World Journal of Cardiovascular Diseases, 2025, 15(1), 8-18
https://www.scirp.org/journal/wjcd
ISSN Online: 2164-5337
ISSN Print: 2164-5329

Cardiac Rehabilitation and Surgery: Epidemiological and Clinical Aspects

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How to cite this paper: Bah, A.M., Doumbouya, A.D., Diallo, M.M., Baldé, M.A., Diallo, H., Barry, A.A., Diaby, A., Diallo, A.O.B., Baldé, A.T., Diallo, M.D., Bah, F.B., Koïvogui, K., Condé, B., Sow, M.O., Camara, A., Béavogui, M., Bah, M.B., Koné, A., Diakité, S., Barry, I.S., Baldé, E.Y. and Baldé, M.D. (2025) Cardiac Rehabilitation and Surgery: Epidemiological and Clinical Aspects. *World Journal of Cardiovascular Diseases*, **15**, 8-18.
https://doi.org/10.4236/wjcd.2025.151002

Received: December 7, 2024
Accepted: January 14, 2025
Published: January 17, 2025

Abstract

Introduction: Cardiac rehabilitation is defined as a comprehensive, multidisciplinary approach to secondary prevention. Its main components include patient assessment (exercise capacity, ventricular function and the existence or risk of arrhythmias), therapeutic education and control of cardiovascular risk factors, optimization of drug therapy, psychosocial support and, of course, personalized physical training. **Method:** The Basse Terre hospital department served as the setting for this study. All patients admitted to the department for cardiac rehabilitation were our target population. All patients operated on and admitted to the cardiology department for cardiac rehabilitation constituted our study population. A pre-established survey form and patient records were used to collect data. Ethical principles and patient confidentiality were paramount. **Results:** The prevalence was 13%. The mean age of our patients was 59.66 ± 12.9 years. Valve replacement was 25%; coronary artery bypass grafting was 75%; Kardégic 83.33%, CHBT protocol 83.33%, muscle fatigue 66.66%. 58.33% had 3 - 8 Watts at initial assessment and ≥15 Watts at final assessment. 8.33% atrial dilatation, and 16.66% segmental hypokinesia. 8.33% VO_2 and ESV and Q necrosis. **Conclusion:** Exercise testing is a reliable means of assessing patients' functional capacity.

Keywords

Cardiac Rehabilitation and Surgery

1. Introduction

The WHO in 1993 defined cardiovascular rehabilitation as all activities necessary to influence positively the disease's evolutionary process, and to ensure patients' best possible physical, mental and social condition, so that they may by their own efforts preserve or regain as normal a place as possible in the life of the community [1].

Cardiac rehabilitation is defined as a comprehensive, multidisciplinary secondary prevention. Its main components include patient assessment (especially exercise capacity, ventricular function and the existence or risk of arrhythmias), therapeutic education and control of risk factors cardiovasculaires, optimized drug therapy, psychosocial support and, of course, personalized physical training [2].

Cardiac surgery was born in the 20th century with the treatment of the first heart wounds, with open-heart surgery developing in the second half of that century. The pioneers laid' all the foundations of cardiac surgery in 10 years, from 1960 to 1970. Cardiac surgery then moved from feasibilitý, to reproducibilitý and reliabilitý. Results over the years have improved.

Cardiac rehabilitation (CR) is mainly aimed at a sedentary, middle-aged population. Nevertheless, some patients referred for CR are active, even athletic, and the management of these patients is less well known.

Cardiac rehabilitation is a "slow", global, positive and multidisciplinary medicine, carried out in conventional hospitalization (for the most serious cases) or, more often, in day hospitalization [3].

Cardiac rehabilitation, or cardiovascular rehabilitation for short, began to develop in the 1970s. In fact, it established itself as a therapy in its own right when its impact on mortality was demonstrated. It has now taken its place in the treatment of cardiovascular diseases, and has considerably improved their functional prognosis. Cardiovascular rehabilitation has four main objectives: to improve functional capacity under stress, to slow down the progression of atheromatous disease and reduce morbidity and mortality, to optimize socio-professional reintegration and to improve quality of life [4].

The term cardiovascular rehabilitation encompasses exercise reconditioning and comprehensive, optimal management of cardiovascular risk factors (secondary prevention). Cardiovascular rehabilitation also includes therapeutic and dietary education, psychological support, help with smoking cessation and return to work.

