The Effects of a Three Month Cardiac Rehabilitation Program on Cardiovascular Endurance, Ejection Fraction, and Quality of Life

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ABSTRACT

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This retrospective study examined the left ventricular ejection fraction (LVEF), six-minute walk test (6MWT), and Short Form 12 Health Survey (SF-12) of 50 individuals following a three-month cardiac rehabilitation program. After receiving approval by the two participating institutional review boards, medical records were examined. Men and women between 40 and 75 years of age who had an uncomplicated myocardial infarction in the past four weeks prior to cardiac rehabilitation and a LVEF between 25-45% were included in the study. Participants who had undergone LVEF, 6MWT, and SF-12 measures at both baseline and following the three-month program were only included. The cardiac rehabilitation program included the treadmill, recumbent cycle, upper body resistance training and was performed three times per week, 45-60 minutes per session. There was no statistically significant change in LVEF following the three-month program (pre: 45% and post: 48%) in seven participants. The results of the SF-12, completed by 36 participants, indicated that the physical component scale (PCS) improved significantly after cardiac rehabilitation (pre: 39.4 and post: 44.5), while the mental component score (MCS) did not (pre: 51.5 and post: 54.1). Submaximal exercise endurance, measured by 6MWT, completed by all 50 participants, improved significantly after the program, with an average increase of 15% on the 6MWT. In conclusion, this three-month cardiac rehabilitation program improved exercise endurance and the PCS of the SF-12 of participants after a recent uncomplicated heart attack, but did not significantly change LVEF or the MCS of the SF-12.
Chapter I

Introduction

Cardiovascular diseases are the number one cause of mortality in men and women according to the World Health Organization (2007). Cardiovascular diseases include high blood pressure, heart failure, stroke, heart attack, and angina. A myocardial infarction, or heart attack, is caused when an artery or arteries in the heart become blocked, causing a decrease of oxygen to the heart. Myocardial infarctions can cause progressive left ventricular remodeling, which can lead to congestive heart failure. Left ventricular remodeling is defined as the thinning of the heart muscle, formation of an aneurysm or weakening of the wall, stress on the wall of the ventricle, enlargement in the area of the infarcted heart muscle, and increase in the size of the left ventricle. The extent of left ventricular remodeling can be measured by the left ventricular ejection fraction (LVEF) obtained from an echocardiogram.

The rise in the number of individuals having a heart attack continues and seems to be a growing trend among obese individuals. There has been much research on the improvement and prevention of myocardial infarctions in individuals, with primary focus on lifestyle modifications. Current research has shown that one major lifestyle modification for the prevention of a re-occurring heart attack and decrease in mortality is cardiac rehabilitation. Cardiac rehabilitation has many benefits which improve an individual’s health. These include: improved exercise tolerance, improved mood, decreased depression, increased stamina, improvement in sleep pattern, decrease in risk factors, and improved submaximal cardiovascular endurance and ejection fraction.
Statement of the Problem

Cardiac rehabilitation may have benefits of improving quality of life, submaximal cardiovascular endurance, and ejection fraction. Following an uncomplicated anterior or inferior myocardial infarction, a three-month cardiac rehabilitation program is effective in improving quality of life, submaximal cardiovascular endurance, and ejection fraction.

Delimitations of the Study

This retrospective study reviewed the medical records of fifty men and women, ages 40-75 years old who had experienced an uncomplicated inferior or anterior myocardial infarction within the prior month. The participants were on a variety of medications, including beta blockers, ACE inhibitors, calcium channel blockers, diuretics, aspirin, and possibly vitamin and mineral supplements. Individuals who completed a three-month outpatient cardiac rehabilitation program were included in the study provided they had completed a six-minute walk test (6MWT), a Short Form 12 Health Survey (SF-12), and echocardiogram to determine left ventricular ejection fraction (LVEF) before and following completion of the rehabilitation program.

