cardiopulmonary arrest care (BLS, ACLS, PALS), in order to offer immediate and effective care during a cardiovascular emergency and thus reduce associated mortality and morbidity. | I | B-NR | C+/B+ | 1 to 6 |
| G5-R3 | It is recommended that the type and level of monitoring for ThPhT sessions in CVRhP-P be assigned according to the patient's risk and the type of facility, in an effort to optimize resources and include the largest number of patients without compromising patient safety. | I | C-EO | C-/B+ | 1 to 6 |
| G7-R3 | It is recommended that patients undergoing sternotomy surgery begin their rehabilitation program in the early postoperative period (Phase I) to reduce complications resulting from prolonged rest, taking care to assess sternal stability and avoid movements that could displace it, for at least 4 weeks. Patients with pacemakers can begin the program from the first week after implantation to avoid shoulder disability and reduce the risk of hematoma or lead dislodgement. In patients undergoing arterial puncture, physical exercise can begin from the first week to improve quality of life and exercise tolerance, minimizing the risk of complications at the puncture site. In the case of femoral arterial access, the presence of local complications, especially AV fistulas, must be ruled out. | IIa | B-NR | C+/B+ | 1,2,6 |
| G7-R7 | It is recommended that a comprehensive activity planner be developed for each patient, individualized and scheduled, with precise identification of the ThPhT characteristics, medical consultations, appointments with other disciplines, or requested studies, so that the activities are carried out and supervised in a visual, harmonious, precise, effective, and safe manner. | IIa | C-EO | C-/B+ | 1 to 6 |
| G7-R6 | It is recommended to monitor the progression of ThPhT according to the comprehensive planner and provide feedback on necessary adjustments based on the response to exercise, preferably changing one component at a time, in order to generate a safe and effective adaptation. | IIa | C-EO | C-/B+ | 1 to 6 |
| G7-R12 | It is recommended that patients in CVRhP-P perform a self-assessment of their health status before each ThPhT session, in order to reduce the risk of exercise-related adverse events, improve empowerment, and promote adherence. | IIa | C-EO | C-/B+ | 1, 4 and 6 |
| G18-R8 | Patients with heart failure in CVRhP-P are recommended to train with interval training, in an individualized, highly supervised, and in-person manner, whenever their conditions permit, in order to improve exercise tolerance and ventricular function. | IIb | B-R | C+/B+ | 1 to 6 |

| Principle | Prescription |
|---|---|
| Functional Unit | Indicate motor gestures that simulate everyday activities (bending, carrying objects, climbing stairs, etc.) |
| Overload and recovery | Indicate the magnitude of the load to be performed (weight, time, perception of effort, target heart rate, target double product) and the type of recovery or rest (recovery time, load-recovery ratio, repetitions-time ratio) |
| Overcompensation | Identify the ideal time to administer the next overload, particularly in frail patients. |
| Progression | Increased load, lengthened exercise time, decreased recovery times, and the incorporation of new routines that include more muscle groups |
| Individualization | Adjust prescription parameters to the characteristics of each patient (age, biological reserve, diagnosis and patient preferences, among others) and take into account the projected goals in each case |
| Continuity | Avoid periods of inactivity (full or partial) beyond adequate rest periods in the training program and encourage adherence to the program |
| Diversification | Incorporate complementary training modalities that allow for comprehensive body stimulation |
| Periodization | Integrate exercise and rest activities into a schedule, in the medium and long term, and identify goals to achieve |
| Specialization | Design specific exercises to achieve specific goals (aerobic base, strength, etc.) |
| Effective stimuli | The program should, at each stage of progression, ensure that the overload is slightly above the patient's threshold, seeking to trigger an adaptive response. |

**Figure 16.** Principles of physical training. Therapeutic physical training requires precise and scientifically based prescriptions. This table shows the principles that should always be followed when planning a program for each patient. All the principles outlined in the table are highly relevant and complementary. Physical exercise for patients with cardiovascular disease should be considered a form of treatment, and its prescription must be meticulously tailored to everyone's needs and limitations. Personalizing the exercise program allows for safe dosage of the exercise load, appropriate progression, and effective stimulation to promote the desired physiological adaptations, without compromising safety.

**(KM)** Risk assessment in patients entering a CVRhP-P should accurately identify the outcomes of interest, risk factors, strength of association and level of chance (p value), within the clinical scenario in each case.

### 3.2.3 Therapeutic physical training (ThPhT)

Physical exercise is a planned, structured, and repetitive physical activity designed to improve or maintain quality such as strength, aerobic capacity, or flexibility, among others. The objectives of physical exercise include athletics, aesthetic, and social purposes. An exercise program focused on restoring health can be defined as Therapeutic Physical Training (ThPhT).

ThPhT is the cornerstone for improving ExTol, reducing mortality, improving HR-QoL, and reducing healthcare costs in patients with CVD.

Cardiovascular rehabilitation based on an individualized ThPhT is necessary to improve exercise tolerance

and reduce the risk of rehospitalization in patients with CVD. An observational study showed that exercise prescription based on heart rate reserve does not always match the anaerobic ventilatory threshold, which can lead to inadequate training intensity, and reinforces the usefulness of a CPET. (GRADE: very low $_{G2\text{-}R4_Ref_1}$).[176]

### *3.2.3.1 Prescription of therapeutic physical training*

Physical training is a stimulus that can generate changes in the body, both structural and physiological, and can be specifically targeted to modify a particular bodily function. Physical exercise can be considered a medicine and, as such, requires a precise prescription. (GRADE: low $_{G7\text{-}R4_Ref_5}$).[177]

ThPhT should be planned according to the physiological principles of exercise (Fig. 16) and prescribed, based on the findings of an exercise test (ideally CPET), in a clear format that includes at least its modality, frequency or periodicity, duration, intensity, and preferably the level of monitoring.

To correctly prescribe and monitor exercise training in patients with CVD, it is crucial to consider risk stratification, treatment response, and the presence of comorbidities. Therefore, before starting any exercise program, an initial clinical assessment and risk stratification using exercise testing are essential steps. These allow for defining the appropriate level of supervision and monitoring, especially in high-risk patients or those with HF, who should begin training in a supervised setting. Exercise prescription should be carefully tailored to be safe and effective.

Based on these assessments, a frequency of CMAT is suggested of three to five times per week, beginning with a 5- to 15-minute warm-up, followed by a 20- to 40-minute main phase at a moderate to moderate-high intensity—always below the ischemic threshold—and concluding with a 5- to 10-minute cool-down phase. Furthermore, allowing patients to choose pleasurable activities has been shown to improve long-term adherence (GRADE: very low $_{G7\text{-}R4_Ref_1}$).[179]

It is essential that therapeutic physical training includes at least, aerobic exercise (CMAT or interval training) and resistance training (Strgh-T), in a supervised setting, especially in the initial sessions. A general indicator of physical training is exercise volume, expressed in units of (frequency) * (intensity) * (time).

Exercise prescription and supervision can range from a highly supervised hospital setting to home programs with self-monitoring of variables using equipment such as smartwatches with heart rate monitors, step counters, etc.

Ilarraza H et al. propose the use of a training planner for patients with CVRhP-P, as an adaptation of the one used by high-performance athletes. Training progression is integrated into its different stages (macro, meso, and micro cycles) and different modalities, in relation to the individualized projection in each case. The planner also includes the programming (weekly, biweekly, monthly, etc.) of other interventions such as medical consultations, clinical studies, nutrition, or psychological activities, along with the training program (Fig. 17) (GRADE: very low $_{G7\text{-}R7_Ref_3}$).[178]

This approach allows for accurate monitoring of the patient's response and adjustments based on tolerance and progress. As the patient progresses, it is necessary to adjust the exercise parameters, preferably in accordance with the pre-established plan, ensuring that adequate progressive overload is maintained. (GRADE: very low $_{G7\text{-}R4_Ref_1}$).[179]

Exercise dosage can be adjusted using several parameters, such as session frequency and duration, the load during the main phase of the CMAT, the progression of warm-up and cool-down periods, repetition volume, and the relationship between intensity and duration of intervals, among others. These adjustments can be titrated based on clinical (symptoms, perceived exertion) or physiological (heart rate, blood pressure, ECG) responses.

Additionally, the combination of CMAT with Strgh-T has been shown to be more effective than isolated aerobic exercise in improving various clinical parameters. In patients with coronary artery disease and HF, this combination has been associated with improvements in $VO_2$peak, total exercise time, and HR-QoL. Furthermore, in people with heart disease, Strgh-T contributes to muscle strengthening, improved body composition, and emotional state. It is recommended to perform Strgh-T two to three times per week on non-consecutive days, including 8 to 10 exercises for the main muscle groups, with moderate intensity (40%–60% of 1RM or 11–13 on the Borg scale), and a volume of 1 to 3 sets of 8 to 10 repetitions. Ensuring progressive overload is key to maximizing benefits. To ensure that these benefits are achieved without causing harm, program progression should be individualized, considering clinical progress and exercise tolerance. This is especially relevant in patients with multiple comorbidities or exercise intolerance, who may require more frequent modifications in exercise intensity or type (GRADE: very low $_{G7\text{-}R4_Ref_3}$).[193]

**Cardiovascular Rehabilitation and Prevention Program**
**Comprehensive Planner**
**First 6 months**

| Timeline | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| Macro-cycle | Macro-cycle (26 weeks) | | | | | | | | | | | | | | | | | | | | | | | | | |
| Meso-cycle | Mesocycle-1 | | | | Mesocycle-2 | | | | Mesocycle-3 | | | | | Mesocycle-4 | | | | Mesocycle-5 | | | | Mesocycle-6 | | | | |
| **Assessment** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Exer_Prescription | x | | | | x | | | | | | | x | | | | | | | | | | | | | | x |
| Medic. consult. | x | | | | | | | | | | | x | | | | | | | | | | | | | | x |
| Nutrition | x | | | | | | | | | | | x | | | | | | | | | | | | | | x |
| Psychology | x | | | | | | | | | | | x | | | | | | | | | | | | | | x |
| Blood chemistry | x | | | | | | | | | | | x | | | | | | | | | | | | | | x |
| Inflammation | x | | | | | | | | | | | | | | | | | | | | | | | | | x |
| Biomarkers | x | | | | | | | | | | | | | | | | | | | | | | | | | x |
| Exercise Test | x | | | | | | | | | | | x | | | | | | | | | | | | | | x |
| Phys. Qualities | x | | | | | | | | | | | x | | | | | | | | | | | | | | x |
| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| **Aerobic ThPhT** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Time (min) | 20' | 20' | 20' | 20' | 25' | 27' | 30' | 27' | 30' | 32' | 35' | 37' | 35' | 40' | 40' | 40' | 40' | 45' | 47'' | 47' | 47' | 55' | 57' | 60' | 60' | 55' |
| Intensity % maxHR | 50% | 52% | 55% | 52% | 55% | 57% | 60% | 57% | 60% | 60% | 60% | 60% | 60% | 65% | 67% | 70% | 67% | 70% | 70% | 70% | 67% | 70% | 70% | 70% | 70% | 70% |
| Progression of aerobic training | | Time → Intensity ↑ | | | | Time ↑ Intensity ↑ | | | | Time ↑ Intensity → | | | | | Time → Intensity↑ | | | | Time ↑ Intensity → | | | | Time ↑ Intensity → | | | |
| Meso-cycle | Mesocycle-1 | | | | Mesocycle-2 | | | | Mesocycle-3 | | | | | Mesocycle-4 | | | | Mesocycle-5 | | | | Mesocycle-6 | | | | |
| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| **Strength ThPhT** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Strength progression | Volume ↑ Intensity → | | | | Volume ↑ Intensity → | | | | Volume ↑ Intensity → | | | | | Volume → Intensity → | | | | Volume ↑ Intensity ↑ | | | | Volume ↑ Intensity → | | | | |
| | 30% | 30% | 30% | 25% | 35% | 35% | 35% | 30% | 40% | 40% | 40% | 40% | 35% | 45% | 45% | 45% | 40% | 45% | 50% | 50% | 40% | 50% | 50% | 50% | 50% | 40% |
| Series | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 |
| Repetitions | 8 | 10 | 10 | 8 | 10 | 12 | 12 | 10 | 12 | 15 | 15 | 15 | 12 | 10 | 12 | 12 | 10 | 12 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Muscle group (Strength) | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Biceps / Triceps | x | x | x | x | x | | x | x | x | | x | | x | x | | x | x | | x | | x | x | | x | x | x |
| Pectoral / Latissimus Dorsi | | x | | x | | x | | x | | x | | x | x | x | | x | x | | x | | x | x | | x | x | x |
| Lumbar / abdomen | | | x | x | x | | x | x | x | | x | | x | | x | | x | x | | x | x | x | | x | x | x |
| Gluteus / hip flexors | | x | | x | | x | | x | | x | | x | x | x | | x | x | | x | | x | x | x | x | | x |
| Quadriceps / hamstrings | x | | x | x | x | | x | x | x | | x | | x | x | | x | x | x | x | x | x | x | x | x | | x |
| Gastrocnemius / Tibialis anterior | | | | x | | x | | x | | x | | x | x | | x | | x | x | | x | x | x | x | x | | x |
| Abductors / Adductors | | | | | | | | | | x | | x | x | | x | | x | x | | x | x | x | x | x | | x |
| **General Physical Conditioning (Circuits)** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Coordination | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Balance | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Stretching | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| Week | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |

**Figure 17.** Comprehensive planner for a patient in CVRhP-P. Precise scheduling of the activities that the patient and CVRhP-P staff must perform helps visually observe the interaction of the different components of the system. This allows for more accurate record-keeping and informed decision-making. This is an example of a treatment plan for a frail patient, classified as being at very high risk of complications during exercise sessions.

**(KM)**. Therapeutic physical training is a medication that must be carefully prescribed and supervised.

### 3.2.3.1.1 Start and duration of the CVRhP-P

Historically, the timing of a patient's admission to a rehabilitation program has been a topic of debate, especially after a thoracotomy or the implantation of an electrical therapy device (pacemaker, ICD, etc.).

In a 2015 cohort of 240 patients (CABG, valve surgery, or post-AMI) found that the time to admission to a CVRhP-P after hospital discharge was 10.5 days post- CABG (8 to 15), 12 days post-valve surgery (8.5 to 21), and 9 days post-AMI (7 to 14). No differences were observed in relation to major adverse events between patients admitted early or late (17% vs. 17%) or by diagnosis (15%, 16%, and 22%). No permanent damage was observed in any case, and 93% did not require referral to the emergency department. There were few low severity adverse events (GRADE: low $_{G7\text{-}R3_Ref_2}$).[180]

Tikhonoff V. et al. recommend that patients after thoracotomy surgery start a CVRhP-P as soon as possible (GRADE: very low $_{G7\text{-}R3_Ref_1}$).[181]

A Swedish registry of 78 cardiac rehabilitation centers found that 78% offered a physiotherapy consultation before discharge. In 23% of the centers, an appointment was scheduled within the first two weeks after discharge, and in 61% within the first four weeks. Thus, 86% of centers met the standard for admission to CVRhP-P within the first four weeks. No adverse events were reported (GRADE: moderate $_{G7\text{-}R3_Ref_5}$).[182]

A systematic review published by Jayaprabha P et al., with patients recently implanted with a pacemaker, included the prescription of upper limb immobilization or the use of pendulum motion, range of motion, strengthening, and stretching. Therapy began in some studies as early as day 1 post-implant and in others as late as week 2. Upper limb exercise was associated with a reduction in dysfunction and disability, especially of the ipsilateral shoulder associated with immobilization. No significant differences were observed between the experimental and control groups regarding complications (hematoma or lead dislodgement). The authors rate the quality of these studies as low to moderate (GRADE: moderate $_{G7\text{-}R3_Ref_6}$).[183]

Based on this evidence, it is recommended that cardiac rehabilitation programs use individualized methods for exercise prescription and last at least 36 sessions, prioritizing those with higher intensity and supervision to maximize their benefits. Regarding program duration, a meta-analysis showed that a CVRhP-P of at least 36 sessions improves ExTol (HR= 1.23; 95% CI 1.10 to 1.37, p< 0.001) and reduces the number of re-hospitalizations (HR= 0.76; 95% CI 0.62 to 0.89, p= 0.002), although without a relevant effect on mortality (GRADE: high $_{G2\text{-}R4_Ref_3}$).[184]

In patients with atrial fibrillation, after an ablation procedure, the 36-session CVRhP-P was associated with an increase in ExTol (HR= 1.28; 95% CI 1.14 to 1.43, p< 0.001), in addition to reducing long-term anxiety (HR= 0.81; 95% CI 0.71 to 0.92, p= 0.002) (GRADE: moderate $_{G2\text{-}R4_Ref_7}$).[185]

It is essential to review the progress of each session to adjust the exercise based on the patient's response. Increasing one component at a time (frequency, intensity, duration, or modality) allows training to be safely adapted, ensuring that progressive overload is effective without putting the patient's health at risk. CMAT can begin with small increases in duration (1–5 minutes) and then move on to an adjustment in intensity or frequency, while Strgh-T should progress in load or repetitions. This methodology avoids excessive restrictions in intensity, which optimizes physiological benefits and maintains proper technique, minimizing the risks of adverse events (GRADE: very low $_{G7\text{-}R6_Ref_1}$).[186]

The progression of training in patients within a CVRhP-P should be a carefully individualized and titrated process, as each patient has different characteristics and needs.

### 3.2.3.1.2 Training modality

The modality of physical training refers to both the type of motor gesture performed (cycling, walking, swimming, etc.) and the way it is delivered to the patient (in person, online, hybrid).

The movement modality, body segment, and how it is used will be chosen depending on two factors: the program's objective and the patient's functional capacity. For example, to improve the aerobic base, a movement that recruits large muscle groups in cyclical movements, such as walking or swimming, can be used. On the other hand, muscle strength can be increased by lifting weights in a certain number of repetitions (sets), adjusting the contraction-relaxation time and rest between sets.

ThPhT is one of the core components of CVRhP-P, which has evolved over time to include modalities ranging from continuous moderate aerobic training (CMAT), such as walking and cycle ergometry, to the incorporation of strength training, high-intensity interval training

(HIIT), circuit training, and other modalities such as ballroom dancing, yoga, Tai Chi or water aerobics, among others.

**(KM)** comprehensive program, choosing the combination of modalities according to the patient's evaluation and in the required sequence.

### 3.2.3.1.2.1 Breathing training

Breathing training integrates a set of exercises and techniques to improve lung capacity. One of the initial goals in a patient's ThPhT plan is to establish an adequate breathing pattern.

Inspiratory muscle training is an effective intervention for CVRhP-P, particularly in patients with heart failure. This therapy is associated with increased respiratory muscle strength, increased ventilatory efficiency and ExTol, reduced dyspnea, and improved HR-QoL. This type of training progressively increases airflow resistance and diaphragmatic breathing awareness, among other factors.

A meta-analysis by Li H et al. evaluated the effect of inspiratory muscle training on respiratory function, ExTol, and HR-QoL in patients with heart failure. The results showed an increase in maximal inspiratory pressure (MD= 17.25 $cmH_2O$; 95% CI from 13.75 to 20.75, p< 0.00001), a reduction in the $VE/VCO_2$ slope (MD= −4.22; 95% CI from −6.78 to −1.66, p = 0.001); an increase in peak $VO_2$ (MD= 2.53 $mlO_2$/kg/min; 95% CI from 1.54 to 3.51, p< 0.0001), and an improvement in HR-QoL (MD= −13.34; 95% CI; from −20.42 to −6.26, p = 0.0002). Results were similar in patients with HFpEF, with an increase in peak $VO_2$ (MD= 2.98 $mlO_2$/kg/min; 95% CI 1.63 to 4.34, p < 0.0001) and an improvement in quality of life (MD= −14.52 points; 95% CI −18.53 to −10.52, p < 0.00001) (GRADE: high $_{G7\text{-}R5_Ref_5}$).[187]

A meta-analysis published in 2024, with 849 patients with ischemic heart disease showed that breathing training was associated with an increase in oxygen uptake rate (MD = 2.18 $mlO_2$/kg/min; 95% CI 0.54 to 3.83), inspiratory muscle strength (MD= 16.62 $cmH_2O$; 95% CI 12.48 to 20.77), inspiratory muscle endurance (SMD= 0.39; 95% CI 0.19 to 0.60) and expiratory muscle strength (MD= 14.52 $cmH_2O$; 95% CI 5.51 to 23.53). No benefits were observed in 6MWT, HR-QoL, lung function and forced expiratory volume in 1 second. Adverse events were reported irregularly (GRADE: high $_{G7\text{-}R5_Ref_1}$).[188]

Piotrowska M et al. conducted a randomized controlled trial with 90 patients with HF, which showed that respiratory training was associated with a significant improvement in hemodynamic parameters in patients who performed cycle ergometry combined with inspiratory muscle training, compared to both therapies separately. An increase in peak HR was observed in this same group. ExTol increased an average of 6.82 METs (2.79 to 6.61) to 8.74 METs (2.4 to 8.17; p < 0.01). Adverse events were not reported (GRADE: moderate $_{G7\text{-}R5_Ref_2}$).[189]

Azambuja ACM et al. published the results of a meta-analysis of 227 patients with HF, where they observed that inspiratory muscle training improved maximal inspiratory pressure (MD = 25.12 $cmH_2O$; 95% CI 15.29 to 34.95). No significant changes were observed in minutes walked, VO2max, and HR-QoL. Patients who showed the greatest improvement were those who started with more weakness, performed a greater number of sessions, and with a higher training load. Adverse events were not assessed (GRADE: moderate $_{G7\text{-}R5_Ref_3}$).[190]

In 2014, a meta-analysis of 239 patients with HF by Montemezzo D et al. showed that those with respiratory muscle weakness had greater gains in inspiratory strength (MD= 22.6 mmH2O; 95% CI 3.7 to 41.54), $VO_2$ (MD= 2.59 $mlO_2$/kg/min; 95% CI 0.9 to 4.28), 6-minute walk distance (MD= 46.66 m; 95% CI 5.49 to 87.82), and minute volume (MD= 11.61 L/min; 95% CI 9.71 to 13.51) compared to those with normal baseline inspiratory pressure. No adverse events were assessed (GRADE: moderate $_{G7\text{-}R5_Ref_4}$).[191]

Inspiratory muscle training is an intervention included in the cardiovascular rehabilitation of patients undergoing cardiac surgery. This therapeutic strategy contributes to strengthening lung function and reducing hospital stay, with an emphasis on specific techniques including deep breathing exercises, controlled coughing, progressive lung expansion, and inspiratory muscle training with progressive resistance.

A meta-analysis by Dsouza et al. evaluated the effects of inspiratory muscle training on lung function, inspiratory muscle strength, and ExTol in post-cardiac surgery patients. The analysis included randomized controlled trials with a total of 293 patients and showed increases in both forced vital capacity (MD=3.47%; 95% CI 0.57 to 6.36, p=0.02), forced expiratory volume in 1 second (MD=5.80%; 95% CI 2.03 to 9.56, p=0.003) and six-minute walk distance (MD=78.05m; 95% CI 60.92 to 95.18, p<0.001). There were no significant differences in inspiratory muscle strength (MD=4.8 $cmH_2O$; 95% CI -4.00 to 13.4, p=0.29). On the other hand, the hospital stay was shorter (MD= -1.82 days, 95% CI -2.45 to -1.18, p< 0.01) (GRADE: high $_{G7\text{-}R5_Ref_6}$).[192]

### 3.2.3.1.2.2 Strength training

This form of exercise uses movement against resistance to build muscle and physical strength, using free weights (such as dumbbells and barbells), machines, resistance bands, or one's own body weight. This type of training improves athletic performance, prevents injuries, strengthens muscle and bone mass, and provides psychological benefits such as improved self-esteem and reduced anxiety.

Strength training used to be contraindicated in patients with heart disease, particularly those with heart failure or coronary artery disease. However, today it is considered a fundamental element of physical training for these patients.

Strength training has become an important focus in the standardization of CVRhP-P, as it contributes to the increase of $VO_2$ max along with aerobic resistance exercise, in addition to increasing muscle strength, particularly useful in frail elderly patients (GRADE: very low $_{G7\text{-}R1_Ref_3}$).[193]

### 3.2.3.1.2.3 Continuous moderate aerobic training

Continuous moderate aerobic training (CMAT), also known as steady-state exercise, involves performing aerobic activities such as running, swimming, or cycling at a moderate intensity (60–85% of maximum heart rate) for an extended period, usually 30 minutes or more. This type of training primarily improves aerobic endurance (the body's ability to use oxygen efficiently) and cardiovascular fitness.

Gerlach S et al. published a meta-analysis with more than 600 patients in CVRhP-P, where they showed that cycle ergometry was associated with a significant increase in ExTol (Hedges g = 0.85; 95% CI: 0.52 to 1.17, k = 13), as was the use of a treadmill (g = 0.46; 95% CI: 0.22 to 0.70, k = 8). On the other hand, during cycle ergometry training, ExTol was higher in patients with ischemic heart disease (g = 1.03; 95% CI: 0.65 to 1.42, k = 9), and lower in patients with heart failure (g = 0.40; 95% CI: 0.09 to 0.71, k = 4, p < 0.001). In contrast, in patients who trained on a treadmill, the effect on ExTol was lower in patients with ischemic heart disease (g=0.33; 95% CI: 0.19 to 0.47, k=5, p<0.01) than in those with heart failure (g=0.94; 95% CI: 0.23 to 1.65, k=2). The occurrence of adverse outcomes was not assessed (GRADE: moderate $_{G7\text{-}R1_Ref_2}$).[194]

A meta-analysis published by Campos HO et al. showed that training improves physical performance in patients, whether with strength exercises (g = 0.75; 95% CI: 0.62 to 0.88), aerobic exercise (g = 0.85; 95% CI: 0.68 to 1.01), or combined training (g = 1.04; 95% CI: 0.70 to 1.38), particularly if performed for 8 to 12 weeks under supervision. Adverse events were not assessed in this study (GRADE: moderate $_{G7\text{-}R1_Ref_4}$) [195]

A meta-analysis published by Gomes-Neto M et al. found that dance therapy was associated with an improvement in $VO_2$max (Diff-M= 4.86 $mlO_2$/kg/min; 95% CI 2.81 to 6.91), as well as in HR-QoL (MD= 2.09; 95% CI 1.65 to 2.54). No adverse events associated with the maneuver were observed (GRADE: high $_{G7\text{-}R1_Ref_1}$).[196]

### 3.2.3.1.2.4 Interval training

Therapeutic physical training can be implemented through interval training, which includes "micro-interval" sessions in extremely weak patients, to modern high-intensity interval protocols.

In 1997, a controlled clinical trial with 18 patients with severe HF first evaluated exercise training with micro-intervals of 30 seconds and 60 seconds of recovery, or 60 seconds per stage if performed on a treadmill. The training lasted 3 weeks. Peak $VO_2$ increased from 12.2 ± 0.7 to 14.6 ± 0.7 $mlO_2$/kg/min (p < 0.001) when assessed with a ramp protocol. No adverse events occurred (GRADE: moderate $_{G18\text{-}R8_Ref_4}$).[197]

Gomes-Neto M et al. published a meta-analysis of 12 studies and 609 patients with coronary artery disease that compared maximum exercise tolerance between HITT therapy and CMAT. Initially, a greater increase in ExTol was observed in the HITT group than in the CMAT group, but when an isocaloric comparison was made, no significant differences were observed between them (SMD= 0.4 $mlO_2$/kg/min; 95% CI: -0.1 to 0.9). No intergroup differences were also observed in HR-QoL (GRADE: moderate $_{G16\text{-}R5_Ref_2}$).[198]

A controlled clinical trial with 93 patients with coronary artery disease showed that, after 4 weeks of CVRhP-P, HIIT further improved ExTol ($VO_2$= 2.9 ± 3.4 $mlO_2$/kg/min), compared to CMAT ($VO_2$= 1.2 ± 3.4 $mlO_2$/kg/min, p= 0.02), a difference that was no longer significant after 12 months (HIIT, $VO_2$= 2.9 ± 4.5 $mlO_2$/kg/min; CMAT, $VO_2$= 1.8 ± 4.3 $mlO_2$/kg/min, p= 0.3). The adherence rate at 12 months was not significantly different in both groups: HIIT 53% vs CMAT 41%; p= 0.35). A higher incidence of adverse events was observed in HITT, but without statistical significance (p=ns) (GRADE: moderate $_{G16\text{-}R5_Ref_3}$).[199]

| Unit type | Patient Risk (Class): A (Apparently healthy) | B (stable CVD, low risk) | C (CVD, mod-high risk) | D (unstable, restricted CVD) |
|---|---|---|---|---|
| Telemedicine | **Phase III.** (CMAT) + (K) + (Inten_L-M) + (Educ) | **Phase III.** (CMAT) + (K) + (Inten_L-M) + (Educ) | | |
| Basic | **Phase III.** (CMAT) + (K) + (Inten_L-M) + (Educ) | **Phase III.** (CMAT) + (K) + (Inten_L-M) + (Educ) | | |
| Intermediate | | **Phase I & Phase II.** (Strat), (ET), (CMAT), (IAE), (K), (Strgh), (Isocin), (Inten_L-M-H), (Educ). Basic information and adherence. | **Phase I & Phase II.** (Strat), (ET), (CMAT), (IAE), (K), (Strgh), (Isocin), (Inten_L-M-H), (Educ) . Basic information and adherence. | |
| Advanced | | | **Phase I & Phase II.** (Strat), (ET), (CPET), (CMAT), (IAE), (K), (Strgh), (Isocin), (Inten_L-M-H), (Educ). Basic information and adherence. | **Phase I.** (Strat), (Physio) |

**Figure 18.** Type of CR Unit according to the Patient's CV Risk. Unit Type Assignment According to Patient Risk. This figure shows the association between the CVRhP Unit level and patient risk. Patients at low risk: Must complete at least six exercise sessions with continuous electrocardiographic monitoring. If at the end of this period the patient's hemodynamic signs and symptoms, electrocardiographic, and exercise tolerance status still place them at low risk, a decision may be made to continue or not continue electrocardiographic monitoring during exercise. Patients at moderate risk: Must complete at least ten exercise sessions with continuous electrocardiographic monitoring. To move them to low risk, the electrocardiographic, hemodynamic, signs and symptoms, and exercise progression findings must be adequate. If the patient develops electrocardiographic and hemodynamic abnormalities, or symptoms of impaired exercise tolerance, this may result in continuing at moderate risk or moving to high risk. High-risk patients: In these, the minimum ECG monitoring is 18 to 36 sessions, starting with continuous monitoring that may become intermittent depending on the patient's progress during the program. To decide to change it to moderate risk, there must be normal hemodynamic and electrocardiographic response to exercise, with adequate progression of exercise tolerance and without symptoms or signs of ischemia. The appearance or worsening of signs and symptoms of ischemia, as well as hemodynamic or electrocardiographic alterations, should be evaluated immediately, suspending exercise until a medical evaluation and intervention is carried out when indicated. Continuous moderate aerobic training (CMAT); kinesitherapy with strength, elasticity, balance and coordination exercises (K); light to moderate intensity (Inten_L-M), health education with basic information and adherence to the program (Educ), risk stratification (Strat), exercise testing (ET), interval aerobic training (IAE), strength exercise (Strgh), isokinetic exercise (Isocin); mild, moderate to high intensity (L-M-H) cardiopulmonary exercise testing (CPET), inpatient physical therapy (Physiot).

### 3.2.3.1.3 Level of monitoring and supervision of ThPhT

Physical training supervision involves a series of protocols, equipment, and personnel that aim to ensure that this intervention is effective and safe. It is important to highlight that closer and more technical supervision generates higher costs.

The level of monitoring for patients in CVRhP-P should be tailored to individual patient characteristics, according to their cardiovascular risk. The available evidence supports a personalized approach, in which monitoring is tailored based on the initial assessment and risk stratification.

There is also a wide variety of types of cardiovascular rehabilitation units, classified by the WHO into three categories: basic, intermediate, and advanced; in relation to the physical area, the level of staff training, and the technological resources available. (GRADE: low $_{G5\text{-}R3_Ref_3}$).[200]

Patients with heart disease have a wide spectrum of complexity and severity, which attributes different levels of risk for complications associated with physical exercise. In general, a patient's risk level will be identified in relation to the presence or absence of symptoms, risk factors, and the severity of their disease from a clinical and paraclinical perspective. (GRADE: low $_{G5\text{-}R3_Ref_1}$).[212]

Continuous monitoring in the early stages of the program is essential to identify any adverse clinical responses, adjust intensity as needed, and promote safe adherence. Throughout the rehabilitation process, periodic re-evaluations are necessary to adapt the

| Equivalents of Ventilatory Thresholds VT1–VT2 | | |
|---|---|---|
| **Method** | **Interval at VT1** | **Interval at VT2** |
| **%Peak $VO_2$** | **40–60%** | **60–80%** |
| **%Heart Rate Reserve (%HRR)** | **40–60%** | **60–85%** |
| **%Maximum Heart Rate (%HRmax)** | **55–75%** | **75–90%** |
| **Power Output (W) on Cycle Ergometer** | **Load corresponding to VT1** | **Load corresponding to VT2** |
| **Speed (km/h) and Incline (%) on Treadmill** | **Speed and incline corresponding to VT1** | **Speed and incline corresponding to VT2** |
| **Talk Test** | **Able to speak with mild to moderate effort** | **Able to speak with difficulty (but still possible)** |
| **Borg Scale (6–20)** | **11–13 (light to moderate)** | **13–15 (moderate to hard)** |

**Figure 19.** Equivalents of Ventilatory Thresholds VT1–VT2. This table provides indicative equivalents for identifying ventilatory thresholds VT1 and VT2 using various physiological, functional, and perceptual methods, useful for exercise prescription in cardiovascular prevention and rehabilitation programs (CVRhP-P).Abbreviations: VT1: first ventilatory threshold; VT2: second ventilatory threshold; $VO_2$ peak: peak oxygen uptake; %HRR: percentage of heart rate reserve; %HRmax: percentage of maximum heart rate; W: watts.

prescription to the patient's progress, always keeping training within a safe range (GRADE: very low $_{G7\text{-}R4_Ref_1}$).[179]

In pursuit of the best balance between patient safety and the level of investment in technological and personnel resources in the rehabilitation unit, it is suggested that patients be assigned to CVRhP-P based on their risk level and the level of expertise/technology at each center. In general, higher-risk patients will require a higher level of supervision by highly trained personnel, both doctor and paramedic. The level of supervision may change during the CVRhP-P, following a re-stratification process, indicated by the appearance of events such as exercise-associated hypotension, arrhythmias, or ischemia, among others (Fig. 18).

High-risk patients, such as those with left ventricular dysfunction, severe coronary artery disease, comorbidities, advanced age, or ischemia, require more intensive monitoring. According to a JACC position paper published in 2021, these patients benefit from close supervision and continuous monitoring to reduce adverse events. Furthermore, it has been observed that monitoring intensity can be decreased as the patient demonstrates a positive response to training and their exercise tolerance improves (GRADE: low $_{G7\text{-}R8_Ref_1}$).[201]

On the other hand, low-risk patients can participate in programs with less intensive monitoring. These patients can follow more flexible exercise protocols, with standard supervision during CMAT and Strgh-T sessions. A 2023 meta-analysis, which included 85 studies with more than 23,000 patients, confirmed that exercise-based rehabilitation significantly reduces cardiovascular mortality, hospitalizations, and recurrent coronary events, with a positive effect on the combination of different strategies, such as program customization, prescribed exercise dose, and follow-up duration (GRADE: high $_{G7\text{-}R8_Ref_2}$).[202]

Squires RW et al. analyzed the effect of supervised ThPhT in heart transplant patients and pointed out that exercise improves peak oxygen uptake ($VO_2$peak) and skeletal muscle strength, in addition to reducing the severity of graft vasculopathy and the incidence of adverse events such as hospitalization and death. These findings indicate that adequate preparation and monitoring during exercise can influence patient safety and clinical outcomes (GRADE: very low $_{G7\text{-}R12_Ref_3}$).[203]

### 3.2.3.1.4 ThPhT intensity

Exercise intensity is the level of physical effort required when performing an activity, measured through

heart rate, speech ability, the scale of perceived exertion (Borg Scale), caloric consumption (METs), or load and repetitions in strength training.

Prescribing exercise intensity in patients with heart disease should be based on a combination of objective and subjective methods to ensure safe and effective training.

In this context, different intensity strategies can be considered. A review published in 2021 explored how to optimize ThPhT intensity, highlighting that moderate-to-vigorous intensity exercise, and particularly high-intensity interval training (HIIT), can maximize physiological adaptations in patients with coronary artery disease and HF. However, it is important to note that this type of training was not evaluated in relation to hard clinical outcomes, nor was the frequency of adverse events analyzed. Therefore, although HIIT may be useful in improving peak oxygen uptake and training efficiency, its implementation should be done with caution, under adequate supervision, and considering the individual risk profile. Furthermore, this modality may be limited by the patient's ability to complete high-intensity levels in a sustained manner (GRADE: very low $_{G7\text{-}R4_Ref_2}$).[204]

Conventional ergometry and CPET allow for specific, precise, and individualized prescription by providing key physiological parameters, which, in practice, are associated with heart rate, workload, or perceived exertion values, thus facilitating training progression in relation to the ventilatory thresholds VT1 and VT2 (Fig. 19).

Exercise intensity is determined from indices obtained in a maximal exercise test, including %$VO_2$peak, % maximal workload (Wpeak), % maximal HR (HRpeak), and % HR reserve (HRR), classifying intensity as mild, moderate, high, and very high based on these parameters. Periodic monitoring and reassessment using ergometry are essential to adjust the prescription and ensure progressive patient adaptation, depending on the availability of resources. In patients with residual ischemia, exercise should be maintained below the ischemic threshold identified in the exercise test, minimizing the risk of adverse events during training.

The use of subjective methods, such as the Borg scale and the Talk Test, complements the control of exercise intensity, especially in patients without effective monitoring of biological variables. These tools allow the patient to maintain exercise intensity within safe and effective ranges (GRADE: very low $_{G7\text{-}R10_Ref_1}$).[205]

In a controlled clinical trial with patients with coronary artery disease participating in a residential cardiac rehabilitation program, it was observed that monitoring exercise intensity based on perceived exertion (Borg scale 6-20) was not inferior in effectiveness and safety compared to using heart rate. (GRADE: high $_{G7\text{-}R10_Ref_2}$).[206]

Muscle strength training is a fundamental aspect of HR-QoL, contributing to increased ExTol and HR-QoL. It can be prescribed using the 1RM or 10RM method, establishing appropriate loads for safe progression. Valsalva maneuvers should be avoided, and appropriate supervision should be maintained (GRADE: very low $_{G7\text{-}R10_Ref_2}$).[207]

### *3.2.3.2 Patient safety during exercise*

Cardiology societies around the world point out that any patient with heart disease is at some risk of experiencing a serious adverse event during physical exercise. Vigorous physical exercise may be associated with cardiovascular complications such as arrhythmias, myocardial infarction, or sudden death in patients with heart disease (GRADE: low $_{G7\text{-}R11\text{-}Ref_3}$).[208]

Regarding training safety, adverse events during CVRhP-P have been documented to be rare. For example, in 2005, a cohort of 3,511 patients diagnosed with myocardial infarction, post-cardiac surgery patients, and patients with cardiovascular risk factors recruited into a CVRhP-P was published with the aim of evaluating the timing of adverse events and the safety of the program. The results showed a very low rate of adverse events, one per 58,902 patient-hours/year (0.02%), with 11 non-fatal events and 2 fatal events (one with successful resuscitation). Notably, 62% of the non-fatal events occurred in the first four weeks, highlighting the importance of close monitoring in the initial phases. One-third of patients who experienced adverse cardiovascular events were able to resume the program without further complications (GRADE: moderate $_{G7\text{-}R4_Ref_4}$).[209]

In patients with heart disease enrolled in CVRhP-P, a low mortality rate associated with ThPhT has been recorded, due in part to the appropriate stratification and prescription of patients, along with rapid intervention in cases of cardiorespiratory arrest.

Van Camp SP et al. conducted a study of 167 CVRhP centers and 51,303 patients, reporting 21 cardiac arrests (19 of which were successfully resuscitated) out of a total of 51,303 patients and 2,351,916 training hours. In addition, 8 non-fatal myocardial infarctions were recorded. Therefore, a total of 1 death was recorded for every 783,972 patient-hours. (GRADE: moderate $_{G5\text{-}R1_Ref_9}$).[210]

Cardiology associations recommend implementing a cardiovascular emergency care team, both in stress

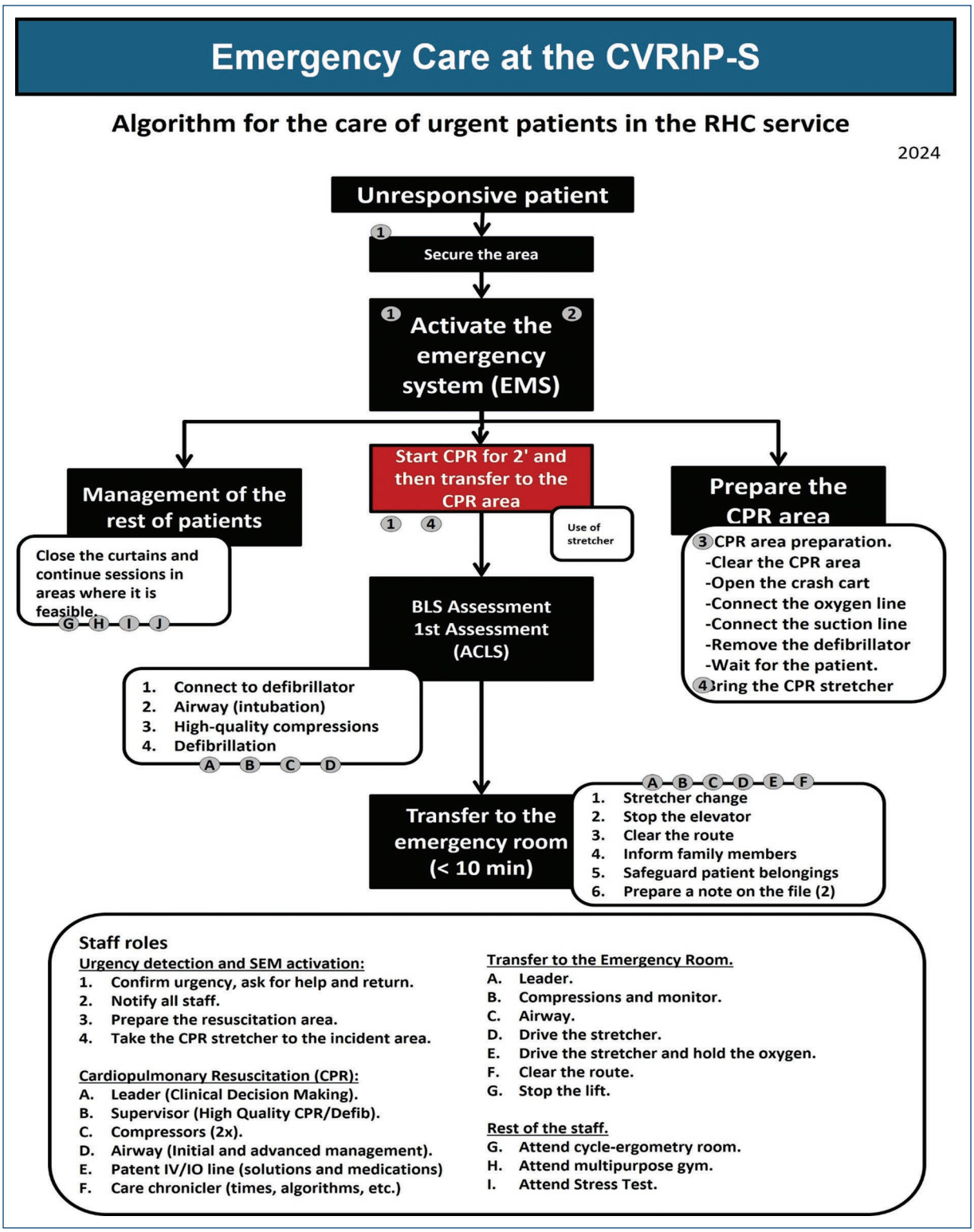


**Figure 20.** Emergency Care at the CVRhP-Unit. Immediate care for a serious emergency, such as cardiorespiratory arrest, is the cornerstone of reducing exercise-related mortality in high-risk patients. Each CVRhP-P should establish an emergency care procedure, appropriate for the type of unit. This figure shows an example of an algorithm for decision-making and assigning interventions for emergency care during physical training sessions.

testing and training for adult or pediatric patients, which includes at least a cardiac arrest care cart and an external defibrillator, as well as personnel trained in CPR (BLS, ACLS or PALS) (Fig. 20) (GRADE: high G5-R1_Ref_1).[211](GRADE: very low G5-R1_Ref_4, G5-R1_Ref_5, G5-R1_Ref_6, G5-R1_Ref_7, G5-R1_Ref_8).[212,213,214,215,216].

It is important to note that, to consider these areas as cardio-protected, regular staff training and frequent drills must be implemented in each care unit.

An effective health care system must include structure, processes, systems, and patient outcomes within a framework of continuous quality improvement. Cardiopulmonary arrest management in the CVRhP center focuses on applying the Chain of Survival algorithm and transferring the patient to an ICU or emergency department. The unit must have an early warning sign assessment system, rapid response teams, and emergency care systems (GRADE: high G7-R11_Ref_2).[217]

An example of a checklist for pre-exercise self-scrutiny can be seen in figure 21.

| Pre-Exercise Cardiovascular Self-Assessment | | |
|---|---|---|
| Name: Date: Date of birth: | | |
| Do you feel unwell? | Yes ( ) | No ( ) |
| Have you had chest pain? | Yes ( ) | No ( ) |
| Have you experienced palpitations? | Yes ( ) | No ( ) |
| Do your feet swell? | Yes ( ) | No ( ) |
| Have you had dizziness or fainting? | Yes ( ) | No ( ) |
| Have you had a cold? | Yes ( ) | No ( ) |
| Have you had a cough? | Yes ( ) | No ( ) |
| Have you had nasal mucus? | Yes ( ) | No ( ) |
| Have you had a fever? | Yes ( ) | No ( ) |
| Have you had diarrhea? | Yes ( ) | No ( ) |
| Did you forget to take your medications? | Yes ( ) | No ( ) |
| Did you eat breakfast less than 2 hours ago? | Yes ( ) | No ( ) |
| Vital Signs: | | |
| HR ___ bpm < 50 / > 100 | BP: ___ / ___ mmHg <90/60; > 140/90 | |
| $SpO_2$ ___% <90 | Temp___ °C > 38 | Blood glucose __ < 60; > 200 |
| Observations: | | |

**Figure 21.** Pre-exercise patient self-screening. Pre-Exercise Cardiovascular Self-Assessment. For patients with heart disease before physical training sessions. Use this checklist to identify any warning signs that may indicate the need to postpone exercise and seek medical evaluation.

### *3.2.3.3 Adherence to ThPhT*

The benefits associated with ThPhT require, in addition to proper prescription and supervision, an adequate level of adherence. Thus, patients with greater persistence benefit the most.

An observational study highlighted that comprehensive programs, which include nutritional counseling, stress management, and social support, favor greater adherence and reduction of major cardiovascular events,

**Recommendation Table 5.** Nutritional assessment and advice

| PICO | 3.2.4 Nutritional assessment and advice | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G8-R5 | It is recommended that the CVRhP-P nutrition specialist motivate patients to implement a Mediterranean diet, in order to reduce cardiovascular mortality, all-cause mortality, MACE, and reducing body weight, blood pressure, and hypercholesterolemia. | I | A | C-/B+ | 1,2,4 and 6 |
| G8-R4 | It is recommended that nutritional interventions in CVRhP-P include educational, stress management, and social support procedures, with the goal of improving adherence, reducing weight, and controlling biological parameters such as lipids and blood glucose. | IIa | B-NR | C-/B+ | 1,2,4 and 6 |
| G8-R3 | A specific nutritional assessment and intervention is recommended for patients with congenital heart disease, in order to identify nutritional risk and establish a regimen appropriate for their age and type of disease. | IIa | C-EO | C-/B+ | 1,2,4 and 6 |
| G8-R2 | Assessment of dietary intake in patients in CVRhP-P using self-assessment tools, such as the 24-hour recall, is recommended in order to personalize nutritional intervention. | IIb | C-EO | C-/B+ | 1,2,4,5,6 |
| G8-R7 | The "dieta de la milpa" (cornfield diet) could be used within a CVRhP-P, in patients unable to establish another type of diet such as the Mediterranean, as an alternative to reduce body weight and improve nutritional adherence. | IIb | C-EO | C-/B+ | 1,2,4 and 6 |

compared to standard programs (HR= 0.72; 95% CI 0.60 to 0.85, p <0.001) (GRADE: moderate $_{G2\text{-}R4_Ref_2}$).[218]

In 2022, a controlled clinical trial of 514 patients with ischemic heart disease in CVRhP-P evaluated the Learning and Coping (LC) strategy versus the Empowerment, Motivation and Medical Adherence (EMMA) method in relation to patient adherence. The authors used the Patient Activation Measure (PAM) questionnaire to assess the level of knowledge and self-management skills. LC was found to be associated with a higher likelihood of educational program attendance and ThPhT greater than 75% (OR = 3.62; 95% CI 1.56 to 8.40) (GRADE: high $_{G2\text{-}R1_Ref_6}$).[219]

Gebremichael LG et al. published a meta-analysis of 33 studies and 16,677 patients with CVD and evaluated the effectiveness of CVRhP-P on treatment adherence. They observed an increase in adherence to pharmacological treatment (RR = 1.14; 95% CI: 1.07 to 1.22, p = 0.0002), a reduction in the risk of death (RR = 0.83; 95% CI: 0.69 to 1.00, p = 0.05), a decrease in medical visits to the treating physician or emergency department (SMD = -0.19; 95% CI: -0.30 to -0.08, p = 0.0008), and an improvement in HR-QoL (SMD = 0.93; 95% CI: 0.38 to 1.49, p = 0.001). No significant changes were observed in lipid profile or blood pressure, but there were changes in total cholesterol levels (SMD = -0.26; 95% CI -0.44 to -0.07, p = 0.006) (GRADE: high $_{G2\text{-}R1_Ref_7}$).[220]

**(KM)** Low adherence to CVRhP-P is currently one of the greatest barriers to success.

### 3.2.4 Nutritional assessment and advice

Nutritional intervention within the CVRhP-P program is one of its essential pillars, seeking to establish a healthy diet and empower patients to choose and prepare their own food. This begins with a nutritional assessment of the patient and the establishment of specific goals to achieve, also taking family members into account. The relevant interventions are then applied in each case, and at the end of the program, a new assessment and analysis of the goals achieved are conducted. The patient will receive a final summary of the interventions implemented, goal achievements, and the long-term plan.

#### *3.2.4.1 Assessment of nutritional status*

Nutritional assessment and intervention in patients in a CVRhP-P should incorporate patient and family education, as well as clinical aspects.

Children with congenital heart disease often have nutritional problems that affect their body composition, some of which are associated with the type of heart disease. Furthermore, poor nutrition can become an atherogenic factor when they reach adulthood.

Centeno-Malfaz F. et al. published a consensus in 2023, where they highlighted that the prevalence of malnutrition in children with congenital heart disease ranges between 15 and 64%. Pathologies associated with a low risk of malnutrition are early intervention of ductus arteriosus, interatrial septal defect, pulmonary stenosis, cor-triatriatum, anomalous pulmonary vein drainage. Heart diseases associated with a high probability of malnutrition are tetralogy of Fallot, wide interatrial communication, transposition of the great vessels, ventricular septal defect, hypoplastic left heart, truncus arteriosus, aorto-pulmonary window, patent ductus arteriosus (large defect or late surgery), tricuspid atresia, Ebstein's anomaly, double outlet right ventricle, coarctation of the aorta, or abnormal pulmonary venous return (GRADE: very low $_{G8\text{-}R3_Ref_1}$).[221]

The Inter-American Society of Cardiology's CPG for patients with congenital heart disease states that nutritional assessment should be performed through clinical history, physical examination, anthropometric assessment, and in some cases, laboratory tests may be requested. The anthropometric assessment is based on weight and length/height measurements, and the construction of anthropometric indices: weight-for-age (W/A), weight-for-length/height (W/L, W/H), length/height-for-age (L/A, H/A), and body mass index-for-age (BMI/A). It is important to note that these indicators are compared with the reference population through percentiles or Z scores (GRADE: high $_{G8\text{-}R3_Ref_2}$).[211]

Machado K et al. highlight that factors associated with high nutritional risk in the pediatric population with congenital heart disease include pressure or volume overload, ventricular dysfunction, HF, chronic hypoxia, hypertension, or the degree of pulmonary hyper blood-flow. On the other hand, extracardiac factors may include intestinal malabsorption, intrauterine growth restriction, prematurity, or poor feeding technique. Referral of high-risk patients to a nutritionist should not wait until an emergency arises. Initial follow-up should be weekly and then every 15 to 30 days. General clinical and nutritional status, as well as relevant laboratory and imaging studies, should be documented. The dietary prescription should include the type of nutrients required and a carefully planned nutritional intervention plan, without forgetting the feeding route, which may be oral, nasogastric tube, or parenteral (GRADE: very low $_{G8\text{-}R3_Ref_3}$).[222]

Dietary intake in patients with cardiovascular disease is a key factor in their treatment and rehabilitation. However, accurately measuring food and nutrient consumption is challenging due to the complexity of eating behavior, the influence of internal and external factors, and the limitations of available assessment methods.

It is recommended that dietary intake assessment in patients undergoing cardiovascular rehabilitation be performed using the Food Frequency Questionnaire (FFQ) and the 24-hour recall, which have proven to be useful and widely used tools in epidemiological and clinical studies to estimate dietary intake. However, due to the inherent limitations of these self-reporting methods, their accuracy can be improved by using objective methods, such as doubly labeled water (DLW) and plasma metabolomics, with the aim of optimizing the personalization of nutritional strategies in cardiovascular rehabilitation (GRADE: very low $_{G8\text{-}R2_Ref_1}$).[223]

Doubly labeled water (DLW) is the gold standard for measuring energy expenditure and, therefore, caloric intake in outpatient settings. Its application has allowed the validation of other dietary assessment instruments, although its high cost and the need for specialized technology limit its widespread use.

The development of new technologies has also driven the creation of mobile applications and digital platforms for self-assessment of dietary intake. These tools allow for more detailed, real-time collection of dietary habits, although they still have limitations, such as mistakes in portion size estimation and a lack of standardization in data analysis (GRADE: very low $_{G8\text{-}R2_Ref_1}$).[223]

Plasma metabolomics has proven to be a promising tool for identifying specific dietary biomarkers associated with different food groups. A study in 7,012 people without CVD identified markers such as hydroxyproline for meat, TMAO for fish, and choline for eggs, which could be useful for a more objective assessment of dietary intake (GRADE: low $_{G8\text{-}R2_Ref_2}$).[224]

Furthermore, the use of wearable devices with chewing sensors and cameras could improve assessment accuracy in the future.

Accurate measurement of food and nutrient intake in patients with CVD requires a combination of self-reported and objective methods. While the Food Frequency Questionnaire and the 24-hour recall remain the most widely used tools, their validation and complementation with doubly labeled water and plasma metabolomics can improve the accuracy of dietary assessment, allowing for the design of more personalized and effective nutritional strategies for patients undergoing cardiovascular rehabilitation.

### *3.2.4.2 Dietary prescription*

Diet type has been associated as a risk factor for CVD, and various types of heart-healthy diets have been studied to reduce the incidence and prevalence of coronary atherosclerosis. One of the most studied diets is the Mediterranean diet, which attempts to explain the “French paradox,” where the population has a relatively low prevalence of coronary heart disease in the presence of an atherogenic diet. Wine intake is the main hypothesis (GRADE: low $_{G8\text{-}R5_Ref_5}$).[225]

The introduction of the Mediterranean diet as a fundamental part of treatment. This recommendation is based on evidence that the Mediterranean diet, characterized by an emphasis on monounsaturated fats, a high consumption of plant-based foods, and a moderate intake of fish and dairy products, with a low meat intake, has positive effects on reducing cardiovascular events and improving cardiovascular risk factors, such as hypertension and cholesterol levels.

