Annales Africaines de Médecine
Article original

Assessing the Benefits of Inpatient vs. Outpatient Cardiac Rehabilitation Among Heart Failure Patients with Reduced Ejection Fraction: Experience of Centre Hospitalier Sud Francilien

Evaluation des bénéfices de la réadaptation cardiaque en hospitalisation versus en ambulatoire chez les patients souffrant d'insuffisance cardiaque à fraction d'éjection réduite : expérience du Centre Hospitalier Sud Francilien

Glodie Dimbu Kiadi[1,2,3], Libérus Ayéwanou Edorh Hervé[1], Cyriac Agavoedo[1], Moctar Bakary[1], Diane Bado[1], Jean-René M'buyamba Kabangu[2↓], François Koukoui[1,4], Nathan Bimbi Buila[2]

Auteur correspondant
Glodie Dimbu Kiadi
Courriel : kiadi6@hotmail.fr

Résumé

Contexte & objectif. L'efficacité de la réadaptation cardiaque (RC) en ambulatoire chez les patients insuffisants cardiaques (IC) à fraction d'éjection (FEVG) réduite reste peu documentée. L'objectif de la présente étude était de comparer les bénéfices de la RC chez deux groupes de patients : en hospitalisation complète versus en hôpital du jour. *Méthodes.* C'était une série descriptive rétrospective des cas d'IC (FEVG ≤ 40% ayant réalisé toute la phase 2 du programme de RC), entre janvier 2021 et décembre 2022, dans le Centre Hospitalier Sud Francilien, France. *Résultats.* Au total, 46 dossiers médicaux des patients (sexe masculin, âge moyen 64,1 ± 12,7 ans) ont été colligés. L'étiologie de l'IC était une coronaropathie chez 17 (41%) et une cardiomyopathie dilatée chez 29 (59%). La réadaptation a été effectuée en hospitalisation et en ambulatoire, respectivement chez 20 et 26 patients. A la fin de la phase 2 de la RC, une augmentation significative des paramètres fonctionnels suivants, a été observée : SV1 : + 5,3 ml/kg/min (15,9 ± 5,3 ml/kg/min à la fin contre 10,6 ± 3,1 ml/kg/min au début ; p = 0,03) ; charge maximale : + 19,4 W (111,8 ± 33,1 W à la fin contre 92,4 ± 30,8 W au début ; p = 0,004) ; TM6 : + 57,2 m (505,9 ± 95.6 m contre 448,7 ±109,5 m ; p = 0,008), ainsi qu'une hausse non significative du pic de VO2. De plus, une hausse significative de la FEVG (+7% ; p = 0,0007) et une baisse significative de la fréquence cardiaque (-5 bpm ; p = 0,0458) ont été constatées. Cependant, aucune différence statistiquement significative entre la modification des paramètres des patients selon les deux modes de RC précités. Un traitement médical optimal en fin de RC était associé à une plus grande baisse de NTproBNP : -1527,5 ± 2742,3 pg/ml contre -39,6 ± 1193,2 pg/ml ; p = 0,0025. *Conclusion.* Le mode de RC en hospitalisation versus en ambulatoire n'influe pas sur les bénéfices de la RC.

Mots-clés *:* réadaptation cardiaque, hospitalisation, consultation externe, France

Summary

*Context and objective***.** The effectiveness of outpatient cardiac rehabilitation (CR) in patients with heart failure (HF) and reduced ejection fraction (LVEF) remains poorly documented. The objective of this study was to compare the benefits of CR in two groups of patients: those hospitalized full-time versus those in day hospital. *Methods.* This was a retrospective descriptive series of HF cases (LVEF ≤ 40% who completed phase 2 of the CR program) between January 2021 and December 2022 at the Centre Hospitalier Sud Francilien, France. *Results*. A total of 46 patient medical records (male, mean age 64.1 ± 12.7 years) were collected. The etiology of HF was coronary artery disease in 17 (41%) and dilated cardiomyopathy in 29 (59%). Rehabilitation was carried out on an inpatient and outpatient basis in 20 and 26 patients, respectively. At the end of phase 2 of CR, a significant increase in the following functional parameters was observed: SV1: +5.3 ml/kg/min (15.9 ± 5.3 ml/kg/min at the end vs. 10.6 ± 3.1 ml/kg/min at the start; p = 0.03); maximum load: +19.4 W (111.8 ± 33.1 W at the end vs. 92.4 ± 30.8 W at the start; p = 0.004); TM6: +57.2 m (505.9 ± 95.6 m vs. 448.7 ± 109.5 m; p = 0.008), as well as a non-significant increase in peak VO2. In addition, a significant increase in LVEF (+7%; p = 0.0007) and a significant decrease in heart rate (-5 bpm; p = 0.0458) were observed. However, there was no statistically significant difference between the changes in patient parameters according to the two aforementioned CR modes. Optimal medical treatment at the end of CR was associated with a greater decrease in NTproBNP: -1527.5 ± 2742.3 pg/mL versus -39.6 ± 1193.2 pg/mL; p =0.0025. *Conclusion.* The mode of CR in hospitalization versus outpatient care does not influence the benefits of CR.