It can also be used to identify patients at risk, monitor cardiac status (to detect worsening) and optimize medical treatments [4].

Over the last twenty years or so, training methods for rugby XV players and heart failure sufferers have become increasingly similar! In the past, countless laps of the field in short strides, interspersed with short sprints, summed up the basic training [5].

Recent international recommendations for the long-term treatment of patients with heart failure include, in addition to the classic adaptation of drug therapies, a global management component involving diet control, regular physical activity and therapeutic education. By definition, cardiac rehabilitation enables this global management: a rehabilitation program is no longer limited to the isolated practice of physical training, but also includes the adaptation of treatments, therapeutic education and psychological and socio-professional support. Cardiac rehabilitation is now recognized as an integral part of modern heart failure treatment [6]. The research hypothesis is that cardiac rehabilitation improves the physical and functional capacity of patients undergoing surgery.

2. Methodology

The cardiology department of the Hospitaller Centre of the Basse-Terre served as the setting for this study.

We targeted all patients admitted to the cardiology department for cardiac rehabilitation during our study period.

Our study covered all patients operated on and admitted to the cardiology department for cardiac rehabilitation.

Collection media: For data collection, we used the consultation register; patients' medical records; a pre-established survey form. This was a descriptive and analytical cross-sectional study with retrospective collection on all patients operated on and admitted for cardiac rehabilitation during the six (6) month period from January 1 to June 30, 2024.

Inclusion criteria: All surgical patients admitted for cardiac rehabilitation during the study period were included in our study.

Patients who had not undergone surgery and/or were not referred for cardiac rehabilitation were not included in our study.

We proceeded with an exhaustive recruitment of patients referred to the cardiology department, and after applying our selection criteria, the final size was twelve (12) patients.

Anonymity and confidentiality were respected for all patients.

Study variables. Our study variables were: Epidemiological variables: (Age, Sex, Socio-professional stratum); cardiovascular risk factors.

Clinical: symptoms, surgical scar and cardiorespiratory stress test parameters.

Paraclinical variables: Biological work-up and ECG.

3. General

3.1. Mechanisms of Heart Failure Symptoms

Congestive heart failure can be defined as the association of systolic and/or diastolic left ventricular dysfunction with effort limitation due to dyspnea or fatigue. Asymptomatic" left ventricular dysfunction is also associated with a reduction in maximum functional capacity when assessed objectively. Exercise intolerance increases markedly as the disease progresses, but there is no relationship between resting hemodynamics (capillary pressure, cardiac output) or left ventricular ejection fraction on the one hand, and functional capacity on the other (NYHA class, 6-minute test, VO_2 max) [6].

3.2. Central Hemodynamics

In normal subjects, exercise capacity does not appear to be limited by cardiac performance. In patients with heart failure, exercise with the legs as well as the arms increases VO_2 max (19). This suggests that there is another factor limiting exercise capacity than simply the reduction in cardiac output during exercise.

3.3. Pulmonary Circulation

While right ventricular failure is a poor prognostic factor in patients with heart failure, there is no relationship between right ventricular function measured at rest and exercise capacity. However, the combination of right ventricular dysfunction and an abnormal pulmonary vascular anomaly during exercise leads to disturbances in pulmonary perfusion, which may explain the abnormal ventilation/perfusion ratio observed in heart failure.

3.4. Lung Function

Several investigators have described pulmonary function abnormalities in patients with heart failure.

However, no spirometric index correlates well with exercise capacity, especially in paucisymptomatic patients. Bronchial hyperreactivity has been found by some authors, without demonstrable exertional bronchospasm. In patients with heart failure, a disturbance in trans-alveolar diffusion has also been observed, as measured by trans-capillary carbon monoxide diffusion. Diaphragmatic muscle fatigue has also been implicated in functional limitation.

Histological abnormalities as in the muscle. Psychological and socio professional. Cardiac rehabilitation is now recognized as an integral part of modern heart failure treatment [6].

