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Original

# Results from the Phase II Cardiac Rehabilitation Program, developed by the National Rehabilitation Center, Costa Rica

(Resultados del Programa de Rehabilitación Cardíaca Fase II, desarrollado por el Centro Nacional de Rehabilitación, Costa Rica)

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## Abstract

**Objective:** Due to the importance of cardiovascular disease in Costa Rica, and the lack of information about Cardiac Rehabilitation Programs in our country, this study aims to describe the results of the Phase II Cardiac Rehabilitation Program, at the National Rehabilitation Center.

**Methods:** This is a retrospective study, a review of the clinical records of patients with coronary artery disease, referred to a cardiac rehabilitation program from March 2009 to May 2010. From a total 158 patients, 131 finished phase II. Maximal functional capacity - estimated by a treadmill stress test - and the lipid profile were compared. These tests were made at the beginning and at the end of this phase II, which lasted 10-12 weeks.

**Results:** A significant statistical increase in the functional capacity was obtained, estimated in Metabolic Equivalents (METs), with a 29,7% average at the end of 10-12 weeks (p<0,05), evaluated with a treadmill stress test; higher (64,37%) for "High risk" patients and lower (19,15%) for younger patients. Total cholesterol decreased an of 4.44mg/dl (-2.9%) (p = 0.145), LDL-cholesterol decreased an average of 0.96 mg/dl (-1.1%) (p=0.746), triglycerides were 19.41mg/dl (-11.2%) (p=0.016) lower, and HDL-cholesterol increased an average of 0.95mg/dl (2.5%) (p= 0.181).

**Conclusions:** The program reported an average improvement in functional capacity of 29.7% for patients with coronary artery disease, with a higher impact for "High Risk" patients and a lower for younger patients. Lipid profile did not have significant changes at the end of this training period.

**Keywords:** exercise, registry, prognosis, coronary disease, lifestyle.

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Cardiovascular disease is the worldwide leading cause of death, and generates important economic costs for healthcare systems. In Costa Rica, for the year 2008, 3813 deaths were reported from cardiovascular diseases. Most of deaths from cardiovascular diseases (55.65%) were people 75 years old or older. Males represented 57.09% of deaths; within these, 1529 were because of infarcts, corresponding to 40% of all deaths from cardiovascular diseases, with an adjusted rate of 29.42/100,000 inhabitants.[1]

Cardiac rehabilitation programs are very important for secondary prevention. Their objectives are to optimize the patient´s functional status, improve their quality of life, as decreasing mortality from other causes as far as 14% for each Metabolic Equivalent (MET) increase in functional capacity of patients. [2] One MET is equal to the amount of energy spent at rest during one minute. There is also a decrease in the incidence of new coronary events, hospital re-admissions, and the need for new surgical procedures, among others. [3-5]

This study aims to determine the results from the Phase II Cardiac Rehabilitation Program, from the National Rehabilitation Center (Centro Nacional de Rehabilitación, CENARE), concerning to the estimated functional capacity (expressed in Metabolic Equivalents, METs) and lipid profile, at the end of this 10-12 weeks training period. Besides, it is intended to inform the results, as there is so little published information about cardiac rehabilitation programs in our country.

## Patients and methods

This study included patients admitted to phase II of the program between March 2009 and May 2010. The study group included patients with coronary artery disease, who underwent surgical procedures like coronary revascularization (angioplasty, coronary stenting or bypassing) and patients with medical management who did not underwent surgical procedures. A total of 158 patients with coronary artery disease participated. Patients with heart valve diseases, dilated cardiomyopathy and heart transplantation were excluded. From the starting 158 patients, 131 completed phase II.

Dropping out reasons were: 1 patient left for work reasons, 1 patient presented bacterial endocarditis, 1 patient because of prostate cancer, 1 patient due to colon cancer, 1 patient due to cerebrovascular disease sequelae, 1 patient because of presenting associated peripheral neuropathy, 1 patient for geographical reasons, 1 patient died from heart failure complications. For 8 patients, there was not obtained enough data from their files and 11 patients left the program with no reasons written on their files.

Based on criteria from the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), [6] patients were classified into three risk groups: low, moderate and high risk. Resulting in: 65 low risk patients (49.6%), 44 moderate risk patients (33.6%) and 22 high risk patients (16.8%).

Results from stress tests were also recorded, with its estimated functional capacity (expressed in METs) and lipid profile.

As this is a review of clinical records, it was not considered necessary to obtain an informed consent. The National Rehabilitation Center´s Bioethical Committee supported the study before it was carried out.