Annales Africaines de Médecine
Article original

Reçu le 22 juin 2025
Accepté 16 novembre 2025
https://dx.doi.org/10.4314/aamed.v19i2.12

1. Cardiac Rehabilitation Service, South Francilien Hospital Center, Corbeil-Essonnes
2. Cardiology Service, Internal Medicine Department, University Clinic of Kinshasa, University of Kinshasa
3. Medicine Service, Cosne sur Loire Hospital Center, GHT of Nièvre, Bourgogne Franche-Compté
4. INSERM I2MC, UMR 1048, UPS University, "Obesity and heart failure: molecular and clinical approaches" team, Toulouse.

Keywords: Heart failure, cardiac rehabilitation, inpatient, outpatient, France
Received: June 22, 2025
Accepted: November 16, 2025
https://dx.doi.org/10.4314/aamed.v19i2.12

Introduction

Heart failure (HF) is a significant public health issue, owing its widespread prevalence, high morbidity and mortality rates, and the financial burden of its management. It Affecting over 64 million people globally, it impacts approximately 1–3% of the adult population in industrialized countries (1). In France alone, an estimated 1.1 to 2 million people are affected by HF (2). In Europe, chronic HF has an overall 1-year mortality rate of 6.4% (3). However, in specific populations, the 1-year mortality rate may reach 15–30%, increasing to as much as 75% at 5 years (4). For those who survive, the readmission within the first year post-diagnosis is 50% (5) . In 2012, the cost of managing HF in the United States amounted to $30.7 billion, with estimates projecting a rise to $69.8 billion by 2030 (6-7).

Cardiac rehabilitation (CR) has proven to be safe and effective means of enhancing patients' functional status while also reducing mortality and hospitalization rates associated with HF (8) (9) . It is highly recommended for patients with HF (10-11) . The program primarily includes exercise retraining, therapeutic optimization and patient education. Classically, CR is conducted either as a full hospitalization or a day hospital program. Full hospitalization is typically reserved for unstable patients admitted immediately after the acute phase, without returning home between the acute event and the start of CR. Conversely, day hospital programs cater to clinically stable patients. Recently, the COVID-19 pandemic, has catalyzed the growth of telerehabilitation, showing promising results in terms of safety and efficacy (12).

The INCARD study conducted at the hospital center in the southern Paris region (Corbeil-Essonnes, France), and published in 2015, involved 63 patients. It demonstrated that phase 2 of CR significantly enhanced all functional parameters in patients with HF, regardless of whether the etiology was coronary or non-coronary (13) .

This study aims is to compare the benefits of CR based on whether it was conducted in full hospitalization or on an outpatient basis in a day hospital setting.

Methods

Study design period

This was a descriptive, retrospective series cases conducted over a 24-month period, from January 2021 to December 2022. It was carried out in the Post-Acute Care and CR department at the Centre Hospitalier Sud Francilien (CHSF) in Corbeil-Essonnes, France.

Inclusion criteria

We included patients aged 18 and over who were admitted for CR specifically indicated for HF with a left ventricular ejection fraction (LVEF) of 40% or less.

Exclusion criteria

We excluded patients who had contraindications to physical exercise, incomplete medical records, experienced an interruption in their rehabilitation program, or did not undergo CR strictly as a full-time inpatient or within a day hospital setting.

Exercise reconditioning program

All participants engaged in a uniform exercise reconditioning program, which included two components: endurance training and muscle strengthening. The regimen was tailored using a cardiorespiratory exercise test conducted on a cycle ergometer. Initially, a baseline exercise test was administered before the commencement of phase 2 of CR, helping to assess the patients'

functional capacities. of patients to be determined. Participants were instructed to perform physical activities at 60–80% of their initial VO_2 peak. The endurance training involved cycling and treadmill walking, with cycling performed in split sessions: alternating 90 seconds of high load with 180 seconds of low load. Muscle strengthening comprised gentle resistance exercises, targeting limb segments with low-intensity movements repeated 10 to 15 times per exercise type. Each patient completed a total of 30 sessions, distributed over 5 half-days per week for 6 weeks. Each half-day session included 90 minutes of activity: 45 minutes of cycling or treadmill exercise, 20 minutes of muscle strengthening, and 25 minutes of gentle gymnastics and relaxation. At the end of the 30 sessions, a final cardiorespiratory exercise test was conducted and compared to the *initial test to evaluate progress*.

Data collection

Data were gathered using individual survey forms derived from the patients' electronic medical records. We collected a range of information, including patients' age, sex, body mass index (BMI), cardiovascular risk factors (CVRF); and HF etiology.