In a study of 605 patients in secondary prevention, the prescription of the Mediterranean diet (with canola oil added) was associated with a reduction in cardiovascular mortality (HR = 0.35; 95% CI: 0.15 to 0.82), as well as all-cause mortality (HR = 0.44; 95% CI: 0.21 to 0.92). There are a larger number of studies in primary prevention, although the evidence on its protective effect is low to moderate (GRADE: high $_{G8\text{-}R5_Ref_1}$).[227]

Tang C et al. published a meta-analysis with 7 studies and 37,879 patients with CVD, and observed that the Mediterranean diet was associated with a reduction in cardiovascular mortality (HR=0.91; 95% CI 0.82 to 1.01) and all-cause mortality (HR=0.85; 95% CI 0.78 to 0.93), particularly in subjects living in the Mediterranean (GRADE: moderate $_{G8\text{-}R5_Ref_2}$).[229]

The CORDIOPREV study, a randomized clinical trial with 1,002 patients with coronary artery disease, showed that the Mediterranean diet group was associated with a lower rate of MACE than the low-fat diet group (HR = 0.72; 95% CI 0.54 to 0.96) (GRADE: moderate $_{G8\text{-}R5_Ref_3}$).[226]

In a 2019 systematic review that included 49 studies with 12,461 patients in both primary and secondary prevention, it was shown that the Mediterranean diet contributes to the reduction of cerebrovascular events in primary prevention (HR = 0.60; 95% CI: 0.45 to 0.80) and moderately improves total cholesterol levels (MD = -0.16 mmol/L; 95% CI: -0.32 to 0.00), as well as

systolic (MD = -2.99 mmHg; 95% CI: -3.45 to -2.53), and diastolic (MD= -2.0 mmHg; 95% CI: -2.29 to -1.71) blood pressure. Although no significant effects were observed on cardiovascular mortality or overall mortality in this study, the diet remains effective in improving risk factors (GRADE: moderate $_{G8\text{-}R6_Ref_3}$).[227]

Świątkiewicz I et al. published a cohort of 314 patients with CVD, where the effect of an intensive CVRhP-P, which included the so-called "plant-based diet," stress management, and social support, was evaluated compared to a standard program that only included lifestyle counseling and supervised exercise. The results showed that the intensive CVRhP-P achieved significant reductions in BMI by 3.4%, in LDL-C levels by 11.3%, as well as in other atherogenic lipids, glycated hemoglobin, and systolic blood pressure. Furthermore, both programs increased exercise tolerance and improved HR-QoL, although major adverse cardiac events were lower in the intervention group (11% vs. 17%), especially in hospitalizations for heart failure (2% vs. 8%) (GRADE: moderate $_{G8\text{-}R4_Ref_1}$).[218]

Bonekamp NE et al. published a meta-analysis in which they observed that a moderate carbohydrate diet was associated with a significant improvement in weight loss (MD= -4.6 kg; 95% CI -25 to +15 kg) and blood pressure (MD= -7 mmHg; 95% CI -16.8 to 2.7 mmHg) (GRADE: moderate $_{G8\text{-}R5_Ref_4}$).[228]

### *3.2.4.3 Adherence to the nutritional plan*

Adherence to a nutritional plan in patients undergoing cardiovascular rehabilitation is essential for improving health outcomes and reducing the risk of adverse events. The implementation of intensive cardiovascular rehabilitation programs that include nutritional education based on a specific diet, along with stress management and social support, has proven to be an effective strategy for optimizing dietary adherence and improving various clinical parameters.

Tang C et al. published a meta-analysis with 37,879 patients with a history of CVD showing that each 2-point increase in adherence to the Mediterranean diet was associated with a 15% reduction in all-cause mortality (HR = 0.85; 95% CI 0.78 to 0.93). Although there was a non-significant trend toward a reduction in cardiovascular mortality (HR = 0.91; 95% CI 0.82 to 1.01), these results confirm that the Mediterranean diet has a positive impact on cardiovascular health (GRADE: moderate $_{G8\text{-}R6_Ref_4}$).[229]

Gebremichael LG et al. published a meta-analysis, which included 33 studies with a total of 16,677 patients with CVD, evaluating the effectiveness of CVRhP-P on therapeutic adherence. The results indicated that these programs increased medication adherence by 14% and reduced the risk of death by 17%. A decrease in visits to primary care and emergency departments was also observed, as well as a significant improvement in HR-QoL. Although this study did not directly evaluate dietary adherence, the findings highlight the importance of education within CVRhP-P as a key factor in improving therapeutic adherence (GRADE: high $_{G8\text{-}R4_Ref_2}$).[220]

The "Milpa diet" (cornfield diet) is defined by the Mexican Ministry of Health as a healthy eating model based on the culture and regional characteristics of Mexican food. On their website, they describe it as based on

**Recommendation Table 6.** Psychological evaluation and counseling

| PICO | 3.2.5 Psychological evaluation and counseling | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G9-R8 | It is recommended to systematically assess the HR-QoL of patients in a CVRhP-P, using validated tools such as the HeartQoL questionnaire, SF-36 or the MLHFQ, to identify and modify the physical or emotional factors that affect it. | I | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R4 | It is recommended to systematically assess psychological risk factors in patients in a CVRhP-P, using psychological, neuropsychological, or self-assessment tests, in order to identify their presence and offer early therapy to improve HR-QoL and reduce symptoms of anxiety and depression. | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R6 | Psychotherapeutic support is recommended for patients who have suffered a cardiovascular event, with the aim of improving their HR-QoL, reducing symptoms of depression and anxiety, and promoting adherence to CVRhP-P. | IIa | B-R | C-/B+ | 1,2,4 and 6 |

*(Continues)*

**Recommendation Table 6.** Psychological evaluation and counseling *(continued)*

| PICO | 3.2.5 Psychological evaluation and counseling | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G9-R3 | It is recommended that patients with coronary artery disease receive specific psychological or pharmacological interventions within a CVRhP-P, in order to reduce anxiety and depression levels and improve the mental component of HRQoL. | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R5 | Mindfulness-based stress management techniques are recommended for patients in a CVRhP-P, in an effort to reduce depression and anxiety levels. | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R7 | It is recommended that patients with coronary artery disease in CVRhP-P receive cognitive-behavioral therapy, in order to reduce levels of depression and anxiety. | IIa | B-NR | C-/B+ | 1,2,4 and 6 |
| G9-R2 | It is recommended to promote the structuring of comprehensive support networks (social, family, psychological and work) in patients in a CVRhP-P, in order to reduce cardiovascular mortality and morbidity. | IIa | B-NR | C-/B+ | Include a social work specialist |
| G9-R1 | It is recommended to use specific psychological interventions in the search for improvement of depression symptoms and possibly a reduction in cardiovascular morbidity. | IIa | C-LD | C-/B+ | 1,2,4 and 6 |

corn, beans, chili, and squash. On this site, they promote its benefits, which include: adequate protein balance, abundant soluble and insoluble fiber, inhibition of cholesterol absorption, reducing the risk of CVD, promoting acid-alkaline balance due to a high calcium and magnesium content, lower fat intake, promoting antioxidant status or oxidative balance, and having an antitoxic effect (GRADE: very low $_{G8\text{-}R7_Ref_4}$).[230]

In 2021, a systematic review of clinical trials on regional (native) diets in primary cardiovascular prevention, including a Mexican diet, showed that those who adhered to them significantly lost body weight, but failed to show any positive effect in terms of change in blood pressure, blood glucose, lipid profile or inflammatory status (GRADE: very low $_{G8\text{-}R7_Ref_1}$).[231]

Valerino-Perea S et al. published a systematic review of traditional Mexican food and noted the impossibility of identifying a reproducible pattern for this diet, which generally includes foods such as corn, beans, chili, squash, tomatoes, and onions. There is no evidence of benefits for obesity, triglyceride levels, or diabetes. Studies are scarce and inconclusive (GRADE: very low $_{G8\text{-}R7_Ref_2}$) [232]

A randomized controlled crossover trial with Mexican women (n=54) showed that an indigenous diet slightly improved insulin sensitivity but had no influence on blood glucose levels or inflammatory markers (GRADE: low $_{G8\text{-}R7_Ref_3}$).[233]

In a systematic review of 16 articles on adherence to dietary recommendations in CVRhP-P, Vanzella LM et al. found multilevel barriers and facilitators. Recommendations included developing healthy eating habits, transitioning to plant-rich diets, and increasing omega-3 fatty acid intake from fish. Only one study included all the recommendations of the corresponding working group. Barriers were poor eating habits, financial situation, personal reasons, time constraints, cultural and psychological aspects, lack of knowledge, language difficulties, social aspects, lack of family support, and difficulty obtaining prescribed foods. Facilitators were good financial situation, older age, support from the CVRhP team, family support, and a higher level of knowledge. Adverse events were not assessed (GRADE: moderate $_{G2\text{-}R1_Ref_5}$).[234]

### 3.2.5 Psychological evaluation and counseling

Patients with heart disease often suffer from a mental health disorder, which can range from a period of grief to pre-existing depression or anxiety.

#### 3.2.5.1 Psychological evaluation

Evaluating a patient's emotional and mental status is very helpful in identifying various problems that require attention. Three aspects are assessed: depression, anxiety, and quality of life. Depending on the case, a referral to a psychology/psychiatry service may be made for a more comprehensive and in-depth evaluation.

The use of psychological, neuropsychological, or self-assessment tests in patients with CVD allows for the identification and addressing of psychosocial factors that may influence their clinical course, improving HR-QoL, and reducing symptoms of anxiety and depression. These tests facilitate the early detection of emotional disorders, allowing for timely and targeted intervention.

Bui QM et al. published a review of patients with advanced HF who were candidates for HxTx or ventricular assist devices. They evaluated the role of psychosocial assessment using objective tools such as the Stanford Integrated Psychosocial Assessment for Transplantation, the Psychosocial Assessment of Transplant Candidates, and the Transplant Assessment Scale. The objective was to propose a multidisciplinary framework to improve consistency in assessments. Objective tools were found to be able to predict clinical outcomes in the transplant population, with higher risk scores associated with readmissions, rejection episodes, and infections. However, it is more difficult to demonstrate that these tools can predict mortality, and their applicability to the population on mechanical circulatory support is less well studied (GRADE: low $_{G9\text{-}R4_Ref_2}$).[235]

To assess HR-QoL in patients with heart disease, the use of validated tools such as the HeartQoL (Heart Disease Health-Related Quality of Life), the SF-36 (Short Form 36 Health Survey), and the MLHFQ (Minnesota Living with Heart Failure Questionnaire) is recommended. These tools allow for accurate assessment of the physical and emotional aspects that affect HR-QoL in patients with CVD, facilitating monitoring of their well-being and the effectiveness of CVRhP-P.

Several studies have supported the usefulness of these instruments in different clinical settings. In a 2020 controlled clinical trial of 200 patients with chronic heart failure in a nurse-led CVRhP-P, those who used the SF-36 and the MLHFQ were found to have significant improvements in their HR-QoL and biological parameters, such as BMI and blood pressure (GRADE: moderate $_{G9\text{-}R8_Ref_1}$).[236]

A cohort study with 76 patients with heart disease evaluated the test-retest consistency of the HeartQoL and compared it with the McNew questionnaire, finding high reliability and a correlation comparable to previous studies (GRADE: low $_{G9\text{-}R8_Ref_7}$).[237]

Luan L et al, published a cross-sectional study with 412 patients with angina, myocardial infarction, and heart failure, where they validated the Mandarin version of the HeartQoL, showing high internal consistency and convergent validity with the SF-12 (GRADE: low $_{G9\text{-}R8_Ref_9}$).[238]

### *3.2.5.2 Psychological intervention*

The high prevalence of anxiety and depression in patients with cardiovascular disease participating in a CVRhP-P highlights the need for interventions, one of which is non-pharmacological tools.

Ski CF et al. recently published a meta-analysis of 21 studies and 2,591 participants, which found that psychological interventions based on cognitive-behavioral therapy or stress reduction using mindfulness were associated with a moderate effect on reducing depression (SMD = -0.36; 95% CI: -0.65 to -0.06) and anxiety (SMD = -0.57; 95% CI: -0.96 to -0.18), compared to the control group. Regarding the mental component of HR-QoL, a moderate effect of improvement was observed (SMD = 0.63; 95% CI: 0.01 to 1.26), and no effect was observed in the physical component (SMD = 0.48; 95% CI: -0.02 to 0.98) compared to no intervention. No effect of psychological intervention was observed on all-cause mortality (RR=0.81; 95% CI 0.39 to 1.69) or MACE (RR=1.22; 95% CI 0.77 to 1.92) when compared with no intervention (GRADE: low $_{G9\text{-}R3\text{-}Ref_1}$).[239]

A controlled clinical trial studied the effect of a patient education program in a CVRhP-P program, taught by medical students. The results showed a reduction in depression levels (HADS = -1.29; 95% CI: -0.7 to -1.88) and (SMD = 0.36; 95% CI: 0.03 to 0.69), compared with conventional management. No adverse events were observed (GRADE: moderate $_{G9\text{-}R3\text{-}Ref_3}$).[240]

In 2023, a controlled clinical trial was published evaluating psychological intervention for negative emotions in anxiety, depression, and HR-QoL. The authors observed a significant reduction compared to conventional treatment, both in anxiety levels (GAD-7= -10.52 ± 3.75) vs (GAS-7= 1.08 ± 4.03, p< 0.001), depression (PHQ-9= -9.40 ± 4.17) vs (PHQ-9= -0.98 ± 6.23, p< 0.001) and an increase in HR-QoL (SF-36= 8.11 ± 17.42) vs (SF-36= -10.67 ± 19.29, p< 0.001) (GRADE: low $_{G9\text{-}R3\text{-}Ref_4}$).[241]

Tully PJ et al. recently published a meta-analysis showing that in patients with coronary artery disease, psychological intervention reduced depressive symptoms (SMD = -0.55; 95% CI -0.92 to -0.19, low certainty). On the other hand, pharmacological intervention was associated with a decrease in depressive symptoms (SMD = -0.83; 95% CI -1.33 to -0.32, low certainty) and an increase in the rate of remission of depression (OR = 2.06; 95% CI 1.47 to 2.89, moderate certainty) (GRADE: moderate $_{G9\text{-}R3\text{-}Ref_5}$) [240]

Holdgaard A et al. published a randomized controlled trial in 147 young patients with coronary artery disease that showed that cognitive behavioral therapy improved

depression and anxiety levels (HADS score) in the intervention group (8.0 ± 5.6) versus standard CVRhP-P (4.1 ± 7.8), p<0.001. Adverse events were not assessed (GRADE: low $_{G9\text{-}R7_Ref_1}$).[242]

In patients with coronary artery disease, acceptance and commitment therapy had no significant effect on the global well-being index (MD = −1.13; 95% CI: −6.40 to 4.14), on LDL-C levels (MD = −2.13; 95% CI: −11.02 to 6.76), systolic blood pressure (MD = −0.50 mmHg; 95% CI: −10.76 to 9.76), diastolic blood pressure (MD = −2.73; 95% CI: −10.12 to 4.65) and on body mass index (MD = −0.16; 95% CI: −1.83 to 1.51), p values = ns (GRADE: moderate $_{G9\text{-}R7_Ref_5}$).[243]

In 2023, a clinical trial was published with 101 patients diagnosed with acute myocardial infarction, who received an integrated psychological intervention (7-8 sessions) compared to general nursing care. The effect of the psychological intervention on negative emotions and HR-QoL was evaluated, showing a significant reduction in anxiety and depression, as well as an HR-QoL improvement. Significant differences in favor of the intervention group were observed in anxiety, depression, physical functioning, bodily pain, general health, vitality, social functioning, emotional role, mental health, and total HR-QoL, all with $p < 0.05$. This study used assessment tools such as the Generalized Anxiety Disorder Questionnaire (GAD-7), the Patient Health Questionnaire (PHQ-9), and the SF-36 Health Survey, which may be useful in identifying relevant psychosocial factors and promoting health in patients with CVD (GRADE: high $_{G9\text{-}R4_Ref_1}$).[241]

A cohort study with 3,434 patients in CVRhP-P identified a relationship between baseline depression and less improvement in exercise tolerance and HR-QoL, while baseline anxiety was associated with improvement in physical and emotional HR-QoL (GRADE: low $_{G9\text{-}R8_Ref_2}$).[244]

Bravo-Escobar R et al published a clinical trial with 80 patients in CVRhP-P that compared the effectiveness of a remote modality with a standard one, finding that both approaches were equally effective in improving HR-QoL, as well as reducing symptoms of anxiety and depression (GRADE: moderate $_{G9\text{-}R8_Ref_3}$).[245]

Likewise, a meta-analysis with 14 studies and 1,739 patients with acute myocardial infarction showed that ThPhT-based CVRhP-P significantly improves HR-QoL in multiple dimensions, including general health and physical functioning at 6 and 12 months of follow-up (GRADE: high $_{G9\text{-}R8_Ref_4}$).[246]

More recent studies have demonstrated the relevance of mental health in the HR-QoL of patients with heart disease. In 2024, a cross-sectional study with 408 pediatric patients with congenital heart disease found an increased risk of mood disorders and a reduction in HR-QoL, especially in those with cyanotic heart disease (GRADE: low $_{G9\text{-}R8_Ref_5}$).[247]

A 2024 cohort study with 905 patients evaluated the effect of a group psychological intervention within a CVRhP-P, showing improvement in HR-QoL, especially in patients with severe depression (GRADE: moderate $_{G9\text{-}R8_Ref_6}$).[248]

Le J et al, published a meta-analysis with 55,735 patients with coronary artery disease found a significant reduction in HR-QoL, especially in the areas of activity and participation, using tools such as the SF-36 (GRADE: high $_{G9\text{-}R8_Ref_11}$).[249]

A 2022 meta-analysis showed that the combination of physical exercise and psychological support, assessed using the SF-36, is effective in improving well-being in post-infarction patients (GRADE: low $_{G9\text{-}R8_Ref_10}$).[250]

A controlled clinical trial using a patient education program delivered by medical students was found to reduce depression levels on the Hamilton Score (HADS = -1.29; 95% CI: -0.7 to -1.88), compared with conventional management (GRADE: moderate $_{G9\text{-}R5_Ref_1}$).[251]

Nijjar PS et al. published a randomized controlled trial with 47 patients in CVRhP-P, where the intervention based on mindfulness techniques was associated with a significant decrease in depression (MD= −2.69; 95% CI: −4.70 to −0.68) and anxiety (MD= −2.75; 95% CI: −5.37 to −0.13) compared to conventional management. No changes were observed in HR-QoL or biomarkers (GRADE: low $_{G9\text{-}R5_Ref_2}$).[252]

In 2020, a meta-analysis of 16 studies and 1,476 adults with CVD showed that patients who received some type of mindfulness-based intervention showed improvements in psychological outcomes such as anxiety, depression, distress, and perceived stress (d+s= 0.49 to 0.64), a reduction in systolic blood pressure (d+= 0.89; 95% CI 0.26 to 1.51; k= 7), and no changes in diastolic BP (d+= 0.07; 95% CI −0.47 to 0.60; k= 6). Adverse events not assessed (GRADE moderate $_{G9\text{-}R5_Ref_3}$).[253]

Albus C et al. published a meta-analysis of 20 studies and 4,450 patients in the CVRhP-P. Initially, low to moderate quality and high heterogeneity of the studies analyzed were observed. The authors showed that psychological intervention in patients with coronary artery disease or HF did not have a statistically significant effect on anxiety control or HR-QoL improvement. A stochastically non-significant trend was observed in the reduction of depression and cardiovascular morbidity. The addition of psychological intervention programs to standard CVRhP-P showed a non-significant trend

toward reducing depression symptoms (SMD = -0.13; 95% CI: -0.30 to 0.05), as well as reducing cardiac morbidity at 5 years of follow-up (RR = 0.74; 95% CI: 0.51 to 1.07) (GRADE: low $_{G9\text{-}R1_Ref_1}$).[254]

A meta-analysis of 35 studies and 10,703 patients with coronary artery disease in CVRhP-P evaluated the effect of specific psychological intervention versus conventional management. The studies were of poor to medium quality and had significant methodological problems. There was no reduction in the risk of total mortality (RR = 0.9; 95% CI, 0.77 to 1.05), requirement for revascularization procedures (RR = 0.94; 95% CI, 0.81 to 1.11), or incidence of non-fatal myocardial infarction (RR = 0.82; 95% CI, 0.64 to 1.05). However, there was a statistically significant reduction in cardiovascular mortality (RR = 0.79; 95% CI, 0.63 to 0.98). In addition, very low-quality evidence (GRADE: low) was detected regarding the reduction of depressive symptoms in patients (SMD = -0.27; 95% CI -0.39 to -0.15), anxiety (SMD = -0.24; 95% CI -0.38 to -0.09, GRADE: low); or stress (SMD = -0.56; 95% CI -0.88 to -0.24) (GRADE: very low $_{G9\text{-}R1_Ref_2}$).[255]

Family, couple, and/or group psychotherapeutic support after a cardiovascular event can play a key role in patient recovery, improving HR-QoL, reducing symptoms of anxiety and depression, and promoting adherence to CVRhP-P.

A cohort study of 3,434 patients undergoing cardiac rehabilitation found that baseline depression was negatively associated with improvements in exercise tolerance and HR-QoL, while anxiety was positively associated with improvements in both (GRADE: low $_{G9\text{-}R6_Ref_1}$).[244]

A systematic review with 3,090 patients evaluated the effectiveness of psychoeducational interventions in acute coronary syndrome and concluded that these strategies improve treatment adherence, HR-QoL and mental health (GRADE: low $_{G9\text{-}R6_Ref_2}$).[256]

Similarly, a cohort study of 905 cardiac rehabilitation patients who received cognitive-behavioral intervention found that one-third had psychiatric comorbidity, negatively affecting their HR-QoL. After the intervention, all showed improvement, with the improvement being more significant in those with severe depression (GRADE: moderate $_{G9\text{-}R6_Ref_4}$).[257]

The importance of social support in the outcomes of patients with CVD has been evaluated in various studies, highlighting its impact on reducing mortality and morbidity.

In 2019, a cohort study with 29,179 patients from the NHIS survey evaluated the effect of social support and integration on mortality, with an association of a 33% lower risk of cardiovascular mortality (HR = 0.67; 95% CI, 0.53 to 0.86) and heart disease mortality (HR = 0.65; 95% CI, 0.49 to 0.85) (GRADE: moderate $_{G9\text{-}R2_Ref_1}$).[258]

Social support is associated with reduced mortality and morbidity after an acute myocardial infarction (AMI). Lack of social support increases the risk of cardiovascular mortality (HR = 2.4; 95% CI, 1.4 to 4.1) or all-cause mortality (HR = 2.11; 95% CI, 1.3 to 3.7). Furthermore, post-AMI patients with depression were found to have a higher risk of cardiac mortality in one

**Recommendation Table 7.** Patient education

| PICO | 3.2.6 Patient education | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G7-R2 | It is recommended that CVRhP-P offer health education activities to patients, including knowledge about CVD, identification and control of risk factors, and proper exercise training techniques, with the goal of improving adherence to a cardio-healthy lifestyle and reducing the risk of exercise-related complications. | I | C-LD | C-/B+ | 1, 4 and 6 |

**Recommendation Table 8.** Daily Life Tips

| PICO | 3.2.7 Daily Life Tips | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G11-R2 | It is recommended that patients with CVD resume sexual activity based on their exercise performance and the rational prescription of medications for sexual dysfunction, in order to safely improve their quality of life. | I | B-NR | C-/B+ | 1,2,4 and 6 |
| G11-R4 | It is recommended that patients with CVD avoid alcohol consumption in order to reduce the risk of adverse cardiovascular events associated with it. | I | B-NR | C-/B+ | 1,2,4 and 6 |

*(Continues)*

**Recommendation Table 8.** Daily Life Tips *(continued)*

| PICO | 3.2.7 Daily Life Tips | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G11-R3 | It is recommended that all patients with CVD receive explicit, written medical advice on when and how to resume driving, so that they can drive again without the risk of road accidents due to inability to control the car, associated with cardiovascular disease or sequelae. It is important to clearly state in writing when the patient should not drive again, in consultation with transportation medicine specialists when the case warrants it. | I | C-LD | C-/B+ | 1,2,4 and 6 |
| G11-R1 | It is recommended that post-sternotomy patients not lift more than 1 kg of weight between both upper limbs until 6 to 8 weeks after surgery and comply with the "stay-in-the-tube" strategy, in order to maintain sternal stability and prevent dehiscence of the surgical wound. | IIa | B-NR | C-/B+ | 1,2,4,5 and 6 |
| G11-R5 | It is recommended that physicians provide informed advice to patients who wish to travel by air, based on their health status and the type of flight, in an effort to reduce the incidence of adverse events or cardiovascular mortality during the flight. The written medical summary should specify the patient's diagnosis, medical treatment, electrical therapy devices, as well as the disqualification or eligibility for travel, and, finally, specific advice for the trip. | IIa | C-LD | C-/B+ | 1,2,4 and 6 |
| G11-R6 | It is recommended that patients with stable CVD use a sauna bath at a moderate temperature (60–70°C) for short periods (up to 10 minutes), followed by a 30-minute recovery period in the supine position, in order to reduce blood pressure and improve endothelial and ventricular function. Advice should be individualized according to the patient's risk level. | IIb | B-NR | C-/B+ | 1 |

year (OR = 3.4; 95% CI, 1.4 to 6.1), although high social support mitigates these effects. Furthermore, living alone after an AMI was associated with a gradual increase in mortality according to the number of people living with (OR = 1.5; 95% CI, 1.0 to 2.9) (GRADE: low $_{G9\text{-}R2_Ref_2}$).[259]

**(KM)** Psychological assessment and intervention for patients with cardiovascular disease identifies mental or emotional issues that can be addressed through specific treatment, thus reducing anxiety and depression levels and improving quality of life.

### 3.2.6 Patient education

The inclusion of an educational program within Cardiovascular Rehabilitation can be useful to improve adherence and promote sustained behavioral changes in the patient, considering strategies based on theoretical models that reinforce self-efficacy and behavioral intention, through understanding the disease.

The "learning and coping" approach was shown to be effective in increasing adherence to educational and exercise sessions compared to the "Empowerment, Motivation, and Medical Adherence" approach ($p < 0.01$). However, no significant differences were found in the program completion rate between the two groups (78.9% vs.[78].2%, p = ns) or in patient activation scores at 12 weeks (GRADE: moderate $_{G7\text{-}R2_Ref_1}$).[219]

However, Lynggaard V et al. showed no significant differences in mortality rates, hospital readmissions, or length of stay when using the "learn and coping" educational strategy compared to a standard educational program. (GRADE: moderate $_{G7\text{-}R2_Ref_4}$).[260]

On the other hand, although patient education improves knowledge about coronary artery disease and attitudes toward cardiac rehabilitation, these changes do not necessarily predict increased attendance at exercise sessions (GRADE: low G7-R2_Ref_2).[261]

However, it has been observed that a curriculum based on the Health Action Process Approach can generate significantly sustained effects on exercise behavior, significantly increasing the number of hours of physical activity up to six months after the end of the program (GRADE: moderate $_{G7\text{-}R2_Ref_3}$).[262]

Thus, comprehensive patient education, including knowledge of their disease, identification and control of risk factors, and training in the technique for performing and self-monitoring physical exercise, plays an important role, especially at the beginning of CVRhP-P.

### 3.2.7 Daily Life Tips

#### 3.2.7.1 Lifting objects

Patients with heart disease, particularly those undergoing sternotomy, often experience concerns about lifting heavy objects. Expert advice on this issue is necessary to ensure the patient can move freely with a reduced risk of sternal instability.

Zheng YT et al. published a meta-analysis of six studies and 752 post-cardiac surgery patients, showing that preoperative training, particularly respiratory muscle training, aerobic exercise, resistance exercise, and stretching sessions, were associated with a reduction in ICU length of stay (MD = 1.35; 95% CI: −2.64 to −0.06, p = 0.04) and an improvement in physical function (MD = 6.81; 95% CI: 5.46 to 8.15, p < 0.00001) compared to the control group. Adverse events were not included (GRADE: moderate $_{G11\text{-}R1_Ref_1}$) [263]

In 2021, a meta-analysis was published with 6 studies and 364 postoperative patients after heart valve surgery, showing that ThPhT was associated with an improvement in physical capacity, both at the end of the CVRhP-P (SMD = 0.38; 95% CI 0.15 to 0.61), and at 24 months (SMD = 0.37; 95% CI 0.13 to 0.61). No statistical association was found with HR-QoL or case fatality (GRADE: low $_{G11\text{-}R1_Ref_2}$).[264]

Pengelly J et al. published a meta-analysis of 18 studies and 3,462 patients undergoing coronary artery bypass grafting and median sternotomy, which evaluated the effect of resistance training on muscle strength, exercise tolerance, body composition, and adverse events. No beneficial effects were observed on muscle strength, exercise tolerance, or body composition. There were no differences in exercise tolerance between strength and aerobic training. No studies measured sternal stability (GRADE: low $_{G11\text{-}R1_Ref_4}$).[265]

El-Ansary D et al, widely recommend the use of the "Stay in the tube" technique, to improve patient mobility and maintain sternal stability (GRADE: low $_{G11\text{-}R1_Ref_5}$).[266]

#### 3.2.7.2 Sexual activity

Sexual activity is a fundamental component of HR-QoL in patients with CVD. Sexual dysfunction is common in people with heart disease, so its management should include targeted rehabilitation strategies and pharmacotherapy. Available evidence indicates that its resumption should be based on exercise testing, the patient's clinical stability, and the use of vasodilators such as nitrates (GRADE: low $_{G11\text{-}R2_Ref_1}$).[267]

In patients with stable coronary artery disease, sexual activity has been equated to an effort of 3 to 5 metabolic equivalents (METs) and is considered safe in those who can complete an exercise test without symptoms. Phosphodiesterase type 5 inhibitors (PDE5i), such as sildenafil, have demonstrated efficacy in the treatment of erectile dysfunction in men with stable coronary artery disease; however, their use is contraindicated in combination with nitrates due to the risk of severe hypotension, secondary myocardial ischemia due to hypoperfusion, and cardiovascular collapse (GRADE: high $_{G11\text{-}R2_Ref_2}$).[601]

In a cohort study of 495 patients after acute myocardial infarction, resumption of sexual activity after the event was associated with lower all-cause mortality (HR = 0.65; 95% CI 0.48 to 0.88) and lower non-cardiovascular mortality (HR = 0.56; 95% CI 0.36 to 0.85), with no differences in cardiovascular mortality (HR = 0.90; 95% CI 0.53 to 1.51) (GRADE: moderate $_{G11\text{-}R2_Ref_4}$).[268]

For the resumption of sexual activity, consideration should be given to assessing clinical stability and ExTol with ET, participating in CVRhP-P to optimize exercise tolerance, avoiding the combined use of nitrates and PDE5i, and educating the patient and their partner about the benefits of sexual activity and the necessary precautions.

#### 3.2.7.3 Driving Motor Vehicles

Driving ability is a concern for both patients and transportation authorities, as the moment a patient's medical condition prevents them from driving, it could cause a fatal accident involving others. Inexplicably, expert medical advice on this issue is lacking, and patients often return to driving without any supervision (Fig. 22).

King D, published a survey that revealed the low level of knowledge in doctors, both general and from various hospital specialties, in relation to the advice on the ability to drive a vehicle in patients with various pathologies such as diabetes, cerebrovascular disease, myocardial infarction, epilepsy or with some physical disability (GRADE: low $_{G11\text{-}R3_Ref_9}$).[269]

A 2018 study showed that only 9% of a group of junior cardiologists prescribed driving advice, which improved after a course of Plan–Do–Study–Act (PDSA),

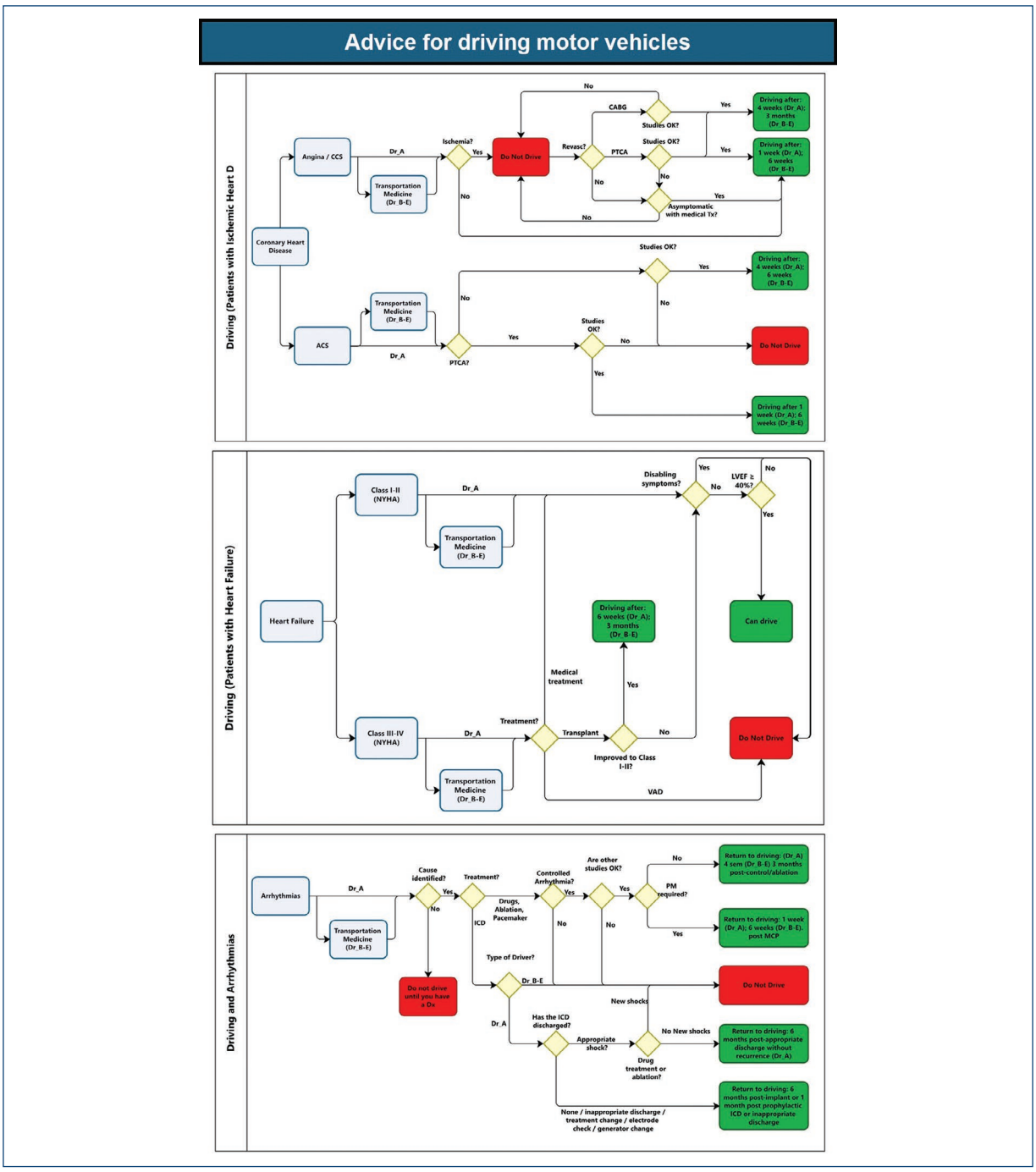


**Figure 22.** Medical advice for driving motor vehicles. Medical advice on driving motor vehicles. This figure illustrates the clinical and contextual factors that should guide decisions regarding driving eligibility. In patients with ischemic heart disease, heart failure, or those with implanted devices such as an implantable cardioverter-defibrillator or a pacemaker, driving eligibility depends on the type of cardiovascular condition, clinical status, patient stability, and the category of the vehicle. Medical conditions that impair the ability to safely operate a motor vehicle may lead to fatal accidents. Nevertheless, expert guidance is often limited or inconsistently applied in clinical practice. For professional drivers, additional medical evaluation may be required under the standards of transportation medicine, a dedicated field that oversees health and safety regulations for individuals operating vehicles in high-risk or professional settings. Abbreviations: ACS: Acute coronary syndrome; CABG: Coronary artery bypass grafting; CCS: Canadian Cardiovascular Society (angina classification); DX: Diagnosis;ICD: Implantable cardioverter-defibrillator; LVEF: Left ventricular ejection fraction; MCP: Pacemaker; NYHA: New York Heart Association (heart failure classification); PTCA: Percutaneous transluminal coronary angioplasty; Tx: Treatment; VAD: Ventricular assist device; Dr_A: Driving license type A – Personal vehicles; Dr_B-E: Driving license types B to E – Professional driving regulated by transportation medicine.

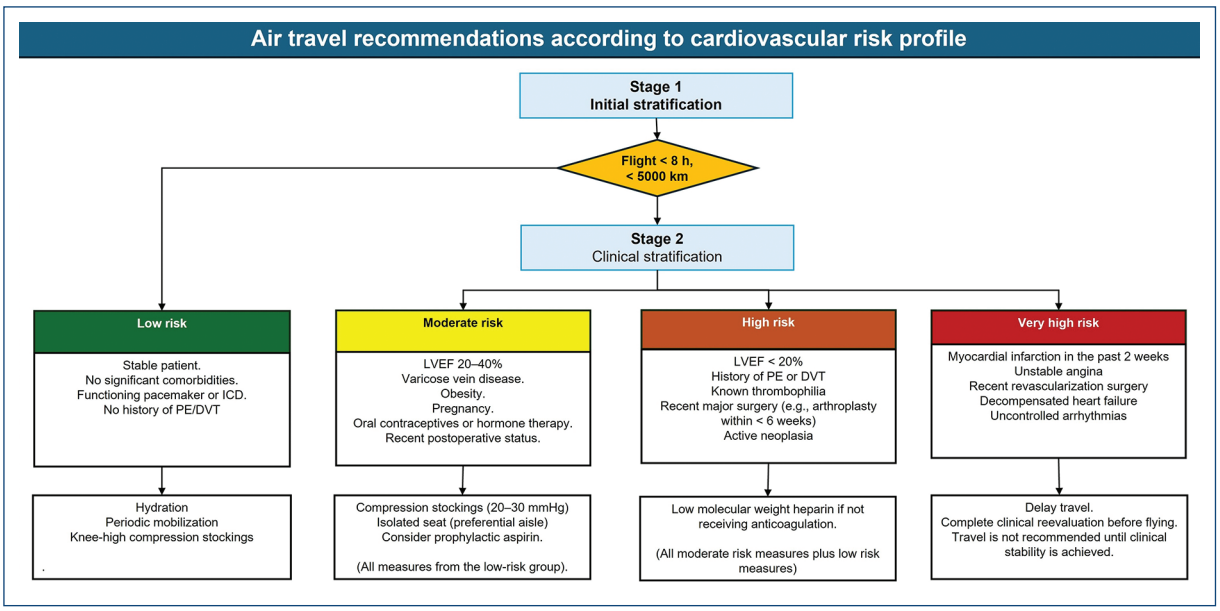


**Figure 23.** Air travel recommendations. Risk assessment and recommendations for patients with cardiovascular disease prior to air travel. Passengers are classified as low, moderate, or high risk based on the type of flight, clinical factors, and personal medical history. Specific suggestions are included for each risk level, as well as absolute contraindications to flying and additional considerations for safe travel planning.Other aspects to consider (for all risk levels): If using oxygen, contact the airline. Carry a list of allergies. Request manual screening (do not go through metal detectors). Bring a medical summary and ECG. Avoid alcohol consumption and high-sodium meals. Consider having travel health insurance. Abbreviations: LVEF: left ventricular ejection fraction; ICD: implantable cardioverter defibrillator; DVT: deep vein thrombosis; PE: pulmonary embolism.

reaching a prevalence of 49% post-training (GRADE: low $_{G11\text{-}R3_Ref_4}$).[270]

A series of 50 ICD patients found that 54% of patients who received a complete driving ban reported that it caused problems in their family and work life. Furthermore, a quarter of the patients admitted to resuming driving despite the restriction. The study reported that there were 6 cases of dizziness or palpitations, but they did not have to stop the car (GRADE: very low $_{G11\text{-}R3_Ref_5}$).[271]

Akiyama T et al. published a series of 627 cases of patients who survived life-threatening arrhythmias and were sent a questionnaire about driving. Fifty-seven percent of patients began driving within the first three months of the study, 78% at six months, and 88% at 12 months. Two patients experienced syncope while driving, 11% stopped their car due to palpitations or dizziness, and 22% had symptoms but did not stop the vehicle. Eight percent of ICD patients received a shock while driving, and fifty patients had at least one accident, for a rate of 3.4% of accidents per patient-year (GRADE: low $_{G11\text{-}R3_Ref_6}$).[272]

A cross-sectional survey of 800 male patients with cardiovascular disease showed that only 30% received advice on driving and most of these were banned from driving for between 1 week and 6 months (85%). The likelihood of having a traffic accident increased in those patients with dyspnea ≥ 2 in the NYHA (46% vs. 20%, $p < 0.0001$) and in those with a history of syncope (41% vs. 10%, $p < 0.0001$) (GRADE: low $_{G11\text{-}R3_Ref_7}$).[273]

Mexico City traffic regulations do not mention any restrictions on driving for patients with CVD. References are only made to pathologies associated with mobility impairment (GRADE: very low $_{G11\text{-}R3_Ref_10}$). Very few medical texts have addressed the recommendation for driving motor vehicles in patients with CVD in Mexico (GRADE: low $_{G11\text{-}R3_Ref_11}$).[274]

### *3.2.7.4 Traveling by plane*

Patients with cardiovascular disease frequently inquire about their ability to travel by air. Although this may seem like an unfounded concern, flight conditions

have been shown to be a physiological challenge for some patients. Even in pressurized cabins, moderate hypobaria is experienced, a condition like living at an altitude of 2,300 meters above sea level (Fig. 23).

Koh CH et al published a review article concluding that most passengers on commercial flights of less than 8 hours are exposed to moderate hypobaria, which, however, does not appear to increase the risk of cardiovascular events, probable ischemia, HF decompensation, or arrhythmias, despite the reduced oxygen content. On the other hand, patients with electrical therapy devices do not have an elevated risk of presenting dysfunction of this during the flight (GRADE: very low $_{G11\text{-}R5_Ref_1}$).[275]

Thibeault C et al. published an editorial stating that, a priori, patients with decompensated illness should not travel. Before traveling by plane, it is important to consider medical history such as CVD, chronic lung disease, history of deep vein thrombosis or pulmonary embolism, mental illness, diabetes, post-surgical status, or contagious diseases. It is always important to consider that, during the flight, passengers experience a state of moderate hypobaria and that the destination airport could be at a higher altitude, posing an added risk to the patient (GRADE: very low $_{G11\text{-}R5_Ref_3}$).[276]

Possick SE et al. proposed a risk assessment and recommendations for patients and physicians regarding air travel. Low risk (distance < 5000 km, flight time < 8 hours); recommendation: Mobilization and hydration, below-the-knee compression stockings. Moderate risk (>5000km, >8hrs), >50 years of age with risk factors (varicose vein disease, HF, LVEF 20-40%, hormone replacement therapy or birth control pills, pregnancy, or obesity); recommendation: below-knee compression stockings (20-30 mmHg), mobilization, hydration, isolated seating, and aspirin. High risk (>5000km, >8hrs), patients with a history of PE, known thrombophilia, recent major surgery, knee arthroplasty in the last 6 weeks, neoplasia, HF with LVEF less than 20%; recommendation: Compression stockings, isolated seating, mobilization, hydration, SC enoxaparin before flight in subjects not taking anticoagulants. The authors also recommend that the following checklist be reviewed before traveling: (1) Carry a sufficient supply of your current medications, labeled, with a signed prescription from the physician (2) Carry a medical summary along with a copy of the most recent electrocardiogram. (3) Carry the pacemaker information card and, if possible, a report of the last reading. (4) Keep a note of the contact numbers and websites of the representatives of the companies that manufactured the pacemaker/ICD, both local and at the destination. (5) Wear elastic compression stockings (subjects > 50 years or with risk factors) on flights over 5,000 km or 8 hrs. (6) Request an isolated seat if you are at risk of DVT. (7) Avoid alcoholic beverages and stay hydrated. (8) Notify your doctor if you experience any new symptoms before traveling. (9) Try to purchase international medical insurance (GRADE: very low $_{G11\text{-}R5_Ref_4}$).[277]

Patients who are contraindicated for flying are those who have had a myocardial infarction in the last two weeks, unstable angina, coronary artery bypass grafting in the last 2 weeks, decompensated heart failure, or the presence of uncontrolled ventricular or supraventricular arrhythmias. In relation to the general recommendations, the following are added in this document: (A) Avoid foods high in sodium, alcohol, or coffee. (B) The patient should carry an ECG with the pacemaker on and another with the device off, if feasible. (C) Carry a list of allergies. (D) If supplemental oxygen is required during the flight, the airlines should be contacted days in advance of travel. Patients who carry a cardiac electrical stimulation device: (1) Carry identification letters in different languages. (2) Do not remain near a metal detector. (3) Metal detectors should not be placed over a device and manual search should be requested. (4) Carry a note from your doctor with the specifications about the device. In relation to the Prevention of Venous Thrombosis and PE. (a) In low-risk patients: mobilization, hydration, and compression stockings. (b) Intermediate risk: Compression stockings, mobilization, hydration, isolated seating. (c) High risk: Compression stockings, mobilization, hydration, isolated seating. A dose of low-molecular-weight heparin before the flight could be considered in patients not on chronic anticoagulation (GRADE: very low $_{G11\text{-}R5_Ref_5}$).[278]

McKerrow JI et al published a systematic review in which they evaluated 18 articles on the risk of thromboembolism associated with travel by plane, train, or automobile. They concluded that the quality of the evidence is generally low to intermediate. The risk of venous thromboembolism increases with travel (RR = 2.8; 95% CI: 2.2 to 3.7). Furthermore, the absolute risk increases by 18% for every 2-hour increase in travel duration, regardless of the means of travel (p = 0.01), but is higher if the means of travel was by plane (26% increase, p = 0.005). The use of low-molecular-weight heparin prophylaxis was associated with a lower frequency of thromboembolism (OR = 0.2; 95% CI: 0.1 to 0.3) (GRADE: moderate $_{G11\text{-}R5_Ref_6}$).[279]

### *3.2.7.5 Sauna and cold-water immersion*

Sauna uses at moderate temperatures has shown positive physiological effects in patients with stable CVD, particularly those with chronic HF.

A meta-analysis of seven studies including 491 patients reported significant improvements in hemodynamic and ventricular function markers after infrared sauna protocols at 60°C for 15 minutes, followed by rest for 30 minutes. Specifically, a significant reduction in natriuretic peptide B (MD= −124.62; 95% CI: −198.09 to −51.14), cardiothoracic index (MD= −1.82; 95% CI: −2.54 to −1.09), and an improvement in left ventricular ejection fraction (MD= 1.45%; 95% CI: 0.55 to 2.35) were documented, suggesting a reduction in ventricular overload and improved myocardial function (GRADE: moderate $_{G11\text{-}R6_Ref_3}$).[280]

Similarly, a controlled clinical trial with 20 patients with NYHA class II-III HF showed a significant improvement in flow-mediated vasodilation (MD= 4.4 ± 2.5% vs.5.7 ± 2.5%, p= 0.0006) and a decrease in BNP (MD= 441±444 pg/mL to 293 ± 302 pg/mL, p= 0.005) after 14 sessions of dry sauna at 60°C (GRADE: low $_{G11\text{-}R6_Ref_4}$).[281]

These results are consistent with those of a general population study, where sauna use at 73°C for 30 minutes significantly reduced arterial stiffness, as measured by pulse wave velocity (MD= 9.8 ± 2.4 m/s to 8.6 ± 1.6 m/s, p<0.0001) and systolic and diastolic blood pressure (MD= 137 ± 16 to 130 ± 14 mmHg, DBP from 82 ± 10 to 75 ± 9 mmHg, p<0.0001) (GRADE: moderate $_{G11\text{-}R6_Ref_5}$).[282]

The vasodilatory effect of sauna bathing could be explained by the increase in body temperature, the activation of endothelial nitric oxide, and the decrease in sympathetic tone. Although no arrhythmias were documented in these studies, mild adverse events such as hypotension, hypovolemia, and polyuria have been reported, which leads to clinical monitoring, including serum creatinine, during repeated sauna bathing (GRADE: moderate $_{G11\text{-}R6_Ref_3}$).[283]

In contrast, immersion baths in cold water or at temperatures below 22°C have demonstrated unfavorable hemodynamic responses. In a cross-sectional study of 22 patients with HF and coronary artery disease, cold water immersion significantly increased the double product and the frequency of ventricular ectopic beats in patients with HF (MD= 15 ± 41 to 76 ± 163 beats in 30 minutes, p< 0.05), with no relevant changes in cardiac index or oxygen uptake rate (GRADE: low $_{G11\text{-}R6_Ref_1}$).[284]

Radtke T et al. studied the hemodynamic effects of independent and combined sauna and cold-water immersion in patients with coronary artery disease or HF. Sauna therapy increased heart rate and cardiac output in patients with HF, but not in patients with coronary artery disease. Furthermore, sauna therapy was associated with a decrease in systolic blood pressure in all patients, whereas cold water immersion increased it (GRADE: moderate $_{G11\text{-}R6_Ref_2}$).[285]

### *3.2.7.6 Intake of alcoholic beverages*

The recommendation to abstain from or reduce alcohol consumption in patients with CVD is supported by multiple sources of evidence showing a dose-dependent relationship between alcohol consumption and the risk of cardiovascular events, with no clear threshold established.

The 2021 European guidelines for cardiovascular prevention emphasize that there is no safe level of alcohol consumption in patients with CVD. They suggest limiting consumption to less than 100 g per week, equivalent to 1–2 standard drinks per day (GRADE: high $_{G11\text{-}R4_Ref_1}$).[286]

Although some studies suggest a possible protective effect of light alcoholism, at the population level the risks outweigh the potential benefits, so excessive alcohol consumption is not recommended in patients with cardiovascular risk (GRADE: very low $_{G11\text{-}R4_Ref_2}$).[287]

O'Keefe JH et al. note that light to moderate consumption (one serving daily for women and one to two servings daily for men) is associated with potential cardioprotective benefits. However, this effect does not justify promoting its consumption, particularly in non-drinkers. (GRADE: very low $_{G11\text{-}R4_Ref_3}$).[288]

Ronksley PE et al. published a meta-analysis (84 studies, 185,659 adults without CVD) showing that light to moderate alcohol consumption was associated with a significant reduction in CVD mortality (RR = 0.75; 95% CI 0.70 to 0.80), coronary heart disease incidence (RR = 0.71; 95% CI 0.66 to 0.77), and coronary heart disease mortality (RR = 0.75; 95% CI 0.68 to 0.81). However, no significant effect was found on stroke incidence (RR = 0.98; 95% CI 0.91 to 1.06) or overall CVD mortality (RR = 1.06; 95% CI 0.91 to 1.23). All-cause mortality was also lower (RR = 0.87; 95% CI 0.83 to 0.92). These results should be interpreted with caution given that participants did not have CVD at baseline (GRADE: high $_{G11\text{-}R4_Ref_4}$).[289]

A cross-sectional study of 1,773 adults without CVD found that moderate alcohol consumption was associated with a lower risk of poor cardiovascular health (OR = 0.73; 95% CI 0.54 to 0.99; p = 0.045), whereas

heavy beer consumption was associated with a higher risk (OR = 1.70; 95% CI 1.04 to 2.77; p = 0.035). No differences were observed with spirits consumption. (GRADE: very low $_{G11\text{-}R4_Ref_5}$).[210]

Regarding recommendations for the general population, the 2023 Mexican Dietary Guidelines and recent European reviews suggest completely avoiding alcohol consumption as a preventive measure for chronic diseases, including cardiovascular diseases, highlighting that there is no safe level of consumption. If the person decides to consume alcohol, it is recommended to limit intake to 20 g/day for men and 10 g/day for women, as well as avoiding heavy consumption (GRADE: moderate $_{G11\text{-}R4_Ref_6}$).[290] (GRADE: very low $_{G11\text{-}R4_Ref_7}$).[291]

Sacanella I et al, point out that moderate consumption of fermented alcohol (10–20 g/day) could reduce total mortality by 20% and the risk of ischemic heart disease by up to 40%, compared with absolute abstainers (GRADE: very low $_{G11\text{-}R4_Ref_8}$).[292]

### *3.2.7.7 Patient autonomy*

One of the goals of CVRhP-P is to induce patient autonomy, in a safe manner and with an increase in self-confidence, particularly when performing physical exercise.

In 2018, a cross-sectional study of 157 patients with coronary artery disease showed that patients had high levels of empowerment and self-efficacy, although the relationship between the two variables was weak. Empowerment was found to be significantly associated with current health perception, suggesting that patients with higher self-management may be better able to assess their own safety before engaging in physical activity (GRADE: low $_{G7\text{-}R12_Ref_1}$).[293]

Fors A et al. published a randomized clinical trial of 199 patients with acute coronary syndrome that analyzed the impact of person-centered care on self-efficacy and other clinical outcomes. In patients with secondary education or less, the intervention significantly improved self-efficacy, return to previous activities, and reduced rehospitalizations or mortality (OR = 2.8; 95% CI: 1.0 to 7.7, p = 0.041). In contrast, in patients with post-secondary education, the improvement was not significant (OR = 3.9, 95% CI: 0.8 to 19.9, p = 0.097). These results suggest that self-management strategies are effective and could influence their ability to assess risks and safety measures before exercise (GRADE: moderate $_{G7\text{-}R12_Ref_2}$).[294]

**(KM)** Patients often have questions about everyday situations, such as sexual activity, driving, air travel, using a sauna, or consuming alcohol. The healthcare

**Recommendation Table 9.** Critically ill patient

| PICO | 3.3.1 Critically ill patient | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G10-R1 | Early mobilization of patients with cardiovascular disease admitted to intensive care units is recommended, in order to reduce their length of stay and increase the likelihood of discharge from the hospital and the return to independent walking. | IIa | B-R | C+/B+ | 1,2,4,5 and 6 |
| G10-R5 | It is recommended that hospitalized patients receive pulmonary physiotherapy techniques several times a day to reduce the rate of nosocomial pneumonia, length of stay, duration of MVA, and hospital case fatality. | IIa | B-R | C+/B+ | 1,2,4,5 and 6 |
| G10-R4 | It is recommended that critically ill patients receive early mobilization therapy, particularly those on mechanical ventilation or ventricular assist device (ECMO), to facilitate discharge from the ICU and hospital, reduce length of stay, and improve exercise tolerance and HR-QoL. This therapy should be performed by highly trained personnel, with extreme safety precautions. | IIa | B-NR | C+/B+ | 1,2,4,5 and 6 |
| G10-R3 | It is recommended that patients with ventricular assist devices receive an early mobilization program to reduce critically ill patient syndrome. This therapy should be performed by highly trained personnel, with extreme safety precautions. | IIb | C-LD | C+/B+ | 1,2,4 and 6 |
| G10-R2 | Aerobic exercise is not recommended for critically ill patients in intensive care units, as the risk would outweigh the potential benefit, and the available evidence is limited. | III-NB | C-LD | C+/B- | 1,2,4 and 6 |

**Evaluation of the critically ill patient**

| | | | | | |
|---|---|---|---|---|---|
| Date of First Contact | | | Session | 1 | 2 |
| Patient identification | | | Date | | |
| | | | Stage | | |
| Diagnosis | | | Time | | |
| | | | Bed | | |
| Invasive device mapping on body scheme | | Vital Signs Pre/Post Session | HR | | |
| Date of insertion | | | BP | | |
| Date of removal | | | Temp | | |
| | | | RR | | |
| | | | $SpO_2$ | | |
| | | General Evaluation | Pain | | |
| | | | Strength | | |
| | | | Falls | | |
| | | | Nutrition | | |
| | | | Cardiovascular | | |
| | | | Ventilatory | | |
| | | | Tegumentary | | |
| | | | Neurological | | |
| | | | Renal | | |
| | | | Endocrine | | |
| | | | Infectious | | |
| | | | Gastrointestinal | | |
| | | | Hematologic | | |
| | | | Medication | | |
| | | | Fluid Balance | | |
| | | Signatures | Responsible PT | | |
| | | | Assigned CRP | | |
| | | | Attending Physician | | |

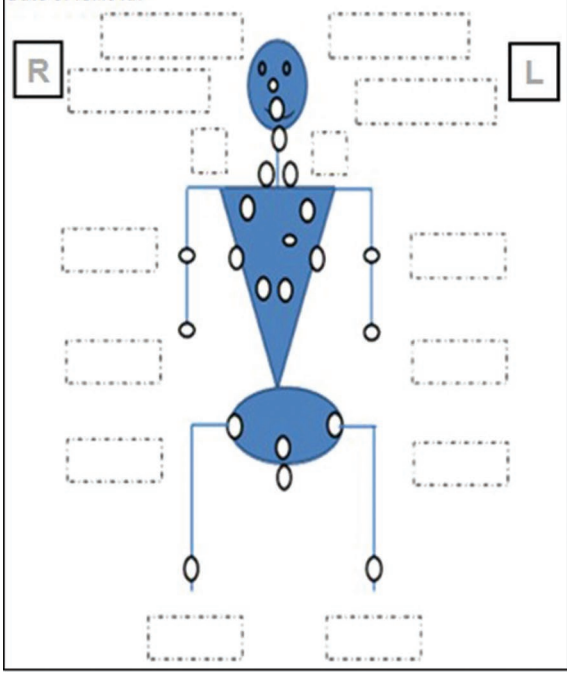


**Figure 24.** Evaluation of the critically ill patient. Evaluation of the Critically Ill Patient. Structured evaluation form for critically ill patients with cardiovascular disease. This tool enables a comprehensive daily assessment of the patient's overall condition, including identification data, vital signs, the status of invasive devices (such as cannulas, catheters, intubation, ECMO, or dialysis access), and a system-by-system functional evaluation. It is recommended that this assessment be carried out collaboratively by the physical therapist and the rehabilitation cardiologist, with the active involvement and awareness of the attending physician, to ensure continuous clinical supervision, daily therapy adjustment, and informed decision-making based on the patient's functional and hemodynamic status. Special emphasis is placed on documenting the number, type, and location of all invasive devices; thus, this format is proposed for systematic use during follow-up in critical care settings.

team should actively address each situation, providing appropriate and evidence-based advice in each case.

## 3.3 Specific Cardiovascular Rehabilitation and Prevention Programs

### 3.3.1 Critically ill patient

Patients admitted to an intensive care unit are exposed to both prolonged rest and a host of physical, chemical, and pharmacological interventions, among others. Thus, these critically ill patients or those with prolonged rest syndrome have various physical therapy and rehabilitation needs based on their condition, which must be evaluated in detail (Fig. 24).