3.5. Re-Training Techniques & Recommendations

Since the first recommendations of the European Physiology and Rehabilitation Working Group in 2001, American (American Heart Association/American College of Cardiology [AHA/ACC]) and European societies have clarified the role of retraining in patients with heart failure. This is, of course, inspired by the techniques used for several decades in the treatment of coronary artery disease. A typical training session usually includes a warm-up phase (breathing exercises, belt loosening, movements with small dumbbells) lasting 15 to 30 minutes, followed by 20 to 30 minutes of effort on a bike or treadmill at a target heart rate, then a phase of light-intensity recovery exercises lasting 5 to 10 minutes, sometimes followed by a period of relaxation and stretching and loosening exercises lasting around 10 minutes. These sessions are daily for in-patients, or multi-weekly for out-patients, with progressive intensity depending on initial condition, generally aimed at a target heart rate designed to improve aerobic capacity (heart rate at ventilatory threshold or set at 60% - 80% of maximum capacity or chronotropic reserve measured during an inclusion exercise test). In France, twenty sessions are usually reimbursed by the national health insurance system. As patients included in rehabilitation centers become increasingly older, rehabilitation principles have tended in recent years to incorporate more and more flexibility, coordination and muscle-strengthening exercises. By definition, the exercise capacity of heart failure patients is much lower than that of coronary artery disease sufferers, and their endurance is disrupted, with earlier activation of the anaerobic mechanism and a disturbed chronotropic and blood pressure profile, combined with much longer recovery times. In addition, many of these patients are in atrial fibrillation, have vasodilatory and hypotensive therapies, and are often fitted with a pacemaker (single, double or triple chamber) or defibrillator. For the most severe patients, conventional programs are totally unsuitable, given their reduced exercise capacity and high arrhythmic risk. It therefore seemed logical to propose physical rehabilitation programs adapted to this pathology, with individualized protocols depending on the initial degree of cardiovascular impairment and, above all, the degree of peripheral muscular deconditioning [6].

Heart failure (HF) is a frequent and serious pathology. An estimated one and a half million French suffer from it, and the condition is responsible for over 200,000 hospitalizations a year. CI mainly affects the elderly, with an average age of between 75 and 80, and it is estimated that 5-year survival is 60% in the ambulatory population and 40% in patients who have been hospitalized. The management of heart failure, irrespective of severity, has been revolutionized over the last few decades, with improvements in patient-centered, holistic diagnostic and therapeutic (drug and non-drug) management. For selected severe patients, heart transplantation and mechanical circulatory assistance have been shown to improve symptoms and life expectancy [7].

Advanced CHF represents the end-stage of heart failure. Interestingly, this classification is generally used to identify selected patients who can benefit from surgical treatment of heart failure, including transplantation (still the gold standard?) and long-term mechanical assistance. Unfortunately, most patients who die of heart failure have not been identified as such by their healthcare team, limiting access not only to therapies but also to palliative care, with a consequent reduction in survival and quality of life. Unlike CI or myocardial infarction, there is no universally accepted definition of advanced CI. However, some criteria are frequently found, such as the severity of symptoms and functional disability, associated with recurrent hospitalizations in therapeutically optimized patients. The definition currently used in France is based on the criteria of the Heart Failure Association (HFA), as set out in the European Society of Cardiology (ESC) 2021 recommendations on heart failure. Advanced CHF is defined by the presence of the following four criteria in patients on optimal therapy:

- Severe and persistent symptoms of CHF [NYHA class III (advanced) or IV];
- Severe cardiac dysfunction defined by at least one of the following: isolated right ventricular failure (e.g. LVEF less than or equal to 30%, ARVC),
- Severe non-operable valvular anomalies? BNP or NT pro BNP values remaining elevated (or in severe non-operable congenital anomalies, increasing) and

severe left ventricular diastolic dysfunction or structural anomalies (as defined by HFpEF).

- Episodes of pulmonary or systemic congestion requiring high-dose intravenous diuretics (or combinations of diuretics) or low-flow episodes requiring inotropes or vasoactive drugs or malignant arrhythmias causing more than one unplanned visit or hospitalization in the last 12 months.
- Severe impairment of exercise capacity with inability to exercise or short 6-minute walk test distance (<300 m) or pVO_2 less than 12 ml/kg/min or less than 50% of predicted value, estimated to be of cardiac origin [7].

The prevalence of advanced CI was initially estimated at between 1% and 10% of the CI patient population, but recent population studies using the above criteria have found higher figures, at around 14%, with an equivalent proportion of CI with reduced or preserved ejection fraction. The median survival time is around 12 months, with 40% to 50% of patients dying within a year, and with an average of three hospital admissions per year in the first year after diagnosis of advanced CI. It should be noted, however, that one of the limitations of this definition is the need for multiple hospitalizations, even though each hospitalization may be associated with a risk of in-hospital death in 5% - 10% of cases [7].