We also collected the following parameters before the start and at the end of phase 2 of CR:

- Clinical and paraclinical parameters: These included heart rate, systolic blood pressure (SBP), N-terminal prohormone of brain natriuretic peptide (NT-proBNP) levels, and left ventricular ejection fraction (LVEF).
- Functional Parameters: We measured the distance covered in the six-minute walk test (6MWT) and assessed maximum load, the first ventilatory threshold (SV1), and peak oxygen consumption (VO2 peak) from the cardiorespiratory exercise test conducted on a cycle ergometer.
- Medication Evaluation: We evaluated whether the HF treatment was optimal or suboptimal. This was determined by the combination and dosage of medications such as beta-blockers, antialdosterone agents, glucose-sodium cotransporter 2 inhibitors, and either angiotensin-converting enzyme inhibitors or sacubitril/valsartan, administered at the optimal or maximum tolerated dose.

Data analysis

We utilize Epi Info software version 7.2.2.6 for our data analysis. Quantitative variables were presented as means ± standard deviations and were compared using the Student t-test or the Mann Whitney U test. Qualitative variables were expressed as numbers followed by percentages and were analyzed using the Fisher exact test or the chi-square test. Statistical significance was defined as a p-value less than 0.05, and odds ratios were reported with their 95% confidence intervals.

Ethical considerations

To ensure data confidentiality, survey forms were anonymized. We secured approval from both the scientific committee and the ethics committee of the South Paris region hospital center, aligning with ethical standards.

Results

From a total of 121 patients, we included 46 in the study and excluded 75. Among those excluded, 18 had a contraindication for physical exercise, 27 had incomplete data, and 20 discontinued their CR program.

Characteristics of patients

The study comprised 38 (82.6%) men and 8 (17.4%) women, resulting in a sex ratio of 4.8. The average age was 64.1 years, with men averaging 61.5 years and women 59.8 years), although this difference was not statistically significant (p-value = 0.08). Smoking was the most prevalent cardiovascular risk factor, affecting 51.2% of the patients. The average BMI was 26 ± 4.5 kg/m², with 12 patients (26.7%) classified as obese (Table 1).

Table 1. Distribution of cardiovascular risk factors

Characteristics	N (%)
Chronic renal failure	3 (6.5)
High blood pressure	18 (39.1)
Diabetes	9 (19.6)
Obesity	12 (26.7)
Smoking	24 (52.2)
Dyslipidemia	8 (17.4)
Coronary heredity	3 (6.5)

The etiology of HF was coronary artery disease in 17 (41%) patients and dilated cardiomyopathy in 29 (59%) patients.

Evolution of patient parameters after phase 2 of cardiac rehabilitation

A total of 20 patients (13.2%) completed their rehabilitation in full hospitalization setting and 26 (86.8%) underwent the program in a day hospital setting. At the beginning, 11 patients (23.9%) were on optimal medical treatment, which increased to 21 (45.7%) at the end.

By the end of phase 2 of CR, we observed significant improvements in several functional parameters:

Peak VO_2 increased by 0.7 ml/kg/min (from 15.2 ± 4.5 ml/kg/min at the start to 15.9 ± 5.3 ml/kg/min; p-value = 0.0497) ; SV1 rose by 5.3 ml/kg/min (from 10.6 ± 3.1 ml/kg/min to 14.9 ± 4.3 ml/kg/min; p = 0.0396); maximum load improved by 19.4 W (from 92.4 ± 30.8 W to 111.8 ± 33.1 W; p = 0.0045); 6MWT distance increased by 57.2 meters (from 448.7 ±109.5 m to 505.9 ± 95.6 m ; p = 0.0085). Additionally, LVEF increased significantly while HR showed a corresponding decrease (Table 2).

Table 2. Clinical, biological, and functional patient parameters inpatient vs. cardiac rehabilitation

Characteristics	Before rehabilitation	After rehabilitation	P
HR (bpm)	73 ± 12	68 ± 10	0.0458*
SBP (mmHg)	110 ± 17	108 ± 18	0.5234
NT-proBNP (pg/ml)	2749 ± 4685	1882 ± 2883	0.3487
LVEF (%)	27 ± 7	34 ± 10	0.0007*
Peak VO2 (ml/kg/min)	15.2 ± 4.5	15.9 ± 5.3	0.0497*
VT1 (ml/kg/min)	10.6 ± 3.1	14.9 ± 4.3	0.0396*
Work load (watts)	92.4 ± 30.8	111.8 ± 33.1	0.0045*
6MWT (meter)	448.7 ± 109.5	505.9 ± 95.6	0.0085*

HR: heart rate in beats per minute; SBP: systolic blood pressure in millimeters of mercury; NT-proBNP: N-terminal prohormone of brain natriuretic peptide in picograms per liter; LVEF: left ventricular ejection fraction; VO2 peak: peak muscle oxygen consumption; SV1: first ventilatory threshold in milliliters per kilogram per minute; 6MWT: 6-minute walk test; *: $p < 0.05$.