Early mobilization can improve respiratory function, reduce pulmonary complications, accelerate recovery, and decrease the duration of mechanical ventilation, as well as ICU and hospital stays (GRADE: very low $_{\text{G10-R4_Ref_6}}$).[295]

An expert consensus published a set of recommendations on safety parameters for the mobilization of

mechanically ventilated patients in intensive care, classified into respiratory, cardiovascular, neurological, and other categories. It was emphasized that intubation is not a contraindication for mobilization. Respiratory parameters include a fraction of inspired oxygen <60%, oxygen saturation >90%, and respiratory rate <30 breaths/minute. However, no consensus was reached on the safe levels of vasoactive agents, and adverse events were not assessed (GRADE: very low $_{G10\text{-}R4_Ref_2}$).[296]

Schweickert WD et al. published a clinical trial with 104 adults receiving assisted mechanical ventilation (MVA). In the intervention group, sedation was interrupted daily, and physical and occupational therapy was added, whereas in the control group, only sedation and standardized care were interrupted. Fifty-nine percent of the intervention group recovered independent function at discharge, compared to 35% of the control group (OR = 2.7; 95% CI 1.2 to 6.1, p = 0.02). Furthermore, patients in the intervention group had a shorter duration of delirium (median 2 days vs. 4 days; p = 0.02) and more days without mechanical ventilation in 28 days (23.5 vs. 21.1 days; p = 0.05). One serious adverse event was recorded in 498 therapy sessions (desaturation <80%), and therapy discontinuation occurred in 4% of sessions, due to ventilator asynchrony (GRADE: moderate $_{G10\text{-}R4_Ref_3}$).[297]

A meta-analysis of 10 studies and 790 ICU patients evaluated physical therapy versus standard care or no therapy. Improvements were seen in HR-QoL (g=0.40; 95% CI, 0.08 to 0.71), physical function (g=0.46; 95% CI, 0.13 to 0.78), peripheral muscle strength (g=0.27; 95% CI, 0.02 to 0.52), and respiratory muscle strength (g=0.51; 95% CI, 0.12 to 0.89). Hospital-stay (g= -0.34; 95% CI -0.53 to -0.15) and ICU stay (g= -0.34; 95% CI -0.51 to -0.18) were also reduced, with more ventilator-free days (g= 0.38; 95% CI 0.16 to 0.59). No differences were found in mortality, and no adverse events were assessed (GRADE: moderate $_{G10\text{-}R4_Ref_4}$).[298]

Patients with heart disease often experience altered ventilatory mechanics, some as part of smoking-related complications and others because of CVD. The timing of presentation varies from hospitalization during the acute event to the baseline state of chronic lung disease.

A crossover clinical trial demonstrated that in patients with bronchiectasis and chronic expectoration, any of three slow airway clearance techniques (autogenic drainage (AD), slow expiration vs. lateral decubitus open glottis (LDOG), or temporary positive expiratory pressure (TPEP) resulted in improvements in indicators such as the cough questionnaire: AD (Delta = 0.5; 95% CI 0.1 to 0.5), LDOG (Delta = 0.9, 95% CI 0.5 to 2.1), and TPEP (Delta = 0.4; 95% CI 0.1 to 1.2), as well as a lower amount of sputum in 24h: AD (Delta = −10.0 g; 95% CI −15.0 to −6.8), LDOG (Delta = −9.2 g; 95% CI −14.2 to −7.9), TPEP (Delta = −6.0 g; 95% CI −12.0 to −6.1) (GRADE: low $_{G10\text{-}R5\text{-}Ref_1}$).[299]

Li Bassi G et al. conducted a randomized controlled clinical trial with 401 ICU patients with MVA greater than 48h, which showed that the lateral Trendelenburg position decreased the incidence of ventilator-associated pneumonia (RR = 0.13; 95% CI 0.02 to 1.03) with a risk difference = -3.5%; 95% CI -6.4 to -0.6; p = 0.04). However, six serious adverse events were observed in the Trendelenburg group (p = 0.019) (GRADE: moderate $_{G10\text{-}R5\text{-}Ref_2}$).[300]

A systematic review of 10 studies and 878 patients published that, in patients undergoing MVA, the semi-recumbent position (30° to 60°) reduced the risk of associated pneumonia compared to the supine position 0° to 10° (RR = 0.36; 95% CI 0.25 to 0.50). The remaining outcomes were not statistically significant (ICU mortality, in-hospital mortality, ICU stay, hospital stay, duration of ventilation, antibiotic use). Only one study reported the presence of bedsores as an adverse event (GRADE: moderate $_{G10\text{-}R5\text{-}Ref_3}$).[301]

Castro AA et al. published a cohort study with 146 ICU patients who were treated with the same physiotherapy modality (endotracheal suctioning, chest percussion, and general mobilization), but in a group with 4 visits per day (intervention) vs. one visit per day (conventional). The conventional therapy group was associated with a longer MVA (OR = 3.8; 95% CI: 1.65 to 9.12, p < 0.0001), a longer ICU stay (OR = 3.1; 95% CI: 1.45 to 6.88, p < 0.0003), and higher mortality (OR = 1.3; 95% CI: 1.08 to 2.33, p = 0.04). Adverse events were not assessed (GRADE: moderate $_{G10\text{-}R5\text{-}Ref_5}$).[302]

Elkins M et al published a systematic review and meta-analysis of 10 studies and 394 patients with MVA comparing inspiratory muscle training therapy vs no training. Inspiratory muscle training was associated with higher maximal inspiratory pressure (MD=7 $cmH_2O$; 95% CI 5 to 9), better rapid shallow breathing index (MD =15 breaths/min/l; 95% CI 8 to 23), and a higher likelihood of successful weaning (RR=1.34; 95% CI 1.02 to 1.76). A decrease in post-extubation noninvasive ventilation time associated with training was observed (MD= 16h; 95% CI: 13 to 18), ICU length of stay (MD= 4.5 d; 95% CI: 3.6 to 5.4), and hospital length of stay (MD = 4.4 d; 95% CI: 3.4 to 5.5). Adverse events were partially assessed and were

reported as not significantly increased or absent (GRADE: low $_{G10\text{-}R5\text{-}Ref_6}$).[303]

A systematic review and meta-analysis of six studies and 704 patients undergoing MVA compared chest physiotherapy (manual hyperinflation, chest vibration, or chest physiotherapy) with controls. The results showed that chest physiotherapy did not reduce the incidence of MVA-associated pneumonia (RR = 1.02; 95% CI 0.82 to 1.26, p = 0.87). However, it was associated with a lower likelihood of in-hospital mortality (RR = 0.68; 95% CI 0.48 to 0.95, p = 0.02). Adverse events were not assessed (GRADE: low $_{G10\text{-}R5\text{-}Ref_7}$).[304]

A meta-analysis of 5 studies and 603 patients undergoing MVA showed that multimodal chest physiotherapy, with two or more procedures (postural drainage, manual hyperinflation, vibration, spring ribs, or suction), was associated with a lower hospital fatality compared to the control group (RR = 0.75; 95% CI 0.58 to 0.92), but not a lower incidence of MVA-associated pneumonia. The rate and nature of adverse events were not included (GRADE: low $_{G10\text{-}R5\text{-}Ref_8}$).[305]

A literature review published by Munir H et al. showed that early post-myocardial infarction mobilization is safe and effective, especially in the pre-revascularization era. However, robust research studies are currently lacking (GRADE: very low $_{G10\text{-}R1\text{-}Ref_4}$).[306]

A meta-analysis of five studies and 562 patients admitted to the ICU after cardiac surgery showed that physical therapy reduced the length of stay in the ICU and hospital (p=ns). Adverse events were assessed and there were no significant differences (GRADE: moderate $_{G10\text{-}R1\text{-}Ref_1}$).[307]

A case series published in 2018 showed that 40.5% of elderly patients with varying degrees of frailty improved with early mobilization relative to the Level of Function (LOF) scale (GRADE: very low $_{G10\text{-}R1\text{-}Ref_2}$, $_{G10\text{-}R1\text{-}Ref_7}$).[308,309]

Hamazaki N et al. published an analysis of a cohort of patients admitted to a cardiovascular ICU, where they compared the CVRhP-P against conventional measures. The authors showed that patients who participated in the program were more likely to regain independent walking (RR = 2.04; 95% CI: 1.77 to 2.36) and return home (RR = 1.22; 95% CI: 1.05 to 1.41). In addition, a lower incidence of adverse events of any type (HR = 0.71; 95% CI: 0.56 to 0.89) as well as cardiovascular events (HR = 0.69; 95% CI: 0.50 to 0.95) was observed (GRADE: moderate $_{G10\text{-}R1\text{-}Ref_3}$).[310]

A non-randomized controlled trial of 1,489 patients admitted to the ICU with CVD compared the use of early mobilization with no mobilization. A higher rate of home discharge and improved overall function were observed, along with a very low complication rate (GRADE: very low $_{G10\text{-}R1\text{-}Ref_5}$).[311]

Wright SE et al. conducted a randomized controlled trial evaluating the effect of increasing rehabilitation therapy time from 30 to 90 minutes per day in a group of patients with CVD admitted to the ICU. Six months after the study, they found no differences in the evaluation of the physical component of the SF-36 between the experimental group (MD=37 ± 12.2) and the control group (37 ± 11.3, p=ns). It is noteworthy that the experimental group only completed 270 of the 450 minutes planned per week (GRADE: low $_{G10\text{-}R1_Ref_6}$).[312]

Although early mobilization has favorable evidence in critically ill patients, routine aerobic training is not supported by sufficient evidence of benefit. It is suggested that early mobilization be prioritized in selected patients, with a supervised intervention and a multidisciplinary approach, given the low level of evidence for the benefits of aerobic training and the risks associated with its implementation in this critical setting.

Thus, a 2018 Cochrane review evaluated early mobilization compared with delayed exercise or usual care. Early mobilization was associated with a better return to functional independence at hospital discharge (RR = 1.71; 95% CI 1.11 to 2.64), although the quality of the evidence was low due to performance bias, small sample size, and heterogeneity in the interventions. Adverse events such as desaturation <80% (2%), catheter dislodgement (2%), and hemodynamic instability (4%) were reported (GRADE: low $_{G10\text{-}R2_Ref_1}$).[313]

In a 2021 pilot feasibility study of 23 post-cardiac surgery ICU patients, the safety of using a cycle ergometer in bed for 20 minutes, 5 days a week, was evaluated. 80.5% of sessions were completed, and the incidence of adverse events was low (2.2 per 100 sessions), with mild events reported (GRADE: low $_{G10\text{-}R2_Ref_2}$).[314]

A 2020 retrospective study of 177 ICU patients on ECMO evaluated early mobilization with active physical therapy. Seventy-eight percent of patients achieved out-of-bed activities, and 61% were able to ambulate. Factors associated with increased mobilization were identified, such as indication for lung transplantation (OR = 17.2; 95% CI, 4.12 to 72.1) and the use of veno-venous ECMO (OR = 2.83, 95% CI, 1.29 to 6.22). Adverse events were reported in 2% of sessions, but the level of evidence was also low (GRADE: low $_{G10\text{-}R2_Ref_3}$).[315]

Polastri M et al. published a review of 839 patients undergoing ECMO and found that early-initiated

CVRhP-P, based on progressive exercise and out-of-bed activities, began between 48 and 96 hours post-ECMO initiation. Some studies reported mild events related to physiotherapy, although details of severity were not specified (GRADE: very low $_{G10\text{-}R2_Ref_4}$).[316]

A systematic review of early mobilization in patients on ECMO revealed benefits in reducing hospital stay, duration of mechanical ventilation, and mortality. Mild adverse events, such as tachycardia and tachypnea, were reported in less than 5% of exercise sessions (GRADE: low $_{G10\text{-}R2_Ref_5}$).[317]

Intensive care units are increasingly using various types of ventricular assist devices, such as ECMO or microaxial flow pumps, with the aim of improving the condition of hemodynamically unstable patients while awaiting improvement in their underlying pathology, the performance of a heart transplant, or, in the least severe cases, offering destination therapy for these patients.

Kourek C et al. published a systematic review of the literature on the use of physical therapy and rehabilitation in patients admitted to the ICU with ECMO implantation. They present a series of scenarios focusing on early mobilization or pre-habilitation protocols for patients undergoing heart, lung, or both transplants. Techniques vary widely, from passive mobilization or electrical stimulation to cycle ergometry and out-of-bed exercises. Most of the evidence is very superficial, and in many cases, only a few case reports are available, without statistical significance, as in the case of aerobic training. Various adverse events have been reported, ranging from ventricular tachycardia during sessions, hemodynamic instability induced by physical therapy, bleeding or hematomas at the puncture sites, or accidental displacement of orotracheal or vascular cannulas, associated with improper handling. The authors emphasize the importance of having multidisciplinary teams with extensive experience in the management of these patients and that they use assessment and stratification scales and perform close follow-up (GRADE: low $_{G10\text{-}R3_Ref_1}$).[318]

A review of the literature on ICU patients with ECMO presents the diversity of current approaches. It initially alludes to the fact that ECMO patients have a wide variety of clinical scenarios and comorbidities, making it difficult to develop a single protocol. A thorough understanding of everything related to the patient's invasiveness, particularly the cannulas, sedation protocol, ventilatory management, pacemaker use, and inotropes, is essential. Therefore, an individualized plan for early mobilization or ambulation must be developed for each patient. Potential risks are present, but no case history of adverse events has been published (GRADE very low $_{G10\text{-}R3_Ref_2}$).[319]

**(KM)** CVRhP-P has proven to be useful and safe for hospitalized and critically ill patients, provided that it is based on evidence and performed by highly qualified staff.

### 3.3.2 Ischemic Heart Disease

The inclusion of core components such as supervised ThPhT, health education, and psychosocial support in CVRhP-P has demonstrated significant clinical and psychosocial benefits in patients with ischemic heart disease.

A 2021 EAPC position paper reinforces the importance of structuring CVRhP-P with a solid clinical basis, including focused clinical assessment, pre- and

**Recommendation Table 10.** Ischemic Heart Disease

| PICO | 3.3.2 Ischemic Heart Disease | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G16-R1 | It is recommended that patients who have suffered an acute coronary syndrome be included in a CVRhP-P, in order to reduce the rate of all-cause mortality, cardiovascular mortality, recurrent ischemic events and rehospitalizations, increase exercise tolerance, improve HR-QoL and optimize care costs. | I | A | C+/B+ | 1 to 6 |
| G16-R8 | It is recommended that patients with stable angina be included in highly specialized CVRhP-P, with the aim of improving exercise tolerance and reducing the intensity, duration, and frequency of angina episodes, in conjunction with conventional treatment. | IIa | B-R | C+/B+ | 1 to 6 |
| G16-R3 | Patients who survived an acute myocardial infarction are recommended to enroll in a CVRhP-P program to increase their return to work, preferably in their previous job, and to reduce the number of days of work disability. | IIa | C-LD | C+/B+ | 1,2,4 and 6 |

post-program exercise testing, and the implementation of aerobic and resistance training. This approach is complemented by interventions focused on dyslipidemia control, where the use of PCSK9 inhibitors is recommended in patients who do not achieve LDL-C goals after 4-6 weeks of statin use with ezetimibe at maximum tolerated doses. The document highlights a reduction in mortality and rehospitalizations, as well as improved HR-QoL in patients with ischemic heart disease, although it recognizes that components such as the routine use of cardiopulmonary exercise testing (CPET) and high-intensity interval training (HIIT) still require more evidence for widespread implementation (GRADE: high $_{G16\text{-}R4_Ref_2}$).[678]

The ThPhT of the aerobic base can be planned with different modalities that integrate the type of motor activity performed (walking, cycling, running, swimming, elliptical, rowing, stair climber, etc.) and the prescribed frequency, intensity, duration, and the use of intervals or continuous workload. In addition, training in physical qualities other than the aerobic base is included, such as coordination, balance, elasticity, and, importantly, muscle strength.

Some authors emphasize that the level of caloric expenditure with exercise is more relevant than the training modality (GRADE: low $_{G16\text{-}R5_Ref_1}$).[320]

### *3.3.2.1 Effect on major outcomes*

CVRhP-P have a beneficial effect on major outcomes such as all-cause mortality, cardiovascular mortality, and myocardial reinfarction.

Maroto JM et al. published a controlled clinical trial with patients following a myocardial infarction, who were randomly assigned to either the intervention group receiving CVRhP-P or the control group. The study showed an increase in 10-year survival (91.8% vs. 83.8%, respectively, p=0.1), a lower incidence of non-fatal complications (35.2% vs. 63.2%, p=0.03), unstable angina (15.7% vs. 33.9%, p=0.02), heart failure (3.0% vs. 14.4%, p=0.02), and a lower need for coronary intervention (8.4% vs. 22.9%, p=0.02). (GRADE: moderate $_{G16\text{-}R1_Ref_5}$).[321]

Cardiovascular rehabilitation and prevention programs have been widely implemented in patients with coronary artery disease for decades, as a response to the cardiovascular pandemic caused by atherosclerosis.

Hermann M et al. published the results of a cohort of 7,883 post-AMI patients and observed a lower incidence of all-cause mortality (p < 0.001), cardiovascular mortality (p = ns), CV rehospitalizations (p < 0.001), stroke (p = ns), myocardial reinfarction (p < 0.005), and need for revascularization (p < 0.001) in the CVRP group. Multivariate analysis showed that referral to cardiovascular rehabilitation was a significant independent factor in reducing mortality (OR = 0.65; 95% CI 0.48 to 0.89, p < 0.007) (GRADE: moderate $_{G16\text{-}R1_Ref_1}$).[322]

Dibben GO et al. published the results of a meta-analysis of 85 studies and 23,430 post-ACS patients, where they observed that ThPhT was associated with a lower risk of CV mortality (RR=0.74; 95%CI 0.64 to 0.86, NNT=37), re-hospitalizations (RR=0.77; 95%CI 0.67 to 0.89, NNT=37), and myocardial infarction (RR=0.82; 95%CI 0.70 to 0.96, NNT=100), with an improvement in the mental component of HR-QoL (DM=2.14; 95%CI 1.07 to 3.22) (GRADE: moderate $_{G16\text{-}R1_Ref_4}$).[202]

Regarding the dose and frequency of the intervention, a historical cohort study published in 2021 found that attending more than 20 CVRhP sessions was associated with a significant reduction in the risk of major cardiovascular events (MACE) (HR = 0.66; 95% CI 0.55 to 0.91, p = 0.007). Furthermore, each additional session showed a beneficial cumulative effect (HR = 0.98; 95% CI 0.97 to 0.99) (GRADE: moderate $_{G16\text{-}R2_Ref_8}$).[323]

### *3.3.2.2 Effect on other outcomes*

Other outcomes associated with CVRhP-P include improved exercise tolerance, improved quality of life, and decreased health care costs.

Regarding exercise type, a 2021 meta-analysis of 2,465 patients found that combining aerobic and counter-resistance training improved exercise tolerance in peak $VO_2$ (MD= 1.36 $mlO_2$/kg/min; 95% CI 0.40 to 2.31, p = 0.005), physical HR-QoL (SMD= 0.71; 95% CI 0.33 to 1.08; p= 0.0003), and global HR-QoL (SMD= 0.78; 95% CI 0.43 to 1.14; p< 0.0001). Compared with usual care, strength training further increased exercise tolerance (MD= 3.1 $mlO_2$/kg/min; 95% CI 2.52 to 3.68) and reduced readmissions (RR = 0.33; 95% CI 0.17 to 0.62). The safety level was comparable to aerobic training (GRADE: high $_{G16\text{-}R2_Ref_9}$).[324]

Bourscheid G et al. published a meta-analysis of 6 studies and 361 patients with coronary artery disease, which showed that aerobic training was associated with an increase in oxygen uptake (MD= 6.07 $mlO_2$/kg/min; 95% CI 1.27 to 10.86, p= 0.013) compared to the control group. In contrast, combined training showed no significant differences (MD= 1.84 $mlO_2$/kg/min; 95% CI -1.73 to 5.42, p= 0.312) (GRADE: moderate $_{G16\text{-}R5_Ref_4}$).[325]

A 2021 systematic review and meta-analysis including patients with stable angina found that physical

exercise within a CVRhP-P increased exercise tolerance (SMD = 0.76 W; 95% CI 0.49 to 1.02) and reduced the frequency of anginal episodes (SMD = -0.27; 95% CI -0.43 to -0.11). However, no significant changes in HR-QoL were observed, and mortality was not adequately assessed due to lack of data (GRADE: moderate $_{G16\text{-}R8_Ref_3}$).[326]

A meta-analysis of 37 studies with 581 patients showed a moderate improvement in exercise tolerance (SMD = 0.45; 95% CI, 0.20 to 0.70), with no complications associated with the intervention. The effects on mortality (RR = 1.01; 95% CI, 0.18 to 5.67), myocardial infarction (RR = 0.33; 95% CI, 0.07 to 1.63), and hospitalization due to cardiovascular causes (RR = 0.14; 95% CI, 0.02 to 1.10) were not significant, given the low number of events (GRADE: high $_{G16\text{-}R8_Ref_1,\ G16\text{-}R8_Ref_2}$).[327,328]

Furthermore, in a 2023 non-randomized clinical trial of 38 patients with refractory angina, supervised ThPhT for 12 weeks significantly increased treadmill exercise time (337.0 ± 131.2 to 459.8 ± 176.7 seconds, p< 0.01), and time to anaerobic threshold (244.6 ± 105.2 to 304.0 ± 117.7 seconds, p= 0.01). A significant decrease in glycated hemoglobin was also observed, from 6.6 ± 1.1% to 6.5 ± 0.9% (p < 0.01), and in systolic blood pressure, from 128.7 ± 19.7 to 119.3 ± 18.6 mmHg (p < 0.01). Although 68% of patients experienced angina during at least one training session, no serious adverse events such as arrhythmias or severe ischemia were reported, reinforcing the safety of supervised exercise even in populations with more severe symptoms (GRADE: moderate $_{G16\text{-}R8_Ref_5}$).[329]

A recent systematic review and meta-analysis of 39 studies and 8,748 patients with coronary artery disease showed that educational interventions (secondary prevention, behavioral change, and risk factor modification) significantly reduced depressive symptoms in the first 6 months (SMD = -0.82; 95% CI, -1.13 to -0.50) and from 6 to 12 months (SMD = -0.38; 95% CI, -0.45 to -0.30). Anxiety levels also decreased in the first 6 months (SMD = -0.90; 95% CI -1.29 to -0.51) and from 6 to 12 months (SMD = -0.32; 95% CI -0.43 to -0.21). A decreased risk of developing clinical depression (RR = 0.40; 95% CI 0.17 to 0.97; p < 0.05) and anxiety (RR = 0.65; 95% CI 0.46 to 0.92; p < 0.05) was also observed compared to standard care (GRADE: high $_{G16\text{-}R4_Ref_1}$).[330]

Furthermore, psychosocial, and occupational aspects should be actively incorporated into the design of CVRhP-P, as described in a 2019 review focused on patients with acute coronary syndrome. This review recommends that these programs should include work reintegration algorithms that consider medical (such as ventricular function and residual ischemia), occupational, and psychosocial factors (such as depression, self-rated health, and cognitive function) to prevent socio-professional exclusion. Identifying patients at risk of poor vocational outcomes allows for timely intervention to optimize their return to the workforce, which is an essential part of comprehensive functional recovery (GRADE: very low $_{G16\text{-}R4_Ref_3}$).[331]

A 2020 systematic review with meta-analysis including 4,890 patients with ischemic heart disease reported significant improvement in short-term HR-QoL, particularly in the physical function (MD= 12.0; 95% CI 4.4 to 19.6) and physical role (MD= 16.9; 95% CI 2.4 to 31.3) domains of the SF-36 (GRADE: moderate $_{G16\text{-}R2_Ref_5}$).[332]

Evidence also supports the effectiveness of the new HR-QoL delivery program. In 2022, a meta-analysis comparing telerehabilitation versus in-person care in 750 patients found no significant differences in exercise tolerance, blood pressure, lipids, or body composition, but did find a reduction in total cholesterol levels and an improvement in the mental component of HR-QoL in the telemedicine group (GRADE: moderate $_{G16\text{-}R2_Ref_6}$).[333]

On the other hand, two cross-sectional studies from 2021 highlighted the need to address sexual health in cardiac rehabilitation. In one of them, interviews with six couples demonstrated the importance of sexual activity in recovery from acute coronary syndrome, although they identified insufficient attention in this regard. In another study with 200 post-infarction or

**Recommendation Table 11.** Post-intervention patients

| PICO | 3.3.3 Post-intervention patients | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G17-R8 | It is recommended that the CVRhP-P cardiologist, in coordination with the treating physician, ensure that patients with MitraClip comply with antiplatelet therapy or chronic oral anticoagulation as indicated, in order to reduce thromboembolic or bleeding events in these patients. | I | B-R | C-/B+ | 1,2,4 and 6 |

*(Continues)*

**Recommendation Table 11.** Post-intervention patients *(continued)*

| PICO | 3.3.3 Post-intervention patients | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G17-R7 | It is recommended that the CVRhP-P cardiologist, in coordination with the attending physician, supervise that patients after surgery or transcatheter implantation of heart valves comply with antiplatelet therapy or chronic oral anticoagulation as indicated, in order to reduce thromboembolic or bleeding events in these patients. | I | B-R | C-/B+ | 1,2,4 and 6 |
| G17-R11 | Patients scheduled for cardiac surgery are recommended to enroll in a prehabilitation program to increase exercise tolerance, reduce the rate of postoperative complications, reduce hospital stays, and improve HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |
| G17-R3 | It is recommended that hospitalized patients with a recent implantation of an electrical stimulation device (pacemaker/ICD), ventricular assist device, or transthoracic catheters be mobilized carefully and progressively, in or out of bed, by highly trained personnel, as long as their clinical condition allows, in order to improve prolonged rest syndrome in critically ill patients. | IIa | B-R | C+/B+ | 1,2,4,5 and 6 |
| G17-R2 | It is recommended that upper limb strength training be started in post-thoracotomy patients between 4 and 6 weeks according to risk factors for complications, as long as there is no evidence of sternal mobility, and that mobilization be progressed to tolerance (without pain or instability), in the search to improve strength in thoracic limbs and reduce the risk of sternal dehiscence. | IIa | B-R | C+/B+ | 1,2,4,5 and 6 |
| G23-R2 | It is recommended to avoid active mobilization of the ipsilateral arm in patients with a pacemaker implant during the first 24 hours, as well as restricting strength exercises in that arm during the first 4 to 6 weeks, in order to reduce the risk of electrode or generator displacement. | IIa | B-R | C-/B+ | 1 to 6 |
| G23-R4 | Patients with pacemakers and defibrillators are recommended to be included in in-person ThPhT programs supervised by qualified personnel to improve exercise tolerance, muscle strenght, and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |
| G17-R4 | The implementation of a CVRhP-P is recommended in children post-cardiac surgery, in order to improve their exercise tolerance and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |
| G17-R1 | Post-surgical scar care techniques such as hydration, massage, dry needling, taping, laser, extracorporeal shock wave therapy, and ultrasound are recommended for patients postoperatively after cardiovascular surgery, provided there are no contraindications, to reduce pain or itching and improve the structural characteristics of the scar such as pigmentation, elasticity, thickness, and area. | IIa | B-R | C+/B+ | 1 to 6 |

post-revascularization surgery patients, low sexual HR-QoL and limited knowledge on the subject were documented. Couple communication and sexual education were associated with better outcomes in this area (GRADE: very low $_{G16\text{-}R2_Ref_2,\ G16\text{-}R2_Ref_3}$).[334,335]

A cohort of over 670,000 older adults (≥65 years) hospitalized for ischemic heart disease showed an 8.0% absolute reduction in five-year mortality ($p < 0.001$) and a gain of 1,344 quality-adjusted life years (QALYs). Additionally, an 8.3% reduction in mortality ($p < 0.0001$) and a gain of 2,018 QALYs were observed. Both scenarios were cost-effective (ICER < $33,000/QALY) (GRADE: moderate $_{G16\text{-}R2_Ref_7}$).[336]

Adherence to an adequate number of sessions is associated with greater benefit. A cohort of 9316 post-ACS patients was recently published and showed that the group of patients who completed at least 12 weeks of a CVRhP-P had a lower mortality due to any cause (HR=0.67; 95%CI 0.54 to 0.83) or cardiovascular causes (HR=0.57, 95%CI 0.40 to 0.81), associated with an increase in maximum exercise tolerance and a reduction in LDL-C (GRADE: moderate $_{G16\text{-}R1_Ref_3}$).[337]

Several publications have shown that CVRhP-P in patients with stable angina significantly increases exercise tolerance and, consequently, their HR-QoL.

### *3.3.2.3 Return to work*

A significant percentage of patients who suffered an acute cardiovascular event do not return to work or do so in lower-level jobs. Patients who have suffered a myocardial infarction often face job loss, particularly young subjects, 15% of whom did not return to work. An important challenge of CVRhP-P is to return to work, in a comprehensive, expeditious manner, and preferably in the same previous job. (GRADE: low $_{G16\text{-}R3_Ref_4}$).[338]

In a controlled clinical trial of 151 post-AMI patients randomized to occupational therapy or standard management, work return was assessed. Patients who received the intervention had a higher return to work compared to the control group (89% vs. 74%, p = 0.0105), and in 1 year, a higher percentage continued working (92% vs. 75%, p = 0.0053). Furthermore, a high percentage retained their previous job (94% vs. 75%, p = 0.0036), and most of them worked full-time (84% vs. 71%, p = 0.039). A similar trend was observed at 2 years of follow-up (GRADE: moderate $_{G16\text{-}R3_Ref_1}$).[339]

Huichan-Muñoz V et al. published a non-randomized clinical trial with 65 Mexican patients who survived a myocardial infarction. This report showed that, although the rate of return to work was not significantly different, there was a significant reduction in the number of days of disability leave granted in the CVRhP group compared to the control group (68.09 ± 47.6 vs. 128.25 ± 91.4 days of disability, p = 0.001) (GRADE: low $_{G16\text{-}R3_Ref_2}$).[250]

**(KM)** The post-operative patient should be assessed from the intensive care unit, with early mobilization, and subsequently undergo outpatient cardiac rehabilitation (CVRhP-P), always taking care of the incision and sternotomy site. Pre-habilitation programs are increasingly used to prepare patients for surgery.

### 3.3.3 Post-intervention patients

#### *3.3.3.1 Post-surgical patients*

##### 3.3.3.1.1 Prehabilitation

In recent years, specific programs have been used to prepare patients physically, nutritionally, and psychologically before surgery, a procedure known as prehabilitation. The clinical effect of prehabilitation in patients scheduled for elective cardiac surgery has been evaluated using various methodologies, with consistent results of improved ExTol and reduced complications.

A meta-analysis of six controlled studies (n=665) demonstrated that structured preoperative exercise programs were associated with significant improvements in ExTol, as evidenced by an increase in 6MWT walking distance after prehabilitation (MD = 75.4 m; 95% CI 13.7 to 137.1, p=0.02) and after surgery (MD= 30.5 m; 95% CI 8.5 to 52.6, p=0.007). In addition, a reduction in hospital stay (MD= -1.00 days; 95% CI -1.78 to -0.23, p = 0.01) and a lower incidence of postoperative atrial fibrillation were observed in patients younger than 65 years (RR = 0.34; 95% CI 0.14 to 0.83, p = 0.02). No adverse events attributable to the intervention were reported (GRADE: moderate $_{G17\text{-}R11_Ref_1}$).[340]

A randomized clinical trial in patients with stable coronary artery disease (n=171), where a supervised two-week aerobic exercise program significantly improved preoperative exercise tolerance (MD= +50.5 m, p= 0.003), reduced Timed-Up-and-Go test time (MD= -0.8 s, p= 0.018) and increased HR-QoL (MD= +0.3 points, p< 0.001). Subsequently, a more accelerated recovery of postoperative functional capacity was observed (MD= +47.2 m; p< 0.001), with no adverse events. (GRADE: high $_{G17\text{-}R11_Ref_2}$).[341]

Nakamura K et al., in a cohort study of patients with acute coronary syndrome awaiting surgery, showed that in-hospital preoperative rehabilitation was safe, with a 96.3% completion rate and only one preoperative adverse event (left bundle branch block). Although no significant differences were observed in mortality or major cardiovascular events at 12 months (RR = 1.97; 95% CI 0.18 to 21.3; p = 1.00), or in duration of mechanical ventilation or hospital stay, these data support the feasibility and safety of this approach in complex clinical settings (GRADE: low $_{G17\text{-}R11_Ref_3}$).[342]

Yamikan H et al. in a systematic review of five randomized trials (n=616) observed that exercise prehabilitation increased ExTol, with favorable changes in 6MWT, Timed-Up-and-Go, and gait speed. A significant reduction in postoperative complications was also identified in at least one study (RR=0.11; 95% CI 0.01 to 0.89, p<0.05), as well as a decrease in hospital and intensive care stay. However, the effects on quality of life, anxiety, depression, and other psychosocial outcomes were less consistent. No adverse events were reported during the intervention (GRADE: low $_{G17\text{-}R11_Ref_4}$).[343]

##### 3.3.3.1.2 Surgical wound care

Patients undergoing cardiovascular surgery require a variety of care options, including surgical wound care, which rehabilitation teams must also monitor. El-Ansary D et al. published a narrative review of post-sternotomy patients to provide information on effective physical mobilization without compromising sternal stability. The authors recommend mobilization using the “stay-in-tube” technique, which can be reviewed in the original reference (GRADE: moderate $_{G17\text{-}R1_Ref_3}$).[266]

Lubczyńska A et al. published a case series of patients with postoperative scars treated with various techniques such as manual manipulation, massage, cupping, dry needling, and wound taping. Changes were assessed

using clinical photography, skin parameters, and high-frequency ultrasound. Improvement was observed with manual therapy, with scars appearing paler, thinner, and more even. Ultrasound showed improvement in scar architecture and collagen density (pre=3.1 ± 1.3, post=5.7 ± 1.3, p<0.005). Furthermore, improvements were observed in various skin parameters such as hydration (pre=37.8 ± 7.7, post=48.6 ± 1.2), trans epidermal water loss (pre=13 ± 4, post=9.7 ± 2.4 g/m$^2$/h), elasticity (pre=0.003 ± 0.0003 mm, post=0.05 ± 0.01mm), and erythema level (pre=352.1 ± 103.1, post=249.9 ± 89.8). No changes associated with melanin were observed (pre=104.9 ± 44, post=83.7 ± 27.7, p=ns). Patient self-assessment included components such as pain, pruritus, stiffness, vascularity, and elasticity, which was statistically significant in all groups and patients were more satisfied (GRADE: low $_{G17\text{-}R1_Ref_2}$).[344]

A meta-analysis was published in 2021, with 19 studies and 661 patients with burn, hypertrophic, post-traumatic, post-surgical, or keloid scars. Mechanotherapy (massage and extracorporeal shock wave therapy), occlusion and hydration therapy (silicone application, moisturizer, and proteolytic enzymes), and laser therapy were compared with the control group (standard treatment or no treatment). Thus, physical therapy in the scar was strongly and significantly associated with a reduction in pain (Hedge's g = -0.95; 95% CI: -1.69 to -0.20), pigmentation (g = -0.72; 95% CI: -1.27 to -0.17), pliability (g = -1.29; 95% CI: -1.88 to -0.70), pruritus (g = -0.99; 95% CI: -1.54 to -0.44), scar area (g = -1.72; 95% CI: -2.12 to -1.33) and thickness (g = -0.68; 95% CI: -1.27 to -0.09) (GRADE: moderate $_{G17\text{-}R1_Ref_4}$).[345]

A systematic review of 16 articles and 625 patients with various types of scars: burns, surgeries, acne, etc. stated that the use of physiotherapy compared to the control group, improved the condition of the scar (GRADE: low $_{G17\text{-}R1_Ref_6}$).[346]

Recently, a narrative review of 25 studies with patients with various types of scars reported that the use of physiotherapy (massage therapy, exercises, extracorporeal shock waves and ultrasound) showed positive effects on scar characteristics, improvement in symptoms such as pain and itching, and physical attributes such as elasticity and pigmentation (GRADE: low $_{G17\text{-}R1_Ref_7}$).[347]

### 3.3.3.1.3 Post-sternotomy physical training

Recent studies have shown that upper extremity strength training can be safe after median sternotomy, provided it is performed carefully, principles of controlled progression are followed, and sternal stability is adequately assessed.

The SAFE-ARMS study (2022) evaluated the safety and feasibility of resistance training, which initiated as early as 2 weeks postoperatively in 16 patients undergoing cardiac surgery via median sternotomy. Six machine exercises were performed, with a starting weight of 9 kg and gradual progression. No sternal micromotion greater than 2 mm or increased pain was observed during the exercises, suggesting that controlled upper extremity movement does not compromise sternal stability in selected patients. Inter- and intra-rater variability was moderate to good, with a lateral-posterior correlation coefficient of 0.73 (95% CI, 0.58 to 0.83) and an intraclass correlation coefficient of 0.83 (95% CI, 0.73 to 0.89). No adverse events were reported, although these were not a primary outcome of the study (GRADE: moderate $_{G17\text{-}R2_Ref_1}$).[348]

The SMART Trial randomized controlled trial compared modified sternal precautions (upper extremity use guided by pain and discomfort) versus traditional restrictive sternal precautions (limiting use for 4 to 6 weeks) in 72 postoperative patients. No significant differences were found between groups in physical function at 4 weeks (MD= 1.0; 95% CI -0.2 to 2.3) or 12 weeks (MD= 0.4; 95% CI -0.9 to 1.6), nor in secondary outcomes such as pain, kinesiophobia, or HR-QoL. Importantly, no adverse events occurred, reinforcing the safety of progressive upper extremity use under conditions of adequate clinical monitoring (GRADE: high $_{G17\text{-}R2_Ref_2}$).[349]

Additionally, a published meta-analysis included 3462 patients and evaluated the effectiveness of strength training versus aerobic training alone after cardiac surgery involving median sternotomy. It was observed that counter-resistance programs, with low to moderate intensity and gradual progression, were safe and feasible. Furthermore, they offered similar benefits in exercise tolerance and body composition compared to aerobic training. It is concluded that, although the intensities employed are lower than those suggested by the American College of Sports Medicine, training should focus on specific functional tasks to promote efficient recovery. No adverse events were reported (GRADE: high $_{G17\text{-}R2_Ref_3}$).[265]

Despite growing evidence supporting early and safe mobilization of the thoracic limbs, considerable variability in clinical practice persists. A cross-sectional study surveyed 87 physical therapists regarding the prescription of upper limb exercises in post-sternotomy patients. Although 96% prescribed these exercises, 95% applied

restrictions, and at least 55–74% continued to restrict unilateral or bilateral lifts, with or without weight-bearing, even at 6 weeks. Only 43% performed formal assessments of sternal stability. This lack of consensus highlights the need for standardized, evidence-based guidelines (GRADE: low $_{G17\text{-}R2_Ref_4}$).[350]

El-Ansary D et al. propose abandoning the paradigm of rigid sternal restraints for 6 to 8 weeks in favor of a model tailored to each patient, with controlled exercises and symptom monitoring. This approach could avoid negative effects such as loss of functional independence, delayed recovery, and decreased HR-QoL. Early implementation of upper limb exercises has not been shown to increase the risk of sternal complications, provided that the principles of individualization and progression are respected (GRADE: very low $_{G17\text{-}R2_Ref_5}$).[266]

In the safe implementation of strength training in post-sternotomy patients, it is essential to consider risk factors associated with sternal complications. A meta-analysis that included 25,668 patients identified that the risk of complications significantly increases if the patient is female (OR=1.98; 95% CI: 1.39 to 2.84), has diabetes mellitus (OR=3.31, 95% CI: 1.71 to 6.41), is obese (OR=2.59, 95% CI: 1.22 to 5.51), receives bilateral breast grafts (OR=3.11, 95% CI: 2.15 to 4.51), undergoes reoperation (OR=8.92; 95% CI: 2.53 to 31.44), and requires blood products (OR=2.84; 95% CI: 1.35 to 5.97). This information allows for adequate risk stratification and personalized interventions (GRADE: high $_{G17\text{-}R2_Ref_6}$).[351]

### 3.3.3.1.4 Heart valve surgery

One of the indications for admission to a CVRhP-P is heart valve disease. Patients with valvular disease or those with prosthetic heart valves require specific care, both in the short, medium, and long term. These programs should implement specific protocols for the prevention of valve thrombosis, where staff will address the potential complications of anticoagulant therapy. Furthermore, the prevention of endocarditis also plays a prominent role.

A randomized controlled clinical trial with 116 patients postoperative after valve surgery or intervention showed differences between the group that performed strength and balance training (ExG) and the control group (CG), both in the meters walked in 6 minutes (ExG from 247m ± 94.1 to 348m ± 100.1 vs CG from 232m ± 102.8 to 333m ± 120.7), in the physical performance score (ExG from 8.31 ± 2.21 to 9.51 ± 2.24 vs CG from 7.95 ± 2.01 to 9.08 ± 2.35), in the speed reached in the 5-minute walk (ExG from 0.847m/s ± 0.31 to 0.965m/s ± 0.3 vs GC from 0.765m/s ± 0.24 to 0.879m/s ± 0.29). In addition, a significant improvement was observed in other frailty variables (GRADE: moderate $_{G12\text{-}R5_Ref_8}$).[352]

In 2023, a narrative review of postoperative heart valve surgery patients mentioned that the likelihood of thrombosis associated with this type of device varies widely. The highest-risk cases are patients with mechanical valves, for whom anticoagulation with vitamin K antagonists (warfarin or acenocoumarin) is recommended. In these patients, the anticoagulation levels adjusted via INR depend on the valve type, its position (mitral, aortic, tricuspid, or pulmonary), the number of prostheses placed, and whether the patient is in atrial fibrillation or flutter. Although some patients with bio prostheses may be exempt from long-term anticoagulation, it should always be used in the immediate postoperative period. In patients with biological valve implantation or valve repair, the benefit of anticoagulation versus antiplatelet therapy is uncertain. In patients who underwent TAVI and who have no other indication for anticoagulation or antiplatelet therapy, long-term aspirin monotherapy may be considered. Patients who received a transcatheter mitral valve device should be anticoagulated. Prosthetic valve thrombosis is a serious complication that, in virtually all cases, requires emergency surgical treatment. Patients with any pathology that requires anticoagulation should continue with their regimens unless the new prosthesis requires higher INR values (GRADE: low $_{G17\text{-}R7_Ref_1}$).[353]

Verstraete A et al. published a review of studies with patients undergoing cardiac valve repair or replacement and compared the ACC/AHA-2020 guidelines with those of the ESC-2017 to establish a consensus on the management of antithrombotic therapy. Antithrombotic or anticoagulant treatment in patients who received surgical treatment for valvular disease is very complex and many of the decisions are made by consensus (GRADE: low $_{G17\text{-}R7_Ref_2}$).[354]

It is common for pre-rehabilitation programs to treat patients with valvular heart disease awaiting surgical treatment. The European Society of Cardiology issued a CPG on the management of patients with valvular heart disease and recommended that, before surgery, patients with valvular heart disease who are receiving anticoagulation should discontinue this medication and maintain an INR < 1.5. Unfractionated or low-molecular-weight heparin should be administered as a bridge during the perioperative period. Anticoagulation after surgery should begin with heparin and subsequently

with vitamin K-antagonist oral anticoagulation (VKA-OAC). Furthermore, antiplatelet therapy secondary to recent coronary intervention (< 1 month) should be restarted as soon as the surgical risk of bleeding decreases. The combination of a dual antiplatelet regimen and OAC after valvular heart surgery should be weighed against the risk of stent thrombosis, valve thrombosis, and bleeding. VKA-OAC are recommended for patients with mechanical or biological heart prosthesis and another indication for OAC. It is recommended that patients be specifically trained to self-monitor their INR by adjusting their VKA-OAC dose. Patients who will not require long-term OAC should use aspirin or an OAC for the first 3 months after implantation of a biological prosthetic valve in the aortic position and VKA-OAC in the mitral or tricuspid positions. Direct oral anticoagulants are not indicated for mechanical prostheses. Patients undergoing mitral or tricuspid valve repair should receive VKA-OAC for the first 3 months and discontinue them if there is no indication to continue. Post-TAVI patients should receive single antiplatelet therapy for life or VKA-OAC if they have any other indication for it (GRADE: high $_{\text{G17-R7_Ref_3}}$).[355]

Coordination between the treating cardiologist and the CVRhP-P team is crucial to adjust anticoagulant treatment and thus reduce complications attributable to this therapy or to the underlying pathology.

#### 3.3.3.1.5 Pediatric population after cardiac surgery

The implementation of CVRhP-P programs in the postoperative pediatric setting has demonstrated significant benefits in the recovery of children with congenital heart disease who have undergone surgery.

In a recent clinical trial conducted in children at high altitude, the initiation of exercise within the first 24 hours postoperatively was associated with a significant improvement in ExTol as measured by the 6MWT. The intervention group showed an increase in the distance covered (6MWT pre: 385.24 ± 55.46 m, post: 426.16 ± 59.75 m, t= 6.363, p< 0.0001), while the control group showed a decrease (6MWT pre: 376.56 ± 54.78 m, post: 347.12 ± 54.36 m, t = 4.248, p= 0.0003), with no adverse events recorded (GRADE: high $_{\text{G17-R4_Ref_1}}$).[356]

On the other hand, a cohort study (n= 1,415) documented that 41% of patients under 18 years of age undergoing surgery for congenital heart disease received some type of rehabilitation therapy in the postoperative period. Patients with greater clinical complexity, including neonates, premature infants, cases with palliative repairs, genetic syndromes, prolonged bypass times, or preoperative stays longer than one day, were more likely to require rehabilitation (GRADE: moderate $_{\text{G17-R4_Ref_2}}$).[357]

A series of 1,358 pediatric patients with transthoracic catheters seeking out-of-bed mobilization. Special catheter preparation was performed before mobilization. There was no control group. At the endline, it was observed that the guidelines were implemented, resulting in mobilization without associated complications. Adverse events were sought, but none were recorded (GRADE: low $_{\text{G17-R3_Ref_4}}$).[358]

Likewise, in children with ventricular assist devices, the implementation of CVRhP-P has been shown to be safe and feasible. In a cohort of 17 patients, the majority successfully completed the functional objectives established within the standardized program without associated complications. Eleven children achieved all protocol milestones, which allowed them to maintain or restore their functionality in the context of transplant waiting (GRADE: moderate $_{\text{G17-R4_Ref_3}}$).[359]

A meta-analysis of 9 randomized clinical trials including 167 children postoperatively for congenital heart disease found that ThPhT programs were associated with a significant improvement in HR-QoL (MD= 3.19; 95% CI 0.23 to 6.16; p = 0.03), although without relevant changes in biomarkers, ExTol or NT-proBNP levels (GRADE: moderate $_{\text{G17-R4_Ref_4}}$).[360]

### *3.3.3.2 Percutaneous cardiovascular intervention*

#### 3.3.3.2.1 Pacemaker and ICD

Any type of mobilization in a critically ill patient may be associated with the inadvertent displacement of an invasive device, such as a pacemaker lead, which can cause an adverse event or endanger the patient's life. Therefore, it is essential that rehabilitation teams recognize this situation and receive appropriate training.

In 2019, a controlled clinical trial was published with 200 patients undergoing cardiac stimulation device (pacemaker, ICD) placement. A protocol for early mobilization with a sling (3 hours post-placement) was used compared to immobilization. Initially, no differences were observed in the percentage of electrodes displaced during early ambulation (3%) vs. immobilization (4%), p = 0.99. No differences were observed between the two groups in relation to other outcomes such as cardiac perforation, tamponade, valvular damage, hemothorax, pneumothorax, myocardial infarction, peripheral embolism, stroke, death (GRADE: high $_{\text{G17-R3_Ref_2}}$).[201]

Ahn, J et al. published a controlled clinical trial with 27 post-pacemaker placement patients, who in addition to having a low ExTol, entered a CVRhP-P and were compared with a control group. A statistically significant improvement in HR-QoL was observed in the intervention group, particularly in the vitality (baseline 42.1 ± 15.9; 4 weeks 57.2 ± 15.4, p = 0.042) and mental (baseline 50.3 ± 18.3; 4 weeks 68.2 ± 22.4, p = 0.046) items. No adverse events occurred (GRADE: low $_{G17\text{-}R3_Ref_3}$).[361]

After implantation of cardiac electronic devices (pacemaker, ICD, or resynchronization therapy), the main risk during the first few days is a lead displacement, before the fibrosis process that secures them in place is complete. Therefore, most clinical protocols recommend avoiding active mobilization of the arm on the generator side for the first 24 hours. Subsequently, progressive mobilization without weight-bearing can be initiated, monitoring technique and joint range of motion, if device fixation is not compromised. Additionally, it is recommended to specifically avoid strength exercises in the upper limbs for the first 4 to 6 weeks to avoid the risk of lead displacement and without interfering with the benefits of supervised exercise in cardiovascular rehabilitation, which has been shown to improve exercise tolerance without increasing complications (GRADE: moderate $_{G23\text{-}R2_Ref_4}$).[362]

On the other hand, a systematic review evaluated the early initiation of active arm exercises, such as pendulum movements and range-of-joint exercises, from days 1 to 14 after implantation. These exercises were associated with improvements in shoulder mobility, pain, and function, with no increase in complication rates. However, strength movements and increased range of motion were not assessed, so their extrapolation should be cautious (GRADE: moderate $_{G23\text{-}R2_Ref_5}$).[363]

Furthermore, a randomized clinical trial evaluated an individualized CVRhP-P from the second day post-implant, excluding arm strength exercises. Significant improvements were observed in HR-QoL: vitality (p=0.042) and mental health (p=0.046) with no device-related adverse events, supporting the safety of progressive programs under supervision (GRADE: moderate $_{G23\text{-}R2_Ref_6}$).[361]

There is information in the literature supporting the safety and effectiveness of incorporating aerobic and resistance training programs in patients with pacemakers and implanted defibrillators. A 2021 cohort study, which included 41,731 patients, demonstrated that participation in early CVRhP-P is associated with a significant reduction in 1- and 3-year mortality, with a 24% relative risk reduction (HR = 0.76; 95% CI 0.69 to 0.85, p = 0.03). After adjusting for changes in physical activity, this difference disappeared, suggesting that increased physical activity is the main mediator of the benefit, with no related serious adverse events reported (GRADE: moderate $_{G23\text{-}R4_Ref_1}$).[364]

Likewise, a 2022 retrospective cohort study with over 12,000 patients showed that exercise-based rehabilitation initiated within six months of implantation is associated with a reduction in mortality (HR=0.63; 95% CI 0.56 to 0.71, p<0.001) and hospitalizations (HR=0.83; 95% CI 0.78 to 0.87, p<0.001). Although an increased prevalence of AF and serious ventricular arrhythmias was observed in the rehabilitation group, no differences were reported in the incidence of adverse events related to physical activity, confirming the safety of the intervention (GRADE: low $_{G23\text{-}R4_Ref_2}$).[365]

A 2021 randomized clinical trial evaluated the implementation of an early four-week CVRhP-P in patients with pacemakers, reporting significant improvements in HR-QoL, specifically in the vitality and mental health domains of the SF-36 questionnaire, without presenting complications or adverse events related to the device, in this way early rehabilitation, including aerobic and strength training, is safe and beneficial in terms of subjective well-being, without increasing the risk of complications (GRADE: moderate $_{G23\text{-}R4_Ref_3}$).[361]

Additionally, a systematic review published in 2025, which included six studies with different methodological designs, concluded that early upper extremity mobilization, using pendulum exercises, range of motion, stretching and strengthening, initiated from less than 24 hours to two weeks post-implant, is safe and is associated with significant improvements in shoulder function, decreased disability and increased HR-QoL, with no relevant adverse events reported (GRADE: low $_{G23\text{-}R4_Ref_4}$).[366]

A 2025 randomized controlled trial involving 24 patients with implanted pacemakers and defibrillators demonstrated that a combined six-week aerobic and strength training program increased peak $VO_2$ by approximately 0.3 liters and percentage of maximum $VO_2$ by 3.5%, as well as improved muscular endurance and HR-QoL, with no serious adverse events (GRADE: high $_{G23\text{-}R4_Ref_5}$).[367]

Thus, it can be concluded that under medical supervision and controlled conditions, early initiation of aerobic and strength training programs in patients with implantable cardiac devices, preferably in the first two weeks post-implantation, can improve exercise tolerance, muscular endurance, and HR-QoL, without increasing the risk of serious adverse events.

### 3.3.3.2.2 Transcatheter heart valve intervention

Percutaneous implantation of intracardiac devices, such as TAVI or mitral clipping, are increasingly common procedures that require specialized medium- and long-term management, particularly due to their underlying pathology.

In the context of antithrombotic treatment following transcatheter aortic valve implantation (TAVI), aspirin monotherapy has been documented to offer a favorable safety profile in patients without additional indications for anticoagulation.

A recent review supports this strategy as an effective measure to reduce clinically relevant thrombotic events without increasing bleeding risk. In the absence of conditions such as atrial fibrillation or coronary artery disease with recent stenting, the residual embolic risk is low, and the benefit of minimizing bleeding complications with aspirin outweighs the potential thrombotic risks (GRADE: low $_{G17\text{-}R6_Ref_1}$).[353]

In post-TAVI patients, a systematic review and meta-analysis demonstrated that post-TAVI CVRhP-P significantly increased both the distance walked in the 6MWT (from 235.88 ± 69.36 m to 292.12 ± 54.92 m; $p < 0.05$) and functional independence (Barthel index from 76.6 ± 11.5 to 89.8 ± 5.5; $p < 0.05$) (GRADE: moderate $_{G21\text{-}R2_Ref_7}$).[368]

Regarding TAVI, comparative data between different antithrombotic regimens have shown that aspirin monotherapy is associated with a lower incidence of major bleeding (RR = 0.43; 95% CI 0.23 to 0.80, p = 0.008), without a significant increase in embolic events, compared with dual therapies or oral anticoagulation. In the presence of atrial fibrillation or venous thromboembolism, complete anticoagulation remains the strategy of choice, preferably with direct oral anticoagulants (DOACs) since the combination with antiplatelet agents increases the bleeding risk without a proportional benefit in the prevention of ischemic events (GRADE: very low $_{G17\text{-}R6_Ref_2}$).[354]

Likewise, the ESC-CPGs for the management of valvular heart disease recommend aspirin as the sole treatment in the post-TAVI period when there is no clear indication for anticoagulation. Although the use of anticoagulants may reduce the risk of subclinical thrombosis, it has not demonstrated significant clinical superiority and has been associated with an increased risk of major bleeding (HR = 1.91; 95% CI 1.10 to 3.31; p = 0.021). Furthermore, these guidelines point out the need for additional studies evaluating the safety and efficacy of early initiation of non-vitamin K antagonist oral anticoagulant in this setting (GRADE: moderate $_{G17\text{-}R6_Ref_3}$).[369]

Based on the available literature, antithrombotic therapy in patients undergoing MitraClip surgery without indication for chronic oral anticoagulation should consider a balance between thrombotic risk and bleeding risk. A systematic review published in 2021 compared contemporary clinical guidelines and practices and concluded that the use of aspirin (81 to 325 mg/day) plus clopidogrel (75 mg/day) for six months represents the preferred regimen in patients without indication for chronic oral anticoagulation, based on pathophysiological reasoning and observational data. In contrast, in patients with indication for anticoagulation, it is recommended to maintain anticoagulation alone, without adding antiplatelet agents, to avoid unnecessary bleeding risk (GRADE: very low $_{G17\text{-}R8_Ref_2}$).[354]

**Recommendation Table 12.** Heart Failure

| PICO | 3.3.4 Heart Failure | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G18-R10 | It is recommended that patients with heart failure be included in a CVRhP-P with in-person therapeutic physical training, in order to increase their exercise tolerance, HR-QoL, and reduce the rate of re-hospitalizations. | I | A | C+/B+ | 1 to 6 |
| G18-R9 | It is recommended that heart transplant patients undergo CVRhP therapy before and after surgery to increase muscle strength, exercise tolerance, and HRQoL, as well as reduce postoperative complication rates and hospital stays. | I | A | C+/B+ | 1 to 6 |
| G18-R11 | Patients with heart failure are recommended to perform resistance training to increase muscle strength and exercise tolerance. | I | B-R | C+/B+ | 1 to 6 |

*(Continues)*

**Recommendation Table 12.** Heart Failure *(continued)*

| PICO | 3.3.4 Heart Failure | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G20-R1 | It is recommended that patients be included in a CVRhP-P during the peri-heart transplant period, in order to increase their exercise tolerance and muscle strength. | I | B-R | C+/B+ | 1 to 6 |
| G20-R3 | It is recommended to measure and monitor the intensity of physical training in post-heart transplant patients using scales of perceived exertion or a percentage of VO2peak (CPET), in order to generate a sufficient and safe stimulus to induce physiological adaptation to physical exercise. | I | B-R | C-/B+ | 1 to 6 |
| G20-R2 | Supervised ThPhT is recommended for post-heart transplant patients, using various modalities such as continuous moderate aerobic exercise, interval, strength, or combined training, with the aim of increasing exercise tolerance and muscle strength. | I | B-R | C+/B+ | 1 to 6 |
| G19-R5 | It is recommended that highly trained personnel carefully assess blood volume parameters, mean arterial pressure, the presence of atrial or ventricular arrhythmias, the status of invasive lines and electrodes, as well as wound care in patients with ventricular assist devices in CVRhP-P, in an effort to reduce the incidence of complications associated with the mobilization of these patients. | IIa | B-R | C+/B+ | 1 to 6 |
| G18-R1 | It is generally recommended that patients with heart failure consume a moderate amount of sodium (2 to 3 g/day) and have mild to moderate fluid restriction (1.5 to 2 L/day) to ensure that these changes are sustainable and associated with a decrease in symptoms and hospital readmissions. | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G19-R1 | It is recommended to include patients with heart failure and ventricular assist devices such as ECMO in CVRhP-P, to perform early mobilization and ThPhT by highly trained personnel, in order to improve myopathy in critically ill patients, increase muscle strength, lung function, reduce MVA time, ICU stay, and improve HR-QoL. | IIa | C-LD | C+/B+ | 1 to 6 |
| G18-R4 | A comprehensive nutritional intervention is recommended for patients with heart failure in CVRhP-P, with an adjusted caloric intake between 22 and 35 kcal/kg/day and a protein intake of 1 to 1.2 g/kg/day, in order to preserve muscle mass, improve HR-QoL, and reduce complications associated with malnutrition and cachexia. | IIa | C-LD | C-/B+ | 1,2,4 and 6 |
| G18-R12 | It is recommended that patients with stable, low-risk CVD who can receive minimal supervision and who have attended an initial in-person phase (Phase II) be integrated into a home-based CVRhP-P, including telemedicine, in order to overcome barriers that impede medium- and long-term compliance, increase adherence, and reduce healthcare costs. | IIb | C-LD | C-/B+ | 1,2,4,5,6 |
| G18-R3 | It is recommended that patients with heart failure taking digoxin or lisinopril not drink green tea, in order to avoid interfering with the pharmacodynamics of these medications. | IIb | C-LD | C-/B+ | 1,2,4 and 6 |

Additionally, observational evidence from a German cohort of 470 patients undergoing percutaneous mitral repair showed that the alternative strategy of administering temporary oral anticoagulation (warfarin with an INR of 2.0 to 3.0) for at least 30 days after the procedure, instead of standard dual antiplatelet therapy, was associated with a significant reduction in the 30-day incidence of stroke (0.2% vs. 1.3% in historical registries, $p < 0.05$). Furthermore, this strategy was not accompanied by a statistically significant increase in major bleeding (4.6% vs. 7.4%; p = ns), suggesting that temporary oral anticoagulation could be a reasonable alternative for the prevention of early embolic events, especially in high embolic risk settings (GRADE: low G17-R8_Ref_4).[370]

On the other hand, data from the TVT-STS registry linked to Medicare claims, analyzed in a retrospective observational study that included 3,261 patients, showed that the presence of atrial fibrillation (AF) is associated with worse clinical outcomes at 1 year after

MitraClip placement. The presence of AF significantly increased the risk of mortality (HR = 1.44; 95% CI: 1.22 to 1.70, p < 0.001), cerebrovascular event (HR = 1.63; 95% CI: 1.01 to 2.64, p = 0.047), and bleeding (HR = 1.34; 95% CI: 1.10 to 1.64, p = 0.004). However, in the AF subgroup, the use of oral anticoagulation was associated with a significant reduction in the risk of cerebrovascular disease (HR = 0.55; 95% CI 0.32 to 0.93, p = 0.026) (GRADE: moderate $_{G17\text{-}R8_Ref_5}$).[371]

### 3.3.4 Heart Failure

#### 3.3.4.1 Therapeutic physical training in HF

ThPhT in patients with heart failure (HF) was initially contraindicated due to fear of serious complications during therapy. However, in recent decades, these patients have increasingly been included in CVRhP-P.