3.6. Sporting Activity after Mitral Valve Replacement: The Vision of a Cardiologist Rehabilitator

Surgical mitral valve repair or mitral valve plasty (MVP) is a long-standing technique, introduced in France in the early 1970s. Its long-term results are well known, and it can be said that, overall, patients with severe primary mitral insufficiency (MI) regain a normal vital prognosis in the absence of cardiac or extracardiac comorbidity [8].

3.7. Valve Rehabilitation

Exercise conditioning (9)

a) Early post-operative phase (J7 - J15)

During this phase, respiratory physiotherapy is important, as thoracotomy leads to a 15% - 20% drop in ventilatory capacity, and pleural effusions, atelectasis and bronchial superinfections are frequent (pre-existing chronic obstructive pulmonary disease (COPD)).

Diaphragmatic mobilization, respiratory synchrony education and de-cluttering are essential [9].

Pain relief, massage and cough education are also essential.

Where necessary, patients should be helped to regain their independence and to walk, especially as they are often elderly (9).

b) In the sub-acute post-operative phase after D15 (9):

Exercise is prescribed in the same way as for coronary artery surgery.

An exercise test with or without VO_2 is used to determine:

- Exercise intensity on ergometer cycle or treadmill, specifying the training frequency (FCE) (Karvonen FCE, or FCE at 1st ventilatory threshold if VO_2 has been used). The intensity will then be adapted using the Borg scale (the effort should be felt to be moderately difficult);

- Training frequency 3 to 5 sessions per week of 20 to 30 min;
- These exercise sessions on a bike or treadmill will be complemented by general gymnastics and gentle endurance training 3 to 5 times a week, for 30 minutes to 1 hour a day.

4. Results

During the study period, we registered ninety patients, twelve (12) of whom met our selection criteria.

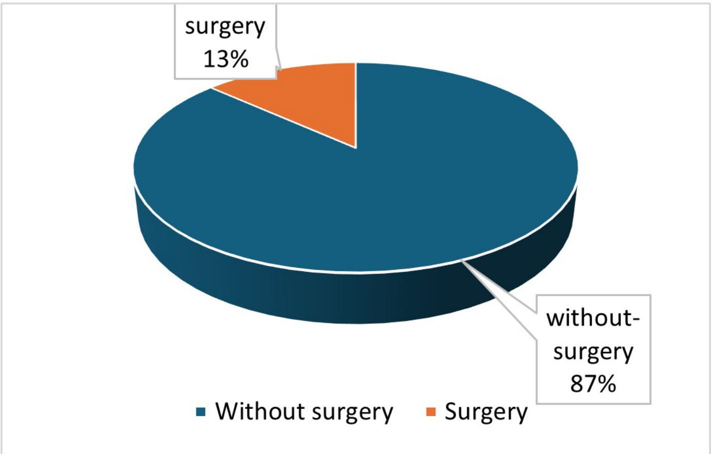

Figure 1. Prevalence of cardiac rehabilitation and surgery.

Table 1. Distribution of patients by age.

Âge	Number	%
36 - 46	2	16.67
46 - 56	2	16.67
56 - 66	**4**	**33.33**
66 - 76	2	16.67
76 - 78	1	8.33
≥78	1	8.33
Total	12	100

The mean age of our patients was 59.66 ± 12.9 years, with extremes of 36 and 78 years.

Table 2. Distribution of patients by indication for cardiac rehabilitation.

Indications	Number	%
CABG	**9**	**75**
RV	1	8.33
RV/PM	2	16.66

Table 3. Distribution of patients according to antecedents.

History	Number	**%**
CABG	**9**	**75**
HTA	6	50
Dyslipidemia	5	41.67
Diabetes	5	41.67

Table 4. Distribution of patients according to usual treatment.

Treatment	Number	**%**
Aspirin	**10**	**83.33**
Bisoprolol	9	75
Atorvastatin	7	58.33
Esomeprazole	6	50
Ramipril	5	41.67
Clopidogrel	4	33.33
Metformin	2	16.67
Ticagrelor	1	8.33

Table 5. Distribution of patients according to the protocol used at initial and final assessment.

Protocol used	Number	**%**
1 km/h, 1%, rower 5	1	8.33
CHBT protocol on treadmill	10	83.33
VO_2 on treadmill	1	8.33
TOTAL	**12**	**100**

CHBT protocol: 1Km/h; 2% slope.

