Early Cardiac Rehabilitation to Reduce Heart Failure Readmissions

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ABSTRACT

Objective: The purpose of this study was to examine if early involvement in cardiac rehabilitation (CR) decreases readmissions after heart failure (HF) hospitalization.

Study Design: A Retrospective Study

Place and Duration of Study: This study was conducted at the University Hospital Center "Mother Teresa" in Tirana, University Hospital "SHEFQET NDROQI", AMERICAN Hospital, HYGEA Hospital, and "Our Lady of Good Counsel, Tirana" from January 2019 - November 2021.

Materials and Methods: There were 120 patients of both gender had heart failure included in this study. Age of the patients was between 18-80 years of age. Patients were equally divided in two groups. Group I had 60 patients were discharged after getting 30-days hospitalization without getting cardiac rehabilitation while in group II 30-patients received at-least 1-sesssion of cardiac rehabilitation in hospitalization. Outcomes among both groups were compared in terms of readmission because of HF. SPSS 24.0 was used to analyze all data.

Results: Among 120 patients, 69 (57.5%) were males and 61 (42.5%) were females. Mean age of the patients was 53.24 ± 11.64 years and had mean BMI 24.11 ± 6.37 kg/m^2. There were 71 (59.2%) patients had hypertension and diabetes mellitus was found in 44 (36.7%) cases, Smoking history was found in 57 (47.5%) cases. There were 10 (8.3%) cases had heat stroke among all cases. Early cardiac rehabilitation dramatically decreased hospital readmissions and cardiac mortality in patients. The cardiac rehabilitation group that had re-hospitalization had higher rates of diabetes, hyperkalemia, and low $P_{ET}CO_2$. An independent risk factor for re-hospitalization was low $P_{ET}CO_2$ (Partial pressure of end-tidal carbon) at anaerobic threshold (≤ 33.5 mmHg).

Conclusion: We found that people with acute myocardial infarction who started cardiac rehabilitation right away had fewer major cardiac events later on. As a risk factor for readmission, decreased PETCO2 at the anaerobic threshold can be utilized to evaluate the efficacy of early cardiac rehabilitation.

Key Words: Heart Failure, Cardiac Rehabilitation, Readmission, $P_{ET}CO_2$, Hyperkalemia

INTRODUCTION

According to estimates, HF affects roughly 2% of adults in wealthy nations like Sweden and increases to 10% of those who are over 70.[1,2] There have been reports of readmission rates as high as 45% within the first six months.[3] According to Statistics Sweden, a government organization, the number of Swedes above the age of 80 will have climbed by 50% in ten years.[4]

Since HF is a disease mostly affecting the elderly, the population's demographics are changing and a greater proportion of individuals are living longer lives.[2]

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Hospitalizations and nursing facility charges together accounted for 75% of the high health care costs associated with HF.[5,6] Since there will be more people with HF overall as a result of demographic changes, the economic cost of HF is anticipated to rise until the incidence of hospital admissions declines.[7]

Hospital readmissions for HF have been linked to a variety of variables, including deteriorating HF (disease-centered factors), poor care (healthcare-centered factors), and particular forms of follow-up (such as multidisciplinary team interventions), which have been demonstrated to minimize hospitalizations.[8] A patient's clinical status and the need for hospitalization can be affected by a number of factors, all of which are subject to change over time. For instance, it has been shown that new drugs can reduce the need for hospitalization.[9] A number of changes have been made to the health care system, including the introduction of home-based and/or palliative care, as well as specialized disease management teams that make house calls. Patients with the highest risks of readmission were classified as high-impact users in a prior research; this category included those who had

experienced three or more emergency hospitalizations in a given year.[10]