CVRhP-P has been associated with a reduction in all-cause mortality, cardiovascular mortality, and the number of re-hospitalizations in patients with heart failure (Fig. 2).

Patients with heart failure can be classified according to left ventricular systolic function and divided into heart failure with preserved ejection fraction (HFpEF), with reduced ejection fraction (HFrEF) or an intermediate state (HFmEF).

Taylor RS et al. published a meta-analysis of 19 studies and 3,989 patients with HF in which they observed that patients included in a CVRhP-P showed an increase in 6-minute walk meters compared to the control group (MD= 21.0 m; 95% CI, 1.57 to 40.4 m, p = 0.03) and in the Minnesota HR-QoL questionnaire (MD= –5.94; 95% CI, –1.09 to –10.9) (GRADE: moderate $_{G18\text{-}R13_Ref_1}$).[372]

A controlled clinical trial with 2,331 patients with HF (HF-ACTION) showed that, in none of the studied outcomes there were significant differences between patients with ThPhT and the control group: mortality from any cause (HR = 0.96; 95% CI of 0.79 to 1.17, p = 0.7), cardiovascular mortality (HR = 0.92, 95% CI of 0.83 to 1.03, p = 0.14) and re-hospitalizations (HR = 0.87, 95% CI of 0.75 to 1.00, p = 0.06). The incidence of adverse events was similar in both groups (GRADE: high $_{G18\text{-}R13_Ref_3}$).[373]

In a controlled clinical trial with 247 patients with decompensated HF, it was shown that ThPhT improved the level of quadriceps isokinetic strength (QIS) after an in-hospital training program, in a stochastically significant manner in younger patients (QIS= 30.0 kgf ± 11.1 vs. 31.6 kgf ± 10.9, p< 0.001), and a marginal non-significant improvement in the older group (QIS 19.1 kgf ± 6.3 vs. 19.5 kgf ± 6.1, p= 0.275) (GRADE: low $_{G12\text{-}R5_Ref_2}$).[374]

Poco LC et al. published the results of a cohort of 251 patients with decompensated HF, where they studied the association between handgrip strength and the rate of adverse events, hospital stay, and healthcare costs. They showed that weak patients were associated with a higher rate of adverse events (incidence = 0.08; 95% CI 0.01 to 0.14, p = 0.026), longer hospital stay (HIS = 4d; 95% CI 1.97 to 6.79, p = 0.003), and increased healthcare costs (overrun = $3,594 USD; 95% CI 1,478 to 5,728, p = 0.014) (GRADE: moderate $_{G12\text{-}R5_Ref_3}$).[375]

A randomized controlled clinical trial with 508 patients with HF in a lower limb muscle strength training program showed significant differences before and after the program in various indicators such as: LVEF (40% ± 3.5 vs 48% ± 1.3), maximum heart rate (MHR = 148 bpm ± 12 vs 161 bpm ± 8), body fat percentage (BF = 29% ± 4.3 vs 23% ± 4.9), muscle percentage (30% ± 12.9 vs 38% ± 6.3), waist circumference (93 cm ± 9.7 vs 84 cm ± 5.4), blood glucose (134 mg/dl ± 9.5 vs 115 mg/dl ± 4.8), BMI (31 ± 4.6 vs 25 ± 3.5), total cholesterol (208 mg/dl ± 29 6 vs 173 mg/dl ± 16.5), triglyceridemia (160 mg/dl ± 18.2 vs 138 mg/dl ± 7.7), HDL-C (45 mg/dl ± 9.3 vs 51 mg/dl ± 2.3), LDL-C (112 mg/dl ± 12.7 vs 109 mg/dl ± 11.6), all these values with p ≤ 0.05 (GRADE: moderate $_{G12\text{-}R5_Ref_7}$).[376]

##### 3.3.4.1.1 Strength training

The role of ThPhT within a CVRhP-P in patients with HF has changed over the years, with strength training frequently being included in these programs.

Fisher S et al. published a meta-analysis of 17 studies and 93 patients with HF and observed that strength training was associated with an increase in peak VO2 compared to the control group (MD= 2.64; 95% CI 1.67 to 3.6, p < 0.001) and with an increase in muscle strength (quadriceps) (MD= 0.76; 95% CI 0.26 to 1.25, p < 0.01). No adverse events occurred during therapy (GRADE: high $_{G18\text{-}R11_Ref_2}$).[377]

A published meta-analysis of 11 studies and 370,256 patients with various pathologies such as diabetes, breast cancer, cardiovascular disease, among others, showed that strength training was associated with a reduction in all-cause mortality (HR = 0.79; 95% CI: 0.69 to 0.91), which decreased further when associated with aerobic training (HR = 0.60; 95% CI: 0.49 to 0.72). (GRADE: moderate $_{G18\text{-}R11_Ref_4}$).[378]

### 3.3.4.1.2 High-intensity interval training

In patients with HF, high-intensity interval training (HIIT) has shown a tendency to be associated with greater benefits compared with continuous moderate intensity training (CMIT), although without statistically significant differences in the main outcomes.

A meta-analysis of 16 studies with 1,094 patients reported a greater increase in peak $VO_2$ with HIIT (MD= 3.96 $mlO_2$/kg/min; 95% CI, 2.12 to 5.92) compared with CMAT (MD= 1.58 $mlO_2$/kg/min; 95% CI, 0.37 to 2.72). HIIT training was associated with an increase in LVEF (MD= 3.77%; 95% CI from -3.2 to 9.85) and for the CMAT (MD= 3.05%; 95% CI from 0.35 to 5.99) and in HR-QoL measured with the MLHFQ for HIIT (MD= -13.03; 95% CI from -15.97 to -10) and for CMAT (MD= -2.56; 95% CI from -5.37 to 1.09) (GRADE: high $_{G18\text{-}R8_Ref_1}$).[379]

A systematic review of 22 studies and 658 patients found an increase in ExTol with HIIT (5.7% to 46.2%) and LVEF (2.6% to 35.7%), although not in all studies with statistical significance. A reduction in ventricular dimensions was observed (LVEDD 7.4%–11.5%, LVESD 14.5%), but the results were considered inconclusive. Only one study reported adverse events, which limits the safety information (GRADE: low $_{G18\text{-}R8_Ref_2}$).[380]

In patients with preserved LVEF, HIIT showed an increase in peak $VO_2$ (MD= 2.25 $mlO_2$/kg/min; 95% CI 1.81 to 2.70; p< 0.001). No differences were found in HR-QoL (MD= -3.36; 95% CI -9.42 to 2.70; p= 0.33). Adverse events were not assessed (GRADE: moderate $_{G18\text{-}R8_Ref_3}$).[381]

### 3.3.4.1.3 Home-based and hybrid modalities

Current evidence supports that ThPhT programs for patients with HF should begin with a highly supervised phase in controlled settings, as this allows for timely detection of minor adverse events, improves adherence, and ensures patient safety.

A joint ACC/AHA position paper on HF with preserved ejection fraction (HFpEF) highlights that this initial approach in specialized centers, followed by a planned transition to home-based or hybrid models, is effective and safe. In a review of six randomized clinical trials (n=276), no major exercise-related adverse events were reported, and the few adverse events described were minor and expected, such as palpitations or musculoskeletal discomfort. This safety was attributed to careful selection of clinically stable patients with no recent hospitalizations and continuous medical monitoring during exercise (GRADE: low $_{G18\text{-}R10_Ref_1}$).[382]

A recent Cochrane meta-analysis of 60 studies with 8,728 patients with HF demonstrated that CVRhP-P, in any of its forms (outpatient, home-based, or hybrid), was associated with a reduction in all-cause hospitalization in the short term (RR = 0.69; 95% CI: 0.56 to 0.86), as well as a clinically relevant improvement in HR-QoL (MLWHF: -7.39 points). Although there was no significant impact on mortality, benefits were maintained in the long term both in hospitalization (RR = 0.84, 95% CI: 0.70 to 1.01) and HR-QoL (MLWHF: -9.59 points). This analysis suggests that home-based programs, due to their lower level of supervision, should be reserved for patients with low to moderate clinical risk who are unable to attend in-person programs. This underlines the need to stratify risk and adapt the level of supervision according to the patient profile (GRADE: moderate $_{G18\text{-}R10_Ref_2}$).[383]

The TELEREH-HF study, a randomized clinical trial with 850 patients with reduced ejection fraction and recent hospitalization, evaluated a hybrid telerehabilitation program (1 week in-person and 8 weeks at home with real-time remote monitoring). No serious exercise-related adverse events were observed during follow-up. Furthermore, the program significantly improved HR-QoL and maximal oxygen uptake in 9 weeks. There were no significant differences between the 12 and 24 months, both in mortality (HR = 1.03; 95% CI, 0.70 to 1.51) and rehospitalizations (HR = 0.94; 95% CI, 0.79 to 1.13). During the home phase, patients were monitored using telemetry devices (ECG, blood pressure, weight) with real-time transmission, allowing safe continuous supervision without the need for frequent hospital visits. This demonstrates the feasibility of hybrid models with intermediate remote supervision for selected patients (GRADE: moderate $_{G18\text{-}R10_Ref_3}$).[384]

An ACC expert review suggests that hybrid protocols with initial in-person components (up to 36 telemetry-monitored sessions) followed by home-based phases of structured aerobic exercise (5 times per week, 40 minutes/session) offer high adherence, functional improvement, and reduced hospitalizations. The use of telemetry and remote monitoring technology contributes to maintaining the safety and efficacy of training outside of the hospital setting, with no serious adverse events reported in these settings (GRADE: low $_{G18\text{-}R10_Ref_4}$).[201]

A Japanese clinical trial in 30 frail patients with chronic heart failure (NYHA II–III) evaluated a technology-supported home-based program (Fitbit® app, remote coaching, and educational videos). This model showed a significant increase in 6-minute walk distance compared to the control

group (52.1 ± 43.9 m vs. -4.3 ± 38.8 m, p < 0.001), with no adverse events reported. Remote monitoring was sufficient to adjust treatment and ensure safety, reinforcing that in selected patients, models with less supervision may be effective (GRADE: moderate $_{G18\text{-}R10_Ref_5}$).[385]

Several investigations have evaluated the efficacy of home-based CVRhP-P in patients with HF, demonstrating clinically relevant benefits in exercise tolerance, HR-QoL, and self-care, without compromising safety. In the REACH-HF clinical trial, conducted in patients with HF with reduced ejection fraction (HFrEF), a significant improvement in health-related HR-QoL was reported, with a mean difference in the Minnesota Living with Heart Failure questionnaire score of -5.7 (95% CI; -10.6 to -0.7, p = 0.025) compared to the control group, in addition to improvements in self-care and high adherence (>85%), with no increase in adverse events (GRADE: high $_{G18\text{-}R12_Ref_7}$).[386]

These findings were consistent with a systematic review published in 2023, which included 11 studies and 1,241 patients with HFrEF, which concluded that home-based programs showed medium to high adherence to the fundamental components of the ESC and BACPR guidelines. The best-met standards were early identification and assessment, while risk factor management and long-term outcome assessment were the least addressed areas. Adverse events were not assessed (GRADE: very low $_{G18\text{-}R12_Ref_1}$).[387]

In studies exploring the implementation of home-based programs such as REACH-HF in routine clinical practice, benefits were observed in exercise tolerance, HR-QoL, and psychological symptoms. Patients showed less gain in 6-minute walk distance (190 m vs. 275 m in the original trial) (GRADE: very low $_{G18\text{-}R12_Ref_10}$).[388]

A clinical trial of patients with HF, either undergoing high-intensity ThPhT, home-based telemedicine (intervention), or standard management, reported no complications during exercise sessions, and 80% of patients were at least partially compliant with the maneuver. In more than 50% of cases, technological difficulties occurred in digital communication. In the end, no significant differences were observed between groups in relation to $VO_2$peak and distance walked in 6 minutes, at the end of the intervention or 3 months later, compared to the control group (GRADE: low $_{G18\text{-}R12_Ref_2}$).[389]

In a cohort study of 81 patients over 65 years of age with HF and LVEF < 40%, a six-month home-based rehabilitation program with telemonitoring significantly improved exercise tolerance (51.2% increase in walking distance vs. 17.7% in the control group; p < 0.005), increased LVEF by 7.7% (p < 0.05), and showed a 4.6% hospital readmission rate. No adverse events were recorded (GRADE: moderate $_{G18\text{-}R12_Ref_4}$).[390]

A randomized study of home-based programs in patients with physical frailty and left ventricular dysfunction (NYHA II–III) showed a significant improvement in exercise tolerance in the intervention group compared to the control group (increase in 6MWT: 52.1 ± 43.9 m vs. -4.3 ± 38.8 m; p < 0.001), with no adverse events or associated complications, and with an adherence rate of 73% (GRADE: high $_{G18\text{-}R12_Ref_13}$).[385]

On the other hand, a narrative review of nine studies on hybrid programs (a combination of center-based supervised exercise and home monitoring) reported improvements in physical function, exercise tolerance, and HR-QoL in patients with HF, with similar adherence to center-based programs and reduced implementation costs. No adverse events were assessed (GRADE: very low $_{G18\text{-}R12_Ref_3}$).[391]

A cohort study of 50 patients with HF and coronary artery disease showed that the use of a virtual assistant for home-based rehabilitation (vCare) improved $VO_2$max in both experimental groups (from 19.21 to 21.32 $mlO_2$/kg/min and from 19.18 to 21.98 $mlO_2$/kg/min, p = 0.002 and p = 0.02, respectively), with reductions in risk factors such as cholesterol and smoking, and decreased symptoms of anxiety and depression. No adverse events were reported (GRADE: low $_{G18\text{-}R12_Ref_6}$).[392]

A cohort study in 10 elderly patients evaluated the safety and feasibility of a real-time tele-rehabilitation program, observing an improvement in six-minute walk distance (from 383 ± 94 m to 432 ± 83 m, p = 0.003), with 94.4% participation in the sessions. Minor adverse events such as fatigue, cold and palpitations were reported, but no serious cardiovascular events (GRADE: low $_{G18\text{-}R12_Ref_5}$).[393]

In an assessment of patient interest in using remote digital programs after discharge for acute coronary syndrome, cardiac surgery, or coronary intervention, 83% were found to be interested, particularly those with heart failure (100%, p<0.05). This interest was associated with positive attitudes toward a healthy lifestyle (OR=2.26, p=0.01) (GRADE: very low $_{G18\text{-}R12_Ref_9}$).[394]

Taken together, these findings suggest that home-based programs could be a useful modality for training patients who cannot attend in-person CVRhP-P training. For now, these programs are recommended only for stable patients with low-risk CVD.

### *3.3.4.2 Ventricular assist devices*

A ventricular assist device (VAD) is a mechanical pump that helps a weakened heart pump blood to the rest of the body or to the lungs. When medications and other treatments are insufficient to control severe heart failure, a VAD can provide temporary support for recovery, serve as a bridge to a heart transplant, or serve as a long-term, definitive treatment option.

An ESC position paper on rehabilitation treatment in patients with ventricular assist devices describes that exercise training and secondary prevention measures aim to stimulate early physical activity and facilitate patient recovery. Exercise training has been proposed for patients with HF using a ventricular assist device to aid in the recovery of their physical capacity. Scientific evidence is limited. Adequate screening is recommended to avoid complications, particularly at the beginning of early mobilization, and to individualize exercise prescription to the patient's needs. Adverse events were not assessed (GRADE: very low $_{G19\text{-}R1_Ref_1}$).[395]

Eickmeyer SM et al. mention that CVRhP-P will increasingly treat patients with ventricular assist devices (VADs) and must understand exercise physiology, medical management, and rehabilitation considerations, as well as the established goal indicators for VAD patients. The conditions faced by rehabilitation professionals in these cases, such as an increased risk of bleeding, thromboembolism, and stroke, are presented, and some recommendations for patient management are mentioned. Rehabilitation is considered safe in these patients but requires sufficient knowledge and specific training, which, along with familiarity with this equipment, are crucial for patient management. This approach should include optimization of heart failure therapy, mean arterial pressure monitoring, line and wound care, and anticoagulation. Close communication with intensive care staff and those who implanted the device is mandatory to identify needs and complications early. The prognosis may be like that of patients hospitalized for other types of heart disease. Adverse events were not evaluated. (GRADE: very low $_{G19\text{-}R1_Ref_3}$).[396]

Scheiderer R et al. conducted a systematic review of 6 articles and 1,291 patients with ventricular assist devices (VADs) showed that the exercise parameters used in the studies were a moderate level of effort either 11 to 13 (Borg scale 6-20), a level of 2 on the dyspnea scale (0 to 4), a mean arterial pressure of 70 to 95 mmHg and a left ventricular assist device flow greater than 3 liters/min. Adverse events were poorly assessed. (GRADE: low $_{G19\text{-}R1_Ref_2}$).[397]

Participation in CVRhP-P in patients with left ventricular assist devices has been shown to significantly improve ExTol and HR-QoL, with no reported serious adverse events related to the intervention. A meta-analysis involving 183 patients with advanced HF and ventricular assist devices showed that CVRhP-P was associated with an increase in peak oxygen uptake (MD= 3.0 $mlO_2$/kg/min; 95% CI 0.64 to 5.35; p = 0.001) and a longer six-minute walk distance (MD= 60.06 meters; 95% CI 22.61 to 97.50; p = 0.002). No serious adverse events related to the maneuver were reported (GRADE: high $_{G19\text{-}R4\text{-}Ref_1}$).[398]

A systematic review involving 40 patients with implantable ventricular assist devices showed that CVRhP-P, with sessions three times a week for six to eight weeks, showed an improvement in HR-QoL, with an increase of 14.4 points on the Kansas City Cardiomyopathy Questionnaire scale and 13 points on the SF-36 questionnaire, compared to usual care. Although two serious adverse events, infections, and four emergency room visits were reported, all participants completed the program, and no adverse events related to physical activity specifically were documented. Thus, CVRhP-P are safe and beneficial, although the quality of the evidence is considered low to moderate due to the study designs (GRADE: low $_{G19\text{-}R4\text{-}Ref_2}$).[399]

A critically ill patient with a ventricular assist device requires careful intervention by rehabilitation and physical therapy teams. Therapeutic physical training and prevention measures in patients with ventricular assist devices aim to encourage early physical activity and facilitate patient recovery. Adequate screening (stratification) is important to reduce the likelihood of complications, particularly at the beginning of early mobilization, as well as individualizing exercise prescription according to each patient's needs (GRADE: very low $_{G19\text{-}R3_Ref_5}$).[395]

Corrà, U et al. published a review of the literature on patients with VAD and mentioned that physical therapy should initially focus on reinstatement of activities of daily living. A CVRhP-P has the potential to increase exercise performance and HR-QoL in patients with VAD. Both early mobilization and progressive ThPhT improve patients' general conditions and the clinical course of their disease (GRADE: very low $_{G19\text{-}R3_Ref_1}$).[400]

Marko C. et al. studied a cohort of 41 patients with VADs, where ThPhT began 48 ± 38 days after implantation and lasted 32 ± 6 days. The intervention was associated with an increase in trained muscle strength (pre=26.6 ± 11.9 vs post=33.6 ± 15.2 kg in leg press, p= 0.002). In addition, an increase in ExTol was

documented ($VO_2$max-pre=11.3 ± 4.1, $VO_2$max-post=14.5 ± 5.2 $mlO_2$/kg/min, p= 0.007). One sustained ventricular tachycardia event was documented in this study. (GRADE: low $_{G19\text{-}R3_Ref_2}$).[401]

A controlled clinical trial with 26 patients with VAD showed a significant increase in ExTol ($VO_2$peak-pre= 13.6 ± 3.3, $VO_2$peak-post= 15.3 ± 4.4 $mlO_2$/kg/min, p< 0.05) in the rehabilitation group, compared to the control group ($VO_2$peak-pre=11.2 ± 2.0, $VO_2$peak-post= 11.8 ± 2.0 $mlO_2$/kg/min, p= 0.22). Treadmill exercise time (TE) increased in both the CVRhP group (TE-pre= 7.9 ± 1.6, TE-post= 11.0 ± 2.1 min, p< 0.05) and the control group (TE-pre= 6.6 ± 2.7, TE-post= 7.4 ± 2.9 min, p< 0.05), with a significant difference between groups, p< 0.05. Leg strength increased by 17% (p< 0.005). During therapy, one patient suffered a syncopal episode (GRADE: high $_{G19\text{-}R3_Ref_3}$).[402]

Feuerstein, A et al. published a controlled clinical trial in 54 patients with stable HF and ventricular assist devices, where it was observed that patients who performed a supervised ThPhT presented a significant change in the distance walked in 6 min (delta = 43.4 m; 95% CI from 16.9 to 69.9, p = 0.0024), although no significant changes were observed in ExTol (Delta $VO_2$peak = 0.826 $mlO_2$/kg/min; 95% CI from -0.37 to 2.03; p = 0.183). On the other hand, an improvement was recorded within the physical domain of the Kansas City Cardiomyopathy Questionnaire (DM= 14.3; 95% CI from 3.7 to 24.9, p = 0.0124). Program adherence was 71%, and a high rate of adverse events was recorded, with no significant differences between the intervention group (82.9%) and the control group (91.3%). Although most complications were minor, one patient experienced a period of SMVT requiring electrical therapy by the ICD within the first 2 hours after the session. No adverse events were observed during the sessions. Three deaths (11.5%) unrelated to therapy were recorded in the training group, and none in the control group (GRADE: high $_{G19\text{-}R3_Ref_4}$).[403]

The implementation of early mobilization programs and individualized therapeutic exercise in patients on ECMO support has proven to be feasible and safe, with a favorable impact on functional recovery.

In a cohort study of 177 adults on ECMO, 61% of patients achieved bed mobility, including 250 ambulation sessions even in the presence of a femoral cannula. The degree of mobility was associated with factors such as the use of veno-venous ECMO (OR = 2.83; 95% CI, 1.29 to 6.22) or its indication as a bridge to transplant (OR = 17.2; 95% CI, 4.12 to 72.1). Adverse events were observed in 2% of patients during mobilization sessions (GRADE: moderate $_{G19\text{-}R2_Ref_3}$).[315]

Chatziefstratiou AA et al mention that early mobilization contributes to reducing the duration of mechanical ventilation, hospital stay, and vasopressor use, in addition to improving functional status and decreasing mortality in patients on ECMO. Although no serious complications were reported, some studies report minor adverse events (GRADE: very low $_{G19\text{-}R2_Ref_5}$).[317]

Early initiation of physical and occupational therapy within the first 7 days of ECMO was associated with a significant improvement in functionality at hospital discharge. In a cohort of 67 patients on veno-venous ECMO for acute respiratory distress syndrome, a longer walking distance (163.5 m vs. 59.5 m; p 0.001) and a better AMPAC physical performance score (16.6 vs. 11.8; p < 0.01) were reported in those receiving early intervention (GRADE: moderate $_{G19\text{-}R2_Ref_6}$).[404]

Rivera JD et al, mention that, although there is no conclusive evidence regarding the beneficial effect of physiotherapy in patients with ECMO in terms of lethality or hospital stay, it is a feasible maneuver and, in expert hands, safe (GRADE: low $_{G19\text{-}R2_Ref_4}$).[405]

Compostella L et al. mention that, although evidence on the management of patients with VADs is limited, CVRhP-P in these cases can be safe in expert hands, particularly in the care of VAD cannulas and electrodes, and is associated with an improvement in symptoms such as fatigue or dyspnea. The intensity of exercise therapy should ideally be dosed based on measured aerobic capacity and with incremental planning. It is important to adjust VAD parameters to maintain adequate blood volume and maximum output while avoiding suction effects. Ventricular arrhythmias are not usually an immediate life-threatening situation but should be treated due to the detrimental effect on function and HR-QoL. Atrial fibrillation is a factor that can worsen the patient's symptoms. Blood pressure should be measured by arterial Doppler, and a mean pressure less than or equal to 80 mmHg is considered ideal. Some patients may present orthostatic intolerance. Adverse events were not assessed (GRADE very low $_{G19\text{-}R5_Ref_2}$).[406]

Mahfood Haddad T et al. performed a meta-analysis of 6 studies and 183 VAD patients and showed that the onset of CVRhP-P was around 10 months after VAD implantation and was associated with an increase in $VO_2$peak (MD= 3.00 $mlO_2$/kg/min; 95% CI 0.64 to 5.35, p=0.001). Patients in CVRhP significantly increased their 6-minute walk distance (MD= 60.06 m; 95% CI 22.61 to 97.50, p=0.002). No study reported serious adverse events related to the intervention. (GRADE high $_{G19\text{-}R5_Ref_1}$).[407]

Grosman-Rimon L et al published a meta-analysis with 16 studies and 800 patients with VAD. Compared with the control group, CVRhP-P was associated with an increase in peak $VO_2$ (MD= 1.94 $mlO_2$/kg/min; 95% CI: 0.63 to 3.26, p = 0.004) and 6-minute walk distance (MD= 42.46 m; 95% CI: 8.45 to 76.46, p = 0.01). No statistical differences were observed in VE/$VCO_2$ or ventilatory threshold. Improvement in HR-QoL was not consistent (GRADE: moderate $_{G19\text{-}R5_Ref_5}$).[408]

### 3.3.4.3 Heart transplant

Heart transplant patients almost always had chronic, severe heart failure prior to surgery. Thus, the bodily changes that were once a sign of adaptation to low LVEF have led to alterations in peripheral muscles associated with low ExTol, even in a fully functioning transplanted heart. ThPhT is a stimulus that induces central and peripheral adaptations that culminate in harmonious bodily function, which can begin even before the transplant.

Patients who have received a heart transplant now have a normally functioning heart, although adaptive extracardiac changes to HF persist after surgery, particularly malnutrition, musculoskeletal atrophy, a “stiff” heart rate due to surgical denervation, and diastolic dysfunction. This leads to low exercise tolerance, with predicted $VO_2$ levels of around 60%. Furthermore, the transplanted heart, initially denervated, has marked chronotropic incompetence, which improves in 40% of patient’s months or years after surgery. Physiological abnormalities that should be taken into account when prescribing training include: elevated resting HR, chronotropic incompetence, reduced HR reserve, inability to increase stroke volume, abnormal HR recovery, elevated pulmonary venocapillary pressure during exercise, and a reduced $VO_2$ at the aerobic-anaerobic threshold, among others (GRADE low $_{G20\text{-}R3_Ref_3}$).[203]

A randomized controlled clinical trial was published in 2023 with heart transplant candidates who completed a ThPhT program before transplantation (pre-habilitation). In the experimental group, compared to the control group, an increase in exercise time (728 s vs. 281 s, p < 0.001), improvement in HR-QoL (Minnesota score of 58 vs. 47, p = 0.046), a lower rate of post-surgical complications (31 vs. 37, p = 0.033), shorter time on mechanical ventilation (20 vs. 37 h, p = 0.032), shorter ICU stay (5 vs. 7 days, p = 0.01), and a shorter hospital stay (18 vs. 23 days, p = 0.008) were observed. The absence of adverse events was reported (GRADE: moderate $_{G18\text{-}R9_Ref_1}$).[409]

Costa R. et al. published a meta-analysis of 11 studies and 404 heart graft recipients, which showed that, in the exercise-based cardiac rehabilitation group, peak $VO_2$ increased in the CVRhP-P group compared to the control group (MD= 3.03 $mlO_2$/kg/min; 95% CI: 2.28 to 3.77 $mlO_2$/kg/min, p < 0.001). A sub-analysis showed a greater increase in peak $VO_2$ in the HIIT group compared to continuous exercise (MD= 2.23 $mlO_2$/kg/min; 95% CI: 1.79 to 2.67, p < 0.001). However, at 1-year follow-up, the additional benefit initially observed with HIIT was lost. Adverse events were irregularly reported (GRADE: high $_{G18\text{-}R9_Ref_2}$).[410]

The inclusion of post-heart transplant patients in CVRhP-P is useful for improving exercise tolerance and maintaining an adequate level of safety in the short term. In a meta-analysis of 10 randomized controlled trials with a total of 300 patients, a significant increase in $VO_2$peak was observed (MD= 2.49 $mlO_2$/kg/min; 95% CI 1.63 to 3.36, p < 0.0001) in patients who trained for 8 to 12 weeks, compared with the non-intervention group. Only one non-serious adverse event attributable to the intervention was reported (GRADE: moderate $_{G20\text{-}R4_Ref_1}$).[369]

In 2023, a meta-analysis of 11 studies and 404 heart transplant recipients showed that $VO_2$peak increased in the CVRhP-P group compared to the control group (DM= 3.03 $mlO_2$/kg/min; 95% CI 2.28 to 3.77, p< 0.001). In a sub-analysis, a greater increase in MET was observed in the HIIT-trained group compared to continuous exercise (Δ $VO_2$peak= 2.23 $mlO_2$/kg/min; 95% CI 1.79 to 2.67, p< 0.001). However, at 1-year follow-up, the additional benefit initially observed with HIIT was lost. Adverse events were irregularly reported (GRADE: high $_{G20\text{-}R1_Ref_1}$).[410]

Anderson L et al. published a meta-analysis of 10 studies and 300 post-HxTx patients, which showed that CVRhP-P was associated with an increase in ExTol ($VO_2$peak) compared to the control group (DM= 2.49 $mlO_2$/kg/min; 95% CI 1.63 to 3.36). Only one study reported an adverse event. The studies were very heterogeneous. Adverse events were poorly assessed. (GRADE: moderate $_{G20\text{-}R1_Ref_2}$).[369]

A randomized controlled trial with 78 post-HT patients showed that peak $VO_2$, after an initial increase, remained stable at 3 years of follow-up, with a small decrease, both in HIIT (-0.3 $mlO_2$/kg/min) and CMAT (-0.9 $mlO_2$/kg/min) patients, p = 0.497 between groups. The 3-year adherence rate was greater than 50%, HIIT (69%), CMAT (66%), and around 80% of patients in both groups exercised more than twice a week. Muscular endurance (J) improved significantly in HIIT patients compared to CMAT at 3 years. No changes in HR-QoL were observed

in either group. Adverse outcomes were not assessed (GRADE: moderate $_{G20\text{-}R1_Ref_3}$).[411]

A randomized controlled trial in 41 post-HT patients showed that ThPhT in the HIIT group increased MET (initial $VO_2$peak = 27.7 ± 5.7 and final $VO_2$peak of 31.2 ± 5.3 $mlO_2$/kg/min). However, over the next 4 years, it decreased to 26.0 ± 6.2 $mlO_2$/kg/min. The control group showed a similar decrease in $VO_2$peak over these 5 years. Adverse events were not assessed (GRADE: moderate $_{G20\text{-}R1_Ref_4}$).[412]

ThPhT in heart transplant patients, in its various forms (aerobic, strength, high-intensity interval training, and combined), significantly improves exercise tolerance, muscle strength, and other key components of cardiorespiratory fitness, with no adverse events reported in the studies analyzed. However, HIIT may represent a greater challenge for some patients in the early stages of post-transplant or with functional limitations, so it is essential to assess its individual feasibility and be alert for the occurrence of adverse events.

In a meta-analysis of 14 studies (n=316), various training modalities were compared and a significant increase in peak $VO_2$ was observed with all exercise modalities compared to the control group. Resistance training was associated with an increase in muscular strength (MD=35.50 kg, 95% CI 19.42 to 51.59, p<0.0001). Aerobic training improved ExTol (MD=3.36 $mlO_2$/kg/min; 95% CI 2.29 to 4.44). Training that combined aerobic power and muscular strength increased ExTol (MD= 2.37 $mlO_2$/kg/min; 95% CI 1.36 to 3.39) and sit-up tests (MD= 5.54, 95% CI 3.07 to 8.01, p< 0.0001). HIIT training showed the greatest gain in $VO_2$ (MD= 4.43 $mlO_2$/kg/min, 95% CI: 0.54 to 8.31) (GRADE: high $_{G20\text{-}R2_Ref_1}$).[413]

In another meta-analysis that included 5 studies with 212 patients, HIIT significantly improved peak $VO_2$ compared to CMAT (MD= 2.1 $mlO_2$/kg/min; 95% CI: 1.1 to 3.1, p< 0.0001) or the untrained group (MD= 3.5 $mlO_2$/kg/min: 95% CI: 2.3 to 4.7, p< 0.00001). An increase in maximum HR was observed vs. CMAT (MD= 3.4 bpm; 95% CI: 0.8 to 5.9, p= 0.009) and vs. inactivity (MD= 5.6 bpm; 95% CI: 1.6 to 9.6, p= 0.006). HR reserve also improved (MD= 4.8; 95% CI -0.05 to 9.6, p= 0.05) (GRADE: high $_{G20\text{-}R2_Ref_2}$).[414]

A randomized crossover trial directly compared HIIT with CMAT in 16 stable patients between 4- and 12-months post-transplant. HIIT showed a significant increase in peak $VO_2$ ($p < 0.001$), improvements in SF-36 physical score ($p = 0.02$), reduction in depressive symptoms ($p = 0.04$), and decrease in anxiety ($p < 0.01$), with less consistent changes observed in the CMAT group ($p = 0.07$ for physical score and $p < 0.05$ for anxiety) (GRADE: moderate $_{G20\text{-}R2_Ref_3}$).[415]

Recent systematic reviews also corroborate that HIIT is associated with a superior or equivalent improvement to other training modalities, in parameters such as muscle strength, heart rate, vascular function and body composition, in heart transplant recipients (GRADE: low $_{G20\text{-}R2_Ref_6,\ G20\text{-}R2_Ref_7}$).[416,417]

In line with these observations, the International Society of Heart and Lung Transplantation recommends supervised moderate aerobic training in the early post-transplant phase, progressing to HIIT and strength training as tolerated by the patient, with the aim of optimizing $VO_2$, muscle strength and bone density, always considering safety and individual response (GRADE: very low $_{G20\text{-}R2_Ref_5}$).[418]

Del Torto A et al conducted a clinical trial on aerobic training with recruitment of different muscle groups (one leg vs two legs) demonstrating relevant increases in $VO_2$ max (13.8% and 18.6%, respectively) in organ transplant patients, including heart recipients (GRADE: high $_{G20\text{-}R2_Ref_8}$).[419]

Kourek, C et al. established that, in patients undergoing heart transplantation, exercise intensity should increase slowly over time, aiming for patients to reach a perceived exertion of 12 to 14 (Borg Scale 6-20). Aerobic exercise intensity will be calculated in relation to $VO_2$peak (<50% or 10% less than the aerobic-anaerobic threshold) in the CMAT and may include sessions of 55 to 75% of $VO_2$peak. The intensity of the exercise in the sessions will increase from 11 to 14 in the following weeks. HIIT, after a warm-up period, will have intervals of 85 to 95% of HRmax (Borg 18-19), with active recovery intervals at Borg intensity 11-13. Adverse outcomes were not assessed (GRADE: very low $_{G20\text{-}R3_Ref_1}$).[420]

Anderson L et al, in a meta-analysis with 10 studies and 300 post-HxTx patients, reported that the analyzed studies used different methods to dose the exercise intensity, such as reaching 85-95% of the HRmax, 60 to 80% of the $VO_2$max, a perception of 11 to 14 on the Borg scale (6-20), a cadence of 50-70 RPM on the cycle ergometer and a respiratory compensation point of 80%. Adverse events were poorly evaluated (GRADE: moderate $_{G20\text{-}R3_Ref_2}$).[369]

### *3.3.4.4 Nutritional advice*

Patients with HF, particularly in advanced stages, require significant dietary adjustments, especially in caloric intake and fluid and electrolyte balance. In patients with HF, high sodium intake is associated with

various alterations in myocardial proteins, which affect their contractile performance. It also coexists with several morbid conditions such as systemic arterial hypertension, chronic kidney disease, and stroke, among others (GRADE: low $_{G18\text{-}R1_Ref_2}$).[421]

In a review of 13 studies and 3,000 patients with HF regarding sodium intake, the authors showed that the information is ambiguous since, on the one hand, in some studies with symptomatic patients with HF, reduced sodium intake showed a decrease in adverse outcomes and hospital readmissions, improvement in symptoms and HR-QoL. On the other hand, some studies show no differences. 24-hour urinary sodium levels can be a useful parameter for oral sodium dosing or to assess adherence to diet. In one study, they mention that restricting sodium intake in patients with compensated HF can have harmful effects on both the kidneys and neurohormonal levels, the latter in patients not receiving ACEIs or ARBs. In an analysis of self-reports in patients with HF, compliance with a low-sodium diet (<3 g/d or 80 mmol/d) was a challenge (GRADE: low $_{G18\text{-}R1_Ref_1}$).[422]

Billingsley HE et al. recommend that patients with HF have a moderate restriction of sodium intake between 2 and 3 g per day, and in some cases, a strict restriction (<1.5 g). The authors recommend including dietary "patterns" instead of specific restrictions (e.g., Mediterranean diet, DASH, etc.), with supplements with nuts and extra-virgin olive oil (fatty acids). Protein intake should be increased in patients with poor nutritional status, sarcopenia, and even cachexia. The "obesity paradox" states that patients with HF and mild obesity (grade I-II) have a lower mortality rate than thinner patients, particularly those with reduced LVEF. Sarcopenic obesity confers greater risk to patients. Specific treatment with micronutrients (vitamins and minerals) has also yielded ambiguous results. Intravenous iron administration in patients with HF has been shown to decrease mortality and hospitalization rates (GRADE: low $_{G18\text{-}R1_Ref_3,\ G18\text{-}R1_Ref_5}$).[423,424]

In another systematic review of 15 studies and 1,041 patients with HF, there was a lack of clear evidence on the usefulness of a sodium and fluid restricted diet for patients with HF (GRADE: very low $_{G18\text{-}R1_Ref_4}$).[425]

Simão DO et al. published a meta-analysis of 22 studies in patients with HF, which showed that the fluid restriction group had a 9.84-point greater sensation of thirst than the control group (95% CI: 27.36 to 47.04; $p < 0.01$). The group that had strict water restrictions experienced an increase in weight compared to the control group (MD= 2.95 kg; 95% CI: 1.52 to 7.42, $p < 0.01$). Moderate sodium restriction together with water restriction managed to decrease sodium intake in food compared to the control group (50.5 ± 34.9% vs 48.1 ± 164.7%, $p = 0.012$) (GRADE: low $_{G18\text{-}R1_Ref_6}$).[426]

Patients with HF should monitor their diet, as some foods may interact with medications. A narrative review of patients with HF mentions that diet can decrease the transient absorption of digoxin but does not affect total absorption or bioavailability. Green tea may decrease digoxin exposure to tissues. Adverse effects not evaluated (GRADE: very low $_{G18\text{-}R3_Ref_1}$).[427]

Misaka S et al. published a randomized clinical trial with 12 healthy volunteers, where they observed the association between ACE inhibitors and green tea intake. In the group that ingested green tea, the plasma concentration of lisinopril was lower (AUC = 0.289; 95% CI: 0.226 to 0.352) than in the control group

**Recommendation Table 13.** Heart valve disease

| PICO | 3.3.5 Heart valve surgery | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G21-R2 | It is recommended that patients postoperatively undergo heart valve surgery or intervention be admitted to a CVRhP-P in order to improve exercise tolerance, HR-QoL, and reduce medium-term mortality and rehospitalization rates. | IIb | B-NR | C+/B+ | 1 to 6 |
| G21-R1 | Patients with valvular disease undergoing valvular surgery or intervention are recommended to enter a CVRhP-P in order to increase their exercise tolerance. | IIb | C-LD | C+/B+ | 1 to 6 |
| G21-R4 | Patients with mitral valve disease are recommended to enroll in a CVRhP-P, according to their risk level, in order to improve exercise tolerance, HR-QoL, and lung function. | IIb | C-LD | C+/B+ | 1 to 6 |
| G21-R3 | It is not recommended that patients with severe aortic heart valve disease perform strength training (isometrics). | III-H | C-EO | C-/B- | 1,6 |

(AUC = 0.337; 90% CI: 0.269 to 0.405). There were no differences in the time to reach maximum concentration of lisinopril in both groups (6 h) as well as its renal clearance (56.9 ml/min in tea intake and 57.7 ml/min in the control group) (GRADE: moderate $_{G18\text{-}R3_Ref_2}$).[428]

#### 3.3.4.4.1 Malnutrition or cachexia

The available evidence suggests that nutritional interventions are a relevant component in the comprehensive management of patients with heart failure, especially in those at risk of malnutrition or cachexia.

In patients with heart failure and cachexia, nutritional support should include a caloric intake of up to 35 kcal/kg/day and a protein intake between 1 and 1.2 g/kg/day. Supplementation with essential amino acids, controlled sodium restriction (0.5 to 2 g/day in severe cases), correction of vitamin and mineral deficiencies, and iron administration in patients with deficiency without anemia are recommended. These interventions have been associated with improvements in muscle mass, body weight, symptom control, and a reduction in cardiac complications, being more evident in subgroups with malnutrition (GRADE: very low $_{G18\text{-}R4_Ref_2}$).[429]

Supplementation with specific micronutrients (B vitamins, vitamin D, coenzyme Q10) may improve some clinical parameters in patients with identified deficiencies, although the evidence is limited and inconclusive. Maintaining optimal medical treatment for heart failure is essential to prevent cachexia (GRADE: very low $_{G18\text{-}R4_Ref_6}$).[430]

Nutritional interventions should include specialized counseling, caloric supplementation, administration of omega-3 polyunsaturated fatty acids, and micronutrient replacement as clinically needed. The recommended protein intake is 1 to 1.2 g/kg/day, with a caloric intake of up to 35 kcal/kg/day, adjusted to a lower limit of 28 kcal/kg in specific patients. These strategies may be especially beneficial in patients at high nutritional risk (GRADE: very low $_{G18\text{-}R4_Ref_1}$).[431]

Additional strategies for the prevention and management of cachexia and sarcopenia include the adoption of healthy diets such as the Mediterranean or DASH diet, caloric intake between 22 and 30 kcal/kg/day, protein ≥1.1 g/kg/day, sodium restriction in selected cases, high-calorie and high-protein oral supplements, β-hydroxy-β-methylbutyrate (HMB), and omega-3 polyunsaturated fatty acids. In extreme situations, enteral or parenteral nutritional support may be considered. These interventions have proved improvements in inflammatory status, HR-QoL, survival, and reduction of hospital readmissions (GRADE: very low $_{G18\text{-}R4_Ref_3}$).[432]

A cohort study in patients over 65 years of age established that a caloric intake of ≤23.9 kcal/kg/day is associated with an increased risk of mortality, while an optimal intake of around 31.5 kcal/kg/day decreases this risk. Malnutrition is an adverse prognostic factor in heart failure (GRADE: moderate $_{G18\text{-}R4_Ref_4}$).[433]

Vitamin D supplementation shows no significant effects on functional capacity measured by the 6MWT, although it improves HR-QoL. On the other hand, oral or intravenous iron supplementation is associated with improved exercise tolerance and HR-QoL in patients with iron deficiency. The evidence regarding protein and essential amino acid supplements is insufficient to make definitive recommendations (GRADE: low $_{G18\text{-}R4_Ref_5}$).[434]

### *3.3.5 Heart valve disease*

Patients with heart valve disease may benefit from a CVRhP-P before or after undergoing valve repair or replacement.

Lakowsky et al. mention that patients with valvular disease, whether repaired or not, who do not have contraindications, are recommended to practice regular aerobic exercise of low or medium intensity to maintain adequate physical fitness. Competitive or high-demand exercise has an uncertain clinical significance. Adverse events were not evaluated (GRADE: very low $_{G21\text{-}R3_Ref_1}$).[435]

The review of CPG (European and American) shows a more permissive position regarding physical exercise in patients with mild to moderate valvular disease, provided there are no high-risk factors (GRADE: very low $_{G21\text{-}R4_Ref_7}$).[436]

Individual risk assessment remains essential. Elevated heart rate or increased afterload associated with exercise can aggravate certain valvular heart diseases, such as mitral regurgitation (GRADE: very low $_{G21\text{-}R4_Ref_13}$).[437]

CVRhP-P in patients with valvular disease can be used in adult patients who have undergone valve surgery, transcatheter valve implantation, as well as in those with mild and stable valvular disease, as part of individualized comprehensive management, considering the type of valvular disease, comorbidities, and arrhythmic risk.

Regarding CVRP-P in patients with valvular disease, there is no evidence from prospective studies evaluating the effect of specific ThPhT, and guidelines are

based on expert consensus. In general, right heart valve disease is better tolerated than left heart valve disease, and valvular insufficiency is better tolerated than stenosis. Mild to moderate valvular disease may be compatible with vigorous exercise in most individuals. Those with more severe valvular disease should discontinue competitive activity and undergo valve repair or replacement. Adverse events were not assessed (GRADE: very low $_{G21\text{-}R1_Ref_1}$).[438]

Chatrath N et al., in a review article, explains that the prescription of physical activity should be tailored to the type of valvular disease. For example, in patients with regurgitant valvular disease (such as mitral or aortic regurgitation), moderate-intensity exercise may be considered if the left ventricle has an ejection fraction ≥60%, a diastolic diameter <60 mm, and pulmonary artery pressure <50 mmHg. In contrast, in cases of severe valvular stenosis, only low-intensity exercise is recommended, under specialized supervision (GRADE: very low $_{G21\text{-}R4_Ref_4}$).[439]

In women with mitral valve prolapse, a higher prevalence of arrhythmic risk has been documented, associated with factors such as a family history of sudden death, complex ventricular arrhythmias, and mitral annular disjunction. In the absence of these high-risk factors, participation in recreational or competitive exercise is considered safe. In a cohort of 215 athletes with MVP, no sudden death events were reported after 8 years of follow-up (GRADE: very low $_{G21\text{-}R4_Ref_3,\ G21\text{-}R4_Ref_5}$).[440,441]

Although some reviews do not provide specific recommendations for exercise in mitral stenosis, it has been documented that ThPhT may increase valvular gradients and pulmonary pressures during activity, especially in degenerative mitral stenosis with annular calcification (exercise gradient = 17.3 ± 8.4 vs. 5.5 ± 2.5 mmHg; $p < 0.0001$) (GRADE: very low $_{G21\text{-}R4_Ref_9,\ G21\text{-}R4_Ref_11}$).[442,443]

A narrative review presenting six controlled clinical trials with a total of 364 postoperative adults found no statistically significant differences in mortality or hospitalizations; however, it did identify a moderate increase in maximum exercise tolerance parameters after admission to CVRhP-P, as well as a slight but sustained improvement during long-term follow-up. The rate of serious adverse events was 7.3% in the intervention group vs. 6.8% in the control group (GRADE: very low $_{G21\text{-}R2_Ref_2;}$ GRADE: low $_{G21\text{-}R2_Ref_3}$).[444,445]

In a cohort study of 41,369 Medicare beneficiaries postoperatively with valvular surgery (aortic, mitral, tricuspid, and pulmonary), participation in a CVRhP program was significantly associated with a reduced risk of hospitalization (HR = 0.66; 95% CI 0.63 to 0.69) and mortality (HR = 0.39; 95% CI 0.35 to 0.44) at 1 year of follow-up (GRADE: low $_{G21\text{-}R2_Ref_4}$).[446]

Similarly, another cohort of 742 postoperative patients after valve surgery showed that moderate to high levels of physical activity in the medium and long term after surgery were associated with a significant decrease in the risk of mortality (HR = 0.19; 95% CI 0.05 to 0.70), and that patients who participated in CVRhP-P were more likely to achieve such activity levels (OR= 1.52; 95% CI 1.03 to 2.24) (GRADE: low $_{G21\text{-}R2_Ref_5}$).[447]

A cohort study in a population with various types of heart disease included 32 patients with valvular heart surgery, and showed a significant clinical improvement after CVRhP-P with an increase in $VO_2$peak (4.3 $mlO_2$/kg/min), reduction in body fat (-1.1 kg), increase in muscle mass (+1.4 kg), improvement in HR-QoL, as well as a decrease in symptoms of anxiety and depression (GRADE: low $_{G21\text{-}R2_Ref_6}$).[448]

Xue W et al. conducted a randomized clinical trial with 120 patients which showed that early CVRhP-P after valve surgery is associated with a significant increase in 6MWD walking distance, HR-QoL (MD=1.89, $p<0.001$) and a reduction in mortality (HR=0.58; 95% CI 0.42 to 0.79) (GRADE: moderate $_{G21\text{-}R2_Ref_8}$).[449]

The long-term follow-up of the CopenHeartVR trial assessed the effects of 12 weeks of CVRhP-P on physical capacity, mental health, hospitalization, and mortality in patients after heart valve surgery. A significant reduction in hospital readmissions was

**Recommendation Table 14.** Peripheral arterial disease

| PICO | 3.3.6 Peripheral arterial disease | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G22-R1 | It is recommended that patients with peripheral arterial disease of the lower limbs, particularly those who are symptomatic, be included in CVRhP-P, with the aim of increasing walking distance and improving the claudication threshold. | I | B-R | C+/B+ | 1 to 6 |

*(Continues)*

**Recommendation Table 14.** Peripheral arterial disease *(continued)*

| PICO | 3.3.6 Peripheral arterial disease | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G22-R4 | It is recommended to measure the ankle-brachial index in patients admitted to a CVRhP-P, in order to identify those at high risk of presenting major adverse outcomes. | I | B-R | C-/B+ | 1 to 6 |
| G22-R2 | It is recommended to perform ThPhT on a treadmill, for patients with peripheral arterial disease of the lower limbs, on a treadmill, with a moderate to high intensity that causes claudication, in search of improvement in the distance walked, reduction of symptoms and increase in HR-QoL. | I | B-R | C+/B+ | 1 to 6 |
| G22-R3 | It is recommended to request carotid circulation evaluation with Doppler ultrasound in patients with coronary artery disease in CVRhP-P, in order to identify and refer those patients with atherosclerotic carotid artery disease to a specialist for evaluation and corresponding treatment. | IIa | B-NR | C+/B+ | 1 to 6 |

observed at 3, 6, and 12 months, and a combined reduction in mortality and readmissions at 12 months. No significant differences were identified in peak $VO_2$ or mental or physical health at 24 months (GRADE: moderate $_{G21\text{-}R2_Ref_9}$).[450]

In post-mitral valve surgery patients, a meta-analysis of six studies (n=364) showed that CVRhP-P significantly increased exercise tolerance (MD=2.38 $mlO_2$/kg/min; 95% CI 0.36 to 4.40, n=250, $I^2$=0%). No significant differences were observed in serious adverse events, such as mortality (RR=0.83; 95% CI 0.26 to 2.68), re-hospitalizations (RR=2.72; 95% CI 0.11 to 65.56), or HR-QoL (GRADE: low $_{G21\text{-}R4_Ref_1}$).[264]

Regarding postoperative ThPhT, a randomized clinical trial (n=100) showed that high-load inspiratory training after mitral valve replacement significantly improves lung function, inspiratory pressure, and exercise tolerance, without reporting significant adverse events (GRADE: high $_{G21\text{-}R4_Ref_10}$).[451]

A cohort study (n=302) identified several predictive variables for poor functional recovery after mitral valve surgery, including female sex (OR=2.65; 95% CI: 1.58 to 4.47), sedentary lifestyle (OR=0.47; 95% CI: 0.28 to 0.79), and obesity (OR=0.26; 95% CI: 0.10 to 0.64); although in the latter case, the protective effect could be due to compensatory hemodynamic mechanisms (GRADE: very low $_{G21\text{-}R4_Ref_16}$).[452]

On the other hand, the risk of atrial fibrillation (AF) during a CVRhP-P after valve surgery is frequent (incidence of 23.1%). Advanced age (OR= 1.030; 95% CI: 1.012 to 1.048), mitral surgery (OR= 1.79; 95% CI: 1.13 to 2.77) and a history of acute AF (OR= 2.96; 95% CI: 2.01 to 4.38) were identified as predictive factors for the onset of AF, which should be considered in the pre-therapy evaluation (GRADE: low $_{G21\text{-}R4_Ref_14}$).[453]

In 2011, a narrative review of patients with valvular heart disease reported that data on exercise in valvular heart disease are very limited. Knowledge of pathophysiology is required to make exercise recommendations. A careful individualized clinical and paraclinical assessment is important, searching for at-risk subjects. Adverse events were not assessed (GRADE: very low $_{G21\text{-}R1_Ref_3}$).[454]

Pollmann AGE et al. published a cohort study of 146 postoperative patients after valve surgery and observed that the ThPhT program was associated with an increase in ExTol ($VO_2$peak from 21.6 to 24.8 $mlO_2$/kg/min, p<0.001) and in the 6MWT (walking distance from 349 to 393 m, p=0.0016). The rate of adverse clinical events was higher in those who did not participate in a CVRhP-P (HR=2.46; 95% CI from 1.26 to 4.80). Age over 75 years was an indicator for not participating in CVRhP-P (OR=2.99; 95% CI from 0.37 to 6.53) (GRADE: low $_{G21\text{-}R1_Ref_4}$).[455]

Van Buuren F et al. published a position paper on sports activity in patients with valvular disease, stating that the effect of chronic and intense physical exercise on these patients is poorly understood, particularly at the level of the diseased or repaired valve, ventricular remodeling, pulmonary artery pressure, or the risk of arrhythmia. Isometric training is not recommended in patients with aortic stenosis or aortic regurgitation. Adverse events were not assessed (GRADE: very low $_{G21\text{-}R3_Ref_3}$).[456]

Fernández AB et al. mention that exercise guidelines for patients with valvular heart disease have become increasingly less restrictive and allow more participation in sports. They do not mention adverse outcomes (GRADE: very low $_{G21\text{-}R1_Ref_2}$).[436]

**(KM)** Patients with valvular heart disease benefit from a cardiac rehabilitation program, particularly after valve repair or replacement surgery.

### 3.3.6 Peripheral arterial disease

Peripheral artery disease is a common condition in which plaque buildup narrows or blocks arteries in areas other than the coronary artery, particularly in the extremities, restricting blood flow.

#### 3.3.6.1 Peripheral arterial disease of the lower limbs

Peripheral artery disease (PAD) in the lower extremities blocks the arteries in the extremities, most commonly the legs and feet. Major risk factors include smoking, diabetes, high blood pressure, and high cholesterol. If left untreated, PAD can lead to serious complications, including tissue death, gangrene, and amputation.