Interestingly, whether patients underwent inpatient or day hospital rehabilitation did not significantly affect their initial and final parameters (Table 3).

Table 3. Changes in patient parameters based on inpatient vs. outpatient cardiac rehabilitation

CR	Inpatient cardiac rehabilitation	Outpatient cardiac rehabilitation	P
Decrease in HR (bpm)	-3.9 ± 1.4	-4.6 ± 3.5	0.0831
Decrease in SBP (bpm)	-1.2 ± 17.6	-2.8 ± 21.0	0.5563
Decrease in NT-proBNP (pg/ml)	-930.5 ± 2973.4	-794.4 ± 1248.2	0.5366
Increase in LVEF (%)	+7.6 ± 0.5	+5.9 ± 0.4	0.1019
Peak VO2 Increase (ml/kg/min)	+0.8 ± 0.4	+0.7 ± 0.5	0.8842
Increase in VT1 (ml/kg/min)	+4.7 ± 2.5	+6.7 ± 4.6	0.8463
Maximum load increase (W)	+15.3 ± 9.4	+25.9 ± 10.3	0.6820
Increase in 6MWT (m)	+75.2 ± 56.8	+46.6 ± 81.2	0.4042

CR:cardiac rehabilitation; HR: heart rate in beats per minute; SBP: systolic blood pressure in millimeters of mercury; NT-proBNP: N-terminal prohormone of brain natriuretic peptide in picograms per liter; LVEF: left ventricular ejection fraction; VO2 peak: peak muscle oxygen consumption; SV1: 1st ventilatory threshold in milliliters per kilogram per minute; 6MWT: 6-minute walk test; *: $p < 0.05$.

However, patients who received optimal medical treatment at the end of CR showed a more substantial reduction in NT-proBNP levels: a decrease of -1527.5 ± 2742.3 pg/ml compared to -39.6 ± 1193.2 pg/ml; p = 0.0025 (Table 4).

Table 4. Changes in parameters based on the optimally of heart failure medication at the end of cardiac rehabilitation

Characteristics	Optimal medical treatment	Optimal non-medical treatment	P
Decrease in HR (bpm)	- 5.8 ± 2.4	-3.3 ± 3.1	0.5433
Decrease in PAS (bpm)	-3.5 ± 1.6	-1.8 ± 1.5	0.7697
Decrease in NT-proBNP (pg/ml)	-1527.5 ± 742.3	- 39.6 ± 193.2	0.0025*
Increase in LVEF (%)	+8 ± 6.4	+5.8 ± 4.4	0.9270
Peak VO2 Increase (ml/kg/min)	+1.7 ± 2.5	+0.8 ± 1.4	0.7279
Increase in SV1 (ml/kg/min)	+2.7 ± 3.5	+5.7 ± 3.5	0.8142
Maximum load increase (W)	+18.8 ± 15.8	+13.3 ± 10	0.7330
Increase in 6MWT (m)	+50.2 ± 12.1	+60.1 ± 20.2	0.5225

HR: heart rate in beats per minute; SBP: systolic blood pressure in millimeters of mercury; NT-proBNP: N-terminal prohormone of brain natriuretic peptide in picograms per liter; LVEF: left ventricular ejection fraction; VO2 peak: peak muscle oxygen consumption; SV1: first ventilatory threshold in milliliters per kilogram per minute; 6MWT: 6-minute walk test; *: $p < 0.05$.

Discussion

Our study confirmed the benefits of CR on functional parameters in HF patients with LVEF of 40% or less.

This was evident regardless of whether patients underwent CR through full hospitalization or in a day hospital setting. In addition to these its functional improvements, CR was associated with LV reverse remodeling, as shown by an increase improvement in LVEF at the end of the program. Patients also experienced a significant reduction in HR and an enhancement titration of HF medications. At the end of the rehabilitation, approximately 50% of the patients had achieved optimal medical management, compared to only almost a quarter at the beginning. NT-proBNP levels were significantly lower in patients whose HF was optimal.

Studies comparing outpatient and inpatient CR formats are scarce. However, the limited data available align with our findings, indicating no significant differences in clinical, biological or functional parameters (14,15) . One might assume that outpatient patients, often more stable at the onset of CR, would exhibit better physical performances. Yet, our study, supported by existing data, does not endorse this assumption. Regardless of whether patients completed CR as inpatient or in a day hospital, they followed the same physical activity regimen. In Europe, the CR format varies by country. Some countries offer phase 2 of CR exclusively on an outpatient basis; while in others provide inpatient options for high-risk patients. Elsewhere, the choice is shaped by both the patient's health condition and personal preferences (16) . Instead of the mode of CR (inpatient, outpatient), It seems that the timing of CR initiation post-cardiac decompensation, rather than the setting (inpatient or outpatient), correlates with better outcomes (17,18). Therefore, the choice between full hospitalization and day hospital should not be a measure of CR program effectiveness. The decision should consider the patient's condition, their preferences, and the organizational structure of each service, as practiced in France and particularly in our current protocols (16).