The majority of referred patients had a previous treadmill stress test with a ramp protocol (Bruce or modified Bruce), performed by the referral cardiologist. If not, CENARE´s cardiologist performed this test with a ramp protocol (Bruce, modified Bruce or Naughton protocols). Ergospirometry was not performed because neither the referral hospitals nor CENARE had the equipment at the moment this study was made. Maximal oxygen consumption values ($VO2_{max}$) were estimated in Metabolic Equivalents (METs) from the stress test, using formulas from the American College of Sports Medicine. [7]

The program consisted of 3 weekly aerobic training sessions, starting with 20 minutes each (at the beginning of the program) and up to 40 minutes (at the end of the program). The program lasted a total of 10-12 weeks. Each session started with a 10 minute warm up and stretching period and ended with a 5-10 minute cooling and stretching period.

Exercise modalities varied between: treadmill, stationary cycling, upper body ergometer, step aerobics and dancing. During exercise sessions, different modalities were combined, according to indications and contraindications established by biomechanical evaluations, for each patient. The aerobic exercise intensity started at 40-55% of the $VO2_{max}$ estimated from the initial stress test (equals to 50-65% of the maximum Heart Rate, $HR_{max}$), adherence level to physical activity and musculoskeletal comorbidities for each patient. So, for example, patients with low or none adherence to exercise history, started at 40% of the $VO2_{max}$ (50% of the $HR_{max}$), estimated from the first week of training. Exercise intensity was increased by 5-10% of the workload every 1-2 weeks (depending on the patient´s tolerance), and a sub-maximum exercise load was maintained. Patients were monitored with their heart rate, using a watch-like heart monitor (Polar brand), rate of perceived exertion (Borg Scale; numbered from 6 to 20) [8]; and telemetry for high risk patients, according to AACVPR classifications.

Besides participating in the physical training program, patients attended to educational speeches about cardiovascular disease, coronary risk factors, lifestyle changes and nutrition.

All the information gathered from patient files was analyzed with SPSS software, version 17.0 (Statistical Package for Social Sciences), with an $\alpha = 0.05$ threshold value.

For all 131 patients who finished program phase II, a stratified analysis was perform, according to gender, age group and risk level. Mean initial AND final METs were compared for each stratus. For this, Student´s t-test for related samples was used.

An analysis was made, in which variables such as gender, age and risk were adjusted; and the METs percentage change was the dependent variable. For this, a multiple linear regression was made, as the resulting variable is a quantitative one. Conditions and hypothesis were tested, obtaining a low (0.289) and significant (0.001) correlation for gender and age.

## Results

**Clinical characteristics of the study patients**

All patients who finished the program had coronary artery disease. Their characteristics are summarized on Table 1.

Regarding the studied population´s clinical characteristics, 95 men (72.5%) and 36 women (27.5%) participated, with a mean of 59.1 + 10.1 years old. The 55 to 64 years-old age group turned to be the most frequent, gathering 42% of the patients.

Regarding the patient´s associated comorbity, 34 (26.2%) had type 2 Diabetes Mellitus; 91 (69.5%) hypertensive patients; 91 (69.5%) had dyslipidemia; 72 (55%) patients had a smoking history, from which 10 (7.6%) were still active smokers when they started the program.

From the 131 patients included, carriers of coronary artery disease, 51 (38.9%) had non-invasive medical management, 10 (7.6%) had an angioplasty, 55 (57.3%) had coronary stents and 9 (6.9%) had a coronary bypass surgery; 6 (4.6%) were referred to the cardiac rehabilitation program as nonrevascularizable coronary artery disease.

As seen on Table 2, there was a statistically significant increase in metabolic equivalents for all the analyzed groups, with important differences: High risk patients had the largest effect with a 64.37% increase and the lowest effect was seen for younger patients, with a 19.15% increase.

Data analysis shows that the risk significantly explains the 14% variation, for it is concluded that as there is a change from low to moderate risk, and from moderate to high risk, the METs percentage change is higher, its mean variation increases 25.96 points, adjusted for gender and age.

A lipid profile analysis was also performed at the end of the training period, showing a mean decrease for total cholesterol of 4.44 mg/dl (-2.9%) ($p=0.145$), for LDL cholesterol of 0.96 mg/dl (-1.1%) ($p=0.746$), for triglycerides of 19.41 mg/dl (-11.2) ($p=0.016$), and a rise in HDL cholesterol in 0.95 mg/dl (2.5%) ($p=0.181$). These findings were not statistically significant, excepting those for triglycerides; however this is not repeated once lipid profile changes are stratified according to their risk level, and do appear as significant changes for total cholesterol and HDL for low and moderate risks respectively.