Mazzolai L et al. published a position paper for patients with peripheral arterial disease of the lower limbs (PADLL), in which they recommended supervised exercise as the first line of treatment for patients with PADLL and exercise-induced symptoms. Supervised exercise should be an adjuvant therapy for patients with PADLL undergoing revascularization. Supervised exercise sessions should ideally be coordinated by angiologists and supervised by exercise physiologists or physical therapists. The program should begin with a comprehensive assessment and risk stratification. Adverse events were not evaluated (GRADE: very low $_{G22\text{-}R1_Ref_1}$).[457]

In a review of 29 studies (10 meta-analyses, 12 controlled clinical trials, and 7 cohort studies) in patients with PADLL, it was observed that physical exercise was associated with a decrease in mortality compared with an inactive lifestyle. Physical exercise improved walking distance in patients with or without revascularization. Adverse outcomes were not assessed (GRADE low $_{G22\text{-}R1_Ref_2}$).[458]

Parmenter, B et al, published a meta-analysis with 41 studies and 1,938 patients with PADLL, where they showed that physical exercise was associated with a significant increase in $VO_2$peak compared to the control group (MD= 0.62 $mlO_2$/kg/min; 95% CI 0.47 to 0.77, p< 0.00001), an increase in the 6-minute walk distance (MD= 52.7m; 95% CI 24.7 to 80.6 m, p= 0.0002), distance to claudication onset (MD= 68.8m; 95% CI 54.4 to 83.2m, p< 0.00001). No significant changes were observed in ABI and mean dilation per flow (p= ns). $VO_2$ at the claudication threshold improved (DM= 1.91 $mlO_2$/kg/min; 95% CI 1.28 to 2.54, p < 0.00001). Adverse events were not assessed (GRADE: moderate $_{G22\text{-}R1_Ref_3}$).[459]

Tremblay, R et al. published a meta-analysis of 18 studies and 1,135 patients with PADLL showing that combined training improved walking distance (MD= 122 m, range 24.2 to 219.8) vs control (MD= 106.8 m, range 34.2 to 179.4). A similar improvement was seen for 6-min walk distance, with improvements seen with combined training (+57.3 m, range 16.2 to 98.5), water exercise (+56.5 m, range 22.4 to 90.5), and aerobic walking (+39.0 m, range 12.8 to 65.1). Adverse outcomes were not assessed (GRADE: moderate $_{G22\text{-}R1_Ref_4}$).[460]

The ankle-brachial index (ABI) is a useful prognostic tool in the evaluation of patients with ischemic heart disease admitted to CVRhP-P. Its measurement allows for the detection of underlying PADLL and the stratification of the risk of adverse cardiovascular outcomes.

In a cohort of 4,909 older adults (60–90 years), the prevalence of PADLL was 16% using the lowest systolic blood pressure as the reference and 9.6% using the highest systolic blood pressure. Ten-year mortality was higher in patients with an ABI <0.9: 48.8% with the lowest blood pressure and 67.2% with the highest blood pressure, compared with 27.6% in the reference group. The adjusted risk for nonfatal cardiovascular events and cardiovascular mortality was higher when the highest blood pressure was used as the numerator (HR= 2.11; 95% CI 1.85 to 2.39). Although an ABI less than 0.9 is associated with a higher risk of developing obstructive arterial disease (GRADE: low $_{G22\text{-}R4_Ref_1}$).[461]

In patients with acute myocardial infarction (AMI) without a previous diagnosis of PADLL, an ABI < 0.9 measured during hospitalization was associated with a significant increase in major adverse cardiovascular events (HR = 2.046; 95% CI 1.344 to 3.144, p < 0.001), with a median follow-up of 497 days (GRADE: low $_{G22\text{-}R4_Ref_7}$).[462]

Similarly, in a cohort of 21,892 hypertensive adults (50 to 75 years), low ABI was an independent predictor of 5-year total mortality (HR = 2.15; 95% CI 1.82 to 2.53, p < 0.001), independent of other cardiovascular risk factors (GRADE: low $_{G22\text{-}R4_Ref_9}$).[463]

Furthermore, the ABI has complementary value in risk stratification when incorporated with other diagnostic tests. In 348 patients with chest pain without changes in biomarkers or electrocardiogram, an abnormal ABI doubled the likelihood of an abnormal PE (OR = 2.03; 95% CI 1.11 to 3.70), and although the incidence of cardiovascular events at one year was higher in those

with both abnormal studies (12.1%), this difference did not reach statistical significance (GRADE: low $_{G22\text{-}R4_Ref_5}$).[464]

Regarding its relationship with the coronary microvasculature, in patients with ST-segment elevation MI undergoing primary percutaneous coronary intervention, a low ABI was associated with a higher frequency of microvascular dysfunction, reflected in lower post-procedural myocardial blush and worse left ventricular function (GRADE: low $_{G22\text{-}R4_Ref_10}$).[465]

The utility of the ABI has also been extended to screening and treatment planning for patients with asymptomatic or previously undiagnosed PADLL. In older adults, people with diabetes, or a history of smoking, an ABI <0.9 represents a key diagnostic criterion for PAD. This parameter allows for individualized interventions within CVRhP-P, including supervised exercise and treatment with cilostazol, both recommended as class I, level A by international guidelines (GRADE: very low $_{G22\text{-}R4_Ref_2}$).[466]

In patients with known peripheral arterial disease and an elevated ABI (≥1.4), they have an increased risk of MACE, acute myocardial infarction and cardiovascular death, compared to patients with a normal ABI (HR= 1.69), low ABI (HR= 1.93) or very low ABI (HR= 1.67) (GRADE: low $_{G22\text{-}R4_Ref_6}$).[467]

Structured ThPhT, specifically supervised walking with an intensity sufficient to induce claudication symptoms, is associated with significant improvements in walking distance and HR-QoL in patients with lower-extremity PADLL.

The LITE (Low-Intensity vs. High-Intensity Walking Exercise) study, a randomized clinical trial of 305 patients with PADLL, compared two home-based walking strategies: low intensity (without inducing symptoms) and high intensity (until claudication was induced). At 12 months, the high-intensity group showed a significant improvement in 6-minute walk distance (+34.5 m; $p < 0.001$), compared with the low-intensity group (-6.4 m; $p = 0.34$) and the non-exercise control group (-15.1 m). The superiority of high intensity training was statistically significant compared to the other two groups ($p<0.001$), with no increase in serious adverse events (GRADE: high $_{G22\text{-}R2_Ref_3}$).[468]

The most recent ACC/AHA guidelines (2024) recommend supervised exercise therapy in patients with PADLL, including walking at an intensity that reaches the claudication threshold, to sustainably increase exercise tolerance, function, and HR-QoL, even without surgical intervention. A frequency of 3 to 5 times per week, with sessions of 30 to 60 minutes, is suggested, stopping when moderate claudication is reached and resuming after recovery (GRADE: high $_{G22\text{-}R2_Ref_8}$).[469]

Ingwersen et al., in a narrative review in patients with PADLL, documented that supervised training increased walking distance by 180 - 310 m (6MWT), while home-based exercise increased walking distance by an average of 136 m. Furthermore, combining it with revascularization can further increase walking distance (+282 m). Behavioral interventions such as goal setting, feedback, and structured planning are useful for improving adherence and outcomes (GRADE: very low $_{G22\text{-}R2_Ref_5}$).[458]

On the other hand, in an AHA position paper on PADLL, they describe that supervised walking three times a week for 12 weeks improves 6MWT, with an average of 180 m for maximum walking distance and 128 m for pain-free walking. This modality also leads to improvements in HR-QoL. Although structured home-based programs can be useful, they require periodic visits to achieve comparable efficacy with outpatient programs (GRADE: very low $_{G22\text{-}R2_Ref_1}$).[470]

A narrative review of pathophysiological studies highlights that regular physical exercise in patients with PADLL reduces inflammation, increases capillary density and mitochondrial function, which translates into improved muscle function and walking distance. Twelve- to 24-week programs have demonstrated sustained effects on strength, flow-mediated dilation, and HR-QoL (GRADE: very low $_{G22\text{-}R2_Ref_6}$).[471]

### *3.3.6.2 Carotid atherosclerotic disease*

A proportion of patients with atherosclerosis have some degree of pan-arteriopathy, with the coronary, carotid, lower extremity, and renal regions being the most involved. Therefore, in the presence of coronary artery disease, it is necessary to rule out atherosclerosis at other levels.

In 2024, a systematic review of 11 studies and 21,046 asymptomatic subjects showed that screening of asymptomatic individuals detected vulnerable carotid atherosclerosis in 9% to 82%. The authors concluded that demonstration of coronary artery disease by an imaging method was associated with increased adherence to medical treatment and a reduction in the Framingham score at 3 years. (GRADE moderate $_{G22\text{-}R3_Ref_1}$).[472]Furthermore, the greater the number and size of carotid plaque, the greater the incidence or severity of coronary artery disease (GRADE low $_{G22\text{-}R3_Ref_3}$).[473]

Imaging studies such as magnetic resonance imaging and computed tomography have potential superiority over routine ultrasound in identifying imaging defects associated with vulnerable plaque, such as intraplaque hemorrhage, necrotic lipid core, fibrous capsule, and calcification, in the coronary territory. In addition, other modalities such as nuclear medicine and intravascular ultrasound have been proposed to assess plaque stability (GRADE: low $_{G22\text{-}R3_Ref_7}$).[474]

Kang MK et al. published the results of a cohort of 150 patients with asymptomatic carotid atherosclerosis, recording 6 stroke events and 25 combined adverse outcomes at 5 years of follow-up. The peak systolic velocity/peak end-diastolic velocity ratio was associated with an elevated risk of stroke (HR = 1.502; 95% CI 1.036–1.968). The Framingham score had a C statistic of 0.646 for major CVD and 0.612 for the combined outcome, while the corresponding C statistic for ASCVD was 0.649. When ultrasound parameters were included, the C statistics increased to 0.937 and 0.856 (Framingham) and 0.941 and 0.886 (ASCVD) (GRADE: moderate $_{G22\text{-}R3_Ref_2}$).[475]

López-Melgar B et al. published a cohort of 3,514 asymptomatic patients (PESA Study), which showed progression of atherosclerosis at 3 years of follow-up in 41% of participants, detected by both ultrasound and computed tomography. In these patients (n=432), plaque progression was observed by two-dimensional US (median=1 plaque; interquartile range: 1 to 3 plaques), by 3D ultrasonography (increment=7.6 mm3; interquartile range: -32.2 to 57.6 mm3), and by CT (median=21.6 Agatston units; interquartile range: 4.8 to 62.6). De Novo development of atherosclerosis was observed in 33% of patients. Factors associated with this progression included age, sex, dyslipidemia, hypertension, smoking, and history of premature CVD. It is noteworthy that within the group of subjects considered at low risk, atherosclerosis progression was observed at 36.5%. Adverse outcomes not applicable (GRADE: moderate $_{G22\text{-}R3_Ref_4}$).[476]

A systematic review of patients with advanced atherosclerosis reported that patients with carotid atherosclerosis and echolucent plaques had a higher risk of ipsilateral stroke in the following 5 years compared to those with non-echolucent plaques (3.1%; 95% CI 2.1% to 4.1%, p = 0.009). After adjusting for risk factors, the HR was 2.52 (95% CI 1.20 to 5.25, p = 0.014) (GRADE: moderate $_{G22\text{-}R3_Ref_6}$).[477]

Chen PC et al. published a cohort of 38,201 patients with carotid atherosclerosis and showed that during the 4.2-year follow-up, 5,644 patients died, and 1,719 deaths were attributed to a cardiovascular cause. The risk of mortality increased with the percentage of obstruction: 30% to <40% (HR=1.33; 95% CI 1.16 to 1.53), 40% to <50% (HR=1.58; 95% CI 1.36 to 1.84), and ≥50% (HR=1.89; 95% CI 1.58 to 2.26) (GRADE: moderate $_{G22\text{-}R3_Ref_9}$).[478]

### *3.3.6.3 Diseases of the aorta*

CVRhP-P has been shown to improve exercise tolerance and HR-QoL in some patients with disease of aorta, with an adequate level of safety.

In a systematic review of six observational studies (n= 556 patients with disease of the aorta), Jepsen LR et al. reported that exercise training programs between 12 weeks and 12 months increased workload from 62.7 ± 11.8 W to 91.6 ± 16.5 W (p=0.002) and $VO_2$max from 23.5 ± 7.9 to 28.6 ± 8.4 $mlO_2$/kg/min (p= 0.001). Patients with a $VO_2$max value <70% predicted were associated with a higher risk of adverse cardiovascular events (HR = 4.31; 95% CI 1.63 to 11.3, p = 0.003), and those with a pulse oxygen level <85% were associated with a higher likelihood of aortic events (HR = 2.35; 95% CI 1.09 to 5.04, p = 0.027). A low incidence of serious

**Recommendation Table 15.** Cardiac arrhythmias

| PICO | 3.3.7 Cardiac arrhythmias | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G23-R3 | It is recommended that the intensity of physical exercise in patients with atrial fibrillation be established by workload, VO2, or the scale of perceived exertion (Borg scale 6-20), in an effort to achieve and maintain a moderate exercise intensity. | I | B-R | C-/B+ | 1 to 6 |
| G23-R1 | It is recommended that ThPhT sessions be monitored with a high level of electrocardiographic supervision and monitoring, based on individual stratification, in order to identify serious arrhythmias and, where appropriate, offer rapid and efficient intervention, such as cardiopulmonary resuscitation and defibrillation. | I | B-NR | C+/B+ | 1 to 6 |

adverse events was reported, and none were associated with exercise (GRADE: low $_{G22\text{-}R5_Ref_1}$).[479]

Early cardiac rehabilitation after surgical repair of acute type A aortic dissection has been shown to be safe and effective. Zhou et al., in a cohort study (n=73), reported an increase in workload (MD=19.6 ± 10.2 W, p< 0.001), oxygen uptake (MD=1.2 ± 0.6 METs, p< 0.001), and an increase in heart rate reserve from 20.2 ± 13.9 to 33.2 ± 16.8 bpm, p< 0.001). The maximum systolic blood pressure during training was 143 ± 14 mmHg and the diastolic blood pressure was 88 ± 14 mmHg. No major adverse events associated with exercise were reported (GRADE: low $_{G22\text{-}R5_Ref_2}$).[480]

Early mobilization after complex aortic surgery is associated with faster recovery and reduced utilization of hospital resources. In a cohort study of 199 patients undergoing elective total aortic arch replacement, early mobilization within the first two days reduced the time on mechanical ventilation from 40.7 h (IQR 14.0 to 96.0) to 10.0 h (IQR 7.0 to 17.0, p< 0.001), the ICU stay from 4 days (IQR 2.0 to 6.0) to 2 days (IQR 2.0 to 3.0), p< 0.001), the hospital stay from 25 days (IQR 21.0 to 37.0) to 18 days (IQR 16.0 to 25.0, p< 0.001), and the time to independent ambulation from 8 days (IQR 6.0 to 11.2) to 6 days (IQR 4.0 to 7.0, p< 0.001). No significant differences were reported regarding postoperative complications (GRADE: low $_{G22\text{-}R5_Ref_3}$).[481]

A systematic review (10 studies and 700 patients) highlighted that individualized aerobic training after spontaneous coronary artery dissection or aortic dissection (Stanford A/B, postsurgical, or medical) could be performed safely and effectively. In patients who trained more than 3 sessions/week and at 50–70% of $VO_2$max and light resistance training, a significant increase in $VO_2$max from 23.5 ± 7.9 to 28.6 ± 8.4 $mlO_2$/kg/min (p = 0.001) and in workload from 62.7 ± 11.8 to 91.6 ± 16.5 W (p = 0.002) was observed. A reduction in systolic (7.6 mmHg) and diastolic (4.7 mmHg) blood pressure was also shown (p < 0.01). Individualized progression of session duration, intensity, and frequency was emphasized. No high-intensity, isometric, or plyometric exercises were included. No serious exercise-related adverse events were reported. (GRADE: very low $_{G22\text{-}R5_Ref_4}$).[482]

**(KM)**: In patients with low-risk aortic disease who are stable or have undergone successful structural repair, individualized training is safe and associated with improved exercise tolerance, blood pressure control, and quality of life.

### 3.3.7 Cardiac arrhythmias

The supervision of patients undergoing a CVRP-P can range from the use of sophisticated monitoring instruments and recording of biological variables by highly specialized personnel to minimal communication with outpatients who manage their program autonomously.

There are several ways to maintain contact with the patient, many of them using innovative technology. These include conventional telephones, devices with vital sign readings and communication with the hospital, and smartphones. Electronic devices capable of remotely recording patient information and transmitting it remotely to the hospital have gained attention in recent years as a medical care modality. Improvement in physical capacity mediated remotely has been proven, although there are still no studies on the prevention of cardiovascular events and mortality associated with this type of session. Remote CVRP-P requires adequate patient risk stratification and highly trained online supervisory staff (GRADE: low $_{G23\text{-}R1_Ref_1}$).[483]

A systematic review of 13 studies with patients in CVRhP-P and the use of assistive technology devices to monitor telerehabilitation reported that included patients significantly improved their exercise capacity compared to those who did not use them. However, further research is needed to verify the usefulness and safety of these programs. Adverse events were not assessed (GRADE: very low $_{G23\text{-}R1_Ref_2}$).[484]

Keteyian SJ et al., in a cohort of 289 patients, sought to evaluate the frequency of cardiac events during electrocardiographic monitoring of patients in a

**Recommendation Table 16.** Congenital Heart Disease

| PICO | 3.3.8 Congenital Heart Disease | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G24-R1 | Patients with congenital heart disease are recommended to perform aerobic and strength training exercises, according to their risk stratification and the ThPhT planner, in order to increase exercise tolerance, muscle strength, and daily activity level. | I | B-R | C+/B+ | 1 to 6 |

*(Continues)*

**Recommendation Table 16.** Congenital Heart Disease *(continued)*

| PICO | 3.3.8 Congenital Heart Disease | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G24-R2 | It is recommended that pediatric patients with congenital heart disease be included in a CVRhP-P, with sessions for balance, coordination, strength, and flexibility, appropriate for their age, in order to improve HR-QoL and exercise tolerance. | I | B-R | C-/B+ | 1 to 6 |
| G24-R4 | It is recommended to identify the nutritional status of children with congenital heart disease in critical condition (ICU), in order to adapt rehabilitation treatment to the patient's energy status. | I | B-R | C-/B+ | 1 to 6 |
| G24-R3 | It is recommended that children with congenital heart disease start aerobic training at the beginning of puberty, in order to increase exercise tolerance. | IIa | B-R | C-/B+ | 1 to 6 |
| G25-R1 | It is recommended that patients with pulmonary arterial hypertension undergo highly supervised ThPhT, ideally in an inpatient setting, in order to increase exercise tolerance, HR-QoL, and decrease systolic pulmonary arterial pressure levels. It is important to weigh the risk-benefit in patients with severe PAH. | IIa | B-R | C+/B+ | 1 to 6 |

hospital-based CVRhP-P over 10 months. No events of sudden death, myocardial infarction, or sustained arrhythmias requiring hospitalization were observed in this study. Minor events (26%) were angina, non-sustained arrhythmias, and ST-segment depression. The rate of asymptomatic events was 3.8%, being higher in those who met ACC monitoring criteria (p<0.01). The training plan was changed for only 1.4% of patients due to ECG changes (GRADE: low $_{\text{G23-R1_Ref_4}}$).[485]

In 1986, an ACC position paper proposed that patients with CVRhP-P require electrocardiographic monitoring: a) Patients with a low LV ejection fraction (<30%). b) Ventricular arrhythmias at rest (Lown 4 or 5). c) Ventricular arrhythmias that appear or increase with exercise. d) Hypotensive response to exercise. e) Survivors of sudden cardiac death. f) Patients with myocardial infarction complicated by heart failure, cardiogenic shock, or severe ventricular arrhythmias. g) Patients with severe coronary artery disease and the presence of marked exercise-induced ischemia. h) Inability to self-monitor heart rate due to some physical or intellectual impairment (GRADE: low $_{\text{G23-R1_Ref_5}}$).[486]

In patients with HF and AF, heart rate can be controlled tightly. Patients with less tight control (resting HR > 110 bpm) did not show a higher incidence of major outcomes than those with tighter control, but they are less likely to require pacemaker implantation. Conversely, patients with very poor HR control may experience recurrent AF events with rapid ventricular response and compromise contractile function during exercise. The ESC recommends the use of drug therapy to control HR and simultaneous pacemaker implantation in certain patients. Accurate dosing and monitoring of exercise intensity using HR in patients with AF is difficult due to the chaotic nature of the rhythm. Thus, it is preferable to use a fixed load, set at 90% of the second aerobic-anaerobic threshold (respiratory compensation point, CRP) around 50% of VO2peak, which requires a CPET, and it is recommended that these patients train under telemetry control. Other methods for establishing intensity are subjective exercise evaluation scales, such as the Borg scale (6-20) at moderate levels (12-14) or the walk and talk scale. High-intensity exercises are not recommended for these patients, although some authors mention that they can be performed. Regarding strength exercise, 10 to 15 repetitions with an intensity of 50 to 70% of voluntary maximum repetition are recommended (GRADE: low $_{\text{G23-R3_Ref_1, G23-R3_Ref_3}}$).[487,488]

Themistocleous I et al. mention that patients with atrial fibrillation who perform aerobic exercise at an effort level of 11 to 14 on the Borg scale (Borg 6-20) have a HR between 50 and 80% of the RHR. If the patients performed strength exercise (40%-50% of a maximum repetition), they had a perception of effort between 11 and 12 (Borg 6-20) (GRADE: low $_{\text{G23-R3_Ref_2}}$).[489]

Shuqing Shi et al. published a meta-analysis of 12 studies and 819 patients with atrial fibrillation. They observed that exercise intensity was programmed either at 40% to 70% of the maximum workload or at a heart rate of 70% to 95% of the maximum HR. At the end, improvements in $VO_2$ and HR-QoL were observed. Adverse outcomes were not assessed (GRADE: moderate $_{\text{G23-R3_Ref_4}}$).[490]

**(KM)** The prescription of ThPhT in patients with heart disease always uses exercise heart rate as the central parameter. The chronotropic response to exercise depends on variables intrinsic to the cardiac excitation-conduction system and extrinsic variables, primarily the autonomic nervous system. Atrial fibrillation (AF) poses a significant challenge in terms of prescription, monitoring, and control, as it is a chaotic rhythm that does not accurately indicate cardiovascular status and is very difficult to control.

### 3.3.8 Congenital Heart Disease

The individualized prescription of ThPhT in children, adolescents and adults with congenital heart disease is supported by growing evidence of its physiological, functional, and psychosocial benefits. Numerous studies have shown that structured physical activity, especially at moderate to vigorous intensity, is not only safe in this population but also generates significant adjustments in various health domains.

A recent meta-analysis (Wang et al., 2023) including 2,724 children and adolescents with obesity found that moderate/high intensity, compared to low intensity or no exercise, significantly increased maximal oxygen consumption (MD: 1.43 $mlO_2$/kg/min; 95% CI 0.04 to 2.82, p= 0.04) and markedly reduced diastolic blood pressure (MD: -6.94 mmHg), systolic blood pressure (MD: -8.11 mmHg), heart rate (MD: -2.77 bpm), and body weight (MD: -2.03 kg) (GRADE: moderate $_{G24\text{-}R2_Ref_1}$).[491]

Likewise, in patients with congenital heart disease, the Cochrane meta-analysis by Williams et al. (2020) (15 studies, 924 patients) demonstrated mild to moderate improvements in exercise tolerance: increased peak $VO_2$ (MD: 0.89 $mlO_2$/kg/min; 95% CI: -0.22 to 3.99) and submaximal $VO_2$ (MD: 2.05 $mlO_2$/kg/min; 95% CI: 0.05 to 4.05), as well as improvements in daily physical activity (SMD= 0.38) and muscle strength (SMD= 17.13 Nm). No hospitalizations or serious complications were reported, and the few adverse events were mild and non-fatal (GRADE: moderate $_{G24\text{-}R2_Ref_2}$).[492]

Intensive and tailored CVRhP-P, such as the one described by Gauthier et al., have been shown to be feasible, safe, and well-accepted by families, especially when they integrate motivational elements, technological tools, emotional support, and effective care coordination. These programs propose a progressive and personalized model with structured monitoring (GRADE: very low $_{G24\text{-}R2_Ref_3}$).[493]

The CPG in Canada recommends starting exercise prescription from childhood, emphasizing that physical activity is safe in most children with congenital heart disease, and should be part of clinical management, even in complex cases (GRADE: moderate $_{G24\text{-}R2_Ref_4}$).[494]

Systematic and narrative reviews agree that structured exercise programs—outpatient, home-based, or camp-based—improve exercise tolerance, motor skills, muscle strength, and HR-QoL, with no reports of serious adverse events (GRADE: very low $_{G24\text{-}R2_Ref_5,\ G24\text{-}R2_Ref_6,\ G24\text{-}R2_Ref_7}$).[495,496,497]

Despite these benefits, up to 46% of children with congenital heart disease do not meet international recommendations for moderate to vigorous physical activity. Objective assessments using accelerometry or questionnaires show low levels of adherence, emphasizing the need for personalized prescription based on mixed data and aimed at improving adherence from an early age (GRADE: very low $_{G24\text{-}R2_Ref_8,\ G24\text{-}R2_Ref_9}$).[498,360]

International positions, such as those of the European Society of Cardiology (ESC) and the European Association of Pediatric and Congenital Cardiology (EAPC), reinforce the need for an individualized risk assessment, beyond the anatomical diagnosis, which includes hemodynamic and functional parameters to determine the type, intensity, and frequency of exercise. These organizations agree that the benefits far outweigh the risks in most cases (GRADE: low $_{G24\text{-}R2_Ref_10}$).[173]

A recent (2023) systematic review of 35 studies and over 3,200 children with congenital heart disease concluded that supervised exercise programs, tailored to individual ability, improve aerobic capacity, physical activity, motor skills, and HR-QoL, with no serious adverse events reported (GRADE: moderate $_{G24\text{-}R2_Ref_11}$).[499]

The meta-analysis by Villaseca-Rojas et al. confirmed that children and adolescents with congenital heart disease have a significantly lower exercise capacity than their healthy peers, especially during adolescence. This finding underscores the need for exercise programs that are not only aerobics, but also target balance, coordination, strength, and flexibility, tailored to the patient's stage of development and individual conditions (GRADE: low $_{G24\text{-}R2_Ref_12}$).[500]

The cornerstone of CVRhP-P is ThPhT, which combines a series of aerobic and resistance (strength) exercises. Strength training has gained popularity in recent years in various pathologies, including HF. Callaghan S et al. conducted a controlled clinical trial with 163 children (5 to 10 years of age) with congenital heart disease (CHD), where the intervention was ThPhT. Initially, it was observed that patients had a good exercise

capacity, although those with cyanotic heart disease and palliative treatment had lower tolerance for activities of daily living. In the intervention group (CVRhP-P), an increase in peak exercise capacity and increased daily activity levels were observed compared to the control group. (GRADE: low $_{G24\text{-}R1_Ref_1}$).[501]

A controlled clinical trial in postoperative patients with Tetralogy of Fallot and others with Fontan surgery showed that workload increased in the ThPhT group (+6.9 ± 11.8 Watts) compared to the control group (0.8 ± 13.9 Watts), p= 0.047. Adverse events were assessed and were negative (GRADE: high $_{G24\text{-}R1_Ref_3}$).[502]

Amedro, P and collaborators published a controlled clinical trial with patients with CHD and poor functional capacity, which showed that patients in mixed ThPhT (aerobic and strength), presented a significant improvement in their HR-QoL (DM= 3.8; 95% CI from 0.2 to 7.3, p = 0.038, effect size 0.34), in the body mass index (DM= -0.7 kg/m2; 95% CI from -1.3 to -0.1, p = 0.022, effect size = 0.41), level of physical activity (DM= 2.5; 95% CI from 0.1 to 5, p = 0.044, effect size = 0.39) and level of knowledge of their disease (DM= 2.7; 95% CI from 0.8 to 4.6, p = 0.007, effect size = 0.51). Adverse outcomes were assessed and negative (GRADE: high $_{G24\text{-}R1_Ref_4}$).[503]

A cohort of adolescents with CHD showed that after CVRhP-P (mixed aerobic and resistance exercise), patients had a significant increase in biceps and quadriceps grip strength, as well as an improvement in triceps surae fatigability, changes that were maintained at 6 months after the maneuver. The observed changes ranged from 17% to 80% (p<0.001). Adverse outcomes assessed and negative (GRADE: low $_{G24\text{-}R1_Ref_5}$).[504]

Williams CA published a meta-analysis with 15 articles and 924 patients with congenital heart disease showed that exercise tolerance improved with ThPhT compared to control (MD= 1.89 $mlO_2$/kg/min; 95% CI: -0.22 to 3.99). The evidence regarding HR-QoL was very low (SMD= 0.76; 95% CI: -0.13 to 1.65). A small improvement in daily physical activity was also observed (SMD= 0.38; 95% CI: -0.15 to 0.92, low evidence), equivalent to approximately 10 minutes more per day. ThPhT was associated with greater muscle strength (MD=17.13; 95% CI: 3.45 to 30.81m). Adverse events had a low incidence with 36% of cardiovascular origin and no serious events, including fatalities. Adverse events if assessed, infrequent and of low severity (GRADE: high $_{G24\text{-}R1_Ref_7}$).[492]

Jones RA et al. published a randomized controlled trial of 97 healthy children aged 3 to 5 years. Those in the structured physical training group showed improved overall movement skill development (adjusted difference = 2.08, 95% CI 0.76 to 3.40, Cohen's d = 0.47) compared to the control group, which was associated with increased preschool measured daily physical activity time (MD= 110.5, 95% CI 33.6 to 187.3, Cohen's d = 0.46). Adverse outcomes were not assessed (GRADE: low $_{G24\text{-}R3_Ref_2}$).[505]

In a randomized controlled trial of 18 patients with congenital heart disease, a significant increase in maximum voluntary contraction was shown in the training group (mean = 101.6 ± 14.0 vs. 120.2 ± 19.4 Nm, p < 0.01), time to fatigue (mean = 66.2 ± 22.6 vs. 86.0 ± 23.0 s, p< 0.01), and increase in oxygenation (0.20 ± 0.13 vs. 0.15 ± 0.07, p< 0.01). No improvement in cardiopulmonary testing results was observed between the two groups. Adverse outcomes were not assessed (GRADE: low $_{G24\text{-}R3_Ref_3}$).[506]

A meta-analysis of 15 studies and 924 patients with congenital heart disease showed that exercise tolerance improved with ThPhT compared with control (MD=1.89 $mlO_2$/kg/min; 95% CI -0.22 to 3.99). The

**Recommendation Table 17.** Pulmonary arterial hypertension

| PICO | 3.3.9 Pulmonary arterial hypertension | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G25-R4 | Patients with stable pulmonary arterial hypertension and optimal treatment are recommended to enter a highly supervised ThPhT program, seeking improvement in quality of life and exercise tolerance. | IIa | B-R | C+/B+ | 1 to 6 |
| G25-R3 | Patients with pulmonary arterial hypertension are recommended to perform ThPhT based on breathing exercises, aerobic and strength training, highly supervised and at low intensity, seeking to improve distance covered in the 6-minute walk test, peak VO2 and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |
| G25-R2 | It is recommended that patients with pulmonary arterial hypertension in functional class I and II perform strength training exercises using isolated muscle groups, with low workloads, according to their risk stratification, with the aim of improving sarcopenia, muscle strength, exercise tolerance and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |

evidence regarding HR-QoL was very low (SMD= 0.76; 95% CI -0.13 to 1.65). A small improvement in daily physical activity was also observed (SMD= 0.38; 95% CI -0.15 to 0.92, low evidence), equivalent to approximately 10 minutes more per day. ThPhT was associated with an increase in muscle strength (MD=17.13; 95% CI 3.45 to 30.81 m, moderate evidence). Adverse events had a low incidence, with a 36% prevalence of cardiovascular events and no serious events, including fatalities (moderate certainty). Adverse outcomes, if assessed, were infrequent and of low severity (GRADE: high $_{G24\text{-}R3_Ref_4}$).[492]

A meta-analysis of 28 studies and 1,288 healthy, athletic children concluded that although children are thought to be aerobically capable of training, the meta-analysis indicated that the changes in children's $VO_2$ max produced by exercise training were small to moderate, with inconsistent data. Adverse events were not assessed (GRADE: moderate $_{G24\text{-}R3_Ref_5}$).[507]

A cross-sectional study of 103 children with no evidence of heart disease who underwent cardiopulmonary testing showed that the average exercise time was 11 ± 4 min and there were no complications. Peak $VO_2$ correlated with height in both boys and girls (both r = 0.84, p < 0.001). Multivariate regression analysis showed that the variables associated with peak $VO_2$ were body surface area, exercise time, gender, and heart rate reserve. In children, peak $VO_2$ increases directly with age until, at 13 years of age, an inflection point is observed that stabilizes the curve and can be interpreted as the level of maturation of the aerobic machinery. Adverse events were assessed and negative. (GRADE: moderate $_{G24\text{-}R3_Ref_6}$).[216]

Early initiation of nutrition in children with critically ill congenital heart disease, once hemodynamic stability has been achieved, contributes to better clinical outcomes following cardiac surgery. A meta-analysis including 17 studies and a total of 609 patients showed that the use of high-energy and/or high-protein infant formulas was associated with a significant weight gain (MD= 0.5 kg; 95% CI 0.23 to 0.77), as well as a clinically relevant reduction in the duration of mechanical ventilation (MD= -17.45 h; 95% CI -27.30 to -7.60, p < 0.001), intensive care unit stay (MD= -1.45 days; 95% CI -2.36 to -0.54, p = 0.002), and total hospital stay (MD= -2.82 days; 95% CI -5.22 to -0.43, p = 0.02). No significant increase in food intolerance was found (RR = 1.09; 95% CI 0.80 to 1.48; p = ns), and no statistically significant reductions were observed in the incidence of infections (RR = 0.68; 95% CI 0.25 to 1.87, p = 0.46) or mortality (RR = 1.50; 95% CI 0.47 to 4.82, p = 0.49), the clinical trend was favorable (GRADE: high $_{G24\text{-}R4_Ref_1}$).[508]

In addition, a pilot randomized clinical trial evaluated the effect of an early enriched enteral feeding strategy (using lipid- and protein-fortified breast milk) in infants younger than six months with congenital heart disease following cardiac surgery. Although no statistically significant differences were reported in the duration of mechanical ventilation (123.2 ± 107.0 h vs. 153.6 ± 149.0 h; p = 0.20), ICU stay (11.0 ± 6.1 days vs. 13.2 ± 8.9 days; p= 0.14), or total hospital stay (14.1 ± 7.0 days vs. 16.5 ± 9.8 days; p= 0.17), the results consistently favored the intervention group, with absolute reductions of 2.2 and 2.4 days in critical care and general hospitalization outcomes, respectively. Furthermore, a higher caloric intake was observed in the intervention group on the tenth postoperative day (127.2 ± 56.1 kcal vs. 87.1 ± 38.3 kcal; p< 0.05), with no adverse events attributable to the intensified nutritional support. These findings support the feasibility and safety of implementing early and reinforced nutritional strategies, even in critically ill infants (GRADE: moderate $_{G24\text{-}R4_Ref_2}$).[509]

**(KM)** Early initiation and tailored prescription of CVRhP-P are essential to maximize physiological, functional, and psychosocial benefits. These interventions are safe and significantly improve exercise capacity, muscle strength, functional status, and health-related quality of life in children, adolescents, and adults with congenital heart disease.

### *3.3.9 Pulmonary arterial hypertension*

Pulmonary arterial hypertension (PAH) is a type of high blood pressure in the lungs that causes narrowing, blockage, or destruction of the pulmonary arteries, increasing resistance to blood flow and increasing pressure on the right side of the heart.

Leggio M et al. describe that physical exercise does not play a role in the reversal of pulmonary arterial hypertension but rather improves the clinical course. Traditionally, physical exercise has not been recommended in patients with pulmonary arterial hypertension due to the significant structural and functional alterations in the minor circulation. Recently, several articles have demonstrated the safety and efficacy of ThPhT in these patients (exercise capacity, peak $VO_2$, and HR-QoL). To date, there is no rigorous and comprehensive evidence on the mechanisms that generate these beneficial effects. Adverse events were poorly assessed (GRADE: very low $_{G25\text{-}R1_Ref_1}$).[510]

In patients with pulmonary arterial hypertension, a meta-analysis (9 studies; n=302) showed that ThPhT significantly improves exercise tolerance: peak $VO_2$ (MD= 2.79 $mlO_2$/kg/min; 95% CI 2.00 to 3.59; p<0.00001), anaerobic threshold (MD= 107.83 $mlO_2$/min; 95% CI 39.64 to 176.00; p= 0.002), 6MWT distance (MD= 46.67 m; 95% CI 32.39 to 60.96; p<0.00001) and HR-QoL in its physical component SF-36 (MD= 3.57; 95% CI 2.04 to 5.10) and mental component (MD= 3.92; 95% CI 1.92 to 5.91). Adverse events were reported in ≥5 studies (GRADE: moderate $_{G21\text{-}R4_Ref_2}$).[511]

A meta-analysis of 16 studies and 469 patients with chronic pulmonary arterial hypertension showed that ThPhT was associated with significant improvements in 6MWT (MD= 53.3 m; 95% CI 39.5 to 67.2), peak $VO_2$ (MD= 1.8 $mlO_2$/kg/min; 95% CI 1.4 to 2.3), pulmonary artery systolic pressure (MD= -3.7 mmHg; 95% CI -5.4 to -1.9), peak exercise HR (MD= 10 bpm; CI 6 to 15), and SF-36 HR-QoL. Adverse events assessed (GRADE: high $_{G25\text{-}R1_Ref_2}$).[512]

Grünig E et al. conducted an uncontrolled clinical trial with 183 patients with pulmonary arterial hypertension, showing a significant improvement associated with ThPhT in relation to the baseline measurement, in the distance walked in the 6MWT, HR-QoL, functional class (WHO), $VO_2$peak, oxygen pulse, heart rate and systolic pulmonary pressure at rest and with maximum load. This was observed in all types of PAH. They recorded a 13% of adverse events in patients, particularly syncope and respiratory infections. (GRADE: low $_{G25\text{-}R1_Ref_3}$).[513]

A meta-analysis of 12 studies and 449 patients with pulmonary arterial hypertension showed significant improvements associated with ThPhT in 6MWT walking distance, HR-QOL, $VO_2$ (peak and aerobic-anaerobic threshold), and heart rate. Adverse outcomes were not assessed (GRADE: moderate $_{G25\text{-}R1_Ref_4}$).[514]

In patients with pulmonary arterial hypertension, a meta-analysis (9 studies; n=302) showed that ThPhT significantly improves exercise tolerance: peak $VO_2$ (MD= 2.79 $mlO_2$/kg/min; 95% CI 2.00 to 3.59; p<0.00001), anaerobic threshold (MD= 107.83 $mlO_2$/min; 95% CI 39.64 to 176.00; p= 0.002), 6MWT distance (MD= 46.67 m; 95% CI 32.39 to 60.96; p<0.00001) and HR-QoL in its physical component SF-36 (MD= 3.57; 95% CI 2.04 to 5.10) and mental component (MD= 3.92; 95% CI 1.92 to 5.91). Adverse events were not assessed. (GRADE: moderate $_{G21\text{-}R4_Ref_2}$).[515]

In patients with pulmonary arterial hypertension (PAH), impaired skeletal muscle function is a key pathogenetic component contributing to exercise intolerance. An observational study identified a reduction in quadriceps cross-sectional area and a decrease in the proportion of type I fibers, accompanied by activation of muscle catabolic pathways (atrogin-1, MuRF1) and suppression of anabolic signals such as AKT and p70S6. Likewise, alterations in proteins associated with mitochondrial fusion (low levels of Mitofusin2) and failures in excitation-contraction coupling, evidenced by ryanodine receptor dysfunction, were observed. These findings suggest that the loss of muscle mass and function in PAH is not solely a consequence of inactivity, but rather a complex molecular process that could benefit from targeted strategies such as mild muscle strength training (GRADE: low $_{G25\text{-}R2_Ref_1}$).[516]

A systematic review of 32 studies with 628 patients with PAH showed that combined exercise programs, including strength and respiratory training, significantly improved ExTol (increased distance in the six-minute walk test and peak oxygen uptake), decreased right ventricular hypertrophy, and promoted psychological well-being. Reported benefits include improved HR-QoL and nitric oxide synthesis. Importantly, a low incidence of adverse events was reported, with 10 studies reporting no events and only 4 reporting non-serious events. (GRADE: low $_{G25\text{-}R2_Ref_2}$).[517]

A meta-analysis of 17 studies involving 651 patients with stable pulmonary hypertension on optimal medical treatment specifically evaluated the impact of structured ThPhT, including low-load muscle strengthening exercises. Results showed a significant increase in 6MWT (MD= 64.75 m; 95% CI 53.19 to 76.31, p< 0.001), as well as an improvement in peak $VO_2$ (MD= 1.78 $mlO_2$/min/kg; 95% CI 1.27 to 2.29, p< 0.001), and an increase in peak HR (MD= 11.07 bpm; 95% CI 8.04 to 14.11, p< 0.001). In addition, a significant improvement in HR-QoL was reported as measured by the SF-36 questionnaire. Importantly, no major adverse events were documented related to strength training, which was performed with low-weight dumbbells (500 to 1,000 g) across different muscle groups. (GRADE: high $_{G25\text{-}R2_Ref_3}$).[518]

In a randomized clinical trial involving 22 patients with PAH in functional class II-III under stable medical treatment, a four-week oscillatory body vibration intervention achieved significant improvements in 6MWT (MD= 39.7 m, p= 0.004), $VO_2$ peak (MD= 65.7 $mlO_2$/min) and anaerobic threshold (MD= 40.9 $mlO_2$/min). A gain in muscle power (MD= 4.4%) and a clinically relevant improvement in HR-QoL were also documented, both in the SF-36 questionnaire (MD= 9.7

points) and in the Living with Pulmonary Hypertension questionnaire (MD= –11.5 points, p<0.05). No adverse events were reported (GRADE: high $_{G25\text{-}R2_Ref_4}$).[519]

The available evidence supports the use of ThPhT in clinically stable patients with PAH. A meta-analysis published in 2023 (28 studies and 1,264 patients with PAH) reported that the implementation of structured physical exercise programs was associated with a significant improvement in 6MWT distance in randomized trials (MD= 49.5 m; 95% CI: 27.2 to 71.8; $I^2$ = 73%) and in pre/post trials (MD= 68.69 meters; 95% CI: 50.5 to 86.69, $I^2$ = 36%). A significant increase in peak $VO_2$ was also observed (MD= 3.03 $mlO_2$/kg/min; 95% CI 2.17 to 3.90; $I^2$ = 0%) and a trend towards improvement in HR-QoL (MD= 2.74 points; 95% CI -0.82 to 6.30). The adverse event rate was 8.5% (98 events in 1,152 cases) (GRADE: high $_{G25\text{-}R4_Ref_1}$).[520]

A randomized clinical trial of 116 patients with primary PAH or pulmonary hypertension due to chronic thromboembolism, enrolled in a standardized ThPhT program with in-hospital initiation (mean duration 25 days) followed by a home phase, demonstrated a statistically significant improvement in 6MWD distance (MD= 34.1 ± 8.3 m, p< 0.0001), HR-QoL in the mental component (p= 0.004), WHO functional class (p= 0.027) and $VO_2$peak (p= 0.048). No significant adverse events were reported, confirming the feasibility and safety of ThPhT as an adjunct to medical therapy. The intervention was well tolerated in clinically stable patients with criteria like those described previously (GRADE: high $_{G25\text{-}R4_Ref_3}$).[521]

Boutou AK et al. published a controlled clinical trial with 9 patients that evaluated the acute effects of oxygen therapy during submaximal exercise in patients with PAH or stable chronic thromboembolism. Oxygen supplementation was associated with a significant increase in ExTol (p = 0.01), greater cerebral oxygenation (p = 0.02), improvement in autonomic modulation (p < 0.05), and increased cardiac output during exercise (p < 0.05). No adverse events were reported (GRADE: moderate $_{G25\text{-}R4_Ref_2}$).[522]

Yan L et al published a meta-analysis of 8 studies and 234 patients with pulmonary arterial hypertension, showing that highly supervised in- and out-of-hospital aerobic ThPhT was associated with an improvement in 6MWT meters walked compared to the control group (MD= 51.94 m; 95% CI 27.65 to 76.23 m, GRADE: low), $VO_2$peak (MD= 2.96 $mlO_2$/kg/min; 95% CI 2.49 to 3.43, GRADE: low) (GRADE: high $_{G25\text{-}R3_Ref_1}$).[523]

In 2021, a meta-analysis of 6 studies and 234 patients with pulmonary arterial hypertension showed that with highly supervised aerobic and strength-based ThPhT, 6MWT distance increased in the exercise group (MD= 70.14 m; 95%CI 58.33 to 81.95, $I^2$=0) and peak $VO_2$ (MD= 1.84 $mlO_2$/min/kg; 95%CI 0.72 to 2.96, p= 0.001). Mean pulmonary artery pressure decreased (MD= -12.17 mmHg; 95%CI -14.53 to -9.82, p< 0.001, $I^2$=99%), and the change in HR-QoL was very heterogeneous. NT-proNBP levels did not change significantly (GRADE: high $_{G25\text{-}R3_Ref_2}$).[524]

Xiaomei Z et al. performed a meta-analysis with 17 studies and 651 patients suffering from pulmonary arterial hypertension and showed that highly

**Recommendation Table 18.** Dysautonomia

| PICO | 3.3.10 Dysautonomia | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G26-R4 | It is recommended that patients with dysautonomia have a high daily intake of salt (6 to 10 g) and fluids (1.5 to 3 l), as tolerated, individualized and dose-response, in the search for improvement of symptoms and a reduction in the frequency of syncopes. | I | B-R | C-/B+ | 1 to 6 |
| G26-R1 | It is recommended that patients with dysautonomia perform aerobic-based training, in horizontal mode (swimming or recumbent cycle ergometer) and continue with conventional cycle ergometry and treadmill, in order to improve exercise tolerance, HR-QoL and reduce frequency of syncope, and improve neurosympathetic activity. | IIa | B-R | C-/B+ | 1 to 6 |
| G26_R2 | It is recommended that patients with dysautonomia perform strength training, preferably in the lower limbs, in order to improve quality of life, exercise tolerance, and the occurrence of syncope. | IIa | B-NR | C+/B+ | 1 to 6 |
| G26-R5 | It is recommended that patients with dysautonomia be assessed for depression or anxiety in order to identify and treat it early. | IIa | B-NR | C-/B+ | 1 to 6 |
| G26-R3 | Patients with dysautonomia and POTS are recommended to perform orthostatic challenge training to reduce the number of syncopal episodes and improve autonomic nervous system function. | IIb | C-EO | C-/B+ | 1 to 6 |

supervised, light-intensity respiratory, aerobic, and resistance-based ThPhT was associated with an increase in 6MWT (MD= 64.75 m; 95%CI 53.19 to 76.31 m, p< 0.001), $VO_2$peak (MD= 1.78 ml$O_2$/min/kg; 95%CI 1.27 to 2.29, p<0.001), peak HR (MD= 11.07 bpm; 95%CI 8.04 to 14.11, p<0.001) and HR-QoL. No major adverse events were observed (GRADE: high $_{G25\text{-}R3_Ref_3}$).[525]

In 2023, a systematic review of 14 studies and 462 patients with pulmonary arterial hypertension showed that HR-QoL in the physical component improved in the training group (MD= 3.98 points; 95% CI 1.89 to 6.07, MI = 38%; moderate certainty) and the mental component (MD= 3.60; 95% CI 1.21 to 5.98 points, moderate evidence) and pulmonary arterial pressure decreased (MD= 9.29 mmHg; 95% CI −12.96 to −5.61; low certainty). Adverse events were assessed and were negative (GRADE: moderate $_{G25\text{-}R3_Ref_7}$).[526]

Nagel C et al. published a randomized controlled trial in 43 patients with pulmonary arterial hypertension, showing that low-dose ThPhT significantly improved pulmonary arterial compliance (MD= 0.39 ml/mmHg; 95% CI 0.15 to 0.94 ml/mmHg, p= 0.004) and right ventricular stroke volume (MD= 14.2 ml; 95% CI 6.5 to 21.8 ml, p< 0.001). Adverse events were not assessed (GRADE: moderate $_{G25\text{-}R3_Ref_10}$).[527]

**(KM)** Nowadays, patients with pulmonary arterial hypertension can participate in the CVRhP-P program, including those at high risk, always with the support of highly skilled staff.

### 3.3.10 Dysautonomia

Dysautonomia is a clinical entity that can present with a wide variety of symptoms, sometimes disabling. Treatment typically ranges from recommending general measures to prescribing medications or installing cardiac stimulation devices, depending on the etiology and severity of the case. In recent years, there has been an increase in the prevalence of this disorder, particularly in association with COVID-19.

Salt and fluid supplementation in patients with dysautonomia has been associated with clinical improvement in multiple orthostatic intolerance syndromes. A meta-analysis of 14 studies involving 391 patients with orthostatic hypotension, syncope, postural orthostatic tachycardia syndrome (POTS), and idiopathic orthostatic tachycardia reported that high salt (6–10 g/day) and fluid (1.5–3 L/day) intakes were significantly associated with increased time to presyncope (MD= 1.57 min; 95% CI 1.26 to 1.88), increased systolic blood pressure (MD= 12.27 mmHg; 95% CI 10.86 to 13.68), and decreased heart rate (MD= -3.97 bpm; 95% CI -4.08 to -3.86). 62.3% of patients reported symptomatic improvement (95% CI 51.6 to 72.6) and there were no reports of relevant adverse effects (GRADE: moderate $_{G26\text{-}R4_Ref_2}$).[528]

Williams EL et al. published a meta-analysis (7 studies and 378 patients with vasovagal syncope and POTS) that evaluated dietary salt supplementation for three months, finding a significant improvement in susceptibility to syncope, as well as in orthostatic tolerance, associated with an increase in plasma volume, better peripheral vascular response, and greater cerebral autoregulation. In patients with POTS, clinical and hemodynamic improvements were also observed, with no significant adverse events reported. These findings suggest that the hemodynamic effect of salt supplementation may be a useful pathophysiological mechanism in the therapeutic approach to dysautonomia (GRADE: moderate $_{G26\text{-}R4_Ref_3}$).[529]

Stock JM et al. support that increased salt and fluid intake may improve orthostatic symptoms in the short term, although they warn of possible long-term adverse effects on target organs such as the heart, kidneys, and autonomic nervous system. While the quality of evidence is limited and long-term effects should be carefully assessed, the immediate clinical benefit observed supports its use under individualized medical supervision (GRADE: very low $_{G26\text{-}R4_Ref_1}$).[530]

Individualized strength training, especially for lower limb muscles, has beneficial effects on improving autonomic and functional symptoms in patients with dysautonomia.

In a cohort of adolescents with dysautonomia referred to a tertiary cardiology center, the inclusion of an eight-week strength exercise program resulted in significant improvements in overall HR-QoL (65.2 vs. 48.9, p = 0.006), psychosocial (65.8 vs. 50.0, p = 0.010), and physical (62.5 vs. 43.8, p = 0.007) domains. In addition, an increase in ExTol was observed (9.1 vs. 8.0 minutes of exercise, p = 0.005). No adverse events were reported (GRADE: low $_{G26\text{-}R2_Ref_1}$).[531]

In older adults with orthostatic hypotension, the implementation of a home-based resistance exercise program using elastic bands showed significant increases in muscle strength, measured in specific exercises such as chest press (p= 0.017), quadriceps extension (p= 0.017), and leg press (p= 0.025). In addition, seven of eight participants improved their performance in the Timed Up & Go functional

test, indicating relevant functional benefits. (GRADE: low $_{G26\text{-}R2_Ref_2}$).[532]

A recent clinical trial in older adults with orthostatic hypotension found that a strengthening program targeting lower extremity muscles resulted in increases in calf muscle strength (MD= 21%, p= 0.018), with no statistically significant changes in muscle pump (MD= –10%, p= 0.8) or postural blood pressure (p = 1.0). No adverse events were reported (GRADE: low $_{G26\text{-}R2_Ref_4}$).[533]

An expert position paper on POTS highlights that progressive physical exercise, including strength training, can reduce the frequency of orthostatic symptoms and improve exercise tolerance. These non-pharmacological interventions are recommended as mainstays of initial treatment due to their safety and the effects observed on HR-QoL (GRADE: very low $_{G26\text{-}R2_Ref_3}$).[534]

Fu Q et al. recommend that patients with dysautonomia and postural orthostatic tachycardia syndrome (POTS) undergo ThPhT early to improve their fitness and increase circulating blood volume with fluid and salt intake. They conducted an analysis on non-pharmacological treatment for patients with POTS and recommend starting with 15-20 minute strength training sessions once a week, gradually increasing to two sessions of 30-40 minutes. They suggest using “horizontal” training such as swimming at the beginning, allowing for less abrupt progress. Exercise intensity and duration should subsequently be increased. Exercises such as leg presses, leg extensions, leg curls, and calf raises performed in a seated position or at home with resistance bands can improve venous return, increase muscle strength, and reduce orthostatic symptoms. Physical countermeasure maneuvers (squats, muscle pumps, negative pressure breathing) are also recommended. These effects, although based on low-quality evidence, are clinically relevant given the chronic and debilitating nature of the disorder. There are no randomized studies. No adverse events were assessed (GRADE: very low $_{G26\text{-}R2_Ref_5}$).[535]

A consensus of experts in CVRhP-P mentions that the inclusion of resistance exercises in rehabilitation programs for patients with dysautonomia can increase the sensitivity of arterial baroreceptors, which contributes to better autonomic regulation. This effect may explain the reduction in the frequency of syncopal episodes observed clinically in these patients (GRADE: low $_{G26\text{-}R2_Ref_6}$).[215]

Saeidi M et al. described that peak $VO_2$ in patients with POTS is lower than that observed in healthy controls. During exercise, patients with POTS present a rapid increase in HR and a reduced stroke volume, regardless of the exercise load, and there do not appear to be differences between them and healthy controls in ExTol. The relationship between cardiac output and $VO_2$ is similar between patients with POTS and controls. ThPhT in patients with POTS increases ventricular volume and peak $VO_2$, while increasing stroke volume and decreasing HR during exercise. The authors suggest that the tachycardia is due to a decrease in stroke volume. Events not assessed (GRADE: very low $_{G26\text{-}R1_Ref_3}$).[536]

A randomized controlled trial of 34 patients with POTS found no significant differences in R-R intervals between subjects undergoing ThPhT and healthy controls. The transfer gain function (systolic blood pressure multiplied by the RR ratio) was used as an index of artery-to-heart baroreflex sensitivity and was similar in patients and controls at both low frequencies (LF, p= 0.470) and high frequencies (HF, p= 0.663). ThPhT was associated with a reduction in standing HR and an increase in RRI variability. Low frequency baroreflex gain increased in the supine and standing positions after the ThPhT program (p = 0.04), but no changes were observed in healthy controls. Outcomes were not assessed (GRADE: low $_{G26\text{-}R1_Ref_5}$).[537]

Gardenghi G et al. conducted a randomized controlled trial with 70 patients with neurally mediated syncope and showed that ThPhT improved baroreflex sensitivity after 4 months. No changes were observed in the orthostatic challenge, pharmacological treatment, and control group. Patients with orthostatic challenge did not have syncopal episodes after the maneuver in contrast to the other 3 groups where between 2 and 4 episodes were observed (GRADE: moderate $_{G26\text{-}R1_Ref_6}$).[538]

Winker R et al. conducted a randomized controlled trial with 31 patients with orthostatic intolerance and found that after a period of EAMC training, only 6 of 16 subjects (38%) persisted with orthostatic intolerance compared to 10 of 11 in the control group (90%), p=0.008. Furthermore, the subjects in the training group showed an improvement in symptoms compared to the control group. Adverse events were not assessed (GRADE: moderate $_{G26\text{-}R1_Ref_7}$).[539]

In 2017, a case series with eight patients with dysautonomia showed that ThPhT improved $VO_2$peak, maximal HR, decreased resting HR, and mean arterial pressure. In addition, improvements were observed in the carotid baroreceptor reflex and orthostatic resistance. Adverse events not assessed (GRADE: very low $_{G26\text{-}R1_Ref_9}$).[540]

**Recommendation Table 19.** Athletes with heart disease

| PICO | 3.3.11 Athletes with heart disease | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G27-R2 | It is recommended to perform risk stratification in athletes with heart disease on an individualized and comprehensive basis, seeking to assign an appropriate risk category for the recommendation for return to sports. | I | C-LD | C+/B+ | 1 to 6 |
| G27-R1 | It is recommended to evaluate athletes with heart disease in a comprehensive and individualized manner, in order to issue a rational opinion on eligibility or sports disqualification, in order to reduce the risk of sudden death associated with the practice of intense physical activity and, on the other hand, avoid unnecessary abandonment of sports practice. | IIa | C-LD | C+/B+ | 1 to 6 |
| G27-R3 | It is recommended that athletes who have been medically disqualified from participating in sports be evaluated by mental health specialists, particularly to identify depression or anxiety, in order to detect this problem early and initiate appropriate treatment. | IIa | C-LD | C-/B+ | 1 to 6 |

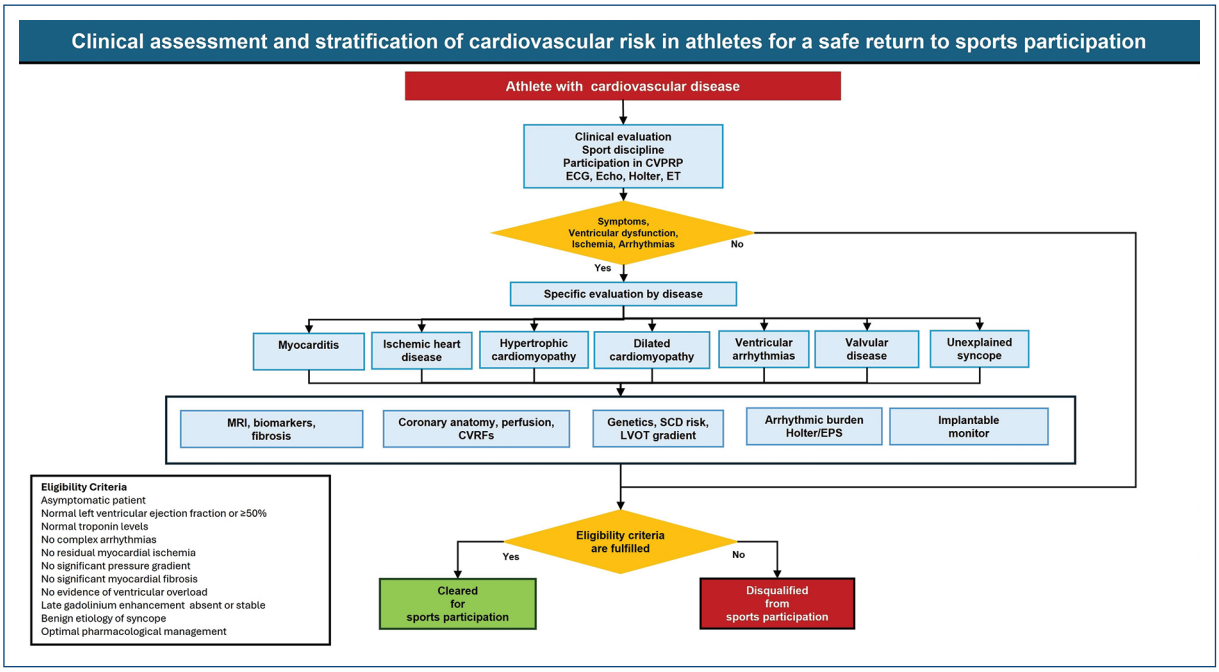


**Figure 25.** Stratification of Athletes with CVD. Risk assessment and stratification for athletes with cardiovascular disease. The process begins with clinical evaluation and general paraclinical studies. When abnormal findings are detected, a focused evaluation is conducted according to the identified pathology. If an active or high-risk condition is identified, the athlete is disqualified from sports participation. In the absence of high risk, eligibility for return to sports is determined based on clinical and functional safety criteria. Abbreviations: CVPRP: cardiovascular prevention and rehabilitation program. CVRFs: cardiovascular risk factors. ECG: electrocardiogram. Echo: transthoracic echocardiogram. EPS: electrophysiological study. ET: exercise testing. Holter: ambulatory electrocardiographic monitoring. LVOT: left ventricular outflow tract. MRI: magnetic resonance imaging. SCD: sudden cardiac death.