Low activity levels are associated with worse survival and quality of life in those with chronic heart failure. Constant fatigue and shortness of breath are symptoms. This condition makes it difficult to participate in physical exercise (QOL). Reduced cardiac and pulmonary reserve, dysfunction of respiratory and peripheral skeletal muscles, and impaired cardiac and pulmonary function are among pathophysiological mechanisms that contribute to exercise intolerance in CHF[11]. Secondary prevention with intensive cardiac rehabilitation (CR) is the most costly strategy shown to enhance exercise capacity, quality of life, and hospital readmissions in patients with congestive heart failure (CHF) above standard care alone[12]. Both passive and active CR exercise are beneficial for patients with mild to severe CHF[13]. The peak VO2 and VE/VCO2 gradient gains shown in HF patients following six weeks of passively electrical activity are most pronounced during periods of intermittent exercise as opposed to continuous activity. Opportunities for secondary prevention at home among CR patients are typically made possible through the use of web and mobile applications, phone interviews, and different wearable activity-tracking gadgets. And it has the potential to greatly expand accessibility, lower prices, and enhance results[14]. However, it is not often documented that patients who acquired CHF immediately after such an AMI with PCI attained an early CR. Houchen L, et al[15] conducted a trial showing that early CR can help reduce sadness, improve exercise tolerance, and minimize CHF-related hospitalizations.

MATERIALS AND METHODS

This retrospective study was conducted at the University Hospital Center "Mother Teresa" in Tirana, University Hospital "SHEFQET NDROQI", AMERICAN Hospital, HYGEA Hospital, and "Our Lady of Good Counsel, Tirana" and comprised of 120 patients. Age, sex, body mass index, comorbidities, and smoking history were among the specific demographics of patients who had been included after receiving informed written consent. Exclusion criteria included multiple organ failure, stroke history, and ankylosing spondylitis, among others, because exercise prescription could not be carried out.

After hemodynamic stability was achieved 24 hours after PCI for patients with AMI, an ultrasonography cardiogram was performed. Using the patient's history and laboratory results, the nursing team established a baseline profile of the patient. Patients were classified as having either heart failure with ejection fraction (HFrEF) (LVEF 40%) or heart failure with mid-range left ventricular (HFmrEF) (LVEF 40%–49%). The patients were subsequently placed into two groups:

group I consisted of people who did not improve with exercise treatment, and group II consisted of those who improved (group II). Participants in the non-CR group was counselled on maintaining a healthy lifestyle upon discharge, with suggestions such as engaging in regular physical activity and using the Borg's rate of exercise intensity (RPE) to gauge intensity. After percutaneous coronary intervention (PCI), the CR subgroup was told to start and complete a 48-hour educational and counselling programme, risk factor management, and fitness training routine for 2 weeks. According to Borg's RPE scale, the exercise should be "very low" to "extremely hard." Three PRMs oversaw the CR training, which included three weekly sessions on a stationary bike (resistance system: electrically charged braked significant resistance, power requirements: ego, watt: 250 Watts, heart rate monitor Wi-Fi and contact groups) and four sessions of electrical activity on days when daily exercise was not done. A average exercise took 20 minutes, including warm-up and cool-down. Three 3-minute efforts, depending on experience, targeted Borg 11–13, followed by 2-minute recoveries at 0 W. The skin was stimulated four times a week for 30 minutes with an electrical stimulation (Elpha-II 3000; DANMETER® A/S; Odense, Danish) powered by two AAA batteries. The stimulator supplied a 25-hertz biphasic current. A "on-off" stimulus pattern with a pulse width of 300 us and rise and fall periods of 1 s was programmed into the electrical current (3 s stimulation, 6 s rest). Patients would experience a muscular contraction without discomfort at the stimulation level set. Top and bottom athleisure, lateral and medial quadriceps, and adhesive patches were electroded. After two weeks of CR, patients were told to continue their tailored workout routine at home. Endurance exercise testing (CPX) was necessary before discharge to create tailored exercise routines. The at-home exercise plan consisted of 30 to 60 minutes of walking or biking three to four times a week at a pulse rate that matched the ventilator threshold (VT).

After consent, patients' phone numbers were recorded. After discharge, patients were called every three months or until cardiac death to obtain follow-up data. After a cardiac emergency, individuals were readmitted often. Due to their non-response to phone interviews, population registration bureau discovered cardiac patients who died. On average, we maintained in contact with them for two years.