While exercise training in our patients improved all functional parameters, it's important to highlight the modest increase in peak VO_2, which was 0.7 ml/kg/min with boderline significance (p-value = 0.0497). Our exercise regimen involved interval training of low to moderate intensity. However, evidence suggests that high-intensity interval training might yield greater improvements in exercise tolerance and in peak VO_2 .(19–23) That said, it's crucial to consider that our study's small sample size might have limited the statistical power of our findings.

On a broader scale, the benefits of CR on the functional capacities of HF patients have been well-documented over the years. Numerous randomized controlled trials and meta-analyses have demonstrated the efficacy of exercise training in HF by enhancing exercise capacity, VO2 peak , maximum load, and 6MWT. (24–28) These improvements collectively enhance health-related quality of life.

The mechanisms underlying these benefits are manifold. Exercise training enhances central and peripheral hemodynamics, peripheral vascular and endothelial function, and muscle physiology. It exerts neurohormonal effects by downregulating the renin–angiotensin and sympathetic nervous systems and upregulating vagal activity (29–32) .

While we observed an increase in LVEF among our patients at the end of CR, it's important to mention that the effects of CR on LV reverse remodeling remain debated. Improvements in LVEF have been documented in small studies and meta-analyses (20,33) , but no randomized controlled trial has definitely confirmed this (24,34) . Moreover, since many patients enhance their physical capacities without a corresponding increase in LVEF, it is not recommended to set LVEF improvement as a primary goal of CR (10-11) .

Even if exercise training is the cornerstone of CR, its effectiveness is amplified when combined with a comprehensive program. This should include patient education on lifestyle and dietary habits, understanding their condition and treatment, managing complications, addressing cardiovascular risk factors, and providing psychological support. (35) CR is also a privileged period for titrating HF medications. In our study, the number of patients with optimal medical treatment nearly doubled by the end of CR, and this optimization was linked to lower NT-proBNP levels, a positive prognostic indicator (36–38) . However, while these results are encouraging, it's clear that medication titration is still insufficient. By the end of CR, fewer than half (49.7%) of our patients were on optimal medical treatment. Rapid titration of HF drugs should be a primary objective during CR, on par with physical exercise. Rapid titration is associated with an improvement in symptoms, quality of life, but also a reduction in the number of cardiac decompensations and all-cause mortality at 180 days (39) .

Limitations

The primary limitations of our study include its retrospective and single-center design, along with small sample size of our sample. These factors may have reduced the power and significance of our statistical analyses.

Conclusion

In this study at CHSF, we observed that CR improved HF patients' functional abilities such as SV1, maximum load, and the 6MWT, even though peak VO2 improvements weren't significant. CR also facilitated the titration of HF medications. While these outcomes are promising, they must be improved. Incorporating

high-intensity interval training could further boost aerobic capacity and peak VO2, as it has been shown to be safe and more effective than continuous moderate exercise for stable HF patients. Additionally, it is crucial to prioritize the titration of HF medications to ensure that all patients achieve optimal medical treatment or reach the maximum tolerated dose by the end of their rehabilitation program.

Conflict of interest

The authors declare no conflicts of interest.

Authors' contributions

Conceptualization, data curation, methodology, formal analysis and writing of the original draft: GDK, LAEH, CA, MB, DB