A 2016 case series of 251 patients with POTS was published, showing that 41% of patients completed the ThPhT program, and 71% of them (n=73) experienced remission of POTS. The increase in HR from the supine to the standing position was documented to be less after training. The effect of the 6 and 12 months was persistent. Adverse events not assessed (GRADE: very low $_{G26\text{-}R1_Ref_10}$).[541]

Gibbons CH et al published a controlled clinical trial with 77 patients with POTS, where it was observed that, at 6 months of ThPhT, 23% of patients continued with the diagnosis of POTS in the training group vs 93% in

the control group (p < 0.001). The HR in the supine position was lower (MD= 68 ± 8 bpm) compared to the control group (MD= 77 ± 6 bpm), p< 0.001). The occurrence of syncope decreased in the trained group of patients (p< 0.001). HR-QoL did not change significantly. Adverse events were irregularly assessed (GRADE: moderate $_{G26\text{-}R1_Ref_11}$).[542]

A randomized controlled trial with 50 patients with vasovagal syncope showed a lower rate of syncope in the training group (28%) compared to the control group (64%), p= 0.17. The adherence rate in the intervention group was higher (80%) than in the control group (52%), p= 0.037). Adverse events were reported and were negative (GRADE: moderate $_{G26\text{-}R1_Ref_12}$).[543]

Moya I et al. mention that patients with dysautonomia who perform orthostatic challenge, even on a single occasion, could have a positive effect on the recurrence of vasovagal syncope. No adverse events were reported (GRADE: very low $_{G26\text{-}R3_Ref_1}$).[544]

Pinter A et al. mention the existence of an association between affective disorders and CVD, based on the dysregulation of the autonomic nervous system, with an increase in sympathetic outflow and a decrease in parasympathetic outflow. Two indicators are commonly used to evaluate this function: heart rate variability (HRV) and baroreflex sensitivity, which are closely linked to cardiovascular morbidity and mortality (GRADE: very low $_{G26\text{-}R5_Ref_1}$).[545]

Siepmann M et al. conclude that mental illnesses such as depression or anxiety are associated with altered cardiovascular function through changes in the autonomic nervous system. HRV is an element that allows for the assessment of these types of disorders (GRADE: very low $_{G26\text{-}R5_Ref_2}$).[546]

A cross-sectional study of 122 post-COVID-19 patients showed that 27.8% presented dysautonomia, with symptoms persisting for a year (11.6 months). Anxiety and depression symptoms were more pronounced after COVID-19 (<0.001) and were associated with reduced HR-QoL. Patients with dysautonomia were more likely to experience depression (p=0.02). COVID symptom duration and HR-QoL were inversely related (p<0.001), particularly in women (GRADE: very low $_{G26\text{-}R5_Ref_3}$).[547]

In a series of 377 patients with mental disorders and joint hypermotility, it was observed that this was usually more profound than in the general population (OR= 2.54, 95% CI 2.05 to 3.16), and they had more autonomic symptoms. A strong association was observed between anxiety disorder, dysautonomia, and joint hypermotility. (GRADE: very low $_{G26\text{-}R5_Ref_4}$).[548]

In 2023, a case-control study with 84 patients showed that patients with major depressive disorder had a higher COMPASS-31 score (dysautonomia assessment) than control subjects (22.56 ± 8.42 vs 7.6 ± 2.72, p = 0.0001) (GRADE: moderate $_{G26\text{-}R5_Ref_6}$).[549]

**(KM)** Dysautonomia may manifest in certain patients, particularly post-COVID-19. Early recognition and individualized management, including salt and fluid supplementation, targeted resistance and strength training, and structured physical therapy, can improve orthostatic tolerance, decrease syncope incidence, and enhance health-related quality of life.

### 3.3.11 Athletes with heart disease

Pre-participation assessment of athletes is an increasingly used strategy to estimate the risk of adverse events associated with sports, including sudden cardiac death. Although traditionally, all individuals with heart disease were disqualified from participating in sports, today the approach is more personalized, and decision-making is shared with patients, leading to an increasing number of returnees, even to high-performance sports (Fig. 25) (GRADE: low $_{G27\text{-}R1_Ref_1}$).[550]

Several recent studies have evaluated risk stratification strategies, safety, and the clinical impact of returning to sports in athletes with CVD predisposing to sudden death.

A set of CPGs (ESC, 2021) recommends a comprehensive cardiovascular assessment for athletes with heart disease. These guidelines propose individualized recommendations based on the pathology and type of activity, including avoiding competitive sports in the presence of high risk of arrhythmias and promoting safe exercise in stable disease. They also emphasize current evidence gaps, limitations in access to personalized assessments, and the negative psychological effects of restricting physical activity in low-risk patients (GRADE: high $_{G27\text{-}R2_Ref_5}$).[172]

Of particular interest is the need to address these guidelines with the goal of reducing sudden death in sports (GRADE: low $_{G27\text{-}R1_Ref_14}$).[551]

Drezner JA et al. mention that the diagnosis of a potentially lethal disease in an athlete represents a complex dilemma in relation to the athlete's health, their autonomy, and the vision of the institutions. One of the medical conditions that has changed decision-making is the presence of hypertrophic cardiomyopathy, where players who carry it, with a low-risk phenotype, have currently been selected. Another novel aspect is involving the athlete and their family (GRADE: very low $_{G27\text{-}R1_Ref_8}$).[552]

Similarly, a 2016 position paper addressed cardiovascular screening in young athletes. It was acknowledged that universal implementation of ECG screening can improve the detection of serious cardiovascular disease, although its effectiveness depends on available resources, the prevalence of risk in the target population, and the possibility of false positives (GRADE: very low $_{G27\text{-}R2_Ref_4}$).[553]

A narrative review published in 2017 highlighted the importance of considering factors such as electrical instability, the presence of syncope, certain genetic mutations, male gender, and exercise type when deciding on defibrillator implantation in young patients with arrhythmogenic right ventricular cardiomyopathy. This review integrated published evidence and clinical experience to guide risk stratification and therapeutic decisions (GRADE: very low $_{G27\text{-}R2_Ref_3}$).[554]

The epidemiology of sudden death in athletes has also been analyzed. A 2014 retrospective study of 45 collegiate athletes identified multiple etiologies, the most common being unexplained death with a structurally normal heart (31%). Other causes included coronary anomalies, myocarditis, various cardiomyopathies, arrhythmogenic right ventricular dysplasia, long QT syndrome, and hematologic conditions. In 41% of cases, there was discordance between the previous clinical diagnosis and the autopsy findings (GRADE: low $_{G27\text{-}R2_Ref_8}$).[555]

A study that sought to evaluate the incidence and etiology of sports-related sudden deaths in Germany, based on an online registry involving 15 forensic medicine institutions in that country, showed that, during a 30-month follow-up period, 144 sports-related sudden cardiac deaths were recorded (mean age 46 +/- 16.2 years), the incidence was 1.2-1.5 deaths/million/year, 97% men, most deaths were in recreational and non-elite athletes (99%). The main cause of death was myocarditis in athletes ≤35 years and coronary artery disease in those ≥35 years (GRADE: low $_{G27\text{-}R2_Ref_9}$).[556]

Regarding specific genetic conditions, a 2018 cohort study analyzed 79 patients with mutations in the lamin A/C gene (mean age: 42 ± 16 years, EF 45 ± 13%). A cardiac penetrance of 61% was identified, with a high frequency of AV block (32%), atrial fibrillation/flutter (23%), and ventricular tachycardia (39%). During follow-up (7.8 ± 6.3 years), 19% of patients required heart transplantation, reflecting the progressive and severe course of this disease (GRADE: moderate $_{G27\text{-}R2_Ref_7}$).[557]

In veteran athletes, a recent cross-sectional study (2024) in 105 asymptomatic men (mean age: 48±5.6 years) found a high burden of coronary atherosclerosis in 25.7% of participants, especially in those with elevated cardiovascular risk according to the SCORE2 scale and high exercise volume. On the other hand, in subjects with low or moderate risk, high-intensity exercise could have a protective effect (GRADE: low $_{G27\text{-}R2_Ref_6}$).[558]

Left ventricular noncompaction is a rare cardiomyopathy in athletes, but increased suspicion and new diagnostic techniques have identified an increasing number of cases. This pathology is thought to be over-diagnosed in athletes, particularly in African Americans, due to the structural changes inherent to their sport. The most common symptom is exertional syncope, and the diagnosis usually requires a clinical history, history of SCD, 12-D ECG, two-dimensional echocardiography or gadolinium-enhanced MRI, stress echocardiography, and Holter monitoring. Adverse events are associated with ventricular dysfunction, the presence of arrhythmias, syncope, aborted SCD, or thromboembolism. In asymptomatic patients, simple hypertrabeculation is not a reason for restricting physical activity. It is recommended that high-risk patients be disqualified from strenuous sports (GRADE: very low $_{G27\text{-}R1_Ref_6}$).[559]

Terry KJ et al. mention that the COVID-19 pandemic has focused physicians' attention on the likelihood of sudden death in athletes with myocarditis. Most athletes with this type of myocarditis recover and undergo extensive evaluation for the presence of inflammation, necrosis, fibrosis, and remodeling (electrocardiography, echocardiography, and MRI). Risk indicators for adverse outcomes include the intensity and duration of sustained exercise, vaccination status, and epidemiological and genetic factors. The authors propose an algorithm for the care and treatment of athletes with myocarditis, based on hemodynamic stability, symptoms, and test findings (GRADE: very low $_{G27\text{-}R1_Ref_2}$).[560]

A cross-sectional study of 5,011 athletes showed the presence of premature ventricular contractions in 7.3% of the study population, with 0.7% having more than 10 premature ventricular contractions, paired, or non-sustained ventricular tachycardia. Athletes with rare PVCs were not restricted from competition, and serial studies of these cases showed a reduction in PVCs in subsequent studies. The remaining athletes were disqualified from sports, and 13 of them were considered for electrophysiological procedures. No alterations in the prognosis of these patients were observed (GRADE: moderate $_{G27\text{-}R1_Ref_12}$).[561]

In 2024, a cross-sectional study evaluated 64 athletes with non-sustained ventricular arrhythmias and right bundle branch block morphology. A 12-lead ECG

scoring system was applied to identify electrocardiographic predictors of nonischemic myocardial scar, confirmed by late gadolinium-enhancing MRI. An electrocardiogram score ≥2, with findings such as: low voltages in enlarged limb leads, negative T waves (DII, DIII, aVF, I-aVL, V4-V6), presence of left posterior fascicular block, pathological Q waves, and poor R wave progression in V1–V3, demonstrated high sensitivity (86%) and specificity (100%). These findings support the use of the ECG as an accessible tool for risk stratification in this population (GRADE: low $_{G27\text{-}R2_Ref_2}$).[562]

A case-control study of 146 athletes and sedentary individuals with atrial fibrillation found that athletes with AF who underwent catheter ablation had a reduction in vigorous physical activity time from 10.2 ± 3.9 h/week to 4.6 ± 3.4, and only 21.9% of athletes resumed the same type of training after ablation. AF recurrence was similar between athletes (n = 38, 52.0%) and sedentary individuals (n = 35, 47.9%) at 5-year follow-up. The effectiveness of the procedure was significantly lower in athletes with non-paroxysmal AF. (GRADE: low $_{G27\text{-}R1_Ref_11}$).[563]

Kay B et al. showed that the group of athletes with ICDs is very heterogeneous, ranging from their underlying pathology to the type and programming of the device. It has been observed that shocks (appropriate or not) do not occur more frequently during sports than during any other activity. Although traditionally, ICD implantation used to be a contraindication for sports practice, this decision is currently shared with the athlete. Programming ICDs with higher thresholds and with longer periods of arrhythmia prior to shock reduces the number of shocks without increasing adverse events. There do not appear to be any differences in outcomes when comparing ICD types, such as the number of leads and device placement (GRADE: very low $_{G27\text{-}R1_Ref_1}$).[564]

Silka MJ et al. consider that advances in medical diagnosis and increased public awareness have led to changes in the disqualification and eligibility criteria for athletes with heart disease, as well as return-to-play protocols for athletes with concussion or orthopedic injuries. However, clear scientific evidence is lacking to develop such protocols. The assignment of a particular medical profile to assume responsibility for these decisions has historically been ambiguous. There are certain topics that should be discussed, such as those patients with supraventricular tachycardia who underwent catheter ablation, ICD carriers, syncope without an identified cause, and athletes with a high-risk genotype but who are asymptomatic (GRADE: very low $_{G27\text{-}R1_Ref_4}$).[565]

Baggish AL et al. argue that after a diagnosis of cardiovascular disease in an athlete, the sports professional group has the responsibility to outline the appropriate treatment to preserve the patient's health and well-being. One of the most challenging aspects is determining the athlete's eligibility to continue sports practice, as well as the manner and timing of doing so. Currently, the guidelines are moving toward a patient-centered approach, where the decision is made jointly by the patient, their family, and the medical team (GRADE: very low $_{G27\text{-}R1_Ref_5}$).[566]

**Recommendation Table. 20** Co-morbidity

| PICO | 3.4 Co-morbidity | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G28-R5 | It is recommended to offer general and pharmacological treatment for conditions such as hypertension, diabetes, hypothyroidism, and hyperuricemia to patients included in CVRhP-P, in order to optimize cardiovascular outcomes. | I | A | C-/B+ | 1 to 6 |
| G28-R1 | It is recommended that written nutritional advice be systematically offered to patients with obesity or overweight who are admitted to a CVRhP-P, with the goal of reducing caloric and saturated fat intake and body weight. | I | B-R | C-/B+ | 1 to 6 |
| G28-R4 | It is recommended that patients with lung disease admitted to a CVRhP-P perform aerobic and muscle-strengthening exercises, on an individualized and supervised basis, in order to improve exercise tolerance and reduce dyspnea. | IIa | B-R | C+/B+ | 1 to 6 |
| G28-R2 | Patients with chronic kidney disease in the CVRhP-P group are recommended to perform respiratory, aerobic, and resistance training tailored to their risk stratification, with medical supervision and vital signs monitoring, in order to improve exercise tolerance, HR-QoL, and metabolic markers. | IIa | B-R | C+/B+ | 1 to 6 |

| Therapeutic targets and treatment of common chronic conditions in patients with heart disease in CVRhP-P | | |
|---|---|---|
| **Pathology** | **Therapeutic Goal** | **Recommended Treatment / Follow-up** |
| **Hypertension** | **Systolic blood pressure <130 mmHg / diastolic < 80 mmHg** | **ACE inhibitors or ARBs, calcium channel blockers or diuretics, adjusted according to tolerance and renal function. Regular blood pressure monitoring.** |
| **Type 2 diabetes mellitus** | **Cardiovascular and renal prevention; HbA1c <7% (individualized); fasting glucose 80–130 mg/dL** | **Metformin as first-line; add SGLT2 inhibitors and/or GLP-1 receptor agonists for added protection; insulin if necessary. Periodic monitoring of HbA1c every 3–6 months and fasting or capillary glucose to adjust therapy.** |
| **Hypothyroidism** | **Normalize thyroid-stimulating hormone (TSH) and avoid cardiovascular symptoms** | **Low-dose levothyroxine with periodic TSH monitoring. Use the same brand to avoid variability.** |
| **Hyperuricemia** | **Serum uric acid < 6 mg/dL and prevention of acute gout flares** | **Allopurinol in patients with gout or symptomatic hyperuricemia. Not indicated in asymptomatic individuals without cardiovascular risk. Clinical follow-up.** |

**Figure 26.** Therapeutic targets and treatment of common chronic conditions in patients with heart disease in CVRhP-P. This table summarizes the therapeutic targets and recommended treatments for common chronic conditions in patients with heart disease. Emphasis is placed on regular follow-up, individualized adjustments, and rational use of pharmacological combinations. Abbreviations: ACE inhibitors: Angiotensin-converting enzyme inhibitors. ARBs: Angiotensin II receptor blockers. CCBs: Calcium channel blockers. SGLT2i: Sodium-glucose cotransporter-2 inhibitors. GLP-1 RA: Glucagon-like peptide-1 receptor agonists. TSH: Thyroid-stimulating hormone. HbA1c: Glycated hemoglobin.

A 2023 retrospective study included 76 collegiate and professional athletes with genetic heart conditions, including hypertrophic cardiomyopathy and long QT syndrome. Medical records, previous symptoms, diagnostic testing (ECG, echocardiogram, MRI, exercise stress test, ambulatory monitoring, genetic studies), and treatments were evaluated through a structured risk stratification and shared decision-making approach. Seventy-two percent of previously disqualified athletes were able to return to competition following this detailed clinical evaluation. One exercise-related cardiac event (1.3%) and two unrelated events were recorded; no deaths were reported. These findings suggest that, with appropriate clinical management, returning to sport can be safe in many cases (GRADE: low $_{G27\text{-}R2_Ref_1}$).[567]

Athletes who have been involuntarily disqualified or removed from sports due to some type of pathology may experience changes in their mental health, which often go unnoticed. In 2021, a questionnaire administered to 249 athletes revealed that 69% were affected by the COVID-19 pandemic, with the most frequently used terms being disappointment, anger, frustration, sadness, boredom, and depression. This feeling was comparable to that of a serious injury, surgery, or the loss of a loved one. No differences were observed between sports disciplines. Women presented higher levels of depression than men (GRADE: low $_{G27\text{-}R3_Ref_1}$).[568]

Adolescence brings significant physical, social, and emotional changes, and participating in sports often offers health benefits. Physical injuries are a common threat, and management is often focused exclusively on pain control and recovery of function. However, significant psychological consequences have been found, with young athletes receiving the least evaluation. Depression and anxiety are associated with the likelihood of not competing again and a high risk of reinjury (GRADE: low $_{G27\text{-}R3_Ref_2}$).[569]

Athletes may experience mental health disorders more frequently than non-athletes, often accompanied by the presence of injuries, substance use and sleep disorders (GRADE: very low $_{G27\text{-}R3_Ref_3}$).[570]

On the other hand, it has been observed that recently retired athletes experience a rapid detraining process, where those who were forced to retire present higher levels of depression (GRADE: very low $_{G27\text{-}R3_Ref_7}$).[571]

Pelliccia A et al, state the recommendations for healthy physical activity in the general population, during the aging process, in patients with coronary artery disease,

with HF, heart transplant, heart valve disease, aortopathy, cardiomyopathy, arrhythmogenic heart disease, myo-pericarditis, arrhythmias, congenital channelopathies, electrical assist devices, pregnant women, spinal cord injuries, ventricular assist devices, peripheral arterial disease (GRADE high $_{G27\text{-}R1_Ref_13}$).[172]

**(KM)** Athletes with heart disease should undergo thorough medical evaluation to identify any characteristics that may indicate a high risk of sudden death, thus determining whether they should be disqualified from participating in sports or allowed to continue. The patient's opinion is increasingly being taken into account in this decision-making process.

## 3.4 Co-morbidity

The physician must identify and, if necessary, provide appropriate treatment for the patient's various comorbidities. This figure shows some examples of chronic disease management (Fig. 26).

Several studies support the need for a comprehensive and personalized approach to chronic conditions in patients with heart disease included in CVRhP-P. In the EUROASPIRE V registry, they analyzed 8,261 patients with coronary artery disease in 27 European countries and reported a prevalence of diabetes of 29%, active smoking in 55%, obesity in 38%, and central obesity in 59%. Only 34% of patients performed adequate physical activity. Despite a high drug prescription (93% received antiplatelet agents, 81% beta-blockers, 75% ACEI/ARB, and 80% statins), 42% had hypertension outside of the target range (≥140/90 mmHg or ≥140/85 mmHg in the case of diabetes), and 71% had LDL-C above 70 mg/dL (GRADE: high $_{G28\text{-}R5_Ref_1}$).[572]

Hansen et al. (EXPERT Group) highlighted the clinical difficulties in prescribing physical exercise in patients with comorbidities such as obesity, diabetes, dyslipidemia, and hypertension. To address this challenge, they developed the online EXPERT Training Tool, which allows individualizing physical training parameters according to the patient's clinical characteristics. This platform seeks to facilitate the integration of exercise as an essential part of cardiovascular management (GRADE: low $_{G28\text{-}R5_Ref_2}$).[573]

Ades et al published a narrative review in which they emphasize that CVRhP-P have evolved from those focused on ThPhT to those based on multidisciplinary, with a systematic approach to cardiovascular risk factor control, where they find obesity, DM and metabolic syndrome as highly prevalent entities, associated with an increase in mortality from coronary heart disease. In the USA, only 8% of programs allocate a specific portion for weight control in patients (GRADE: very low $_{G28\text{-}R1_Ref_2}$).[574]

Brandt EJ et al. published an observational study of patients discharged from the hospital with a diagnosis of heart disease. They observed 175,631 healthcare interventions in 146,185 patients, with a higher prevalence in men (55.8%) and adults older than 65 years (71.9%). A 22.8% prevalence of dietary advice was recorded, more associated with CVRhP-P than with other types of services. Variables associated with a low probability of receiving nutritional advice were age over 65 years (OR=0.77, p<0.001), female gender (OR=0.83, p<0.001), acute myocardial infarction (OR=0.29, p<0.001), heart failure (OR=0.12, p<0.001), post-coronary intervention (OR=0.36, p<0.001), chronic kidney disease (OR=0.74, p<0.001), and diabetes (OR=0.95, p<0.001). Variables associated with a higher rate of nutritional advice were obesity (OR=1.28, p<0.001) and having been discharged from non-metropolitan hospitals (OR=1.31, p<0.001). Adverse events were not assessed (GRADE: high $_{G28\text{-}R1_Ref_4}$).[575]

A randomized controlled trial with 160 patients in CVRhP-P evaluated the effect of an educational program at baseline and after 12 months of follow-up. The intervention, with a dropout rate of 11%, was associated with a significant reduction in daily caloric intake (2,218.03 Kcal ± 567.0 vs 1,726.8 ± 495.5, p< 0.001), saturated fat intake (21.8 g ± 7.8 vs 15.7 ± 7.6, p< 0.001), weight loss (79.29 kg ± 13.62 vs 76.66 ± 12.7, p< 0.001) and an increase in HDL-C. However, an increase in fasting blood glucose (p=0.042), total cholesterol (p=0.001), and LDL-C (p=0.001) levels was observed, associated with a decrease in adherence to pharmacological treatment. No adverse events were reported (GRADE: moderate $_{G28\text{-}R1_Ref_3}$).[576]

### 3.4.1 Diabetes

Diabetes is one of the main risk factors for cardiovascular disease and, at the same time, one of the most prevalent comorbidities that healthcare professionals must address. It is particularly important for the patient to maintain adequate metabolic control since hyperglycemic states lead to fluid and electrolyte disturbances that can lead to adverse events during physical training.

Because diabetes is a systemic disease, patients often experience complications in other organs and systems that must be evaluated and treated, such as kidney disease. Zhao et al. evaluated the effect of sodium-glucose

cotransporter 2 inhibitors (SGLT2i) in a meta-analysis of 42,568 patients with type 2 diabetes mellitus and cardiovascular disease or high cardiovascular risk. Treatment with SGLT2i was associated with a reduction in the combined risk of cardiovascular death and hospitalization for heart failure (HR= 0.90; 95% CI 0.84 to 0.98, p = 0.01), hospitalization for isolated heart failure (HR= 0.84; 95% CI 0.73 to 0.98, p = 0.02), and composite renal outcomes (HR= 0.83; 95% CI 0.74 to 0.92, p = 0.0007). A significant reduction in HbA1c levels was also observed (MD= −0.30; 95% CI −0.36 to −0.23, p < 0.00001). The renal benefit was even more evident in patients without previous heart failure (HR= 0.75; 95% CI 0.62 to 0.91, p = 0.003). (GRADE: high $_{G28\text{-}R5_Ref_3}$).[577]

### 3.4.2 Hypertension

High blood pressure is a major risk factor for cardiovascular disease. It is also a condition that should be evaluated and monitored long-term, with special attention paid to blood pressure changes during exercise sessions.

Wamil et al. published a systematic review of blood pressure control strategies in patients with type 2 diabetes and cardiovascular risk. Intensive control (<130 mmHg) was associated with a relative risk reduction for major cardiovascular events (RR= 0.90; 95% CI 0.84 to 0.98), with comparable benefits across drug classes. Initial combinations of ACE inhibitors or ARBs with calcium channel blockers or thiazide diuretics are recommended, followed by escalation with mineralocorticoid receptor antagonists, beta- or alpha-blockers in resistant hypertension. Furthermore, the addition of SGLT2i or GLP-1 agonists is advised for greater cardiorenal protection. (GRADE low $_{G28\text{-}R5_Ref_4}$).[578]

### 3.4.3 Hyperuricemia

Regarding the treatment of hyperuricemia, in a cohort study of 7,127 patients with hyperuricemia (uric acid ≥6 mg/dL), treatment with allopurinol was reported to be associated with a reduction in the risk of major cardiovascular events (HR= 0.89; 95% CI 0.81 to 0.97) and all-cause mortality (HR= 0.68; 95% CI 0.62 to 0.74). (GRADE: moderate $_{G28\text{-}R5_Ref_5}$).[579]

### 3.4.4 Dysthyroidism

Regarding thyroid dysfunction, Yu et al. evaluated 153,892 adults with subclinical hypothyroidism (TSH between 5 and 10 mU/l) in a cohort study, comparing 76,946 patients treated with levothyroxine versus an untreated control group. Treatment with levothyroxine was associated with a reduced risk of major cardiovascular events (HR= 0.88; 95% CI 0.83 to 0.93), with incidence rates of 12.8 per 1000 person-years in the treated group versus 13.9 per 1000 person-years in the untreated group (GRADE: moderate $_{G28\text{-}R5_Ref_6}$).[580]

### 3.4.5 Chronic lung disease

ThPhT is a fundamental strategy in the rehabilitation of patients with lung disease, as it helps improve ExTol and reduce the sensation of dyspnea. The literature supports the combination of aerobic training and muscle strengthening interventions, tailored to each patient and with specialized supervision.

A randomized study evaluated a high-intensity interval training program combined with strength training in patients with COPD, compared with the use of supplemental oxygen. It was observed that, while oxygen had a limited impact on improving ExTol, ThPhT allowed a reduction in cardiocirculatory and metabolic stress, reflected in decreases in heart rate, blood pressure, respiratory quotient, and lactate levels (GRADE: moderate $_{G28\text{-}R4_Ref_1}$).[581]

On the other hand, in patients with pulmonary disease and moderate or severe exercise-induced hypoxemia, supplemental $O_2$ should be used to maintain a saturation ≥90%. (GRADE: low $_{G28\text{-}R4_Ref_3}$).[582]

A randomized study evaluated the effect of high-intensity noninvasive ventilation during exercise training in patients with severe COPD and chronic hypercapnic respiratory failure. It was found that, although both groups improved their exercise time, those who used noninvasive ventilation experienced a greater reduction in dyspnea and showed a preference for this intervention. These findings underscore the importance of adapting training to the patient's clinical condition, starting at a low intensity and adjusting oxygen flow according to clinical response (GRADE: moderate $_{G28\text{-}R4_Ref_2}$).[583]

### 3.4.6 Obstructive sleep apnea

Obstructive sleep apnea (OSA) is a disorder in which breathing repeatedly stops and starts due to an obstruction in the upper airway, usually caused by the relaxation and collapse of the throat muscles during sleep.

This breathing interruption can lead to oxygen deprivation, poor sleep quality, excessive daytime sleepiness, and an increased risk of other health problems.

In patients referred to CVRhP-P, it is essential to identify the presence of obstructive sleep apnea (OSA) from admission, given its high prevalence and elevated cardiovascular risk. Validated screening tools such as the STOP-Bang score are available in the literature, allowing for the identification of patients who require further evaluation (pulmonology consultation or polysomnography) (GRADE: moderate $_{G28\text{-}R4_Ref_4}$).[584]

OSA is associated with refractory hypertension, endothelial dysfunction, structural remodeling, and an increased risk of progression to heart failure with reduced or preserved ejection fraction. It is important to ensure that patients with OSA are receiving appropriate treatment, which may include CPAP (GRADE: low $_{G28\text{-}R4_Ref_5}$).[585]

### 3.4.7 Chronic kidney disease

Cardiovascular diseases are frequently linked to kidney disorders, particularly the presence of kidney failure associated with diabetes, high blood pressure, or heart disease itself or its treatment.

Regardless, physical exercise is essential for the management of patients with chronic kidney disease, showing significant benefits in multiple health aspects, such as improved exercise tolerance, health-related quality of life, and metabolic parameters, regardless of the severity of kidney disease and in a safe manner.

In a randomized clinical trial, various ThPhT modalities were compared, including inspiratory muscle training in patients with chronic kidney disease, performed at 30% of the maximum inspiratory pressure and, an increase in muscle strength was observed, both in ventilatory and peripheral muscles, which translates into an increase in the distance traveled in the 6MWT, in addition to improvements in dyspnea and fatigue, contributing to a better HR-QoL (GRADE: high $_{G28\text{-}R2_Ref_1}$).[586]

A controlled clinical trial showed that long-term supervised exercise in patients with chronic kidney disease was associated with benefits, especially in ExTol and 6MWT distance. The effect on ExTol decreased over time, and close supervision is mentioned as crucial to maximize the benefits of ThPhT (GRADE: high $_{G28\text{-}R2_Ref_6}$).[587]

Uchiyama K et al. published a controlled clinical trial in patients with severe chronic kidney disease, where they observed that home-based exercise programs combining aerobic and resistance training showed significant improvements in ExTol and HR-QoL, without the need for a clinical setting, making them accessible to a wider group of patients. In these programs, the distance covered in the walking test increased by an average of 39.4 meters. (GRADE: high $_{G28\text{-}R2_Ref_5}$).[588]

On the other hand, resistance exercise, which includes the use of elastic bands and dumbbells, has shown improvements in muscle strength, fat-free mass and reduction of inflammation, especially through the decrease in C-reactive protein and glycosylated hemoglobin, crucial factors for the management of chronic kidney disease (GRADE: moderate $_{G28\text{-}R2_Ref_3}$).[589]

Supervised aerobic exercise programs in pre-dialysis patients have been effective in increasing exercise tolerance, with a significant increase in peak $VO_2$ of 2.66 $mlO_2$/kg/min and in the distance covered in the 6MWT, averaging 58.83 meters, in addition to being associated with the reduction of inflammatory and metabolic markers (GRADE: moderate $_{G28\text{-}R2_Ref_2}$).[590]

Intradialytic exercise, performed during hemodialysis sessions, has also been shown to be effective in improving patients' ExTol and HR-QoL, without causing adverse events. In a study of elderly patients, combined intradialytic exercise showed an increase in the distance covered in the 6MWT, reinforcing its effectiveness (GRADE: high $_{G28\text{-}R2_Ref_4}$).[591]

These findings underscore the importance of implementing personalized, supervised exercise protocols in cardiac rehabilitation programs for patients with concomitant heart and kidney disease to optimize their physical capacity, improve their metabolic status, and enhance HR-QoL.

**Recommendation Table 21.** Pedagogical strategies in prevention

| PICO | 3.5.1 Pedagogical strategies in prevention | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G29-R4 | It is recommended that patients admitted to a CVRhP-P receive a planned cardiovascular education program that includes classes and workshops on secondary prevention and risk factor identification and control. This program seeks to reduce morbidity and mortality, improve control of chronic conditions, and improve treatment adherence. | I | B-R | C-/B+ | 1 to 6 |

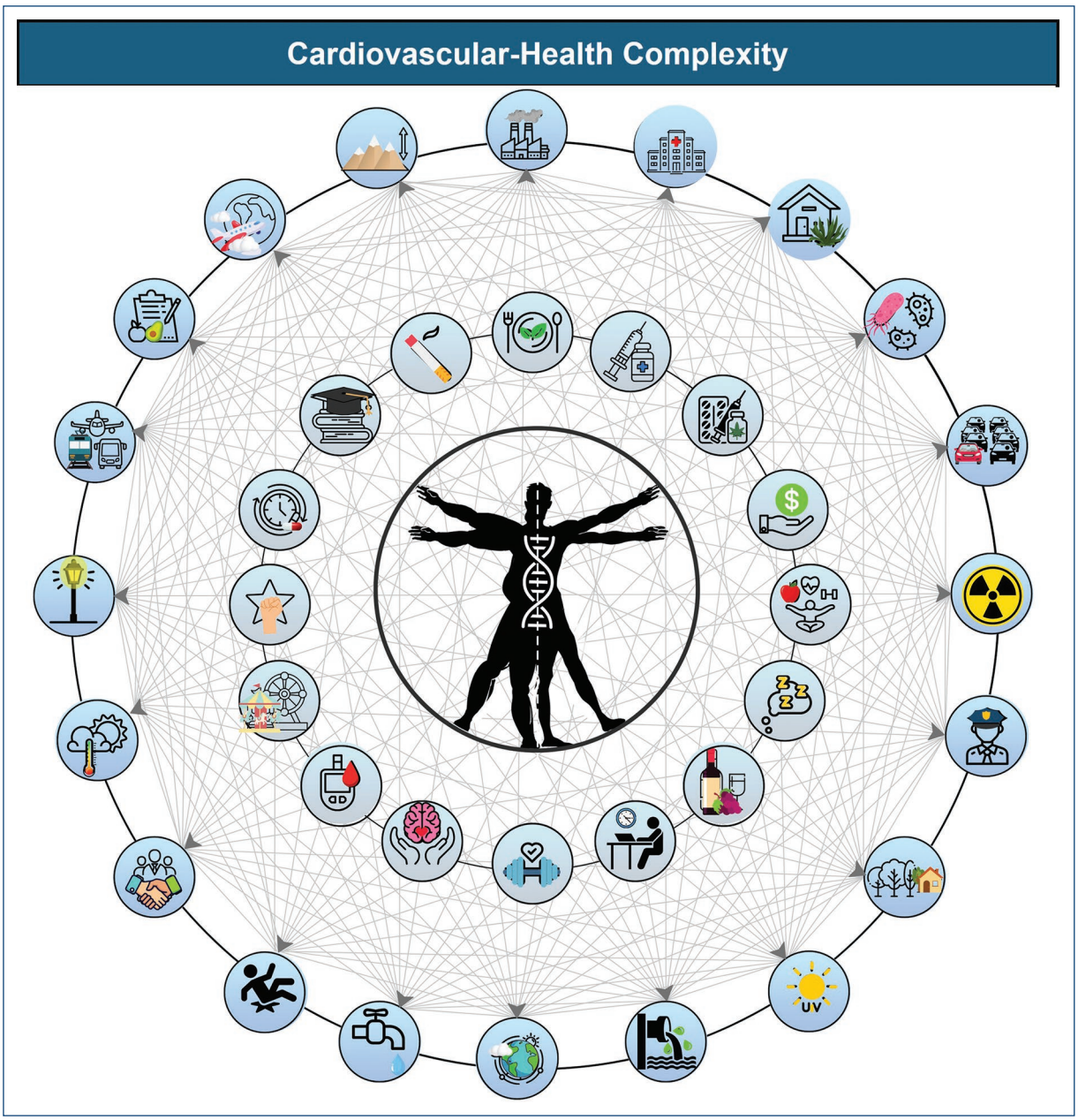


**Figure 27.** Cardiovascular-Health Complexity. Humans are immersed in a continuous interaction between their most intimate components (DNA), their decision-based behavior, and their exposure to external elements, forming a network (plexus, complexity). Cardiovascular-Health Complexity is a conceptual framework that describes the association of these interactions with potential outcomes, whether favorable or adverse. Therefore, these interactions drive our reality, whether in a vicious or virtuous cycle.

**(KM)** Systematic identification and management of comorbidities, including diabetes, hypertension, chronic kidney disease, OSA, and thyroid or pulmonary disorders, are essential in CVRhP-P to optimize cardiovascular outcomes, personalize exercise prescriptions, and improve quality of life.

### *3.5 Prevention*

The second fundamental pillar supporting the CVRhP-P is cardiovascular prevention, which focuses on identifying factors associated with a higher likelihood of suffering an adverse cardiovascular event and selecting appropriate interventions to reduce this risk.

**Recommendation Table 22.** Atherosclerosis

| PICO | 3.5.2 Atherosclerosis | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G4-R4 | It is recommended that smoking patients with CVD be included in a formal smoking cessation program, which includes both pharmacological and psychological therapy, in the pursuit of both smoking cessation and long-term abstinence. | I | A | C+/B+ | Smoking Cessation Clinic |
| G4-R2 | It is recommended to use LDL-C, non-HDL-C, and triglyceride levels as the main indicators for lipid control in patients with ischemic heart disease in CVRhP-P, and therapeutic goals will be determined by the individual risk of each case, in order to reduce cardiovascular risk. | I | A | C-/B+ | 1,2 and 6 |
| G29-R1 | Patients with hypercholesterolemia are recommended for pharmacological treatment, depending on their cardiovascular risk level. Drugs such as statins, ezetimibe, PCSK-9 inhibitors, inclisiran, or bempedoic acid may be prescribed to reduce LDL-C and triglyceride levels and cardiovascular risk. | I | A | C-/B+ | 1 to 6 |
| G4-R1 | It is recommended that adult patients with heart disease in a CVRhP-P complete the full vaccination schedule, which includes at least immunization against coronavirus (COVID-19), influenza virus, and pneumococcus, in order to reduce the morbidity and mortality associated with these pathologies. | I | A | C-/B+ | 1,2 and 6 |
| G4-R3 | It is recommended to investigate the presence of periodontal disease in patients in a CVRhP-P, because it is associated with an increased risk of coronary atherosclerosis, arterial hypertension, and atrial fibrillation. This is done in order to achieve a lower level of systemic inflammation and better control of arterial hypertension and endothelial function. | I | B-R | C-/B+ | 1,2 and 6 |
| G4-R5 | It is recommended that obese children and adolescents engage in aerobic and strength training to control their weight, reduce their body fat percentage, waist circumference, blood pressure, LDL-C, and blood glucose levels, and increase HDL-C. | I | B-R | C-/B+ | 1 to 6 |
| G8-R1 | It is recommended that a nutritionist evaluate patients who have recently quit smoking, in order to identify and correct the onset of eating disorders such as high-calorie, high-salt, high-fat, and high-sugar foods, thereby preventing weight gain and cardiovascular risk associated with an unhealthy diet. | IIa | B-R | C-/B+ | 1, 4 and 6 |
| G29-R2 | It is recommended that patients with identified atherosclerosis receive a dietary plan based on proven effective diets, such as the Mediterranean, DASH, or even vegetarian diets, in order to reduce the number and size of plaques, change their composition, improve their lipid profile, and lower inflammation. | IIa | B-R | C-/B+ | 1 to 6 |
| G16-R6 | It is recommended that patients with ischemic heart disease participating in a CVRhP-P follow a nutritional plan with reduced calories and the inclusion of fiber, fish, and mono- or polyunsaturated fats, in order to support pharmacological treatment in achieving lipid level goals. | IIa | B-NR | C-/B+ | 1,2,4 and 6 |

Cardiovascular outcome often occur because of interactions between individual determinants (genetics), behavior, and environmental factors.

Health determinants, risk factors, and inherent patient characteristics, such as genetics and medical history, have been integrated into a recent model known as the Exposome (Christopher Wild, 2005), which highlights the prevalent interactions among them. These interactions, far from having a cause-effect association, seem to experience complex and non-linear behavior (Fig. 27).[592,593,594]

### 3.5.1 Pedagogical strategies in prevention

The greatest evolutionary advance in CVRH, in addition to providing therapeutic physical training, systematically integrates secondary prevention.

CVRhP-P begins immediately after a patient has suffered an adverse cardiovascular event, a period vulnerable to short- or medium-term complications, but also a time when the patient is most receptive to interventions from the healthcare team. This is an ideal

opportunity for the implementation of cardiovascular prevention models.

The design and implementation of prevention models will depend on the adverse outcomes to be avoided. Thus, preventing the progression of atherosclerotic plaque, atherothrombosis and infarction, the onset of heart failure, valvular complications such as thrombosis or endocarditis, and sudden death, among others, requires specific and often concomitant programs.

The implementation of structured educational programs for patients with heart disease is supported by a strong evidence base. A meta-analysis of 22 studies including 76,864 patients with coronary artery disease found a significant reduction in fatal and non-fatal cardiovascular events associated with the implementation of educational programs (RR = 0.36; 95% CI, 0.23 to 0.56), although no reduction in total mortality (RR = 0.80; 95% CI, 0.60 to 1.05) or decrease in hospitalizations, revascularizations, or myocardial infarction was observed. (GRADE: moderate $_{G29\text{-}R4_Ref_1}$).[595]

A meta-analysis of 44 studies on cardiovascular risk communication in primary and secondary prevention showed significant improvements in risk perception (OR = 2.31; 95% CI: 1.63 to 3.27) and a moderate reduction in cardiovascular risk scores (MD= -0.27; 95% CI: -0.45 to -0.09). Furthermore, greater changes in dietary habits were observed (OR = 1.50; 95% CI: 1.21 to 1.86). (GRADE: high $_{G29\text{-}R4_Ref_2}$).[596]

Bagheri H et al. published a clinical trial with 120 patients with acute coronary syndrome, evaluating a person-centered education program. The study showed significant improvements in self-efficacy for managing symptoms and maintaining functionality (GRADE: moderate $_{G29\text{-}R4_Ref_4}$).[597]

In a randomized clinical trial with 236 patients with heart failure, an empowerment-based educational program was evaluated, showing a significant reduction in the risk of emergency department visits (RR = 0.55; 95% CI 0.31 to 0.95) and hospitalizations (RR = 0.38; 95% CI 0.21 to 0.68), with improvements in self-care and symptom perception (GRADE: high $_{G29\text{-}R4_Ref_3}$).[598]

A systematic review on educational interventions in patients undergoing cardiac rehabilitation, which included telemedicine and educational software, showed an increase in medication adherence (94%) and a decrease in cardiovascular risk, demonstrating the effectiveness of these interventions (GRADE: low $_{G29\text{-}R4_Ref_5}$).[599]

**(KM)** Educational programs can have a positive effect on patients' cardiovascular health, improving medication adherence, reducing rehospitalizations, and improving risk perception, justifying their implementation in cardiovascular health education planning.

### 3.5.2 Atherosclerosis

Patients referred to rehabilitation programs often suffer from atherosclerosis, where comprehensive management is essential for proper control and better prognosis. One of the pillars of treatment is dyslipidemia control.

#### 3.5.2.1 Dyslipidemia

Lipid levels, particularly low-density lipoprotein cholesterol, are causal indicators of atherosclerosis that must be identified and modified in all cases.

A meta-analysis of 14 studies and 746 patients evaluated the effect of a CVRhP-P on lipid levels versus the control group. CVRhP-P was associated with a non-significant increase in HDL-C levels (MD= 1.297; 95% CI: -1.620 to 4.214) and a significant decrease in LDL-C (MD= -7.797; 95% CI: -14.005 to -1.588), a significant decrease in total cholesterol (MD= -11.029; 95% CI: -20.716 to -1.342), and in triglycerides (MD= -14.602; 95% CI: -28.992 to -0.212). No adverse events were reported (GRADE: high $_{G14\text{-}R3_Ref_4}$).[600]

LDL-C levels are closely associated with the presence and severity of atherosclerotic disease and cardiovascular events, so maintaining their control within established goals is a fundamental strategy. Therapy is based on the administration of statins, and in some cases, other drugs that contribute to reducing residual risk will be prescribed, such as ezetimibe, PCSK9 inhibitors, icosapent ethyl, bempedoic acid, or inclisiran. The main indicators for lipid control are LDL-C, non-HDL-C, and triglycerides, whose therapeutic goals will be determined by the individual risk in each case (GRADE: high $_{G16\text{-}R2_Ref_1}$).[601]

Patients with atherosclerotic disease are recommended to achieve the following therapeutic goals: Low risk: LDL-C < 115 mg/dL and non-HDL-C < 145 mg/dL. Moderate risk: LDL-C < 100 mg/dL or non-HDL-C < 130 mg/dL. High risk: LDL-C < 70 mg/dL or non-HDL-C < 100 mg/dL. Very high risk: LDL-C < 55 mg/dL or non-HDL-C < 85 mg/dL. Triglyceride levels should be below 150 mg/dL (GRADE: very low $_{G4\text{-}R2_Ref_3}$).[602]

A narrative review evaluated the recommendations on lipid-lowering therapy in three CPGs: the ESC, AHA/ACC, and CCS, seeking to compare lipid-lowering therapy recommendations. All three documents agree in identifying LDL-C levels as the primary goal in cardiovascular prevention. These working groups recommend

intensifying lipid-lowering therapy in high-risk individuals. It should be noted that the method of assessing patient risk varies from guideline to guideline. The SEC's goals are increasingly demanding and suggest the use of statins or other types of therapy to achieve them. The American societies advocate for more consistent combination therapy in selected patients. All three societies recognize the importance of shared decision-making with the patient. The strength of these recommendations lies in their implementation (GRADE: moderate $_{G29\text{-}R1_Ref_1}$).[603]

In 2019, the ESC lowered the LDL-C goal from <1.8 to <1.4 mmol/L in secondary prevention patients. Shortly thereafter, Haegele, M, et al. published the results of a cohort study with 875 patients in CVRhP-P and showed the level of adherence to this new recommendation in the real world. This cohort was divided into two groups, either management before or after the change in LDL-C goal. In the post-adjustment group, a higher prevalence of patients was observed on maximum doses of statins (20% vs. 9%, p<0.0001) or in combination with ezetimibe (51% vs. 17%, p<0.0001). Furthermore, 53% of patients reached the goal of <1.4 mmol/L after the goal change. Adverse events were not assessed (GRADE: high $_{G29\text{-}R1_Ref_2}$).[604]

Dyslipidemias are one of the most prevalent disorders among patients with CVD, associated with a high risk and characterized by elevated levels of total cholesterol, triglycerides, or LDL-C. The authors identified that familial hypercholesterolemia requires combined treatment. Among the innovative drugs in this area are alirocumab, bempedoic acid, antisense oligonucleotides, angiopoietin-like protein inhibitors, apolipoprotein C-III (APOC3) inhibitors, lomitapide, and cholesterol ester transfer protein inhibitors. Adverse events were evaluated and were mild (GRADE: low $_{G29\text{-}R1_Ref_3}$).[605]

The treatment of dyslipidemia, which is increasingly complex and complex, is a dynamic and controversial topic in the search for a rational approach. It is important to emphasize the importance of adequate adherence and not forget to also focus on triglyceride levels. Adverse events were assessed irregularly (GRADE: low $_{G29\text{-}R1_Ref_4}$).[610]

In recent years, a wealth of evidence has accumulated supporting the positive impact of healthy dietary patterns on the progression of atherosclerosis and cardiovascular risk. In randomized trials, the Mediterranean diet, rich in monounsaturated fatty acids from extra virgin olive oil, was shown to significantly reduce carotid intima-media thickness at 5 years (MD= −0.027 ± 0.008 mm) and at 7 years (MD= −0.031 ± 0.008 mm, p < 0.001), while the low-fat diet showed no significant changes. Furthermore, a greater decrease in the number and height of carotid plaques was observed with the Mediterranean diet (GRADE: high $_{G29\text{-}R2_Ref_1}$).[606]

Yubero EM et al, observed how the Mediterranean diet improved endothelial function, increasing flow-mediated dilation (DM= 3.83% vs. 1.16%, p= 0.011), increasing endothelial progenitor cells (p = 0.028) and reducing endothelial microparticles (p = 0.015) (GRADE: high $_{G29\text{-}R2_Ref_2}$).[607]

Intervention with icospent ethyl (4 g/day for 18 months) in patients with elevated triglycerides on statin therapy significantly reduced the volume of low-attenuation coronary plaques by 17%, while the placebo group showed an increase of 109% (GRADE: moderate $_{G29\text{-}R2_Ref_3}$).[608]

Combined omega-3 and statin therapy also showed a lower progression of total arterial plaque volume (SMD= -0.36; 95% CI: -0.64 to -0.08, p = 0.01) and an increase in fibrous cap thickness (+29.45 mm), accompanied by a significant reduction in high-sensitivity C-reactive protein levels (SMD= -0.30; 95% CI: -0.59 to -0.01, p = 0.04) (GRADE: high $_{G29\text{-}R2_Ref_4}$).[609]

The implementation of a structured diet based on specific components has been shown to be effective in improving lipid profiles in patients with ischemic heart disease, especially within cardiac rehabilitation programs.

Contemporary management of dyslipidemia underscores the importance of lifestyle changes as a fundamental pillar of treatment. Dietary modification, along with adherence to medication intake, is key to achieving stricter lipid goals. In patients at high cardiovascular risk, a combined strategy (diet, exercise, and drug treatment) is associated with higher success rates in LDL-C reduction. In this context, it is highlighted that increased consumption of fish, fiber, and legumes, as well as reduced consumption of red meat and ultra-processed products, are an essential part of comprehensive intervention (GRADE: very low $_{G16\text{-}R6_Ref_2}$).[610]

A meta-analysis of 30 randomized trials of plant-based diets showed improvements in plasma lipid levels. Vegetarian and vegan diets reduced total cholesterol by −0.34 mmol/L, LDL-C by −0.30 mmol/L, and apolipoprotein B by −12.92 mg/dL, with no significant differences in triglyceride levels compared to omnivorous diets (GRADE: high $_{G29\text{-}R2_Ref_5}$).[611]

Makarewicz M et al. published a randomized clinical trial on the DASH diet, which included 81 patients with stable coronary artery disease, showed a significant reduction in body weight, high-sensitivity C-reactive protein concentration (-0.32 ± 2.8 mg/l, p< 0.05) and

platelet factor 4 concentration (-3.35 ± 3.4 ng/ml, p< 0.0001), while no significant changes were observed in the control group (GRADE: moderate $_{G29\text{-}R2_Ref_6}$).[612]

The 2019 ESC/EAS guidelines emphasize that nutritional goals should aim to achieve significant reductions in LDL-C, proposing a decrease of more than 50% from baseline and even reaching levels below 55 mg/dL in very high-risk patients. To achieve this, it is recommended to increase the consumption of unsaturated fats, soluble fiber, and phytosterols, as well as eliminate trans fats and limit saturated fats to less than 10% of total caloric intake. These dietary changes are associated with significant reductions in LDL-C and cardiovascular risk (GRADE: high $_{G16\text{-}R6_Ref_1}$).[613]

Plant-based dietary patterns such as the Mediterranean, Nordic, DASH, Portfolio, vegetarian, and vegan diets have been shown to significantly decrease LDL-C, total cholesterol, and triglyceride levels, in addition to improving the ApoB/ApoA1 ratio. Specifically, studies show that soluble fiber consumption can reduce LDL-C by 5–10%, while phytosterols can achieve an additional 7–12% reduction. Likewise, replacing saturated fats with mono- or polyunsaturated fats reduces LDL-C and the risk of cardiovascular events. This translates into a reduction in cardiovascular risk, particularly when implemented on a sustained basis (GRADE: very low $_{G16\text{-}R6_Ref_3}$).[614]

McCaughey C et al. published an analysis of a cohort of 163 patients in CVRhP-P, where they observed that 59% achieved the LDL-C targets recommended by the 2019 ESC guidelines when an intensive approach was applied that included dietary modifications and lipid-lowering therapies. However, underutilization of ezetimibe and PCSK9 inhibitors limited the achievement of more stringent goals, highlighting the need to adequately integrate pharmacological and nutritional interventions (GRADE: low $_{G16\text{-}R6_Ref_4}$).[615]

### *3.5.2.2 Smoking*

Smoking is considered the most important modifiable risk factor for atherothrombosis, particularly in the coronary territory. Actions focused on helping patients quit smoking are one of the pillars of CVRhP-P.

Several studies have documented the effectiveness of incorporating formal smoking cessation interventions in active smokers with CVD, which combines pharmacological treatment with cognitive-behavioral strategies.

#### 3.5.2.2.1 Smoking cessation

Over the years, several types of smoking cessation interventions have been established, including the use of medications and behavioral therapy. The former has been accepted worldwide as an effective method for quitting smoking, with medications such as varenicline, bupropion, and cytisine. These therapies have demonstrated their efficacy and safety, even in patients with CVD (GRADE: low $_{G29\text{-}R3_Ref_3}$).[616]

A systematic review of 22 articles on smoking examined the effects of various intervention modalities, including abstinence, smoking frequency reduction, HR-QoL, and adverse events. Both pharmacological (varenicline, cytisine, nicotine replacement therapy, and bupropion) and behavioral (physician counseling, provision of written educational materials, and step-based individual counseling) interventions showed an increase in smoking cessation. On the other hand, other measures such as text messaging, hypnotherapy, acupuncture, continuous auditory stimulation, laser, electrostimulation, acupressure, S-adenosylmethionine, and interactive voice response (IVR) did not yield significant benefits. Adverse effects associated with anti-smoking interventions were classified as mild to moderate, and included palpitations, chest pain, nausea, insomnia, and headache, particularly common with nicotine replacement therapy, varenicline, and cytisine. No adverse events were documented in the remaining interventions (GRADE: high $_{G29\text{-}R3_Ref_1}$).[617]

Thomas KH et al. published a meta-analysis of 363 studies in smokers, which showed that most interventions (monotherapy or combinations) were superior to placebo in maintaining sustained abstinence. The most effective interventions were varenicline (OR= 2.83; 95% CI 2.34 to 3.39) and varenicline plus nicotine replacement therapy (OR= 5.75; 95% CI 2.27 to 14.88), with smokers receiving counseling and those with high nicotine dependence benefiting most. Regarding adverse effects, only bupropion was statistically different from placebo (OR= 1.27; 95% CI 1.04 to 1.58) (GRADE: high $_{G29\text{-}R3_Ref_2}$).[618]

A meta-analysis that included more than 8,000 smokers showed that treatments with varenicline, bupropion, and nicotine patches were not associated with a significant change in major cardiovascular events during follow-up (HR for varenicline = 0.29; HR for bupropion = 0.50), with an overall incidence of events < 0.8% (GRADE: high $_{G4\text{-}R4_Ref_4}$).[619]

Patten T et al. published that nicotine flavorings in electronic cigarettes affect the sensation of reward, as

well as its pharmacokinetics, which reinforces its consumption (GRADE: very low $_{G8\text{-}R1_Ref_3}$).[620]

In 2023, a systematic review of 124 studies and 48,832 ex-smokers showed that there is high certainty that bupropion increases the smoking cessation rate compared to placebo or non-pharmacological treatment (RR = 1.60; 95% CI from 1.49 to 1.72; I2 = 16%). Moderate certainty was observed regarding the effect of the combination of bupropion and varenicline compared to the latter alone (RR = 1.21; 95% CI from 0.95 to 1.55; I2 = 15%). However, today there is disparity in the results since some only mention a certain tendency to present serious adverse events when taking bupropion treatment, while others show a statistically significant association (RR = 1.44; 95% CI from 1.27 to 1.65; I2 = 2%) (GRADE: high $_{G8\text{-}R1_Ref_5}$).[621]

Lindson N et al. published a meta-analysis of 51 studies and 22,509 smokers, where they recorded that, on average, they smoked 23 cigarettes per day. It was observed that individuals in a smoking cessation program using "intention to quit" interventions had a greater tendency to do so compared to the control group, but without statistical significance (RR = 1.74; 95% CI: 0.90 to 3.38, I2 = 45%). When comparing "intention to quit" vs. immediate quitting (conventional treatment), no differences were observed (RR = 1.01; 95% CI: 0.87 to 1.17, I2 = 29%), although in a sub-analysis, a tendency toward higher quitting was observed in the intervention group if varenicline was added (p = 0.01, I2 = 77%). When comparing smoking cessation with or without pharmacotherapy (varenicline or long-acting nicotine replacement therapy), a higher quit rate was observed in the first subgroup (RR = 1.68; 95% CI 1.09 to 2.58, I2 = 78% with low certainty). Behavioral support therapy was not associated with a higher quit rate. Adverse events in the interventions were irregularly reported, although they were mild and associated with nicotine replacement therapy. Overall, the studies were very heterogeneous (GRADE: high $_{G8\text{-}R1_Ref_6}$).[622]

A meta-analysis of 115 studies and 17,866 smokers showed that bupropion use was associated with a higher long-term smoking cessation rate (RR=1.64; 95% CI: 1.52 to 1.77, $I^2$=15%). There was insufficient evidence to assess the presence of side effects, however, a higher quit rate associated with bupropion-related adverse events was observed compared with placebo (RR=1.37; 95% CI: 1.21 to 1.56, $I^2$=19%). Patients assigned to bupropion were more likely to experience psychiatric adverse effects compared with placebo (RR=1.25; 95% CI: 1.15 to 1.37; $I^2$=15%). On the other hand, no association was observed between the quit rate and the combination of bupropion with nicotine replacement therapy compared with the latter administered alone (RR = 1.19; 95% CI: 0.94 to 1.51; $I^2$ = 52%), or the combination of bupropion and varenicline versus varenicline alone (RR = 1.21; 95% CI: 0.95 to 1.55; $I^2$ = 15%). Bupropion showed a lower probability of quitting compared with varenicline (RR = 0.71, 95% CI: 0.64 to 0.79; $I^2$ = 0%). The use of nortriptyline improved smoking cessation compared with placebo (RR = 2.03, 95% CI: 1.48 to 2.78; $I^2$ = 16%). No differences were observed between the use of bupropion or nortriptyline (RR = 1.30 95% CI 0.93 to 1.82; $I^2$ = 0%). No beneficial effect was seen with other types of medication such as serotonin reuptake inhibitors or monoamine oxidase (MAO) inhibitors. Adverse events were irregularly reported (GRADE: high $_{G8\text{-}R1_Ref_7}$).[623]

Treatment effectiveness also depends on adherence. In a randomized clinical trial in patients with acute myocardial infarction (n=388), those with complete adherence to bupropion treatment showed a significantly higher probability of maintaining abstinence at 12 months (adjusted OR=7.6; 95% CI 3.2 to 17.6), while even partial adherence was associated with a higher cessation rate compared to non-adherence (DM=13.3%; 95% CI 1.3 to 25.3) (GRADE: high $_{G4\text{-}R4_Ref_3}$).[624]

On the other hand, a meta-analysis of 18 studies on CVRhP-P in patients with CVD showed that the average smoking cessation rate was 53% (95% CI, 22% to 83%). The most effective programs were those that combined ThPhT and education, with cessation rates of up to 99% (95% CI, 98% to 100%), with group methods being more effective than individual ones (GRADE: moderate $_{G4\text{-}R4_Ref_2}$).[625]

### 3.5.2.2.2 Nutritional advice for ex-smokers

Smoking cessation has become a challenge, from the moment a patient contemplates quitting to the behavioral patterns that emerge afterward, such as weight gain due to compulsive eating.