Medians were displayed for discrete data, whereas continuous data included averages and standard deviations (interquartile range). The data was displayed graphically and numerically, making category correlations easier to analyze. Each analysis of variance, Mann-Whitney U test, or Chung test was used to compare continuous parameters across groups, and the chi-square test was employed to analyze dichotomous data. The statistical significance criterion

for all tests was 0.05. SPSS 24.0 was used for statistical analysis.

RESULTS

Among 120 patients, 69 (57.5%) were males and 61 (42.5%) were females. Mean age of the patients was 53.24±11.64 years and had mean BMI 24.11±6.37 kg/m^2. There were 71 (59.2%) patients had hypertension and diabetes mellitus was found in 44 (36.7%) cases, Smoking history was found in 57 (47.5%) cases. There were 10 (8.3%) cases had heat stroke among all cases (table -1).

Table No.1: Cases' pre-enrollment features

Variables	Frequency	Percentage
Mean age (years)	53.24±11.64	
Mean BMI (kg/m^2)	24.11±6.37	
Gender		
Male	69	57.5
Female	61	42.5
Hypertension		
Yes	71	59.2
No	49	40.8
Diabetes Mellitus		
Yes	44	36.7
No	76	63.3
Smoking History		
Yes	57	47.5
No	63	52.5
Heat Stroke		
Yes	10	8.3
No	110	91.7

We found that ALT and AST was significantly higher among cases of group I with p value 0.004 as compared to group II while there was no any significantly difference observed in both groups in terms of HDL-c, creatinine, blood potassium, TC and urea nitrogen among both groups (table-2).

Table No.2: Comparison of biochemical parameters among all cases

Variables	Group I	Group II
ALT (U/l)	58.12±14.87	42.7±8.38
AST (U/l)	118.7±13.91	102.16±5.44
HDL-c (mmol/l)	1.3±2.20	1.4±3.14
Creatinine (umol/l)	76.8±9.19	75.3±6.27
blood potassium (mmol/l)	3.7±4.15	4.0±1.22
TC (mmol/l)	1.26±0.88	1.34±1.11
urea nitrogen (mmol/l)	5.3±7.17	6.7±3.37

Early cardiac rehabilitation dramatically decreased hospital readmissions and cardiac mortality in patients. (Table-3)

Table No.3: Comparison of readmission and mortality among both groups

Variables	Group I	Group II
Readmission		
Yes	37 (61.7%)	7 (11.7%)
No	23 (38.3%)	53 (88.3%)
Mortality		
Yes	15 (26.7%)	2 (3.3%)
No	45 (73.3%)	58 (96.7%)

The cardiac rehabilitation group that had re-hospitalization had higher rates of diabetes, hyperkalemia, and low P$_{ET}$CO$_2$. An independent risk factor for re-hospitalization was low P$_{ET}$CO$_2$ (Partial pressure of end-tidal carbon) at anaerobic threshold (≤33.5 mmHg). (Figure-1)
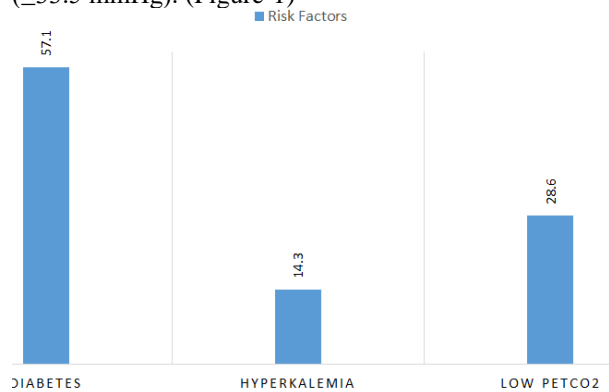

Figure No.1: Risk factors for readmission among patients of group II

DISCUSSION

This study is a retrospective look at the effects of active and passive exercise in the early stages of cardiac rehabilitation (CR) for patients with heart failure following acute myocardial infarction and percutaneous coronary intervention (AMI and PCI). According to our findings, patients with HFmrEF who undergo early CR at two weeks after an AMI had a lower risk of re-hospitalization and those with HFrEF have a lower risk of cardiogenic death. In addition, we found that the VT PETCO2 level was a significant independent risk factor for readmission.