## Discussion

This study shows the typical clinical characteristics for patients referred to the cardiac rehabilitation program; with coronary artery disease, male gender, mean age 60 years old, hypertensive, inactive smoker and a history of some type of myocardial revascularization. These findings are in accordance with national and international studies. [9,10]

**Table 1. Clinical characteristics of Coronary Artery Disease patients who finished phase II of the Cardiac Rehabilitation Program**

| Parameters | | N | % |
|---|---|---|---|
| Age | < 35 years | 1 | 0.8 |
| | 35 – 44 | 5 | 3.8 |
| | 45 – 54 | 36 | 27.5 |
| | 55 – 64 | 55 | 42 |
| | 65 – 74 | 24 | 18.3 |
| | 75 years > | 10 | 7.6 |
| Gender | Male | 95 | 72.5 |
| | Female | 36 | 27.5 |
| DM | | 34 | 26.2 |
| HTA | | 91 | 69.5 |
| Dyslipidemia | | 91 | 69.5 |
| Smoking history | | 72 | 55 |
| Active smoker | | 10 | 7.6 |
| Management | Medical non invasive | 51 | 38.9 |
| | Invasive | | |
| | Angioplasty | 10 | 7.6 |
| | Stents | 55 | 57.3 |
| | Bypass | 9 | 6.9 |
| | Nonrevascularizable | 6 | 4.6 |
| Risk | Low | 65 | 49.6 |
| | Moderate | 44 | 33.6 |
| | High | 22 | 16.8 |

In this program, patients are classified into risk levels, to assign them different physical training loads, and to evaluate their response and acceptance to these training loads; monitoring is achieved by measuring heart rate and rate of perceived exertion (Borg Scale); and, for high risk patients, telemetry is also associated. AACVPR´s risk scale is used to classify the patients. This classification has a relationship with patient monitoring during exercise sessions; however, it can be concluded from this study, that high risk patients improve their functional capacity proportionally more than lower and moderate risk patients: the increase in the estimated functional capacity (expressed in METs), at the end of 10-12 weeks, averages 29.7%, similar to that described in other studies, [11-13] and 64.37% for high risk patients. This improvement is caused by several mechanisms: there are three described explanations for the improved myocardial perfusion after training: 1)Direct regression of atherosclerotic lesion, 2)Collateral vessel formation, 3)Changes at the epicardial blood flow dynamics. [14,15] At a peripheral level, there is an increase in collateral blood flow and an improvement in nitrous oxide-mediated vasodilation, mitochondrial enzyme metabolism, as a decrease in systemic inflammation markers (PCR, IL-6, fibrinogen, SVCAM-1); [16] and in regards to body composition there is an increase in bone mineral density, a decrease in fat percentage, an increase in lean mass and muscular strength. [17]

There is a low (0.289) and significant (0.001) correlation for gender and age variables with the

**Table 2. Performance of the metabolic equivalents (METs), at the beginning and the end of the Cardiac Rehabilitation Program, according to gender, age group and risk level from March 2009 to May 2010.**

| | METs | | Patients | Increase | Change | |
|---|---|---|---|---|---|---|
| Characteristic | INITIAL | FINAL | Number | METs | Percentage | p Value |
| Gender | | | | | | |
| Men | 8.8 | 11.5 | 80 | 2.6 | 29.81 | 0.000 |
| Women | 6.7 | 8.7 | 30 | 2.0 | 29.44 | 0.000 |
| Age | | | | | | |
| 35 – 44 | 10.6 | 12.6 | 4 | 2.0 | 19.15 | 0.057 |
| 45 – 54 | 9.5 | 12.1 | 31 | 2.6 | 27.10 | 0.000 |
| 55 – 64 | 8.3 | 10.8 | 47 | 2.5 | 30.75 | 0.000 |
| 65 – 74 | 7.0 | 9.2 | 20 | 2.1 | 30.53 | 0.000 |
| More than 75 | 5.3 | 7.7 | 8 | 2.5 | 46.58 | 0.008 |
| Risk | | | | | | |
| Low | 10.1 | 12.4 | 53 | 2.3 | 22.46 | 0.000 |
| Moderate | 7.1 | 9.2 | 36 | 2.1 | 29.26 | 0.000 |
| High | 5.5 | 9.1 | 21 | 3.6 | 64.37 | 0.000 |