It has been observed that, after quitting smoking, ex-smokers gain between 4 and 5 kg in weight, which sometimes constitutes an obstacle to quitting this harmful habit. Tobacco and food addictions, particularly those based on chocolate, donuts, cookies, cakes, white bread, pasta, rice, French fries, or hamburgers, share common neural pathways and are dependent on the activation of dopaminergic reward pathways, in addition to being associated with low levels of

dopamine receptors. However, experts acknowledge that further research is needed in this area (GRADE: very low $_{G8\text{-}R1_Ref_9}$).[626]

Likewise, various researchers have entered a debate on addiction theories, seeking to explain the compulsive intake of certain types of foods, particularly those highly processed and rich in carbohydrates or fats, a situation that contributes to obesity and other pathologies. A subgroup has been identified whose eating habits resemble those of narcotic substances. Withdrawal syndrome is an inherent characteristic of addictions; however, there is still no conclusive evidence that it is associated with food, which has limited the addiction model to explain compulsive eating. Animal studies suggest the existence of food withdrawal syndrome, based on models of behavioral changes associated with the neurological reward of certain foods. There is preliminary evidence of similar experiences in humans, although more in-depth research is needed (GRADE: very low $_{G8\text{-}R1_Ref_8}$).[627]

Smoking cessation is associated with a significant reduction in cardiovascular risk, even when weight gain occurs after abstinence. In a meta-analysis that included current and former smokers, the risk of CVD was lower in both former smokers who gained weight (RR = 0.74; 95% CI 0.66 to 0.83) and those who maintained weight gain (RR = 0.86; 95% CI 0.80 to 0.92) compared with current smokers (GRADE: high $_{G4\text{-}R4_Ref_1}$).[628]

Regarding weight loss therapy, a systematic review of 61 articles and 69.25 individuals from the general population found that those who were overweight had a weight loss between 300g and 13.1kg when following a diet focused on carbohydrate intake, although no changes were observed in relation to the specific type of diet, reduced or balanced in carbohydrates (GRADE: moderate $_{G8\text{-}R1_Ref_2}$).[629]

In 2021, a systematic review of 88 studies and 871,378 subjects from the general population showed that while social media use was statistically significantly associated with weight loss (SMD= -1.34 kg; 95% CI -2.00 to -0.69), it was not able to establish a healthy diet (SMD= 0.11; 95% CI -0.25 to 0.47) (GRADE: low $_{G8\text{-}R1_Ref_1}$).[630]

In 2024, a randomized controlled clinical trial with 104 smokers, published by Singh A et al., showed that adding 10 ml of linseed oil (omega-3 FA) to the daily diet for 6 months reduced smoking dependence and the desire to smoke (GRADE: moderate $_{G8\text{-}R1_Ref_4}$).[631]

Anker J et al. studied 105 subjects (active smokers, smokers in withdrawal syndrome, and nonsmokers) and showed that men and smokers with withdrawal syndrome had a high intake of foods with high salt, sugar, and fat content. On the other hand, if the subjects received an opioid blocker (naltrexone), they consumed these foods in smaller quantities than when smokers received a placebo. Thus, it is observed that the opioid reward system is associated with both smoking and diet type (GRADE: moderate $_{G8\text{-}R1_Ref_10}$).[632]

### *3.5.2.3 Overweight and obesity*

Obesity is a chronic disease characterized by the accumulation of excessive body fat, which can be detrimental to health. Obesity increases the risk of other serious diseases, such as diabetes, obstructive sleep apnea, and heart disease, among others.

The treatment of overweight and obesity should be multidisciplinary and comprehensive, with dietary prescription, psychological intervention, and the use of certain medications being the most used therapeutic tools.

Currently, the use of new cardiometabolic imaging technologies has allowed us to classify different patterns of overweight, ranging from centripetal to “ectopic” obesity with fat deposits in sites such as the liver or pericardium. It is very difficult to normalize body fat content in patients with severe obesity, so more aggressive treatments have been studied in this subgroup of individuals, such as obesity surgery, also known as metabolic surgery. (GRADE: low, $_{G4\text{-}R5_Ref_4}$).[633]

On the other hand, there is an association between childhood obesity, a worrying problem in our country, and the development of risk factors in adulthood.

In 2017, a meta-analysis of 21 studies and 54,981 obese children showed that childhood obesity is associated with an increase in systolic blood pressure (Zr= 0.10; 95% CI 0.06 to 0.13), diastolic blood pressure (Zr= 0.11; 95% CI 0.07 to 0.14), and triglyceride levels (Zr= 0.08; 95% CI 0.03 to 0.13). It was also inversely associated with HDL-C levels (Zr= -0.06; 95% CI -0.10 to -0.02) (GRADE: high $_{G4\text{-}R5_Ref_3}$).[634]

In 2020, a cohort of patients in CVRhP-P that included adolescents showed that patients in early outpatient setting (4–6 weeks) improved their metabolic risk factors and exercise capacity by 14.3%. In these patients, along with those in medium-term rehabilitation (6–12 months), an additional 10% improvement in their

**Recommendation Table 23.** Heart valve disease

| PICO | 3.5.3 Heart valve disease | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G30-R4 | Antibiotic prophylaxis is recommended before invasive dental procedures in patients with prosthetic valves or other conditions that place them at high risk for infective endocarditis, in order to reduce the risk of developing this potentially serious infection. | I | B-NR | C+/B+ | 4 |
| G30-R3 | It is recommended that post-valve surgery patients, particularly older adults, be included in CVRhP-P to perform strengthening, balance, and gait exercises, in order to improve muscle strength and exercise tolerance, reduce the number of falls, and increase the time between falls. | IIa | B-R | C+/B+ | 1 to 6 |
| G30-R2 | In patients on chronic treatment with oral anticoagulants containing vitamin K inhibitors, INR levels should be adjusted according to the goals established by their clinical diagnosis and in coordination with their treating physician, in an effort to reduce the rate of bleeding or thrombotic events. Evidence regarding dietary adjustment in relation to anticoagulant therapy remains controversial, and no recommendation can be made. | III-NB | C-EO | C-/B- | 1 to 6 |

ExTol and an increase in HDL-C was observed. In patients in residential settings, an increase in their ExTol was observed by 18.4%, with improvements in blood pressure, HDL-C, LDL-C, and glycemia (GRADE: moderate $_{G4\text{-}R5_Ref_1}$).[635]

A randomized controlled trial of 304 obese adolescents showed that body fat percentage decreased in the aerobic training group (MD = -1.1; 95% CI: -1.7 to -0.5), the resistance training group (MD = -1.6; 95% CI: -2.2 to -1.0), and the control group (MD = -0.3; 95% CI: -0.9 to 0.3). Waist circumference decreased in the aerobic training group (MD = -3.0 cm; 95% CI: -4.4 to -1.6), the strength training group (MD = -2.2 cm; 95% CI: -3.7 to -0.8), and the control group (MD = -0.2 cm; 95% CI: -1.7 to 1.2). The greatest differences were observed with combined training (GRADE high $_{G4\text{-}R5_Ref_2}$).[636]

### *3.5.2.4 Oral health*

For decades, a relationship has been observed between oral health and the presence of various types of cardiovascular disease. Bacterial periodontitis is associated with increased platelet activation, atherosclerosis, and atherothrombosis (GRADE: low $_{G4\text{-}R3_Ref_1}$).[637]

In a meta-analysis by Muñoz E et al, it was reported that subjects with periodontal disease had higher blood pressure levels than controls (SBP difference = 4.49 mmHg; 95% CI 2.88 to 6.11, and DBP difference = 2.03 mmHg; 95% CI 1.25 to 2.81). In addition, previously normotensive patients with periodontal disease were more likely to be hypertensive than controls (OR = 1.68; 95% CI 0.85 to 3.35, p = 0.14) (GRADE: high $_{G4\text{-}R3_Ref_4}$).[638]

In relation to atherosclerosis, a cross-sectional study by Costa T et al. found that the presence of chronic apical periodontitis is associated with atheromatous plaques by coronary angiography (RR= 2.79; 95% CI 1.1 to 7.3) (GRADE: moderate $_{G4\text{-}R3_Ref_6}$).[639]

On the other hand, a cohort study with 787,490 patients (393,745 with periodontitis and the rest without) showed, after adjustment for confounders, that patients had a higher risk of presenting atrial fibrillation (HR = 1.31; 95% CI 1.25 to 1.36) (GRADE: high $_{G4\text{-}R3_Ref_5}$).[640]

In the search for a prophylactic intervention in this type of patients, Tonetti MS and collaborators observed that inflammation levels and flow-mediated vasodilation (endothelial function) significantly improved 6 months after intensive periodontal treatment, compared with traditional management (flow difference = 2.0%; 95% CI 1.2 to 2.8) (GRADE: high $_{G4\text{-}R3_Ref_7}$).[641]

### *3.5.2.5 Vaccination schedule*

Infections with influenza, coronavirus, or pneumococcal pneumonia have been associated with a higher number of adverse cardiovascular outcomes (MACE) and all-cause mortality (GRADE: high $_{G11\text{-}R2_Ref_2,\ G4\text{-}R1_Ref_2}$).[601,642]

The CDC (Centers for Disease Control and Prevention, USA) advises that patients with cardiovascular or respiratory diseases receive their full vaccination schedule for coronavirus (COVID), influenza, and pneumococcus (annually). Patients over 60 years of age with heart or lung disease may also receive annual immunization against respiratory syncytial virus, based on the physician's clinical judgment. Vaccines should be

administered if there are no contraindications (GRADE: high $_{G4\text{-}R1_Ref_1}$).[643]

**(KM)** CVRhP-P must address comprehensive prevention: dyslipidemia control with LDL-C as the main therapeutic target, smoking cessation to reduce cardiovascular risk, and promotion of healthy habits such as regular vaccination, good oral health, balanced diet, and physical activity. Together, these strategies strengthen prognosis and improve quality of life in cardiovascular patients.

### 3.5.3 Heart valve disease

Preventive measures for heart valve disease aim to prevent thrombosis, endocarditis, and the development of heart failure.

#### 3.5.3.1 Thrombosis

The indication for anticoagulant therapy in patients with heart valve disease depends on each case, ranging from patients with mechanical prosthetic valves and atrial fibrillation requiring more intensive therapy to those who will receive antiplatelet agents after intervention.

Although these guidelines do not address this topic in depth, it is desirable for CVRhP-P staff to be familiar with the topic and support the monitoring of these patients in conjunction with the treating physician.

Stability in anticoagulation with vitamin K antagonists, such as warfarin or acenocoumarin, depends on dietary factors, especially consistency in vitamin K intake.

Kampouraki E et al. documented that significant variations in vitamin K intake can reduce the INR by 0.2 units for every 100-µg increase over four days, leading to a higher risk of adverse events such as valvular thrombosis, myocardial infarction, and bleeding. Patients with intakes ≥250 µg/day had lower INR values and a greater need for warfarin dose adjustment. This same review emphasizes that a stable daily intake, within the recommended range of 65–80 µg/day, can significantly improve INR control, also highlighting that erratic alcohol consumption can alter anticoagulant response. Tools such as the "K-Card," which identifies foods with ≥5 µg of vitamin K per serving, can facilitate patient dietary self-monitoring (GRADE: very low $_{G30\text{-}R2_Ref_1}$).[644]

Chang CH et al. designed a scoring scale based on the vitamin K content of 23 commonly consumed vegetables, with the aim of providing patients and healthcare professionals with a practical guide to avoid variability in anticoagulation. This tool proved useful for standardizing diet and facilitating clinical follow-up, with no adverse events reported. The study supported the concept of maintaining a constant dietary intake rather than imposing strict restrictions on vitamin K-rich vegetables (GRADE: low $_{G30\text{-}R2_Ref_2}$).[645]

Regarding interactions with other dietary components, Mouly S et al. emphasize that foods, herbs, and supplements can alter plasma concentrations of anticoagulants, reduce their efficacy or increase their toxicity. The risk increases considerably in the presence of polypharmacy: 50% in patients with 5 drugs and more than 80% with 7 or more. Furthermore, potentially dangerous interactions were identified with products such as ginkgo, horse chestnut, and danshen, which are associated with an increased risk of bleeding. A detailed dietary history, including supplements and herbal products, and reporting suspected interactions to pharmacovigilance systems is strongly recommended (GRADE: very low $_{G30\text{-}R2_Ref_3}$).[646]

Several clinical studies have not demonstrated any associations between warfarin intake and various fruit products. However, clinical cases have been reported that could link fruits such as blueberries, pomegranates, avocados, grapefruits, and mangos with alterations in warfarin pharmacodynamics. Consequently, caution is recommended with the consumption of these foods, especially in patients with a history of INR instability (GRADE: low $_{G30\text{-}R2_Ref_4}$).[647]

**Recommendation Table 24.** Arrhythmias and sudden death

| PICO | 3.5.4 Arrhythmias and sudden death | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G31-R5 | It is recommended that patients within a CVRhP-P who present any type of arrhythmia be evaluated by a cardiology professional who should request consultation with an electrophysiology specialist when, in his or her judgment and based on risk stratification and analysis of the ECG trace, the patient presents alterations that potentially put his or her life at risk, in search of a definitive diagnosis and treatment and thus reduce the lethality associated with them. | I | A | C+/B+ | 1 to 6 |

*(Continues)*

**Recommendation Table 24.** Arrhythmias and sudden death *(continued)*

| PICO | 3.5.4 Arrhythmias and sudden death | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G31-R2 | It is recommended that patients admitted to a CVRhP-P who present ventricular ectopics during training sessions or during ergometry be studied in greater depth using various diagnostic methods and their risk stratified, in order to select the appropriate therapeutic measure in each case and thus reduce the likelihood of serious complications, particularly in high-risk patients. | I | B-NR | C+/B+ | 1 to 6 |
| G31-R1 | It is recommended that CVRhP-P staff who supervise high-risk patients be trained to identify the appearance of arrhythmias, ischemia, or hemodynamic alterations during ThPhT sessions and immediately notify the attending physician, so that appropriate intervention can be provided for each type of adverse event. | I | C-LD | C+/B+ | 1 to 6 |
| G31-R3 | It is recommended that patients with heart disease follow a diet that maintains serum potassium and magnesium levels within reference parameters, in an effort to reduce the occurrence of arrhythmias. | IIb | C-EO | C-/B+ | 1 to 6 |

A high intake of vitamin K (>150 µg/day) could affect INR values, although results across studies are conflicting. Some supported that a consistent diet improves anticoagulation control, while others found no clinically significant effects. However, the consensus among the authors was that strict restrictions on foods high in vitamin K are not justified, but that a consistent and adequate intake should be prioritized (GRADE: low $_{G30\text{-}R2_Ref_5}$).[648]

Hatfield J et al reviewed the interaction between 47 dietary supplements and bleeding risk in anticoagulated patients. Supplements such as garlic, hawthorn, and ginkgo biloba were identified as having a strong association with clinically relevant bleeding events, especially when used in conjunction with warfarin. The authors concluded that healthcare professionals should actively inquire about supplement use and consider discontinuing supplement use before surgical procedures or changes in anticoagulant therapy (GRADE: very low $_{G30\text{-}R2_Ref_6}$).[649]

### *3.5.3.2 Endocarditis*

Several recent observational studies and meta-analyses have demonstrated a significant association between invasive dental procedures and the development of endocarditis in patients with high-risk clinical conditions, defined as those with a history of previous infective endocarditis, prosthetic heart valves (mechanical or biological) or prosthetic material used in valve repair, unrepaired cyanotic congenital heart disease, congenital heart disease with prosthetic materials implanted within the previous 6 months, or repaired congenital heart disease with residual defects. Also included in this group are patients who undergo invasive dental procedures, such as manipulation of gingival tissue, the periapical region, or the perforation of the oral mucosa. In a 2023 meta-analysis, which included more than one million cases and 30 observational studies, the administration of antibiotic prophylaxis before such procedures was associated with a significant reduction in the risk of endocarditis in this high-risk population (RR = 0.41, 95% CI 0.29 to 0.57), with no benefit demonstrated in low-risk individuals (GRADE: moderate $_{G30\text{-}R4_Ref_1}$).[650]

Another 2023 meta-analysis, which evaluated 38 observational studies (n= 158,246), found that 11% of endocarditis cases occurred after an invasive dental procedure. In studies where all high-risk patients received antibiotic prophylaxis, no cases of endocarditis were reported. Furthermore, Streptococcus viridans was identified as the causative agent in 69% of post-dental procedures, compared with 21% in controls (p= 0.003). Having had a recent dental procedure was 12% more common among patients with endocarditis compared to controls (RR= 1.12; 95% CI 1.00 to 1.26, p= 0.048). Adverse events associated with amoxicillin use were mild and gastrointestinal, with no need to discontinue treatment. (GRADE: moderate $_{G30\text{-}R4_Ref_2}$).[651]

In a cohort study published in 2022, a significant temporal association was documented between invasive dental procedures and the development of endocarditis in high-risk patients, especially after tooth extractions (OR= 11.08, 95% CI: 7.34 to 16.74) and oral surgery (OR= 50.77, 95% CI: 20.79 to 123.98). The likelihood of endocarditis was highest within 4 weeks of the procedure (OR= 2.00, 95% CI: 1.59 to 2.52,

p= 0.002). The use of antibiotic prophylaxis was associated with a significant risk reduction (OR= 0.49, 95% CI 0.29 to 0.85, p = 0.01), with results confirmed in the analysis by procedure type (extractions: OR= 0.13, 95% CI 0.03 to 0.34; oral surgery OR= 0.09, 95% CI 0.01 to 0.35). (GRADE moderate $_{G30\text{-}R4_Ref_3}$).[652]

**(KM)** When monitoring a patient with valvular heart disease, it is important to consider the prevention of complications such as thrombosis or prosthetic endocarditis.

### 3.5.4 Arrhythmias and sudden death

Cardiovascular Rehabilitation and Prevention programs are widely recommended by the world's leading cardiology societies. However, it can be concerning that patients with heart disease may experience sudden death during physical exercise, usually associated with malignant arrhythmias. For decades, ThPhT has been shown to be effective and safe in patients with heart disease, even in high-risk subjects, if prescribed and supervised appropriately and expertly.

In a 65-year C-CVRhP registry with 25,420 patients, 42,419 exercise tests, and 74,3471 patient-hours of ThPhT, 20 adverse cardiovascular events were reported, 5 related to exercise tests and 15 to ThPhT. The rate was one event per 8,484 exercise tests and 49,565 patient-hours of training. The cardiac arrest rate was 1.3 per million patient-hours (GRADE: moderate $_{G31\text{-}R1_Ref_1}$).[653]

Kim C et al. reported the absence of major events such as mortality, cardiac arrest, or myocardial infarction during a CVRhP-P. They recorded a very low incidence of minor events: 17 patients presented angina, 31 electrocardiographic abnormalities, and 12 with both (angina and ECG abnormalities), as well as 10 patients with altered hemodynamic response (GRADE: moderate $_{G31\text{-}R1_Ref_2}$).[654]

El Masri I et al. published a narrative review of patients with arrhythmias, where they pointed out that exercise improves health and reduces cardiovascular risk. However, in patients with specific cardiac conditions such as channelopathies, cardiomyopathies, or coronary artery disease, physical exercise may be associated with sudden cardiac death. The risk of myocardial infarction during strenuous exercise in asymptomatic patients with coronary artery disease decreases with regular physical activity. Furthermore, CVRhP-P has been shown to be beneficial to patients with HF. Patients with hypertrophic cardiomyopathy are usually prohibited from exercising, although this absolute contraindication has recently changed. Conditions such as premature repolarization have also been considered risky by some research groups (GRADE: low $_{G31\text{-}R5_Ref_4}$).[655]

In ThPhT sessions for patients with heart disease, rhythm or conduction disturbances are common, some of them benign and others not. Khong A et al. described a series of 251 patients in CVRhP-P in which 55% of patients experienced one or more "disruptions" during the program, including glycemic (71%), blood pressure (12%), symptomatic arrhythmia (8%), or chest pain (7%). Most events (66%) occurred during the first 12 weeks. The authors performed a regression model, which showed that the diagnosis most strongly associated with adverse events was diabetes mellitus (OR = 2.66; 95% CI 1.57 to 4.52, p < 0.0001) (GRADE: high $_{G31\text{-}R5_Ref_1}$).[656]

The presence of high-risk premature ventricular contractions (PVC) during exercise and the recovery phase has been associated with increased total and cardiovascular mortality, underscoring the importance of their identification, study, and systematic monitoring. A recent meta-analysis including 7 studies with 24,518 patients showed that exercise-related PVC increased the risk of total mortality (HR=1.27; 95% CI 1.07 to 1.48), whereas both exercise-related (HR=1.69; 95% CI 1.19 to 2.20, $I^2$=17.6%) and recovery-related PVC (HR=1.62; 95% CI 1.25 to 2.00, p< 0.001) were associated with an increased risk of cardiovascular mortality. High-risk PVC is characterized by: high frequency (>10% of all ventricular depolarizations or >10 PVC per minute), complex morphology (multifocal, paired, R-in-T phenomenon), or the presence of non-sustained ventricular tachycardia (≥3 consecutive at more than 100 bpm with spontaneous termination in <30 seconds) (GRADE: high $_{G31\text{-}R2_Ref_1}$).[657]

Given its prognostic impact, it is recommended that patients with high-risk PVCs be studied deeply using echocardiography or Holter monitoring, among others, to complement cardiovascular risk stratification and determine the need for specific interventions to reduce the risk of mortality. Marcus GM et al. highlight that a high PVC burden could be related to ventricular dysfunction and an increased risk of mortality. Among the therapeutic options, the use of beta-blockers, calcium channel blockers, and, in selected cases, catheter ablation has been suggested, which has been shown to be effective in patients with symptoms or impaired ventricular function (GRADE: very low $_{G31\text{-}R2_Ref_2}$).[658]

Rius MD et al. developed a multivariate model to predict exercise-related arrhythmias in a group of 412 patients who received physical therapy training and observed that the presence of arrhythmias in the

exercise stress test (ET) before the start of the rehabilitation program was associated with an increase in arrhythmias during physical therapy sessions (RR= 1.89; 95% CI: 1.25 to 2.86). Furthermore, the regression model identified that the variables associated with rhythm disorders in physical therapy were the presence of arrhythmia in the ET, peak oxygen utilization ($VO_2$peak), and the use of diuretics (GRADE: high $_{G31\text{-}R1_Ref_3}$).[169]

A cohort study of 11,662 patients with ischemic heart disease enrolled in a CVRhP-P trial showed that the incidence of atrial fibrillation was 1.04 per 100 patient-years. There was no association between completion of the rehabilitation program and the risk of AF incidence after adjustment for confounders (HR= 0.97; 95% CI, 0.83 to 1.15). Furthermore, with each increase in METs after the program, a decrease in the incidence of AF was observed (MD= 18%; 95% CI, 6% to 28%). This decrease in risk was directly associated with the increase in METs, until they reached 10.3 METs, at which point the risk stabilized (GRADE: moderate $_{G31\text{-}R5_Ref_3}$).[659]

A systematic review showed that regular, moderate exercise, as part of a CVRhP-P, was associated with a reduction in atrial fibrillation periods in patients with paroxysmal and persistent AF. Furthermore, in patients with chronic AF, ventricular HR response values decreased, with subsequent improvement in symptoms. CVRhP-P was considered safe and "manageable" in patients with AF, although the absence of serious adverse events, such as hospitalization or death, has not been adequately demonstrated (GRADE: moderate $_{G31\text{-}R5_Ref_5}$).[660]

A position paper published by the European Association of Preventive Cardiology and the European Heart Rhythm Association (EHRA) posited that an increasing number of patients with implanted electronic devices are entering CVRhP-P. Interventions need to be directed not only at the underlying pathology but also at improving psychological adaptation to device use, the occurrence of shocks, and the risk of arrhythmias, syncope, or sudden cardiac death, which necessitates special interventions in this population. The literature contains scattered information, and there is a lack of CPGs. The authors issued some recommendations for the CVRhP program in these patients (GRADE: moderate $_{G31\text{-}R5_Ref_6}$).[126]

Steinhaus DA et al. published a meta-analysis of 8 studies and 2,547 ICD patients participating in a CVRhP-P, finding that exercise therapy characteristics varied widely. Exercise-related outcomes were the most common endpoints (87.5%), with 81% of studies showing improvement. ICD shocks were lower during exercise (15.6%) compared with 23% associated with other activities (OR= 0.68; 95% CI 0.48 to 0.80, p< 0.001). Furthermore, ThPhT was associated with an increase in peak $VO_2$ (MD=1.98 $mlO_2$/kg/min compared with non-trainers (MD=0.36 $mlO_2$/kg/min), p<0.001) (GRADE: moderate $_{G31\text{-}R5_Ref_2}$).[661]

Electromagnetic interference constitutes a significant risk for patients with implantable electrical therapy devices such as cardioverter-defibrillators or pacemakers, as it can inappropriately inhibit sensing, misdetect arrhythmias, or deliver inappropriate shocks. The main sources of this type of interference include medical equipment (MRI, electrocautery, radiofrequency therapy) and high-power everyday devices (wireless chargers, industrial tools, etc.). It is important to identify and minimize or prevent exposure to intense electromagnetic fields. Furthermore, implantable device programming should be optimized, and in high-risk medical environments, temporary reprogramming, or the use of magnets under specialized supervision should be considered. It is essential to inform the patient about the importance of electromagnetic interference, emphasizing the identification of potential sources and preventing exposure to them (GRADE: low $_{G27\text{-}R3_Ref_7}$).[662]

Nielsen KM et al. published a meta-analysis of 8 studies and 1,730 patients in CVRhP-P with ICDs, which showed that the use of this device is an effective way to prevent sudden death. However, it is important to note that patients who wear them experience psychological problems once the device is implanted, and it often negatively affects their HR-QoL. The duration of CVRhP-P was 12 weeks on average, with no significant increase in mortality observed compared to the control group (RR= 1.96; 95% CI: 0.18 to 21.26, GRADE: low). Nor were differences observed in relation to the occurrence of serious adverse events (RR= 1.05; 95% CI: 0.77 to 1.44, GRADE: low). A meta-analysis of HR-QoL was not possible due to the heterogeneity of the data. A significant increase in $VO_2$peak was observed (DM= 0.91 $mlO_2$/kg/min; 95% CI 0.60 to 1.21, GRADE: very low, and high heterogeneity $I^2$= 78%). No differences were observed in relation to the requirement for anti-tachycardia therapy (RR= 1.26; 95% CI 0.84 to 1.90, GRADE: moderate), appropriate shocks (RR= 0.56; 95% CI 0.20 to 1.58, GRADE: low) or inappropriate shocks (RR = 0.60; 95% CI 0.10 to 3.51, GRADE: moderate) (GRADE: high $_{G31\text{-}R5_Ref_7}$).[663]

Hughes A et al. reviewed the usefulness of wearable devices (watches and smartphones, among others) in relation to patient monitoring and showed that wearable devices are increasingly used by the general

population, where a large amount of data, including physiological data, is collected on a daily-basis. This could help the medical team understand the patient's health status, compared to traditional methods such as consultations or hospitalizations. This information could allow the clinicians to make diagnoses or manage patients such as those with ischemic heart disease or even HF (GRADE: very low G31-R5_Ref_9).[664]

Patients with CVD are at increased risk for both ventricular and supraventricular arrhythmias. In addition to treating the underlying cause and using antiarrhythmic medication, there are some dietary recommendations that are advisable.

Arnal LM et al. mention that potassium intake has been increased in the general population, particularly to improve cardiovascular outcomes and reduce arrhythmias. However, this may worsen the prognosis in some cases, such as in patients with chronic kidney disease (GRADE: very low G31-R3_Ref_1).[665]

Esteban-Fernández A et al. establish that the role of hypomagnesemia in patients with HF, defined as magnesium levels below 1.5 mg/dL, has been described as an underdiagnosed electrolyte disorder in patients with HF, which is associated with the appearance of ventricular arrhythmias, and its relationship with mortality is still controversial. The presence of hypomagnesemia is associated with the use of some drugs, such as proton pump inhibitors, diuretics, or potassium chelators, as well as with other conditions such as alcoholism, malabsorption disorders, or malnutrition. The detection of hypomagnesemia in patients with HF requires periodic monitoring of magnesium along with renal function and other ions, to assess its severity and propose correction through oral and, less frequently, intravenous supplements. Hypomagnesemia is associated with ventricular arrhythmias (GRADE: very low G31-R3_Ref_2).[666]

Morales KP et al. published a review of various nutritional topics associated with cardiovascular diseases. They initially highlighted that magnesium is an essential mineral that plays an important role in various bodily functions, including heart rhythm regulation. Eating disorders

**Recommendation Table 25.** Operational Management

| PICO | 3.6 Operational Management | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G5-R2 | It is recommended that the director of the CVRhP-P observe the regulations applicable to clinical and administrative operations, infrastructure, equipment, staff training, accounting and tax operations, as well as all other general regulations in accordance with the Law, in pursuit of a lawful, effective, and sustainable comprehensive practice. | I | C-EO | C-/B+ | 1 to 6 |
| G5-R4 | It is suggested that cardiac rehabilitation gyms have spacious, well-lit and ventilated training areas with appropriate accessibility and suitable for patients with frailty and disabilities, in order to ensure a functional and safe environment. | I | C-EO | C+/B+ | 1 to 6 |
| G6-R1 | It is recommended that CVRhP-P be created, implemented, operated, supervised, and audited within a structured quality management model that includes mission, management, and support processes (accounting, administrative, technical, etc.) in order to consolidate, update, and innovate their operation. | I | C-EO | C-/B+ | Establish a quality management culture |
| G6-R2 | It is recommended that CVRhP-P managers implement planning, training, supervision, certification, and reengineering processes, as well as strategies for recognizing and rating quality standard indicators, risks, and threats, in order to improve operational effectiveness and efficiency, particularly in areas of low compliance or high risk. | I | C-EO | C-/B+ | Establish a quality management culture |
| G6-R3 | It is recommended that the multidisciplinary staff of a CVRhP-P receive appropriate training in their professional area according to the type of rehabilitation unit and, in particular, have up-to-date cardiopulmonary resuscitation courses (BLS, ACLS, or PALS) in order to offer an effective, efficient, and safe service. | I | C-EO | C-/B+ | 1,2,4,5 and 6 |
| G6-R4 | It is recommended to implement continuous improvement strategies that include auditing, clinical performance feedback, and training of multidisciplinary teams, with the aim of promoting the systematic identification of successes and opportunities for improvement in care processes in CVRhP-P. | IIa | B-NR | C-/B+ | 1 to 6 |
| G6-R6 | It is recommended that eligible patients be referred to CVRhP-P through automated referral systems, ideally with the support of inter-agency networks, the use of liaison managers, and explicit referral by treating physicians, in order to increase referral rates, reduce any disparities in access to care, and increase the likelihood of receiving the benefits offered by these programs. | IIa | C-LD | C-/B+ | 1 to 6. Establish inter-institutional networks |

(EDs), such as anorexia nervosa, bulimia nervosa, and binge eating disorder, can have serious consequences for the physical and mental health of those who suffer from them. Among the physical complications associated with EDs, cardiac arrhythmia is a major concern. Coffee is one of the most consumed beverages worldwide, but the acute health effects of coffee consumption remain uncertain. A prospective, randomized, case-crossover trial was conducted to examine the effects of caffeine on cardiac ectopia and arrhythmias. Alcohol and heart rhythm disorders are linked, with excessive consumption increasing the risk of developing certain types of arrhythmias (GRADE: very low $_{G31\text{-}R3_Ref_3}$).[667]

**(KM)** Cardiac Rehabilitation Programs are safe and effective, with very low rates of adverse events. When supervised appropriately, structured exercise reduces cardiovascular risk, improves prognosis, and enhances quality of life, even in high-risk patients.

### 3.5.5 Falls

In particular, many patients admitted to CVRhP-P are at high risk of falls, due to their age or the clinical conditions of their heart disease. Therefore, it is especially important to gather relevant information to assess the risk of falls in this population and thus establish a targeted plan.(GRADE: moderate $_{G12\text{-}R2_Ref_8}$).[668]

Bernocchi P et al published a randomized controlled trial with 283 older adults at high risk of falls and with various comorbidities who were treated with 6 months of telerehabilitation to prevent falls (n=141) vs. conventional management (n=142). Telerehabilitation consisted of a fall prevention program using strength, balance, and gait exercises, followed by telephone supervision. During the 6 months, 85 patients suffered at least one fall: 29 (20.6%) in the intervention group versus 56 (39.4%) in the control group ($p < 0.001$). The risk of falls was significantly reduced in the intervention group (RR= 0.60; 95% CI 0.44 to 0.83; $p< 0.001$). The time to first fall was longer in the intervention group (152 ± 58 vs. 134 ± 62 days, $p = 0.001$). Furthermore, fewer patients experienced two or more falls in the telerehabilitation group (n = 11, 8%) compared to the control group (n = 24.17%), $p = 0.020$. (GRADE: high G30-R3_Ref_1).[669]

In 2022, evidence-based and expert consensus-based CPGs for falls prevention and management applicable to older adults were published for use by healthcare and other professionals. These CPGs consider: a person-centered approach that includes the perspectives of experienced older adults, caregivers, and other stakeholders; gaps in previous guidelines; recent advances in e-health; and implementation in settings with limited access to resources, such as low- and middle-income countries. The guidelines conclude that all older adults should be assessed for falls prevention and physical activity. Early detection of high-risk falls in community-dwelling older adults is recommended. Individuals considered at high risk should be offered a comprehensive multifactorial falls risk assessment to design and implement tailored multidomain interventions. Other recommendations include details on the components and combinations of assessment and intervention, as well as recommendations for specific settings and populations. No adverse events were reported (GRADE: high $_{G30\text{-}R3_Ref_3}$).[670]

A randomized controlled trial of 87 patients postoperatively after heart valve surgery showed that the group that performed sitting, standing, and walking exercises followed by resistance training showed a significant beneficial effect on physical capacity, as demonstrated by the Short Physical Performance Battery (SPPB) and the 6-minute walk test at hospital discharge, an effect that was maintained at 6 months compared to the control group. Improvement in the SPPB was associated with a reduction in mortality (OR = 0.416; 95% CI 0.218 to 0.792). Falls were not measured. (GRADE: moderate $_{G30\text{-}R3_Ref_2}$).[671]

**(KM)** Assessing the risk of falls in patients is of paramount importance and should be implemented in all inpatient rehabilitation centers.

## 3.6 Operational Management

### 3.6.1 Regulations

The operation of cardiovascular rehabilitation and prevention units in Mexico is initially regulated by the Federal Commission for the Protection against Health Risks (COFEPRIS), the General Health Council (CSG), and other institutions such as the Ministry of Health, the Mexican Social Security Institute (IMSS), the Institute of Social Security and Services for State Workers (ISSSTE), the National Civil Protection Coordination, and the Ministry of Finance and Public Credit, among others.

It is mandatory that the personnel working in these units be technically and academically trained, and certified by the corresponding bodies, such as the General Directorate of Professions (DGP) of the Ministry of Public Education (SEP), the National Regulatory Committee of Medical Specialty Councils (CONACEM) through the Mexican Councils of Cardiology and Rehabilitation

| Origin | Key Components | Items |
|---|---|---|
| Internal | Strengths | Decreased case fatality.<br>Increased quality of life.<br>Decreased morbidity.<br>Decreased care costs.<br>Transdisciplinary approach.<br>Versatility in service delivery.<br>Focus on secondary prevention |
| | Weaknesses | Low number of CVRhP units.<br>Geographical, transportation, support, or financial barriers to accessing centers.<br>Low adherence to programs.<br>Need for specific staff training.<br>High staffing requirements for inpatient care.<br>Lack of recording and analyzing quality indicators. |
| External | Opportunities | Awareness and advocacy.<br>Expand service delivery modalities (AI, telemedicine, etc.).<br>Increase therapeutic indications.<br>Improve efficiency and effectiveness in end-of-program indicators.<br>Standardize and automate patient referrals.<br>Implementation of emerging techniques.A culture of user satisfaction. |
| | Threats | Low patient referrals.<br>Overcrowding of existing units.<br>Ineffective communication.<br>Biases in patient care based on gender, socioeconomic status, and age.<br>Learning curve for staff in training.<br>Generation gap.<br>Healthcare contingencies.<br>High staff turnover. |

**Figure 28.** SWOT Analysis of Cardiovascular Rehabilitation and Prevention Programs. Analyzing the situation in a cardiovascular rehabilitation unit can lead to better decision-making that stabilizes or improves its processes. By understanding the components of these four areas, weaknesses can be transformed into strengths and threats into opportunities. Strengths and Weaknesses, and external Opportunities and Threats (SWOT).

Medicine, in addition to the specific colleges for each discipline.

It is important that the actions carried out in these units occur within the current legal framework, which must comply with the General Health Law and the General Labor Law, as well as the regulations emanating from them. (GRADE: very low G5-R2_Ref_16, G5-R2_Ref_17, G5-R2_Ref_18, G5-R2_Ref_19).[672,673,674,675]

**(KM)** The operation of a CVRhP center must strictly adhere to current regulations.

### 3.6.2 Staff, infrastructure, and equipment

#### 3.6.2.1 Staff

The structure of these programs can vary widely, but some points must prevail, such as the formation of a team led by a clinical specialist, highly trained in cardiology and physical training, who may be supported by an administrative management team. The other professionals are usually comprised of specialists in physical training, physical therapy, nursing, nutrition, psychology, and occupational therapy, among others. Professionals working in CVRhP units typically initially interact in a multidisciplinary manner, in other words, independently and coordinated by the clinical record. However, when the staff matures toward a level of interdisciplinary communication, direct relationships are established among them. The most advanced and comprehensive approach is transdisciplinary, where not only does the interaction of different professionals occur, but a new framework of knowledge is created that transcends them.

In Mexico, medical specialists must receive a certificate in cardiac rehabilitation issued by CONACEM (National Council of Medical Professionals) through the Medical Councils. For paramedical personnel, certification depends on each individual regulatory institution.

| Ideal and Minimum Outcome Targets by Discipline in CVRhP-P | | | |
|---|---|---|---|
| Discipline | Parameter | Ideal outcome | Minimum outcome |
| Nutrition | Lecture attendance | 100% | 80% |
| | Workshop attendance | 100% | 80% |
| | Final evaluation | 100% | 90% |
| | Diet implemented | Yes | Yes |
| | Weight loss (BMI >25) | 1 kg/week | 0.5 kg/week |
| Psychology | Session attendance | 100% | 80% |
| | Depression | Absent | Improvement |
| | Anxiety | Absent | Improvement |
| | Sexual satisfaction | Satisfied | Improvement |
| | HR-QoL | No deterioration (up to -25%) | Improvement |
| Non-Aerobic training (Kinesiotherapy) | Session attendance | 100% | 80% |
| | % Target HR achieved | < 105% | < 105% |
| | % Theoretical Max HR achieved | < 85% | < 85% |
| | % Target DP achieved | < 105% | < 105% |
| | % Theoretical Max DP achieved | < 85% | < 85% |
| | Intensity (Borg 6–20) | Regular (100%) | Regular (75%) |
| | Strength | 3/3 | Improvement |
| | Balance | 3/3 | Improvement |
| | Coordination | 3/3 | Improvement |
| | Flexibility | 3/3 | Improvement |
| | Class attendance | 100% | 80% |
| Aerobic training (Cycle ergometry and dance) | Session attendance | 100% | 80% |
| | % Target HR achieved | 100% | 95–105% |
| | % Theoretical Max HR achieved | 70% | 40–85% |
| | % Target DP achieved | 100% | 95–105% |
| | % Theoretical Max DP achieved | 70% | 40–85% |
| | Intensity (Borg 6–20) | Regular (100%) | Regular (75%) |
| | Workload (cycle) | > 20% * | Increment * |
| | ΔHR/W * | ↓ in comparative session* | = in comparative session * |
| | ΔDP/W * | ↓ in comparative session* | = in comparative session * |
| | Class attendance | 100% | 80% |
| Prevention | Class attendance | 100% | 90% |
| | Final evaluation | 100/100 | 90/100 |

**Figure 29.** Process Matrix. The Quality Management System represents an institution's universe of action and can be presented as a process matrix that includes mission, strategy, and support processes. Regulatory bodies and stakeholders are also included.

The assignment of different functions within the CVRhP, such as the supervision of patients in training, must be clearly assigned by the governing body, which must ensure the staff's training level and request formal feedback on the corresponding activities.

The conformation of CVRhP units should focus on solving the core problem in each environment and historical stage. The overall status of the CVRhP-P can be assessed through a SWOT analysis, in which managers identify strengths, weaknesses, opportunities, and threats. This figure (Fig. 28) shows some examples of the information obtained with this strategy.

### *3.6.2.2 Facilities*

Architectural design can consider the quality of the visual and acoustic environment, as this positively

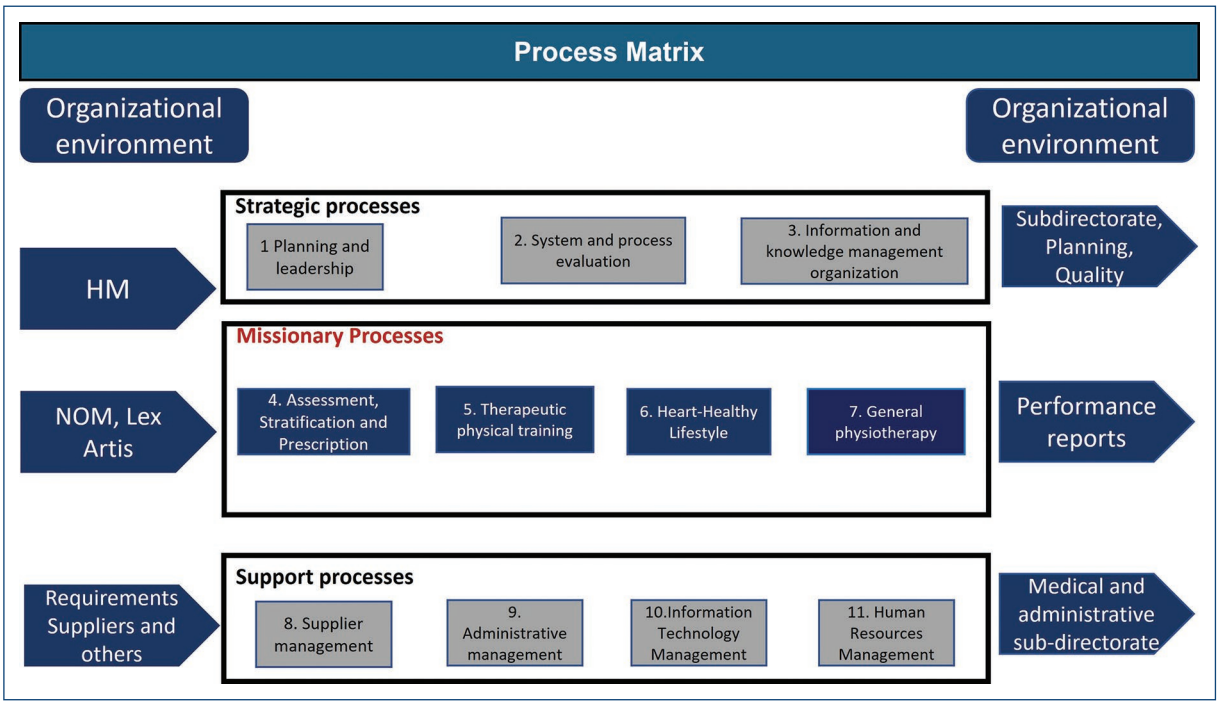


**Figure 30.** Solution tree. This is a widely used tool in process management, which identifies a core problem, followed by its underlying causes and consequences (problem tree). This allows a specific solution to be found for each problem and confirms cause-effect interactions, creating a virtuous cycle of improvement in the Quality Management System.

impacts staff satisfaction, reduces patient stress, and decreases the risk of falls. Proper space planning ensures an optimal environment for comprehensive cardiac rehabilitation. (GRADE: very low $_{G5\text{-}R4_Ref_3}$).[676]

A cardiovascular rehabilitation center must have spacious, functional, and safe facilities that guarantee quality care. The gym, a key element, must have at least 4 m² per patient, with a surface area greater than 100 m² ideal for groups of 8 to 12 people. This space should be comfortable and functional, with well-defined areas for activities such as assessment, aerobic training, strength training, and health education. The gym should be well-lit and ventilated, with adequate access for both outpatients and inpatients, and designed to facilitate mobility without creating overcrowding (GRADE: very low $_{G5\text{-}R4_Ref_1}$).[214]

### *3.6.2.3 Equipment and technology*

Furthermore, the center should ideally include integrated areas with telemetry, emergency medical equipment, and a defibrillator, changing rooms with showers, consultation rooms, spaces for diagnostic testing and therapeutic procedures, as well as educational areas equipped with audiovisual media. Safety is also a priority, so adequate accessibility, emergency exits, and evacuation plans must be guaranteed. (GRADE: very low $_{G5\text{-}R4_Ref_2}$).[677]

**(KM)** CVRhP-P must include a certified interdisciplinary team, safe and functional facilities, and appropriate technological equipment to ensure comprehensive, high-quality care. Proper staff organization, well-designed accessible spaces, and the availability of emergency resources are essential to provide a safe and effective environment for both patients and professionals.

### *3.6.3 Management and administration*

A system that offers some type of service, such as the CVRhP-P, is a set of processes and procedures that require attention to continue achieving its goals. However, it is very common for them to face challenges that jeopardize this operation.

When starting a CVRhP-P, the strategic planning team faces the challenge of creating a system of a certain level of complexity, where a coordinated process of planning, implementation, operation, and monitoring constitutes a practical tool that helps achieve both specific patient-centered objectives and the effectiveness and efficiency of a self-sustaining operation.

Another position paper published in 2021 emphasized the importance of effective implementation of CVRhP-P, highlighting their role in reducing mortality and hospitalizations, as well as improving HR-QoL. However, it also highlighted the need to improve the adoption of these programs globally and ensure an interdisciplinary and personalized approach to optimize their benefits (GRADE: low $_{G7\text{-}R8_Ref_3}$).[678]

In the United Kingdom, there are several cardiac rehabilitation units operating with very heterogeneous programs. The National Coronary Heart Disease Services Network clearly establishes the expected goals of Cardiac Rehabilitation interventions, emphasizing lifestyle changes. However, many patients do not have access to these services. Currently, there is a trend to focus these programs directly on patient needs rather than simply on standardizing processes. Traditionally, nursing staff play a crucial role in these services, but they require specific training (GRADE: very low $_{G7\text{-}R7_Ref_1}$).[679]

The International Council of Cardiac Rehabilitation (ICCPR) reports that CVRhP-P certification is feasible and can be implemented even by services with limited resources. A systematic process of certifying CVRhP centers can contribute to improving their processes and even strengthen their financial status. (GRADE: very low $_{G6\text{-}R1_Ref_2}$).[680]

In Mexico, certification of personnel and CVRhP units is carried out by the National Regulatory Committee of Medical Specialties (CONACEM) through the Mexican Councils of Cardiology and Rehabilitation Medicine, and the Mexican Society for Heart Care (SOMECCOR). (GRADE: low $_{G6\text{-}R1_Ref_4}$).[681]

Likewise, the Quality Management Model has been useful in creating, implementing, and updating the CVRhP-P. This approach includes the development of a matrix of processes—both mission-oriented, strategic, and support—complemented by the preparation of technical sheets for each process, which identify internal and external (stakeholder) interactions with current regulations (Fig. 29). This mechanism is crucial to the project's viability.

Thus, identifying the core problem, its causes, and consequences offers us the opportunity to identify and implement solutions for each problem at each hierarchical level (Fig. 30).

Recently, it has been proposed that, within the structure of cardiac rehabilitation units, a specific quality management model can be used, with a process matrix that includes mission, strategic, and support processes. In a second step, technical sheets are developed for each process to identify the interactions between them and other stakeholders. Finally, process map modeling (Bizagi) is included, identifying the linear action plan, which can be in the form of a tree related to the procedures. Processes and procedures can have a high level of complexity, such as risk stratification, patient referral sources, and safety protocols (GRADE: very low $_{G6\text{-}R1_Ref_3}$).[682]

In a document published by Thomas E et al., a significant heterogeneity of the CVRhP-P in Australia was observed, and they proposed centralizing information electronically (on a web platform) from the country's operational centers, with the aim of equalizing the quality of care and ensuring equitable distribution of services nationwide. This system would improve the quality of care, identify barriers and opportunities, and promote cost efficiency. (GRADE: low $_{G6\text{-}R2_Ref_3}$).[683]

A survey conducted in Ohio (USA) showed that only 39% of the programs evaluated were AACVPR-certified, 40% offered a case-based program, and 73% had an exercise physiologist. Sixty-six percent of centers did not perform 12-lead ECGs, and only 36% offered depression screening. However, certified programs were more effective at controlling weight and conducting admission assessments. The authors concluded that adherence to the implementation of the core components published in the guidelines was inconsistent (GRADE: low $_{G6\text{-}R2_Ref_6}$).[684]

Currently, a significant deficiency has been observed in both the number and quality of CPGs specific to CVRP. According to Mehra V. et al., only three CPGs have been developed under contemporary editorial standards. (GRADE: low $_{G6\text{-}R2_Ref_7}$).[685]

Improving the operational effectiveness of CVRhP-P requires competent leadership, the implementation of universal electronic records, and external audits that promote a management model based on efficiency, quality of care, and transparency, with a focus on innovation in healthcare networks. (GRADE: low $_{G6\text{-}R4_Ref_1}$).[686]

In such a specific area of cardiology, rehabilitation, and preventive medicine, ad hoc conceptual and technical knowledge is required, so multidisciplinary staff must acquire competencies and skills in the following areas: comprehensive cardiovascular assessment of the patient, blood pressure control, lipids, diabetes, smoking cessation, weight control, psychological counseling, nutritional counseling, and ThPhT. (GRADE: low $_{G6\text{-}R3_Ref_5}$).[687]

Although traditionally, cardiology specialists have led CVRhP-P, Papathanasiou J et al. mention the increasing inclusion of other specialties, such as physiotherapy and physical medicine. (GRADE: very low $_{G6\text{-}R3_Ref_3}$) [688]

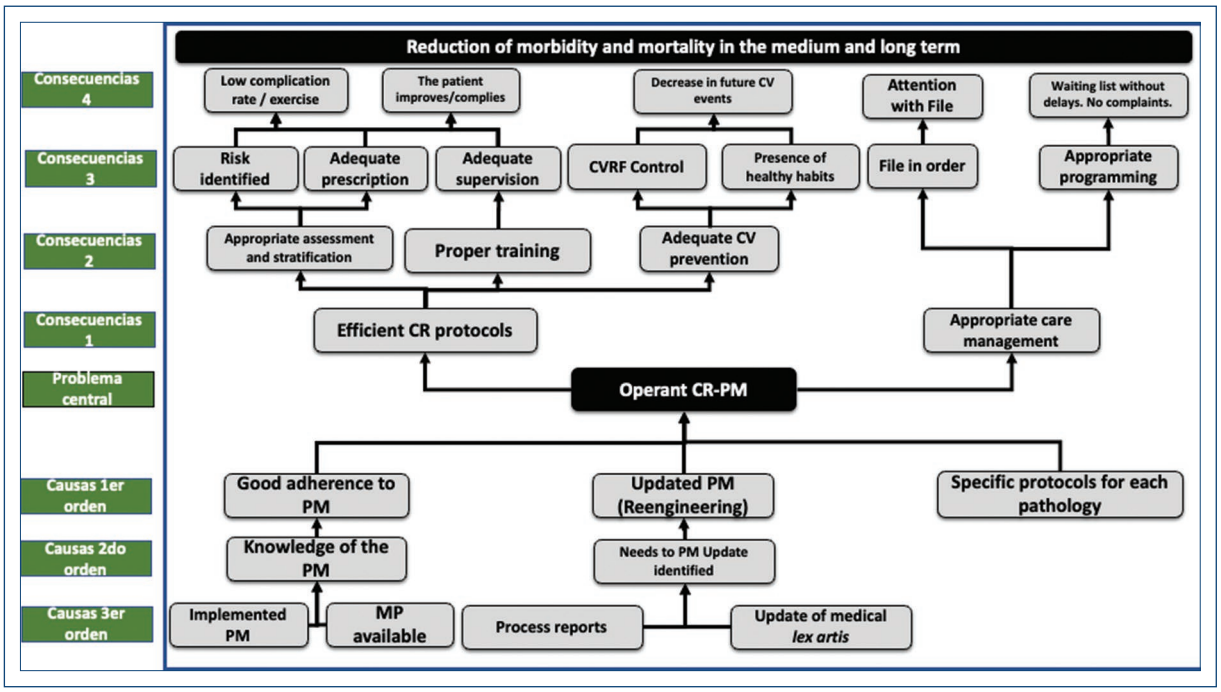


**Figure 31.** Outcome Targets by Discipline in CVRhP-P. This table summarizes the ideal and minimum CVRhP-P outcome targets, and includes assessment parameters for nutrition, psychology, non-aerobic training (kinesiotherapy), aerobic training (cycle ergometry and dance), and preventive education. These indicators establish ideal goals and minimum acceptable thresholds to evaluate adherence, clinical progression, and therapeutic response in each program component. Physiological variables such as percentage of target heart rate achieved (% Target HR), percentage of theoretical maximum heart rate achieved (% HRmax), percentage of target double product achieved (% Target DP), and percentage of theoretical maximum double product achieved (% DPmax), as well as the Borg rating of perceived exertion scale (6–20), are used to quantify exercise intensity and cardiovascular efficiency. The ΔHR/W and ΔDP/W parameters represent changes in heart rate (HR) or double product (DP) relative to workload (W); decreases across sessions reflect improved cardiovascular adaptation. Weight loss targets apply to patients with a body mass index (BMI) > 25. Psychological and functional outcomes are assessed qualitatively by the interdisciplinary therapeutic team based on predefined criteria.

Cardiac rehabilitation training programs have been developed for non-specialized personnel, and this training is considered feasible and effective. Regarding the competency assessment after this type of training, an improvement in staff scores was observed, from 12.81 to 14.63 (MD = 1.81 ± 1.42, $p < 0.001$) (GRADE: low $_{G6\text{-}R3_Ref_1}$).[689]

Regarding the training of nurses as professionals in cardiac rehabilitation, a study published by Lin S et al, demonstrated a global and significant deficiency, particularly in 3 items: professional preparation, role responsibility and ability to report the structure for career development in CVRhP for nurses (GRADE: very low $_{G6\text{-}R3_Ref_2}$).[690]

The integration of clinical audit, feedback, and educational visits as continuous improvement strategies has been analyzed in the context of cardiovascular care and specifically in CVRhP-P.