It has been shown that exercise-based CR is more successful than no exercise in improving QoL, reducing all-cause and HF-dependent hospital admissions, and perhaps reducing death in HF patients.[16,17] In current study 120 patients were presented. Mean age of the patients was 53.24±11.64 years and had mean BMI 24.11±6.37 kg/m^2. Among 120 patients, 69 (57.5%) were males and 61 (42.5%) were females. There were 71 (59.2%) patients had hypertension and diabetes mellitus was found in 44 (36.7%) cases, Smoking history was found in 57 (47.5%) cases. There were 10 (8.3%) cases had heat stroke among all cases. These findings were comparable to the previous

researches.[18,19] 30-day readmission rates for all causes were 61.7% in the non-CR group and 11.7% in the CR group, which is consistent with earlier research.[20] Researchers have already looked for ways to identify people who use a disproportionately large amount of healthcare resources by being readmitted to the hospital frequently. Using data from a large British registry study conducted in 2018, Rao et al. analyzed the reasons for and patterns of hospitalization among HF patients. Patients were categorized as either high-impact users, who required multiple hospitalizations, or low-impact users, who required fewer hospitalizations.[21] Patients were classified into different groups according on their tendencies, as opposed to utilizing a predetermined number of readmissions. Despite the fact that Rao et al. found that the high-impact group had a higher percentage of patients aged 75 and up in comparison to the low-impact group, we did not find any difference in the ages of patients who had been readmitted or who had never been readmitted.[21]

Congestive heart failure has been linked to a poor prognosis and decreased functional abilities. One of the symptoms of congestive heart failure is an intolerance to movement. People who have CHF are increasingly thought to have a diminished lung reserve and worse muscle tissue function[22], which are the underlying reasons of exercise intolerance in these individuals. People who have CHF can benefit from exercise in a number of ways, including, but not limited to, enhancements in quality of life[27,28], reductions in hospitalizations[26], improvements in cardiac remodeling[24], and gains in neurovascular functional competence[25].

According to our findings, the cardiovascular outlook was more favorable for patients with early CR who had a VE/VCO2 slope that was lower than 36. The VE/VCO2 slope is a valid independent predictor of long-term prognosis in CHF[27], and the only way to get it is to exercise at a lower intensity than your maximum capacity. This is true even while taking into account the highest possible VO2 production.

Heart rate recovery (HRR) is an assessment of the drop in heart rate during the first minute following exercise. This decrease in heart rate is a sign of vagal tone, which is a powerful predictor of mortality in patients with coronary artery disease[28] and in older persons.

After making adjustments for factors like as age, gender, diabetes status, blood potassium levels, and ejection fraction, PETCO2 at VT is a metric that may be used to predict re-hospitalization in patients with CHF who have suffered an AMI. Inadequate PETCO2 levels may be a sign of poor pulmonary arterial perfusion, reduced cardiac output, or impaired CO2 generation in the body's routine physiological operations[29]. This may be the case if the cardiac output is lowered. Patients with HF who are exposed to high levels of acidity or who have their sympathetic nerves activated have increased sensitivity in their respiratory chemoreceptors. Inadequate expansion as well as bigger empty spaces between the artery and the alveolus both lead to reduced CO2 diffusion, which in turn leads to a reduction in PETCO2[30]. It has been demonstrated that among patients who suffer from congestive heart failure, an inability to exercise is associated with an increased risk of readmission (CHF). The decrease in PETCO2 that occurs during VT may be the result of many factors, including lower respiratory capacity, poor action of peripheral skeletal muscles, and weakened cardiac reserve. However, PETCO2 at VT is an independent risk factor for readmission, in contrast to high blood potassium levels and a previous history of diabetes.

CONCLUSION

We found that people with acute myocardial infarction who started cardiac rehabilitation right away had fewer major cardiac events later on. As a risk factor for readmission, decreased PETCO2 at the anaerobic threshold can be utilized to evaluate the efficacy of early cardiac rehabilitation.

Author's Contribution:
Concept & Design of Study: Ledi NEÇAJ
Drafting: Ledi NEÇAJ
Data Analysis: Ledi NEÇAJ
Revisiting Critically: Ledi NEÇAJ
Final Approval of version: Ledi NEÇAJ

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