Table 6. Distribution of patients by reason for stopping EE.

Reason for stopping	**Number**	**%**
Shortness of breath	4	33.33
Muscle fatigue	**8**	**66.66**
TOTAL	**12**	**100**

Table 7. Distribution of patients according to performance at initial assessment.

PM initiale en W	Number	**%**
3 - 8	**7**	**58.33**
8 - 13	4	33.33
≥15	1	8.33
Total	12	100

Mean MP was 7.8 ± 3 W with extremes of 3.49 and 15 W.

Table 8. Distribution of patients according to performance at final assessment.

Maximum power (en W)	Number	%
5 - 10	1	8.33
10 -15	4	33.33
≥15	**7**	**58.33**
Total	12	100

Mean MP was 21 ± 12.9 w with extremes of 5.27 and 15 w.

Table 9. Distribution of patients according to VO_2.

VO_2 Max (ml/min/m^2)	Number	%
17.5	1	100
Total	1	100

Table 10. Distribution of patients according to electrocardiographic data.

Electrical anomalies	Number	%
ESV	1	8.33
Necrosis Q	1	8.33

Table 11. Distribution of patients according to echocardiographic data.

Parameters	Number	%
Hypokinesia	2	16.67
Atrial dilatation	1	8.33

5. Discussion

During our study period, we identified ninety (90) patients. Twelve (12) patients met our selection criteria, representing a prevalence of 13% (Figure 1).

The age group most affected was 55 to 66 years, with a mean age of 59.66 ± 12.9 years, ranging from 36 to 78 years (Table 1). Our study population is relatively young. This could be explained by the frequency of cardiovascular risk factors.

In our series, there were 3 cases of valve replacement (25%) (Table 2). To date, the contribution of exercise testing with measurement of respiratory exchange in the rehabilitation of patients who have undergone valve replacement or repair is poorly documented.

It is not currently used in daily practice to calibrate patient rehabilitation post-operatively. However, pre- and postoperative assessment of exercise tolerance in patients with mitral valve disease has shown that, six months after surgery, there was no improvement in aerobic capacity in the absence of re-training (8).

According to indications and history, coronary artery bypass grafting (CABG) was the most common, accounting for 75% (Table 2 & Table 3).

According to treatment, patients with Aspirin were the most represented, at

83.33% (**Table 4**). This can be explained by the fact that most of our patients have ischemic heart disease.

According to the protocol used, that of CHBT: (1 Km/h; 2% gradient) *i.e.* 83.33% (**Table 5**).

According to the reason for stopping EE, muscular fatigue was the most common, with 66.6% of patients (**Table 6**).

According to our patients' exercise capacity, those with more than 3 - 8 watts (**Table 7**) at initial assessment and ≥15 watts at final assessment were the most represented, *i.e.* 58.33% (**Table 8**). Our result is strictly inferior to that reported by Pavy *et al.* [9].

This may be explained by our smaller sample size. As noted in the literature, our study shows that cardiac rehabilitation improves functional capacity. The beneficial effects of exercise training are felt at different levels, on cardio-circulatory function, musculoskeletal performance, respiratory function and so on [10].

Cardorespiratory exercise testing is the gold standard for measuring aerobic fitness. In adult heart failure, maximal oxygen consumption, or VO_2 max, and ventilatory efficiency are prognostic factors correlated with NYHA class, quality of life and mortality [10].

In our study, only one patient performed the cardiorespiratory exercise test with a VO_2 max of 17.5% of theoretical VO_2 (**Table 9**). This may be explained by the fact that our study population was not in heart failure, and so the EECR was not systematized for patients with heart failure.

There was one case of ESV and Q-wave necrosis (8.33%) (**Table 10**).

In our study, we noted one case of atrial dilatation and two cases of hypokinesia, *i.e.* 8.33% and 16.66% respectively (**Table 11**). This can be explained by the fact that these patients have ischemic heart disease.

6. Conclusions

Exercise testing is a reliable way of assessing a patient's functional capacity. It is essential for cardiac surgery patients, and for objectivizing the benefits obtained. It is also useful for defining re-training modalities.

The initial and final stress tests demonstrated the improvement in the functional capacity of the operated patients and highlighted the importance and value of cardiac rehabilitation after cardiac surgery.

Cardiorespiratory stress testing should be systematized for all patients. Specific future research could be carried out over longer periods to better explore the benefits of cardiac rehabilitation.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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