**Table 3. Performance of the lipid profile, at the beginning and at the end of the Cardiac Rehabilitation Program, according to the risk classification, from March 2009 to May 2010.**

| | Initial | Final | Change | p |
|---|---|---|---|---|
| Low Risk (n=64) | | | | |
| Total Cholesterol | 160.26 ± 43.36 | 150.76 ± 39.79 | 9.50 ± 33.88 | 0.028 |
| LDL | 82.86 ± 34.34 | 78.75 ± 28.92 | 4.22 ± 33.24 | 0.338 |
| HDL | 40.12 ± 14.42 | 39.26 ± 11.71 | 0.86 ± 8.41 | 0.417 |
| Triglycerides | 191.00 ± 122.51 | 166.57 ± 126.28 | 24.42 ± 98.21 | 0.057 |
| Moderate Risk (n=44) | | | | |
| Total Cholesterol | 160.06 ± 42.80 | 155.90 ± 45.68 | 4.15 ± 31.62 | 0.388 |
| LDL | 81.63 ± 30.34 | 79.07 ± 33.82 | 2.56 ± 23.19 | 0.484 |
| HDL | 35.88 ± 11.35 | 39.61 ± 12.86 | -3.72 ± 7.60 | 0.002 |
| Triglycerides | 195.09 ± 114.79 | 172.30 ± 103.67 | 22.79 ± 81.17 | 0.073 |
| High Risk (n=21) | | | | |
| Total Cholesterol | 146,76 ± 35,08 | 157,14 ± 43,06 | -10,38 ± 38,47 | 0,231 |
| LDL | 74,38 ± 29,34 | 76,47 ± 28,71 | -2,09 ± 29,04 | 0,744 |
| HDL | 37,60 ± 10,78 | 38,50 ± 8,31 | -0,90 ± 6,33 | 0,533 |
| Triglycerides | 168,55 ± 110,32 | 171,70 ± 90,99 | -3,15 ± 71,99 | 0,847 |

change in METs at the end of program phase II; similar to data found in other studies. [18]

Regarding changes in lipid profiles, many other studies have reported changes after being subject to cardiac rehabilitation programs. [19,20] In this study just modest and non significant changes were found. These patients, in the majority of cases were already taking lipid-lowering drugs, and this was not taken into account, neither the fact that during this 10-12 week period they could have been subject to changes in their medication dosages by their physicians.

Concerning this aspects, there are possible explanations, such as:

Firstly, an inadequate caloric expenditure: a meta-analysis published in 2007 by Kodama[21] reported statistically significant changes, even though those were modest changes (2.53 mg/dl [0.065 mmol/L]; P<0.001), with the minimal weekly volume to increase HDL levels estimated at 900 Kcal of caloric expenditure or 120 exercise-minutes a week; it is also indicated that, for each 10 minutes that an exercise session is extended, there is an approximate 1.4 mg/dl (0.036 mmol/L) increase in HDL levels and, however, there was not found any significant association between exercise frequency or intensity with the HDL change.

Secondly, in this study HDL nor LDL subfractions were not measured, from which there have been consequent changes described even with low intensity exercise (Kraus et al, 2002) [22], producing larger and more $HDL_2$ subfractions, with a higher anti-atherogenic potential, and producing larger and less atherogenic LDL.

As a third hypothesis, the lack of an adequate and individualized diet; even though patients received nutritional education, does not seem to be enough, because this speeches do not replace an adequate individualized diet for each patient´s preferences and eating habits. Besides, it should be considered that exercise increases appetite in most cases.

Within the most important limitations for this study, is that the functional capacity is not measured directly through Ergospirometry, but $VO2_{max}$ is calculated from mathematical estimates and equivalent in METs, this decreases the data trustability, overestimating the real maximal oxygen consumption. It is recommended to realize stress tests with ergospirometry, to assure obtaining trustful maximal oxygen consumption values, and to get more information concerning compromise of the musculoskeletal or pulmonary systems, which could also affect the patient´s maximal functional capacity.[23]

There were not included data about waist circumference measures, weight nor fat percentage, this because measures were not made by the same examiner, and fat percentage was not trustable as it was measured by bioimpedance, and there were not available other methods such as skinfold measures, or densitometry (considered as the Gold Standard for body composition). It is necessary to perform more studies at the Rehabilitation Center, in which there is a standardization of anthropometric measurement, and, if possible, that all values are measured by the same examiner.

In conclusion, cardiac rehabilitation programs represent a benefit for coronary artery disease patients. This study found an increase in the estimated maximal functional capacity (expressed in METs) after a 10-12 weeks training period, in the Phase II Cardiac Rehabilitation Program, with a higher increase for high risk patients and lower for younger patients. A non significant improvement was also identified for total cholesterol, LDL-cholesterol, triglycerides and HDL-cholesterol, comparing results at the beginning and at the end of phase II.

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