Formal analysis writing of the original draft: GDK, LAEH,

Supervision and validation of the original draft: FK, NBB

References

1. GBD 2017 Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet.* 10 Nov 2018;**392** (10159):1789-858.. doi: 10.1016/S0140-6736(18)32279-7. Epub 2018 Nov 8. Erratum in: *Lancet.* 2019 Jun 22;393(10190):e44. doi: 10.1016/S0140-6736(19)31047-5. PMID: 30496104; PMCID: PMC6227754.
2. Gabet A, Olie V, De Peretti C, Juilliere Y, Chin F, Lamarche Vadel A, *et al.* Mortality due to heart failure in France, trends 2000-2010. *Bull epidemiol hebd.* 2014**;(21-22**):386-94.
3. Crespo-Leiro MG, Anker SD, Maggioni AP, Coats AJ, Filippatos G, Ruschitzka F, *et al*. European Society of Cardiology Heart Failure Long-Term Registry (ESC-HF-LT): 1-year follow-up outcomes and differences across regions. *Eur J Heart Fail*. juin 2016;**18** (6):613-625. doi: 10.1002/ejhf.566. Erratum in: *Eur J Heart Fail*. 2017 Mar;**19** (3):438. doi: 10.1002/ejhf.772. PMID: 27324686.
4. Shah KS, Xu H, Matsouaka RA, Bhatt DL, Heidenreich PA, *et al.* Heart Failure With Preserved, Borderline, and Reduced Ejection Fraction: 5-Year Outcomes. *J Am Coll Cardiol.* 14 nov 2017;**70**(20):2476-86. doi: 10.1016/j.jacc.2017.08.074. Epub 2017 Nov 12. PMID: 29141781.
5. Lawson CA, Zaccardi F, Squire I, Ling S, Davies MJ, Lam CSP, *et al.* 20-year trends in cause-specific heart failure outcomes by sex, socioeconomic status, and place of diagnosis: a population-based study. *Lancet Public Health*. août 2019;**4**(8):e406-20. doi: 10.1016/S2468-2667(19)30108-2. PMID: 31376859; PMCID: PMC6686076.
6. Virani SS, Alonso A, Aparicio HJ, Benjamin EJ, Bittencourt MS, Callaway CW, *et al.* heart disease and Stroke Statistics-2021 Update: A Report From the American Heart Association. *Circulation.* 23 févr 2021;**143**(8):e254-743. doi: 10.1161/CIR.0000000000000950. Epub 2021 Jan 27. PMID: 33501848.
7. Heidenreich PA, Albert NM, Allen LA, Bluemke DA, Butler J, Fonarow GC, *et al.* Forecasting the impact of heart failure in the United States: a policy statement from the American Heart Association. *Circ Heart Fail.* mai 2013;**6** (3):606-19. doi: 10.1161/HHF.0b013e318291329a. Epub 2013 Apr 24. PMID: 23616602; PMCID: PMC3908895.
8. Balady GJ, Ades PA, Bittner VA, Franklin BA, Gordon NF, Thomas RJ *et al*. Referral, enrollment, and delivery of cardiac rehabilitation/secondary prevention programs at clinical centers and beyond: a presidential advisory from the American Heart Association. *Circulation.* 2011;**124**(25):2951-2960. doi: 10.1161/CIR.0b013e31823b21e2. Epub 2011 Nov 14. PMID: 22082676.
9. Piepoli MF, Conraads V, Corrà U, Dickstein K, Francis DP, Jaarsma T, *et al.* Exercise training in heart failure: from theory to practice. A consensus document of the Heart Failure Association and the European Association for Cardiovascular Prevention and Rehabilitation. *European Journal of Heart Failure*. 2011;**13**(4):347-57. doi: 10.1093/eurjhf/hfr017. PMID: 21436360.
10. McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, *et*

al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. *Eur Heart J*. 21 sept 2021;42(36):3599-726. doi: 10.1093/eurheartj/ehab368. Erratum in: Eur Heart J. 2021 Dec 21;**42**(48):4901. doi: 10.1093/eurheartj/ehab670. PMID: 34447992.

11. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, *et al.* 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*. 3 mai 2022;**145**(18):e895-1032. . doi: 10.1161/CIR.0000000000001063. Epub 2022 Apr 1.
12. Shi W, Green H, Sikhosana N, Fernandez R. Effectiveness of Telehealth Cardiac Rehabilitation Programs on Health Outcomes of Patients With Coronary Heart Diseases: An Umbrella Review. *J Cardiopulm Rehabil Prev*. 1 janv 2024;**44**(1):15-25. doi: 10.1097/HCR.0000000000000807. Epub 2023 Jun 20. PMID: 37335820.
13. Koukoui F, Desmoulin F, Lairy G, Bleinc D, Boursiquot L, Galinier M, *et al.* Benefits of cardiac rehabilitation in heart failure patients according to etiology: INCARD French study. *Medicine (Baltimore)*. févr 2015;**94**(7):e544. doi: 10.1097/MD.0000000000000544. PMID: 25700319; PMCID: PMC4554184.
14. Steinacker JM, Liu Y, Muche R, Koenig W, Hahmann H, Imhof A, *et al*. Long term effects of comprehensive cardiac rehabilitation in an inpatient and outpatient setting. *Swiss Med Wkly*. 2011;**141**:w13141. doi: 10.57187/smw.2011.13141. PMID: 21213150.
15. Zhang ZY, Sun XG, Xi JN, Feng J, Sun XJ, Liu YL. The impacts of outpatient vs inpatient holistic management based on exercise training on cardiac rehabilitation efficacy among patients with chronic heart failure]. Zhongguo *Ying Yong Sheng Li Xue Za Zhi*. janv 2021;**37**(1):89-95. doi:10.12047/j.cjap.0085.2021.110. PMID: 34672468.
16. Ruivo J, Moholdt T, Abreu A. Overview of Cardiac Rehabilitation following post-acute myocardial infarction in European Society of Cardiology member countries. *Eur J Prev Cardiol.* 2023 Jul 12;**30**(9):758-768. doi: 10.1093/eurjpc/zwad024.
17. Meng Y, Zhuge W, Huang H, Zhang T, Ge X. The effects of early exercise on cardiac rehabilitation-related outcome in acute heart failure patients: A systematic review and meta-analysis. I*nt J Nurs Stud.* juin 2022;**130**:104237. doi: 10.1016/j.ijnurstu.2022.104237. Epub 2022 Mar 26. PMID: 35421772.
18. Kitzman DW, Whellan DJ, Duncan P, Pastva AM, Mentz RJ, Reeves GR, *et al*. Physical Rehabilitation for Older Patients Hospitalized for Heart Failure. *N Engl J Med.* 15 juill 2021;**385**(3):203-16. doi: 10.1056/NEJMoa2026141. Epub 2021 May 16. PMID: 33999544; PMCID: PMC8353658.
19. Wisløff U, Støylen A, Loennechen JP, Bruvold M, Rognmo Ø, Haram PM, *et al.* Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: a randomized study. *Circulation*. 19 juin 2007;**115**(24):3086-94. doi: 10.1161/CIRCULATIONAHA.106.675041. Epub 2007 Jun 4. PMID: 17548726.
20. Haykowsky MJ, Timmons MP, Kruger C, McNeely M, Taylor DA, Clark AM. Meta-analysis of aerobic interval training on exercise capacity and systolic function in patients with heart failure and reduced ejection fractions. *Am J Cardiol.* 15 mai 2013;**111**(10):1466-9. doi: 10.1016/j.amjcard.2013.01.303. Epub 2013 Feb 21. PMID: 23433767.
21. Ismail H, McFarlane JR, Nojoumian AH, Dieberg G, Smart NA. Clinical outcomes and cardiovascular responses to different exercise training intensities in patients with heart failure: a systematic review and meta-analysis. *JACC Heart Fail*. déc 2013;**1**(6):514-22. doi: 10.1016/j.jchf.2013.08.006. Epub 2013 Oct 23. PMID: 24622004.
22. Freyssin C, Verkindt C, Prieur F, Benaich P, Maunier S, Blanc P. Cardiac rehabilitation in chronic heart failure:

effect of an 8-week, high-intensity interval training versus continuous training. *Arch Phys Med Rehabil*. août 2012;**93**(8):1359-64. doi: 10.1016/j.apmr.2012.03.007. Epub 2012 Mar 21. PMID: 22446291.

23. Chrysohoou C, Angelis A, Tsitsinakis G, Spetsioti S, Nasis I, Tsiachris D, *et al.* Cardiovascular effects of high-intensity interval aerobic training combined with strength exercise in patients with chronic heart failure. A randomized phase III clinical trial. *Int J Cardiol.* 20 janv 2015;**179**:269-74. doi: 10.1016/j.ijcard.2014.11.067. Epub 2014 Nov 6. PMID: 25464463.
24. Bozkurt B, Fonarow GC, Goldberg LR, Guglin M, Josephson RA, Forman DE, *et al*. Cardiac Rehabilitation for Patients With Heart Failure: JACC Expert Panel. *J Am Coll Cardiol.* 2021;**77**(11):1454-1469. doi: 10.1016/j.jacc.2021.01.030. PMID: 33736829.
25. Taylor RS, Long L, Mordi IR, Madsen MT, Davies EJ, Dalal H, *et al.* Exercise-Based Rehabilitation for Heart Failure: Cochrane Systematic Review, Meta-Analysis, and Trial Sequential Analysis. *JACC Heart Fail*. août 2019;**7**(8):691-705. doi: 10.1016/j.jchf.2019.04.023. Epub 2019 Jul 10. PMID: 31302050.
26. Taylor RS, Walker S, Smart NA, Piepoli MF, Warren FC, Ciani O, *et al.* Impact of Exercise Rehabilitation on Exercise Capacity and Quality-of-Life in Heart Failure: Individual Participant Meta-Analysis. *J Am Coll Cardiol*. 2 avr 2019;**73**(12):1430-43. doi: 10.1016/j.jacc.2018.12.072. PMID: 30922474
27. O'Connor CM, Whellan DJ, Lee KL, Keteyian SJ, Cooper LS, Ellis SJ, *et al.* Efficacy and Safety of Exercise Training in Patients With Chronic Heart Failure: HF-ACTION Randomized Controlled Trial. *JAMA* [Internet]. 8 avr 2009 [cité 15 mars 2024];**301**(14):1439-50. doi: 10.1001/jama.2009.454. PMID: 19351941; PMCID: PMC2916661.
28. van Tol BAF, Huijsmans RJ, Kroon DW, Schothorst M, Kwakkel G. Effects of exercise training on cardiac performance, exercise capacity and quality of life in patients with heart failure: a meta-analysis. *Eur J Heart Fail*. déc 2006;**8**(8):841-50. doi: 10.1016/j.ejheart.2006.02.013. Epub 2006 May 18. PMID: 16713337.
29. Downing J, Balady GJ. The role of exercise training in heart failure. *J Am Coll Cardiol.* 2 août 2011;**58**(6):561-9. doi: 10.1016/j.jacc.2011.04.020. PMID: 21798416.
30. Coats AJ, Adamopoulos S, Radaelli A, McCance A, Meyer TE, Bernardi L, *et al.* Controlled trial of physical training in chronic heart failure. Exercise performance, hemodynamics, ventilation, and autonomic function. *Circulation*. juin 1992;**85**(6):2119-31. doi: 10.1161/01.cir.85.6.2119. PMID: 1591831.
31. Roveda F, Middlekauff HR, Rondon MUPB, Reis SF, Souza M, Nastari L, *et al*. The effects of exercise training on sympathetic neural activation in advanced heart failure: a randomized controlled trial. *J Am Coll Cardiol*. 3 sept 2003;**42**(5):854-60. doi: 10.1016/s0735-1097(03)00831-3. PMID: 12957432.
32. Hambrecht R, Fiehn E, Weigl C, Gielen S, Hamann C, Kaiser R*, et al.* Regular physical exercise corrects endothelial dysfunction and improves exercise capacity in patients with chronic heart failure. *Circulatio*n. 15 déc 1998;**98**(24):2709-15. doi: 10.1161/01.cir.98.24.2709. PMID: 9851957.
33. Tucker WJ, Beaudry RI, Liang Y, Clark AM, Tomczak CR, Nelson MD, *et al*. Meta-analysis of Exercise Training on Left Ventricular Ejection Fraction in Heart Failure with Reduced Ejection Fraction: A 10-year Update. *Prog Cardiovasc Dis.* 2019;**62**(2):163-71. doi: 10.1016/j.pcad.2018.08.006. Epub 2018 Sep 15. PMID
34. Klecha A, Kawecka-Jaszcz K, Bacior B, Kubinyi A, Pasowicz M, Klimeczek P, *et al.* Physical training in patients with chronic heart failure of ischemic origin: effect on exercise capacity and left ventricular remodeling. *Eur J Cardiovasc Prev Rehabil*. févr 2007;**14**(1):85-91. doi: 10.1097/HJR.0b013e3280114f12. PMID: 17301632.