In a randomized clinical trial of 18 CVRhP centers in the Netherlands, with 14,847 patients, the effect of a multifaceted intervention combining a web-based feedback system based on clinical performance indicators, improvement goal-setting tools, action planning, and in-person educational visits was evaluated. Although 233 improvement objectives were defined by the participating teams, only 21% were achieved. No significant differences were observed in care processes or clinical outcomes between the intervention groups, except for a modest improvement in data completeness, with an annual increase of 4.5% (95% CI: 0.65 to 8.36). Thus, the intervention favored the generation of local initiatives for positive change. Effective implementation of adjustments may be limited by organizational factors and by low effective action on the stated objectives (GRADE: moderate $_{G6\text{-}R4_Ref_2}$).[691]

On the other hand, from a structural and managerial perspective, it has been argued that strengthening the quality of care in the cardiovascular field depends on evidence-based management, which incorporates the systematic use of electronic records, external audits, and competent clinical leadership. These tools not only make it possible to highlight successes and deviations in clinical processes, but also to establish more efficient organizational models, adaptable to new forms of care such as telemedicine and healthcare networks. Although this statement is based on expert opinion and observational studies, it underscores the role of clinical auditing and structured measurement as necessary conditions for improving the productivity and quality of cardiovascular care (GRADE: very low $_{G6\text{-}R4_Ref_1}$).[686]

The implementation of electronic referral systems, through automated medical records and pop-up reminders, has proven to be a highly effective strategy for increasing referral rates to CVRhP-P. Khadanga S et al reported that 59% of the analyzed patients were included in a CVRhP-P, with the following independent predictors for participation: the use of electronic referrals (OR = 7.35; 95% CI: 3.09 to 17.47, p < 0.001), having a surgical diagnosis, not being an active smoker, and receiving a strong medical recommendation (OR = 1.40; 95% CI: 1.01 to 1.89, p < 0.02) (GRADE: low $_{G6\text{-}R6_Ref_1}$).[50]

Li S et al reported that referral to CVRhP was associated with a 40% reduction in all-cause mortality in patients with CVD at 3 years. Particularly, in certain groups, a significant difference was observed between having been referred to or not. The benefit of express referral to CVRhP-P was observed both in the female group (OR = 0.61; 95% CI: 0.56 to 0.66), as well as in black patients (OR = 0.75; 95% CI: 0.63 to 0.88), patients of Hispanic origin (OR = 0.62; 95% CI: 0.50 to 0.79), and for Asian patients (OR = 0.63; 95% CI: 0.46 to 0.85) (GRADE: low $_{G6\text{-}R6_Ref_2}$).[692]

Regional initiatives, such as the Michigan Cardiac Rehab Network, have explored collaborations between hospitals and CVRhP centers to improve participation. This approach identified 95 hospitals and 84 centers, achieving a 33.4% enrollment rate, where barriers such as limited capacity, lack of referrals, and geographic and financial challenges persisted (GRADE: very low $_{G6\text{-}R6_Ref_3}$).[693]

Technology-enabled redesign of CVRhP services, such as the model implemented at Buckinghamshire Healthcare NHS Trust, improved the capture, storage, and review of patient data. This model included a secure technology platform and standardized processes, which were associated with a higher admission rate (84.3% vs. 76%, p = 0.006), a reduction in 6-month readmissions (4.3% vs. 8.9%, p = 0.015), and a higher program adherence rate (75.6% vs. 47.4%, p < 0.001) (GRADE: moderate $_{G6\text{-}R6_Ref_4}$).[694]

In addition, specific factors such as physicians' positive perceptions of the benefits of CVRhP-P, the geographic proximity of the CVRhP unit, and a lower perception of barriers to care improve referral likelihood. Patients with a greater sense of personal control over their disease tend to be referred more (p=0.001) (GRADE: low $_{G6\text{-}R6_Ref_5}$).[695]

Adusumalli S et al highlighted that in hospitals with automated referral systems, 85.7% of patients were referred to CVRhP-P, compared to 31.6% in control group hospitals (GRADE: low $_{G6\text{-}R6_Ref_6}$).[696]

Management is the way an institution organizes the activities of a productive, creative, or service process, seeking to meet proposed goals within a quality control framework. In relation to the CVRhP-P, this strategy helps us guarantee a safe, efficient, self-sustaining, and user-satisfactory service, provided to the greatest possible number of patients. Management includes the procurement and coordination of human, technological, and financial resources, along with the explicit interaction of stakeholders at the operational, regulatory, scientific, and academic levels, among others. Some recognizable stages in management processes are planning, operation, supervision, database development and analysis, control, auditing, and process reengineering.[697]

Program modality. Initially, CVRhP programs were based on therapeutic physical training, with patients hospitalized in residential centers and highly supervised, due to fear of complications during exercise sessions. Over time, some programs evolved to an outpatient modality, where patients received therapy in the hospital and then returned home. Subsequently, care for these patients was extended to an unsupervised home setting once the patient had completed the in-person intensive phase. Technology now allows us to contact, advise, direct, and monitor patients remotely, through videoconferences or online biometric data collection devices. There are even applications designed using artificial intelligence that could direct therapies and make decisions in the absence of healthcare personnel. The program should begin as early as possible, and its duration will depend on the patient's characteristics.

| PICO | 3.1 Common elements of cardiovascular rehabilitation and prevention | Class (Strength) | Level of Evidence | C/B | Applicability |
|---|---|---|---|---|---|
| G2-R1 | It is recommended that the benefits associated with the CVRhP-P be widely disseminated among healthcare providers and the general population, in an effort to increase patient referrals to these programs. This will include the impact on survival, quality of life, and reduction in healthcare costs | I | A | C-/B+ | Disseminate guidelines, establish interactions with stakeholders, public policies, and advocacy. |
| G2-R2 | It is recommended that patients with CVD, whether post-PCI or post-surgical, be referred to the CVRhP-P through optimized strategies, such as electronic referral, the use of liaison managers, and explicit physician recommendation, in order to increase their participation rate. | I | B-NR | C-/B+ | Disseminate guidelines, establish interactions with stakeholders, public policies, and advocacy. |
| G3-R2 | It is recommended that patients at low cardiovascular risk who participated in the initial part of the in-person CVRhP-P continue with a distance rehabilitation program in order to maintain their adherence. | IIa | B-R | C-/B+ | 1 to 6 |
| G2-R6 | It is recommended that the CVRhP-P leader establish precise, patient-centered indicators and goals, both at the clinical and technical levels, in order to ensure adequate quality control of interventions based on patient outcomes. | IIa | C-EO | C-/B+ | 1,2,6 |
| PICO | 3.2.1 Patient First Evaluation | Class (Strength) | Level of Evidence | C/B | Applicability |
| G12-R6 | It is recommended that a comprehensive assessment be performed at the start of a CVRhP-P, including a detailed medical history, functional physical, nutritional, and psychosocial assessment. This will allow us to obtain the necessary information to assess the level of frailty, classify the patient's risk, design a training plan, determine the level of supervision required, and set goals for each individual case. | I | A | C+/B+ | 1 to 6 |
| G12-R1 | It is recommended that patients' nutritional status and body composition be assessed in order to establish an appropriate nutritional diagnosis and treatment. This assessment may include anthropometry or more sophisticated techniques | I | B-R | C-/B+ | 1 to 6 |
| G12-R4 | It is recommended to assess the mental health status (depression, anxiety, or personality disorder) of patients in CVRhP-P, in order to identify psychological risk factors and establish appropriate interventions that contribute to improving treatment adherence, HR-QoL, and reducing cardiovascular mortality. | I | B-R | C-/B+ | 1,2,4 and 6 |
| G12-R2 | It is recommended to perform a comprehensive functional assessment prior to enrollment in cardiac rehabilitation, including objective tests of exercise tolerance (such as the 6-minute walk test or cardiopulmonary exercise testing), muscle strength (e.g., handgrip strength or one-repetition maximum tests), balance (tandem stance or the Tinetti test), and mobility (gait speed or the Timed Up & Go test). The purpose of this assessment is to identify relevant functional limitations, personalize the CR intervention, establish a baseline to evaluate progress, and detect conditions such as frailty or fall risk that may require specific adaptations to the program | I | B-NR | C+/B+ | 1,2,4 and 6 |
| G12-R5 | It is recommended that hand grip and quadriceps muscle strength be assessed in patients participating in a CVRhP-P, in order to establish an initial diagnosis and prognosis, as well as to prescribe ThPhT in a targeted manner. | I | B-NR | C-/B+ | 1 to 6 |
| G12-R7 | It is recommended to evaluate coronary anatomy, presence of ischemia, ventricular function, electrical stability, as well as ergometric response in patients in a CVRhP-P, in order to perform a comprehensive risk stratification. | I | C-EO | C+/B+ | 1 to 6 |
| G12-R3 | It is recommended to evaluate biomarkers such as NT-proBNP, hs-CRP, and troponins in patients in a CVRhP-P, according to the physician's clinical judgment, in order to establish a prognosis and evaluate the achievement of goals during follow-up | IIa | B-NR | C+/B+ | 1 to 6 |
| PICO | 3.2.2 Risk stratification | Class (Strength) | Level of Evidence | C/B | Applicability |
| G13-R3 | It is recommended that maximum exercise tolerance be assessed in all patients with CVRhP-P, in order to predict long-term survival and guide follow-up. | I | A | C-/B+ | 1 to 6 |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

| | | | | | |
|---|---|---|---|---|---|
| G13-R1 | It is recommended to evaluate the chronotropic response and HR recovery in patients in a CVRhP-P, in order to stratify the risk of overall mortality, cardiovascular mortality, the incidence of acute coronary syndromes or atrial fibrillation. | I | A | C+/B+ | 1 to 6 |
| G14-R1 | It is recommended to use some method of assessing myocardial perfusion in patients with symptomatic coronary artery disease in CVRhP-P, in order to identify the presence of ischemia. | I | A | C+/B+ | 1,6 |
| G14-R5 | An exercise test is recommended upon admission of patients with congenital heart disease, in order to assess their exercise tolerance, hemodynamic abnormalities or arrhythmias | I | A | C+/B+ | 1,6 |
| G14-R2 | It is recommended that the arrhythmogenic status of patients participating in CVRhP-P be assessed through appropriate studies, in order to identify the risk of developing arrhythmias associated with a poor prognosis. | I | B-R | C+/B+ | 1,6 |
| G15-R4 | It is recommended to stratify the risk of patients in CVRhP-P, in order to identify those who have a higher probability of complications during training and consequently, adjust the exercise plan, prescription, and assign monitoring. | I | B-NR | C-/B+ | 1,2,4 and 6 |
| G15-R5 | Patients with reduced exercise tolerance who have not improved at the end of CVRhP-P (non-responders) will be re-stratified as high risk. | I | B-NR | C-/B+ | 1 to 6 |
| G15-R1 | It is recommended to systematically include the main risk indicators for each patient in the CVRhP-P, preferably using scales validated for the target population, in order to calculate the probability of experiencing adverse events associated with ThPhT, assign the appropriate level of supervision, and prescribe individually. | I | B-NR | C-/B+ | 1,2,4 and 6 |
| G13-R2 | It is recommended to evaluate the response of systolic blood pressure during exercise testing and recovery in patients in a CVRhP-P, in order to calculate the risk of cardiovascular events and mortality. | I | B-NR | C-/B+ | 1 to 6 |
| G13-R6 | Exercise testing is recommended for patients in a CVRhP-P to assess the risk of potentially lethal exercise-induced arrhythmias. | I | B-NR | C-/B+ | 1 to 6 |
| G13-R4 | Exercise testing is recommended for patients with coronary artery disease to estimate the risk of ischemia and other adverse events associated with therapeutic physical training. | I | B-NR | C-/B+ | 1 to 6 |
| G13-R5 | An exercise test is recommended upon admission of patients with congenital heart disease to assess their ExTol, hemodynamic abnormalities, or arrhythmias. | I | B-NR | C-/B+ | 1 to 6 |
| G14-R3 | It is recommended to evaluate metabolic indicators such as blood glucose, cholesterol, LDL-C, HDL-C, and triglycerides before and after a CVRhP-P, in order to identify goal attainment and audit the program's results. | I | B-NR | C-/B+ | 1,6 |
| G15-R2 | It is recommended to perform a risk stratification process in the pediatric population with congenital heart disease, with a comprehensive assessment of anatomical, functional, hemodynamic, and electrophysiological parameters, for the purpose of planning and supervising physical training in CVRhP-P. This information also supports the recommendation or disqualification for sports participation. | I | C-EO | C-/B+ | 1,2,4 and 6 |
| G14-R4 | It is recommended to request inflammatory markers in patients in a CVRhP-P, particularly post-infarction, in order to assess the risk of future acute coronary events. | IIb | B-NR | C+/B- | 1,6 |
| PICO | 3.2.3 Therapeutic physical training (ThPhT) | Class (Strength) | Level of Evidence | C/B | Applicability |
| G7-R1 | It is recommended that patients in a CVRhP-P perform ThPhT, at least aerobic and strength training, in order to increase their exercise tolerance and quality of life. | I | A | C+/B+ | 1 to 6 |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

| | | | | | |
|---|---|---|---|---|---|
| G7-R4 | It is recommended that therapeutic physical training be prescribed for patients in a CVRhP-P, based on the principles of physical exercise and risk stratification, with the goal of safely improving their exercise tolerance and quality of life. | I | B-R | C-/B+ | 1 to 6 |
| G16-R5 | It is recommended that patients with ischemic heart disease perform ThPhT (aerobic and resistance training) in order to increase their exercise tolerance. | I | B-R | C+/B+ | 1 to 6 |
| G7-R5 | It is recommended to train the respiratory muscles of patients in CVRhP-P, in order to improve their inspiratory strength, minute volume, forced inspiratory volume, exercise tolerance and HR-QoL. | I | B-R | C-/B+ | 1 to 6 |
| G7-R10 | It is recommended that the intensity of physical training be prescribed for patients in a CVRhP-P based on ergometric assessment and non-aerobic physical qualities, so that ThPhT sessions generate an effective and safe stimulus. | I | B-NR | C-/B+ | 1 to 6 |
| G2-R4 | It is recommended to develop a comprehensive and individualized plan with 36 ThPhT sessions, in order to increase exercise tolerance, increase HR-QoL and reduce all-cause mortality in patients participating in a CVRhP-P. | I | B-NR | C+/B+ | 1,2,6 |
| G5-R1 | It is recommended that all CVRhP-P have an emergency care protocol, a properly equipped area, and personnel trained in cardiopulmonary arrest care (BLS, ACLS, PALS), in order to offer immediate and effective care during a cardiovascular emergency and thus reduce associated mortality and morbidity. | I | B-NR | C+/B+ | 1 to 6 |
| G5-R3 | It is recommended that the type and level of monitoring for ThPhT sessions in CVRhP-P be assigned according to the patient's risk and the type of facility, in an effort to optimize resources and include the largest number of patients without compromising patient safety. | I | C-EO | C-/B+ | 1 to 6 |
| G7-R3 | It is recommended that patients undergoing sternotomy surgery begin their rehabilitation program in the early postoperative period (Phase I) to reduce complications resulting from prolonged rest, taking care to assess sternal stability and avoid movements that could displace it, for at least 4 weeks. Patients with pacemakers can begin the program from the first week after implantation to avoid shoulder disability and reduce the risk of hematoma or lead dislodgement. In patients undergoing arterial puncture, physical exercise can begin from the first week to improve quality of life and exercise tolerance, minimizing the risk of complications at the puncture site. In the case of femoral arterial access, the presence of local complications, especially AV fistulas, must be ruled out. | IIa | B-NR | C+/B+ | 1,2,6 |
| G7-R7 | It is recommended that a comprehensive activity planner be developed for each patient, individualized and scheduled, with precise identification of the ThPhT characteristics, medical consultations, appointments with other disciplines, or requested studies, so that the activities are carried out and supervised in a visual, harmonious, precise, effective, and safe manner. | IIa | C-EO | C-/B+ | 1 to 6 |
| G7-R6 | It is recommended to monitor the progression of ThPhT according to the comprehensive planner and provide feedback on necessary adjustments based on the response to exercise, preferably changing one component at a time, in order to generate a safe and effective adaptation. | IIa | C-EO | C-/B+ | 1 to 6 |
| G7-R12 | It is recommended that patients in CVRhP-P perform a self-assessment of their health status before each ThPhT session, in order to reduce the risk of exercise-related adverse events, improve empowerment, and promote adherence. | IIa | C-EO | C-/B+ | 1, 4 and 6 |
| G18-R8 | Patients with heart failure in CVRhP-P are recommended to train with interval training, in an individualized, highly supervised, and in-person manner, whenever their conditions permit, in order to improve exercise tolerance and ventricular function. | IIb | B-R | C+/B+ | 1 to 6 |
| PICO | 3.2.4 Nutritional assessment and advice | Class (Strength) | Level of Evidence | C/B | Applicability |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

| | | | | | |
|---|---|---|---|---|---|
| G8-R5 | It is recommended that the CVRhP-P nutrition specialist motivate patients to implement a Mediterranean diet, in order to reduce cardiovascular mortality, all-cause mortality, MACE, and reducing body weight, blood pressure, and hypercholesterolemia. | I | A | C-/B+ | 1,2,4 and 6 |
| G8-R4 | It is recommended that nutritional interventions in CVRhP-P include educational, stress management, and social support procedures, with the goal of improving adherence, reducing weight, and controlling biological parameters such as lipids and blood glucose. | IIa | B-NR | C-/B+ | 1,2,4 and 6 |
| G8-R3 | A specific nutritional assessment and intervention is recommended for patients with congenital heart disease, in order to identify nutritional risk and establish a regimen appropriate for their age and type of disease. | IIa | C-EO | C-/B+ | 1,2,4 and 6 |
| G8-R2 | Assessment of dietary intake in patients in CVRhP-P using self-assessment tools, such as the 24-hour recall, is recommended in order to personalize nutritional intervention. | IIb | C-EO | C-/B+ | 1,2,4,5,6 |
| G8-R7 | The "dieta de la milpa" (cornfield diet) could be used within a CVRhP-P, in patients unable to establish another type of diet such as the Mediterranean, as an alternative to reduce body weight and improve nutritional adherence. | IIb | C-EO | C-/B+ | 1,2,4 and 6 |
| PICO | 3.2.5 Psychological evaluation and counseling | Class (Strength) | Level of Evidence | C/B | Applicability |
| G9-R8 | It is recommended to systematically assess the HR-QoL of patients in a CVRhP-P, using validated tools such as the HeartQoL questionnaire, SF-36 or the MLHFQ, to identify and modify the physical or emotional factors that affect it. | I | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R4 | It is recommended to systematically assess psychological risk factors in patients in a CVRhP-P, using psychological, neuropsychological, or self-assessment tests, in order to identify their presence and offer early therapy to improve HR-QoL and reduce symptoms of anxiety and depression. | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R6 | Psychotherapeutic support is recommended for patients who have suffered a cardiovascular event, with the aim of improving their HR-QoL, reducing symptoms of depression and anxiety, and promoting adherence to CVRhP-P. | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R3 | It is recommended that patients with coronary artery disease receive specific psychological or pharmacological interventions within a CVRhP-P, in order to reduce anxiety and depression levels and improve the mental component of HRQoL | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R5 | Mindfulness-based stress management techniques are recommended for patients in a CVRhP-P, in an effort to reduce depression and anxiety levels. | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G9-R7 | It is recommended that patients with coronary artery disease in CVRhP-P receive cognitive-behavioral therapy, in order to reduce levels of depression and anxiety | IIa | B-NR | C-/B+ | 1,2,4 and 6 |
| G9-R2 | It is recommended to promote the structuring of comprehensive support networks (social, family, psychological and work) in patients in a CVRhP-P, in order to reduce cardiovascular mortality and morbidity. | IIa | B-NR | C-/B+ | Include specialty in social work |
| G9-R1 | It is recommended to use specific psychological interventions in the search for improvement of depression symptoms and possibly a reduction in cardiovascular morbidity. | IIa | C-LD | C-/B+ | 1,2,4 and 6 |
| PICO | 3.2.6 Patient education. | Class (Strength) | Level of Evidence | C/B | Applicability |
| G7-R2 | It is recommended that CVRhP-P offer health education activities to patients, including knowledge about CVD, identification and control of risk factors, and proper exercise training techniques, with the goal of improving adherence to a cardio-healthy lifestyle and reducing the risk of exercise-related complications. | I | C-LD | C-/B+ | 1, 4 and 6 |
| PICO | 3.2.7 Daily Life Tips | Class (Strength) | Level of Evidence | C/B | Applicability |
| G11-R2 | It is recommended that patients with CVD resume sexual activity based on their exercise performance and the rational prescription of medications for sexual dysfunction, in order to safely improve their quality of life. | I | B-NR | C-/B+ | 1,2,4 and 6 |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

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| G11-R4 | It is recommended that patients with CVD avoid alcohol consumption in order to reduce the risk of adverse cardiovascular events associated with it. | I | B-NR | C-/B+ | 1,2,4 and 6 |
| G11-R3 | It is recommended that all patients with CVD receive explicit, written medical advice on when and how to resume driving, so that they can drive again without the risk of road accidents due to inability to control the car, associated with cardiovascular disease or sequelae. It is important to clearly state in writing when the patient should not drive again, in consultation with transportation medicine specialists when the case warrants it. | I | C-LD | C-/B+ | 1,2,4 and 6 |
| G11-R1 | It is recommended that post-sternotomy patients not lift more than 1 kg of weight between both upper limbs until 6 to 8 weeks after surgery and comply with the "stay-in-the-tube" strategy, in order to maintain sternal stability and prevent dehiscence of the surgical wound. | IIa | B-NR | C-/B+ | 1,2,4,5 and 6 |
| G11-R5 | It is recommended that physicians provide informed advice to patients who wish to travel by air, based on their health status and the type of flight, in an effort to reduce the incidence of adverse events or cardiovascular mortality during the flight. The written medical summary should specify the patient's diagnosis, medical treatment, electrical therapy devices, as well as the disqualification or eligibility for travel, and, finally, specific advice for the trip. | IIa | C-LD | C-/B+ | 1,2,4 and 6 |
| G11-R6 | It is recommended that patients with stable CVD use a sauna bath at a moderate temperature (60–70°C) for short periods (up to 10 minutes), followed by a 30-minute recovery period in the supine position, in order to reduce blood pressure and improve endothelial and ventricular function. Advice should be individualized according to the patient's risk level. | IIb | B-NR | C-/B+ | 1 |
| PICO | 3.3.1 Critically ill patient | Class (Strength) | Level of Evidence | C/B | Applicability |
| G10-R1 | Early mobilization of patients with cardiovascular disease admitted to intensive care units is recommended, in order to reduce their length of stay and increase the likelihood of discharge from the hospital and the return to independent walking. | IIa | B-R | C+/B+ | 1,2,4,5 and 6 |
| G10-R5 | It is recommended that hospitalized patients receive pulmonary physiotherapy techniques several times a day to reduce the rate of nosocomial pneumonia, length of stay, duration of MVA, and hospital case fatality. | IIa | B-R | C+/B+ | 1,2,4,5 and 6 |
| G10-R4 | It is recommended that critically ill patients receive early mobilization therapy, particularly those on mechanical ventilation or ventricular assist device (ECMO), to facilitate discharge from the ICU and hospital, reduce length of stay, and improve exercise tolerance and HR-QoL. This therapy should be performed by highly trained personnel, with extreme safety precautions. | IIa | B-NR | C+/B+ | 1,2,4,5 and 6 |
| G10-R3 | It is recommended that patients with ventricular assist devices receive an early mobilization program to reduce critically ill patient syndrome. This therapy should be performed by highly trained personnel, with extreme safety precautions. | IIb | C-LD | C+/B+ | 1,2,4 and 6 |
| G10-R2 | Aerobic exercise is not recommended for critically ill patients in intensive care units, as the risk would outweigh the potential benefit, and the available evidence is limited. | III-NB | C-LD | C+/B- | 1,2,4 and 6 |
| PICO | 3.3.2 Ischemic Heart Disease | Class (Strength) | Level of Evidence | C/B | Applicability |
| G16-R1 | It is recommended that patients who have suffered an acute coronary syndrome be included in a CVRhP-P, in order to reduce the rate of all-cause mortality, cardiovascular mortality, recurrent ischemic events and rehospitalizations, increase exercise tolerance, improve HR-QoL and optimize care costs | I | A | C+/B+ | 1 to 6 |
| G16-R8 | It is recommended that patients with stable angina be included in highly specialized CVRhP-P, with the aim of improving exercise tolerance and reducing the intensity, duration, and frequency of angina episodes, in conjunction with conventional treatmen | IIa | B-R | C+/B+ | 1 to 6 |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

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| G16-R3 | Patients who survived an acute myocardial infarction are recommended to enroll in a CVRhP-P program to increase their return to work, preferably in their previous job, and to reduce the number of days of work disability. | IIa | C-LD | C+/B+ | 1,2,4 and 6 |
| PICO | 3.3.3 Post-intervention patients | Class (Strength) | Level of Evidence | C/B | Applicability |
| G17-R8 | It is recommended that the CVRhP-P cardiologist, in coordination with the treating physician, ensure that patients with MitraClip comply with antiplatelet therapy or chronic oral anticoagulation as indicated, in order to reduce thromboembolic or bleeding events in these patients. | I | B-R | C-/B+ | 1,2,4 and 6 |
| G17-R7 | It is recommended that the CVRhP-P cardiologist, in coordination with the attending physician, supervise that patients after surgery or transcatheter implantation of heart valves comply with antiplatelet therapy or chronic oral anticoagulation as indicated, in order to reduce thromboembolic or bleeding events in these patients. | I | B-R | C-/B+ | 1,2,4 and 6 |
| G17-R11 | Patients scheduled for cardiac surgery are recommended to enroll in a prehabilitation program to increase exercise tolerance, reduce the rate of postoperative complications, reduce hospital stays, and improve HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |
| G17-R3 | It is recommended that hospitalized patients with a recent implantation of an electrical stimulation device (pacemaker/ICD), ventricular assist device, or transthoracic catheters be mobilized carefully and progressively, in or out of bed, by highly trained personnel, as long as their clinical condition allows, in order to improve prolonged rest syndrome in critically ill patients. | IIa | B-R | C+/B+ | 1,2,4,5 and 6 |
| G17-R2 | It is recommended that upper limb strength training be started in post-thoracotomy patients between 4 and 6 weeks according to risk factors for complications, as long as there is no evidence of sternal mobility, and that mobilization be progressed to tolerance (without pain or instability), in the search to improve strength in thoracic limbs and reduce the risk of sternal dehiscence. | IIa | B-R | C+/B+ | 1,2,4,5 and 6 |
| G23-R2 | It is recommended to avoid active mobilization of the ipsilateral arm in patients with a pacemaker / ICD implant during the first 24 hours, as well as restricting strength exercises in that arm during the first 4 to 6 weeks, in order to reduce the risk of electrode or generator displacement. | IIa | B-R | C-/B+ | 1 to 6 |
| G23-R4 | Patients with pacemakers and defibrillators are recommended to be included in in-person ThPhT programs supervised by qualified personnel to improve exercise tolerance, muscle strenght, and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |
| G17-R4 | The implementation of a CVRhP-P is recommended in children post-cardiac surgery, in order to improve their exercise tolerance and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |
| G17-R1 | Post-surgical scar care techniques such as hydration, massage, dry needling, taping, laser, extracorporeal shock wave therapy, and ultrasound are recommended for patients postoperatively after cardiovascular surgery, provided there are no contraindications, to reduce pain or itching and improve the structural characteristics of the scar such as pigmentation, elasticity, thickness, and area. | IIa | B-R | C+/B+ | 1 to 6 |
| PICO | 3.3.4 Heart Failure | Class (Strength) | Level of Evidence | C/B | Applicability |
| G18-R10 | It is recommended that patients with heart failure be included in a CVRhP-P with in-person therapeutic physical training, in order to increase their exercise tolerance, HR-QoL, and reduce the rate of re-hospitalizations | I | A | C+/B+ | 1 to 6 |
| G18-R9 | It is recommended that heart transplant patients undergo CVRhP therapy before and after surgery to increase muscle strength, exercise tolerance, and HRQoL, as well as reduce postoperative complication rates and hospital stays. | I | A | C+/B+ | 1 to 6 |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

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| G18-R11 | Patients with heart failure are recommended to perform resistance training to increase muscle strength and exercise tolerance. | I | B-R | C+/B+ | 1 to 6 |
| G20-R1 | It is recommended that patients be included in a CVRhP-P during the peri-heart transplant period, in order to increase their exercise tolerance and muscle strength | I | B-R | C+/B+ | 1 to 6 |
| G20-R3 | It is recommended to measure and monitor the intensity of physical training in post-heart transplant patients using scales of perceived exertion or a percentage of VO2peak (CPET), in order to generate a sufficient and safe stimulus to induce physiological adaptation to physical exercise. | I | B-R | C-/B+ | 1 to 6 |
| G20-R2 | Supervised ThPhT is recommended for post-heart transplant patients, using various modalities such as continuous moderate aerobic exercise, interval, strength, or combined training, with the aim of increasing exercise tolerance and muscle strength. | I | B-R | C+/B+ | 1 to 6 |
| G19-R5 | It is recommended that highly trained personnel carefully assess blood volume parameters, mean arterial pressure, the presence of atrial or ventricular arrhythmias, the status of invasive lines and electrodes, as well as wound care in patients with ventricular assist devices in CVRhP-P, in an effort to reduce the incidence of complications associated with the mobilization of these patients. | IIa | B-R | C+/B+ | 1 to 6 |
| G18-R1 | It is generally recommended that patients with heart failure consume a moderate amount of sodium (2 to 3 g/day) and have mild to moderate fluid restriction (1.5 to 2 L/day) to ensure that these changes are sustainable and associated with a decrease in symptoms and hospital readmissions. | IIa | B-R | C-/B+ | 1,2,4 and 6 |
| G19-R1 | It is recommended to include patients with heart failure and ventricular assist devices such as ECMO in CVRhP-P, to perform early mobilization and ThPhT by highly trained personnel, in order to improve myopathy in critically ill patients, increase muscle strength, lung function, reduce MVA time, ICU stay, and improve HR-QoL. | IIa | C-LD | C+/B+ | 1 to 6 |
| G18-R4 | A comprehensive nutritional intervention is recommended for patients with heart failure in CVRhP-P, with an adjusted caloric intake between 22 and 35 kcal/kg/day and a protein intake of 1 to 1.2 g/kg/day, in order to preserve muscle mass, improve HR-QoL, and reduce complications associated with malnutrition and cachexia. | IIa | C-LD | C-/B+ | 1,2,4 and 6 |
| G18-R12 | It is recommended that patients with stable, low-risk CVD who can receive minimal supervision and who have attended an initial in-person phase (Phase II) be integrated into a home-based CVRhP-P, including telemedicine, in order to overcome barriers that impede medium- and long-term compliance, increase adherence, and reduce healthcare costs. | IIb | C-LD | C-/B+ | 1,2,4,5,6 |
| G18-R3 | It is recommended that patients with heart failure taking digoxin or lisinopril not drink green tea, in order to avoid interfering with the pharmacodynamics of these medications | IIb | C-LD | C-/B+ | 1,2,4 and 6 |
| PICO | 3.3.5 Heart valve disease | Class (Strength) | Level of Evidence | C/B | Applicability |
| G21-R2 | It is recommended that patients postoperatively undergo heart valve surgery or intervention be admitted to a CVRhP-P in order to improve exercise tolerance, HR-QoL, and reduce medium-term mortality and rehospitalization rates. | IIb | B-NR | C+/B+ | 1 to 6 |
| G21-R1 | Patients with valvular disease undergoing valvular surgery or intervention are recommended to enter a CVRhP-P in order to increase their exercise tolerance. | IIb | C-LD | C+/B+ | 1 to 6 |
| G21-R4 | Patients with mitral valve disease are recommended to enroll in a CVRhP-P, according to their risk level, in order to improve exercise tolerance, HR-QoL, and lung function. | IIb | C-LD | C+/B+ | 1 to 6 |
| G21-R3 | It is not recommended that patients with severe aortic heart valve disease perform strength training (isometrics) | III-H | C-EO | C-/B- | 1,6 |
| PICO | 3.3.6 Peripheral arterial disease | Class (Strength) | Level of Evidence | C/B | Applicability |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

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| G22-R1 | It is recommended that patients with peripheral arterial disease of the lower limbs, particularly those who are symptomatic, be included in CVRhP-P, with the aim of increasing walking distance and improving the claudication threshold. | I | B-R | C+/B+ | 1 to 6 |
| G22-R4 | It is recommended to measure the ankle-brachial index in patients admitted to a CVRhP-P, in order to identify those at high risk of presenting major adverse outcomes | I | B-R | C-/B+ | 1 to 6 |
| G22-R2 | It is recommended to perform ThPhT on a treadmill, for patients with peripheral arterial disease of the lower limbs, on a treadmill, with a moderate to high intensity that causes claudication, in search of improvement in the distance walked, reduction of symptoms and increase in HR-QoL. | I | B-R | C+/B+ | 1 to 6 |
| G22-R3 | It is recommended to request carotid circulation evaluation with Doppler ultrasound in patients with coronary artery disease in CVRhP-P, in order to identify and refer those patients with atherosclerotic carotid artery disease to a specialist for evaluation and corresponding treatment. | IIa | B-NR | C+/B+ | 1 to 6 |
| G22-R5 | Patients with stable chronic aortic disease or successfully resolved through surgery or intervention, are recommended to participate in cardiac rehabilitation programs (CVRhP-P) based on their risk level and seeking to improve exercise tolerance, maintain blood pressure targets, and enhance health-related quality of life. | IIb | B-NR | C+/B+ | 1 to 6 |
| PICO | 3.3.7 Cardiac arrhythmias | Class (Strength) | Level of Evidence | C/B | Applicability |
| G23-R3 | It is recommended that the intensity of physical exercise in patients with atrial fibrillation be established by workload, VO2, or the scale of perceived exertion (Borg scale 6-20), in an effort to achieve and maintain a moderate exercise intensity. | I | B-R | C-/B+ | 1 to 6 |
| G23-R1 | It is recommended that ThPhT sessions be monitored with a high level of electrocardiographic supervision and monitoring, based on individual stratification, in order to identify serious arrhythmias and, where appropriate, offer rapid and efficient intervention, such as cardiopulmonary resuscitation and defibrillation. | I | B-NR | C+/B+ | 1 to 6 |
| PICO | 3.3.8 Congenital Heart Disease | Class (Strength) | Level of Evidence | C/B | Applicability |
| G24-R1 | Patients with congenital heart disease are recommended to perform aerobic and strength training exercises, according to their risk stratification and the ThPhT planner, in order to increase exercise tolerance, muscle strength, and daily activity level. | I | B-R | C+/B+ | 1 to 6 |
| G24-R2 | It is recommended that pediatric patients with congenital heart disease be included in a CVRhP-P, with sessions for balance, coordination, strength, and flexibility, appropriate for their age, in order to improve HR-QoL and exercise tolerance. | I | B-R | C-/B+ | 1 to 6 |
| G24-R4 | It is recommended to identify the nutritional status of children with congenital heart disease in critical condition (ICU), in order to adapt rehabilitation treatment to the patient's energy status. | I | B-R | C-/B+ | 1 to 6 |
| G24-R3 | It is recommended that children with congenital heart disease start aerobic training at the beginning of puberty, in order to increase exercise tolerance. | IIa | B-R | C-/B+ | 1 to 6 |
| G25-R1 | It is recommended that patients with pulmonary arterial hypertension undergo highly supervised ThPhT, ideally in an inpatient setting, in order to increase exercise tolerance, HR-QoL, and decrease systolic pulmonary arterial pressure levels. It is important to weigh the risk-benefit in patients with severe PAH. | IIa | B-R | C+/B+ | 1 to 6 |
| PICO | 3.3.9 Pulmonary arterial hypertension | Class (Strength) | Level of Evidence | C/B | Applicability |
| G25-R4 | Patients with stable pulmonary arterial hypertension and optimal treatment are recommended to enter a highly supervised ThPhT program, seeking improvement in quality of life and exercise tolerance. | IIa | B-R | C+/B+ | 1 to 6 |
| G25-R3 | Patients with pulmonary arterial hypertension are recommended to perform ThPhT based on breathing exercises, aerobic and strength training, highly supervised and at low intensity, seeking to improve distance covered in the 6-minute walk test, peak VO2 and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

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|---|---|---|---|---|---|
| G22-R1 | It is recommended that patients with peripheral arterial disease of the lower limbs, particularly those who are symptomatic, be included in CVRhP-P, with the aim of increasing walking distance and improving the claudication threshold. | I | B-R | C+/B+ | 1 to 6 |
| G22-R4 | It is recommended to measure the ankle-brachial index in patients admitted to a CVRhP-P, in order to identify those at high risk of presenting major adverse outcomes | I | B-R | C-/B+ | 1 to 6 |
| G22-R2 | It is recommended to perform ThPhT on a treadmill, for patients with peripheral arterial disease of the lower limbs, on a treadmill, with a moderate to high intensity that causes claudication, in search of improvement in the distance walked, reduction of symptoms and increase in HR-QoL. | I | B-R | C+/B+ | 1 to 6 |
| G22-R3 | It is recommended to request carotid circulation evaluation with Doppler ultrasound in patients with coronary artery disease in CVRhP-P, in order to identify and refer those patients with atherosclerotic carotid artery disease to a specialist for evaluation and corresponding treatment. | IIa | B-NR | C+/B+ | 1 to 6 |
| G22-R5 | Patients with stable chronic aortic disease or successfully resolved through surgery or intervention, are recommended to participate in cardiac rehabilitation programs (CVRhP-P) based on their risk level and seeking to improve exercise tolerance, maintain blood pressure targets, and enhance health-related quality of life. | IIb | B-NR | C+/B+ | 1 to 6 |
| PICO | 3.3.7 Cardiac arrhythmias | Class (Strength) | Level of Evidence | C/B | Applicability |
| G23-R3 | It is recommended that the intensity of physical exercise in patients with atrial fibrillation be established by workload, VO2, or the scale of perceived exertion (Borg scale 6-20), in an effort to achieve and maintain a moderate exercise intensity. | I | B-R | C-/B+ | 1 to 6 |
| G23-R1 | It is recommended that ThPhT sessions be monitored with a high level of electrocardiographic supervision and monitoring, based on individual stratification, in order to identify serious arrhythmias and, where appropriate, offer rapid and efficient intervention, such as cardiopulmonary resuscitation and defibrillation. | I | B-NR | C+/B+ | 1 to 6 |
| PICO | 3.3.8 Congenital Heart Disease | Class (Strength) | Level of Evidence | C/B | Applicability |
| G24-R1 | Patients with congenital heart disease are recommended to perform aerobic and strength training exercises, according to their risk stratification and the ThPhT planner, in order to increase exercise tolerance, muscle strength, and daily activity level. | I | B-R | C+/B+ | 1 to 6 |
| G24-R2 | It is recommended that pediatric patients with congenital heart disease be included in a CVRhP-P, with sessions for balance, coordination, strength, and flexibility, appropriate for their age, in order to improve HR-QoL and exercise tolerance. | I | B-R | C-/B+ | 1 to 6 |
| G24-R4 | It is recommended to identify the nutritional status of children with congenital heart disease in critical condition (ICU), in order to adapt rehabilitation treatment to the patient's energy status. | I | B-R | C-/B+ | 1 to 6 |
| G24-R3 | It is recommended that children with congenital heart disease start aerobic training at the beginning of puberty, in order to increase exercise tolerance. | IIa | B-R | C-/B+ | 1 to 6 |
| G25-R1 | It is recommended that patients with pulmonary arterial hypertension undergo highly supervised ThPhT, ideally in an inpatient setting, in order to increase exercise tolerance, HR-QoL, and decrease systolic pulmonary arterial pressure levels. It is important to weigh the risk-benefit in patients with severe PAH. | IIa | B-R | C+/B+ | 1 to 6 |
| PICO | 3.3.9 Pulmonary arterial hypertension | Class (Strength) | Level of Evidence | C/B | Applicability |
| G25-R4 | Patients with stable pulmonary arterial hypertension and optimal treatment are recommended to enter a highly supervised ThPhT program, seeking improvement in quality of life and exercise tolerance. | IIa | B-R | C+/B+ | 1 to 6 |
| G25-R3 | Patients with pulmonary arterial hypertension are recommended to perform ThPhT based on breathing exercises, aerobic and strength training, highly supervised and at low intensity, seeking to improve distance covered in the 6-minute walk test, peak VO2 and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

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| G25-R2 | It is recommended that patients with pulmonary arterial hypertension in functional class I and II perform strength training exercises using isolated muscle groups, with low workloads, according to their risk stratification, with the aim of improving sarcopenia, muscle strength, exercise tolerance and HR-QoL. | IIa | B-R | C+/B+ | 1 to 6 |
| PICO | 3.3.10 Dysautonomia | Class (Strength) | Level of Evidence | C/B | Applicability |
| G26-R4 | It is recommended that patients with dysautonomia have a high daily intake of salt (6 to 10 g) and fluids (1.5 to 3 l), as tolerated, individualized and dose-response, in the search for improvement of symptoms and a reduction in the frequency of syncope: | I | B-R | C-/B+ | 1 to 6 |
| G26-R1 | It is recommended that patients with dysautonomia perform aerobic-based training, in horizontal mode (swimming or recumbent cycle ergometer) and continue with conventional cycle ergometry and treadmill, in order to improve exercise tolerance, HR-QoL and reduce frequency of syncope, and improve neurosympathetic activity. | IIa | B-R | C-/B+ | 1 to 6 |
| G26_R2 | It is recommended that patients with dysautonomia perform strength training, preferably in the lower limbs, in order to improve quality of life, exercise tolerance, and the occurrence of syncope. | IIa | B-NR | C+/B+ | 1 to 6 |
| G26-R5 | It is recommended that patients with dysautonomia be assessed for depression or anxiety in order to identify and treat it early. | IIa | B-NR | C-/B+ | 1 to 6 |
| G26-R3 | Patients with dysautonomia and POTS are recommended to perform orthostatic challenge training to reduce the number of syncopal episodes and improve autonomic nervous system function. | IIb | C-EO | C-/B+ | 1 to 6 |
| PICO | 3.3.11 Athletes with heart disease | Class (Strength) | Level of Evidence | C/B | Applicability |
| G27-R2 | It is recommended to perform risk stratification in athletes with heart disease on an individualized and comprehensive basis, seeking to assign an appropriate risk category for the recommendation for return to sports. | I | C-LD | C+/B+ | 1 to 6 |
| G27-R1 | It is recommended to evaluate athletes with heart disease in a comprehensive and individualized manner, in order to issue a rational opinion on eligibility or sports disqualification, in order to reduce the risk of sudden death associated with the practice of intense physical activity and, on the other hand, avoid unnecessary abandonment of sports practice. | IIa | C-LD | C+/B+ | 1 to 6 |
| G27-R3 | It is recommended that athletes who have been medically disqualified from participating in sports be evaluated by mental health specialists, particularly to identify depression or anxiety, in order to detect this problem early and initiate appropriate treatment. | IIa | C-LD | C-/B+ | 1 to 6 |
| PICO | 3.4 Co-morbidity | Class (Strength) | Level of Evidence | C/B | Applicability |
| G28-R5 | It is recommended to offer general and pharmacological treatment for conditions such as hypertension, diabetes, hypothyroidism, and hyperuricemia to patients included in CVRhP-P, in order to optimize cardiovascular outcomes. | I | A | C-/B+ | 1 to 6 |
| G28-R1 | It is recommended that written nutritional advice be systematically offered to patients with obesity or overweight who are admitted to a CVRhP-P, with the goal of reducing caloric and saturated fat intake and body weight | I | B-R | C-/B+ | 1 to 6 |
| G28-R4 | It is recommended that patients with lung disease admitted to a CVRhP-P perform aerobic and muscle-strengthening exercises, on an individualized and supervised basis, in order to improve exercise tolerance and reduce dyspnea | IIa | B-R | C+/B+ | 1 to 6 |
| G28-R2 | Patients with chronic kidney disease in the CVRhP-P group are recommended to perform respiratory, aerobic, and resistance training tailored to their risk stratification, with medical supervision and vital signs monitoring, in order to improve exercise tolerance, HR-QoL, and metabolic markers. | IIa | B-R | C+/B+ | 1 to 6 |
| PICO | 3.5.1 Pedagogical strategies in prevention | Class (Strength) | Level of Evidence | C/B | Applicability |

*(Continues)*

**Figure 32.** General recommendation table *(continuation).*

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| G29-R4 | It is recommended that patients admitted to a CVRhP-P receive a planned cardiovascular education program that includes classes and workshops on secondary prevention and risk factor identification and control. This program seeks to reduce morbidity and mortality, improve control of chronic conditions, and improve treatment adherence. | I | B-R | C-/B+ | 1 to 6 |
| PICO | 3.5.2 Atherosclerosis | Class (Strength) | Level of Evidence | C/B | Applicability |
| G4-R4 | It is recommended that smoking patients with CVD be included in a formal smoking cessation program, which includes both pharmacological and psychological therapy, in the pursuit of both smoking cessation and long-term abstinence. | I | A | C+/B+ | Smoking Cessation Clinic |
| G4-R2 | It is recommended to use LDL-C, non-HDL-C, and triglyceride levels as the main indicators for lipid control in patients with ischemic heart disease in CVRhP-P, and therapeutic goals will be determined by the individual risk of each case, in order to reduce cardiovascular risk. | I | A | C-/B+ | 1,2 and 6 |
| G29-R1 | Patients with hypercholesterolemia are recommended for pharmacological treatment, depending on their cardiovascular risk level. Drugs such as statins, ezetimibe, PCSK-9 inhibitors, inclisiran, or bempedoic acid may be prescribed to reduce LDL-C and triglyceride levels and cardiovascular risk. | I | A | C-/B+ | 1 to 6 |
| G4-R1 | It is recommended that adult patients with heart disease in a CVRhP-P complete the full vaccination schedule, which includes at least immunization against coronavirus (COVID-19), influenza virus, and pneumococcus, in order to reduce the morbidity and mortality associated with these pathologies | I | A | C-/B+ | 1,2 and 6 |
| G4-R3 | It is recommended to investigate the presence of periodontal disease in patients in a CVRhP-P, because it is associated with an increased risk of coronary atherosclerosis, arterial hypertension, and atrial fibrillation. This is done in order to achieve a lower level of systemic inflammation and better control of arterial hypertension and endothelial function. | I | B-R | C-/B+ | 1,2 and 6 |
| G4-R5 | It is recommended that obese children and adolescents engage in aerobic and strength training to control their weight, reduce their body fat percentage, waist circumference, blood pressure, LDL-C, and blood glucose levels, and increase HDL-C. | I | B-R | C-/B+ | 1 to 6 |
| G8-R1 | It is recommended that a nutritionist evaluate patients who have recently quit smoking, in order to identify and correct the onset of eating disorders such as high-calorie, high-salt, high-fat, and high-sugar foods, thereby preventing weight gain and cardiovascular risk associated with an unhealthy diet. | IIa | B-R | C-/B+ | 1, 4 and 6 |
| G29-R2 | It is recommended that patients with identified atherosclerosis receive a dietary plan based on proven effective diets, such as the Mediterranean, DASH, or even vegetarian diets, in order to reduce the number and size of plaques, change their composition, improve their lipid profile, and lower inflammation. | IIa | B-R | C-/B+ | 1 to 6 |
| G16-R6 | It is recommended that patients with ischemic heart disease participating in a CVRhP-P follow a nutritional plan with reduced calories and the inclusion of fiber, fish, and mono- or polyunsaturated fats, in order to support pharmacological treatment in achieving lipid level goals. | IIa | B-NR | C-/B+ | 1,2,4 and 6 |
| PICO | 3.5.3 Heart valve disease | Class (Strength) | Level of Evidence | C/B | Applicability |
| G30-R4 | Antibiotic prophylaxis is recommended before invasive dental procedures in patients with prosthetic valves or other conditions that place them at high risk for infective endocarditis, in order to reduce the risk of developing this potentially serious infection. | I | B-NR | C+/B+ | 4 |
| G30-R3 | It is recommended that post-valve surgery patients, particularly older adults, be included in CVRhP-P to perform strengthening, balance, and gait exercises, in order to improve muscle strength and exercise tolerance, reduce the number of falls, and increase the time between falls. | IIa | B-R | C+/B+ | 1 to 6 |

**Figure 32.** General recommendation table *(continuation).*

*(Continues)*

| | | | | | |
|---|---|---|---|---|---|
| G30-R2 | In patients on chronic treatment with oral anticoagulants containing vitamin K inhibitors, INR levels should be adjusted according to the goals established by their clinical diagnosis and in coordination with their treating physician, in an effort to reduce the rate of bleeding or thrombotic events. Evidence regarding dietary adjustment in relation to anticoagulant therapy remains controversial, and no recommendation can be made | III-NB | C-EO | C-/B- | 1 to 6 |
| PICO | 3.5.4 Arrhythmias and sudden death | Class (Strength) | Level of Evidence | C/B | Applicability |
| G31-R5 | It is recommended that patients within a CVRhP-P who present any type of arrhythmia be evaluated by a cardiology professional who should request consultation with an electrophysiology specialist when, in his or her judgment and based on risk stratification and analysis of the ECG trace, the patient presents alterations that potentially put his or her life at risk, in search of a definitive diagnosis and treatment and thus reduce the lethality associated with them. | I | A | C+/B+ | 1 to 6 |
| G31-R2 | It is recommended that patients admitted to a CVRhP-P who present ventricular ectopics during training sessions or during ergometry be studied in greater depth using various diagnostic methods and their risk stratified, in order to select the appropriate therapeutic measure in each case and thus reduce the likelihood of serious complications, particularly in high-risk patients. | I | B-NR | C+/B+ | 1 to 6 |
| G31-R1 | It is recommended that CVRhP-P staff who supervise high-risk patients be trained to identify the appearance of arrhythmias, ischemia, or hemodynamic alterations during ThPhT sessions and immediately notify the attending physician, so that appropriate intervention can be provided for each type of adverse event. | I | C-LD | C+/B+ | 1 to 6 |
| G31-R3 | It is recommended that patients with heart disease follow a diet that maintains serum potassium and magnesium levels within reference parameters, in an effort to reduce the occurrence of arrhythmias. | IIb | C-EO | C-/B+ | 1 to 6 |
| PICO | 3.6 Operational Management | Class (Strength) | Level of Evidence | C/B | Applicability |
| G5-R2 | It is recommended that the director of the CVRhP-P observe the regulations applicable to clinical and administrative operations, infrastructure, equipment, staff training, accounting and tax operations, as well as all other general regulations in accordance with the Law, in pursuit of a lawful, effective, and sustainable comprehensive practice. | I | C-EO | C-/B+ | 1 to 6 |
| G5-R4 | It is suggested that cardiac rehabilitation gyms have spacious, well-lit and ventilated training areas with appropriate accessibility and suitable for patients with frailty and disabilities, in order to ensure a functional and safe environment. | I | C-EO | C+/B+ | 1 to 6 |
| G6-R1 | It is recommended that CVRhP-P be created, implemented, operated, supervised, and audited within a structured quality management model that includes mission, management, and support processes (accounting, administrative, technical, etc.) in order to consolidate, update, and innovate their operation. | I | C-EO | C-/B+ | Establish a quality management culture |
| G6-R2 | It is recommended that CVRhP-P managers implement planning, training, supervision, certification, and reengineering processes, as well as strategies for recognizing and rating quality standard indicators, risks, and threats, in order to improve operational effectiveness and efficiency, particularly in areas of low compliance or high risk. | I | C-EO | C-/B+ | Establish a quality management culture |
| G6-R3 | It is recommended that the multidisciplinary staff of a CVRhP-P receive appropriate training in their professional area according to the type of rehabilitation unit and, in particular, have up-to-date cardiopulmonary resuscitation courses (BLS, ACLS, or PALS) in order to offer an effective, efficient, and safe service. | I | C-EO | C-/B+ | 1,2,4,5 and 6 |
| G6-R4 | It is recommended to implement continuous improvement strategies that include auditing, clinical performance feedback, and training of multidisciplinary teams, with the aim of promoting the systematic identification of successes and opportunities for improvement in care processes in CVRhP-P. | IIa | B-NR | C-/B+ | 1 to 6 |
| G6-R6 | It is recommended that eligible patients be referred to CVRhP-P through automated referral systems, ideally with the support of inter-agency networks, the use of liaison managers, and explicit referral by treating physicians, in order to increase referral rates, reduce any disparities in access to care, and increase the likelihood of receiving the benefits offered by these programs. | IIa | C-LD | C-/B+ | 1 to 6. Establish inter-institutional networks. |

**Figure 32.** General recommendation table.

### *3.6.3.1 Quality indicators*

Medical staff leading CVRhP-P must clearly identify clinical care quality indicators to ensure that procedures are performed according to scientific principles and that patients are receiving the expected benefits. These indicators will guide appropriate adjustments to provide a safe and effective comprehensive service.

The certification process proposed by the ICCPR comprises thirteen quality standards. (GRADE: very low $_{G6\text{-}R2_Ref_2}$).[680]

Cowie A et al. published a manuscript on the British Association for Cardiovascular Prevention and Rehabilitation quality standards and core components of CVRhP-P. This group of clinicians set the importance of establishing robust quality indicators to monitor the functioning of these services, while emphasizing the multidisciplinary characteristics of these programs. This working group proposed six core components within six stages of CVRhP care, which may be applicable to other countries, namely: (1) Establishment of a competent multidisciplinary team, led by a coordinator; (2) identification and referral of patients; (3) early assessment of patient needs and identification of personalized goals; (4) provision of a structured cardiovascular prevention program; (5) conducting a final assessment of patients; and (6) Participation in the National Cardiac Rehabilitation Certification Program and reporting on management and the degree of goal achievement (Fig. 31) (GRADE: very low $_{G7\text{-}R7_Ref_2}$).[699]

Several countries, including the United States, Canada, Australia, and Japan, among others, have developed quality indicators for CVRhP-P, with the highest-rated indicators focusing on post-program physical activity promotion, blood pressure assessment, and communication with the treating physician. In the evaluation of CVRhP-P, some areas with low operational quality were observed: stress-reduction counseling, smoking cessation, inclusion of recommendations in the discharge report, and blood glucose assessment. It is worth mentioning that systematic audits were only conducted in Canada, the United Kingdom, and the Netherlands. The main areas for improvement were patient and provider education, reminder systems, organizational change, and seeking financial reimbursement. Moghei M et al. propose strategies to improve the quality of CVRhP-P, including: 1) Education for both patients and healthcare providers to increase awareness of best practices. 2) Implementation of reminder systems to ensure adherence to key interventions. 3) Organizational adjustments to achieve quality standards. 4) Promotion of policies to improve reimbursement and financing to ensure sustainability and accessibility. (GRADE: low $_{G6\text{-}R1_Ref_1}$).[698]

Several members of the BACPR have emphasized the importance of having robust quality indicators for CVRhP-P, and proposed six core components to be fulfilled: 1) education and health behavior, 2) control of risk factors and lifestyle, 3) psychosocial health, 4) medical risk management, 5) long-term strategies and 6) audit and evaluation of the program. In addition, the following strategies should be used to accredit these points: a) the implementation of the six core components by qualified and multidisciplinary personnel, coordinated by a clinical leader, b) early identification, referral and admission of eligible patients, c) initial evaluation considering the needs of each patient with periodic review, d) establishment of a structured CVRhP program with patient flow diagrams, e) the final evaluation of each patient highlighting the clinical results, f) submission of data to the central level and participation in unit certification programs (GRADE: low). $_{G6\text{-}R2_Ref_4)}$.[699]

Specialists in China published a consensus with twenty-six quality indicators of CVRP-P in post-myocardial infarction patients, seventeen of which focused on strategies to improve the quality of the programs. Within these indicators, five were highlighted as most in need of improvement, namely: automatic referral of eligible patients, written recommendations post-CVRhP, ThPhT prescribed based on the initial evaluation, the inclusion of staff to educate patients, as well as assessment and education on risk factors for coronary artery disease (GRADE: low $_{G6\text{-}R2_Ref_5}$).[700]

**(KM).** The successful implementation and long-term sustainability of a CVRhP center is directly linked to its financial viability, which requires the involvement of professionals in accounting and administrative areas.

## Concluding remarks

Cardiovascular rehabilitation and prevention have had to carve their own path from the very beginning. It is important to acknowledge those who came before us, professionals from various fields and eras who have maintained their enthusiasm and translated it into their scientific, clinical, and teaching work for decades.

Although the beneficial effects and safety of CVRhP-P have been firmly established over the years, referring patients to these programs and ensuring their adherence remains a “Sisyphean task” today.

The main objective of these guidelines is to contribute to the improvement and standardization of clinical practice, by providing a scientifically sound approach

to addressing common clinical questions (PICO), formulated by experts in the field.

Furthermore, the group of collaborators adhered to the most rigorous standards currently in place for developing clinical practice guidelines and invited internationally recognized external reviewers to participate.

These guidelines have a broad scope, so it is natural that there will be gaps in the evidence which we hope to address in future updates. Scientific knowledge is advancing at a rapid pace and requires continuous updating; therefore, future publications should continue to uphold the purpose of this manuscript.

**Acknowledgments.** First, we would like to thank all the people who contributed to the development of this document, including authors, coordinators, reviewers, and editors. We also thank SOMECCOR and SMC for their support of this project. We would like to thank the authorities and all the staff involved in the operation of the participating cardiac rehabilitation units for their solidarity in the development of these CPGs. We also thank the group of patients who contributed their perspectives and preferences regarding these CPGs. Finally, we would like to particularly thank AMIR and MFQG for their time.

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