35. Davidson PM, Cockburn J, Newton PJ, Webster JK, Betihavas V, Howes L, *et al.* Can a heart failure-specific cardiac rehabilitation program decrease hospitalizations and improve outcomes in high-risk patients? *Eur J Cardiovasc Prev Rehabil.* août 2010;**17**(4):393-402. doi: 10.1097/HJR.0b013e328334ea56. PMID: 20498608.
36. Anand IS, Fisher LD, Chiang YT, Latini R, Masson S, Maggioni AP, *et al*. Changes in brain natriuretic peptide and norepinephrine over time and mortality and morbidity in the Valsartan Heart Failure Trial (Val-HeFT). *Circulation.* 11 mars 2003;**107**(9):1278-83. doi: 10.1161/01.cir.0000054164.99881.00. PMID: 12628948.
37. Zile MR, Claggett BL, Prescott MF, McMurray JJV, Packer M, Rouleau JL, *et al*. Prognostic Implications of Changes in N-Terminal Pro-B-Type Natriuretic Peptide in Patients With Heart Failure. *J Am Coll Cardiol*. 6 déc 2016;**68**(22):2425-36. doi: 10.1016/j.jacc.2016.09.931. PMID: 27908347.
38. Gardner RS, Ozalp F, Murday AJ, Robb SD, McDonagh TA. N-terminal pro-brain natriuretic peptide. A new gold standard in predicting mortality in patients with advanced heart failure. *Eur Heart J.* oct 2003;**24**(19):1735-43. doi: 10.1016/j.ehj.2003.07.005. PMID: 14522568.
39. Mebazaa A, Davison B, Chioncel O, Cohen-Solal A, Diaz R, Filippatos G, *et al*. Safety, tolerability and efficacy of up-titration of guideline-directed medical therapies for acute heart failure (STRONG-HF): a multinational, open-label, randomized, trial. *Lancet.* 3 déc 2022;**400**(10367):1938-52. doi: 10.1016/S0140-6736(22)02076-1. Epub 2022 Nov 7. PMID: 36356631.

Cite this article as: Kiadi GD, Hervé LAE, Agavoedo C, Bakary M, Bado D, M'buyamba-Kabangu JR, *et al*. Assessing the benefits of inpatient vs outpatient cardiac rehabilitation among heart failure patients with reduced ejection fraction: experience of centre hospitalier sud Francien. *Ann Afr Med* 2026; **19** (2): e6915-e6924. https://dx.doi.org/10.4314/aamed.v19i2.12