Each exercise session consisted of a five minute warm-up, treadmill, recumbent bicycle, and upper body free weight exercises using dumbbells, followed by a five minute cool down. The total duration of each exercise session was 45-60 minutes and was performed three times per week. The cardiac rehabilitation program was telemetry monitored, clinically supervised program that included a medical director, nurses, and exercise physiologists. Each individual agreed to stay compliant with his/her exercise program. Reasons for not attending
a session included when a patient did not feel well, had angina symptoms, orthopedic injury, doctor’s appointment or diagnostic appointment, but otherwise participants adhered to the program three times per week. If a participant missed more than seven consecutive sessions and with a minimum of twelve visits, they were excluded from the study. The exercise prescription was at a moderate intensity with a target heart rate (THR) of no greater than 20-30 beats above resting heart rate, not to exceed more than 110 beats per minute (bpm) or a THR based on a recent negative stress test, using 50% - 85% of max heart rate achieved. Another measurement used to rate each participant’s exercise intensity was using a self-reported rating of perceived exertion (RPE) of 3-4, or a moderate intensity, on a scale between 0-10. Each participant had an individualized exercise prescription that was continuously increased in intensity when the RPE became less than a 3. If the participant rated an effort less than 3, they would be working at a low intensity. At this point the participants need an increase in their exercise workload so they are working at a moderate intensity. Before and following the three-month cardiac rehabilitation program, participants were tested for LVEF, using a resting echocardiogram, submaximal cardiovascular endurance by the 6MWT, and quality of life with the SF-12.

Limitations

This study was limited by the following factors: selection bias, small sample size, and increased incidence of dropping out of program, and/or morbidity and mortality. Selection bias may take place because this present study was a retrospective study based on a medical record review, meaning that it was not a randomized, controlled trial (RCT). A small sample size has the chance to cause false positive results and inaccurate interpretation of the results.
Participants’ adherence, frequency of dropping out, and morbidity and mortality also affect the results and interpretation. Failure to complete the twelve week cardiac rehabilitation program may be due to several reasons, such as concurrent illnesses, high fitness level, orthopedic injuries, occupation, loss of health insurance, and/or mortality.

**Hypotheses**

For the purpose of this study, the following hypotheses were examined:

1. There would be a significant increase in quality of life measures following the completion of a three month cardiac rehabilitation program.
2. There would be a significant increase in submaximal cardiovascular endurance following the completion of a three month cardiac rehabilitation program.
3. There would be a significant increase in ejection fraction following the completion of a three month cardiac rehabilitation program.
4. There would be a significant correlation among the three dependent variables of quality of life, submaximal cardiovascular endurance, and ejection fraction after controlling for age, gender, adherence to exercise, and the number of co-morbidities.

**Definition of Terms**

*Left Ventricular Ejection Fraction (LVEF)* is the fraction of blood that is pumped out of the left ventricle during one contraction, determining the function of the heart. A normal left ventricular ejection fraction (LVEF) is 50-75%. An LVEF is beneficial to get estimations of end diastolic volume (the quantity of blood in the ventricle at the end of ventricular filling), end systolic volume (the quantity of blood in the ventricle at the end of
contraction), and stroke volume (the amount of blood pumped out of the ventricle during one heart beat). Left Ventricular Ejection Fraction (LVEF) = Stroke volume (SV)/End diastolic volume (EDV)

**Echocardiogram** is an ultrasound of the heart, which looks at all four chambers of the heart and functioning of all the heart’s valves. It is a safe and painless procedure that examines the heart. An echocardiogram measures an ejection fraction by measuring the volumes of each heart chamber during a cardiac cycle.

**Quality of life** is measured using the Short Form 12 Health Survey (SF-12) and it includes assessing an individual’s physical and mental health. The SF-12 also includes the sub categories of physical functioning, bodily pain, general health, vitality, social functioning, and emotional role.

**Submaximal cardiovascular endurance** is measured by the six-minute walk test (6MWT) and is an estimation of each individual’s maximal cardiovascular endurance capacity. It is an endurance workload below maximum effort, but beneficial for individuals with any type of chronic disease or untrained, older, and/or untrained individuals to show improvements in cardiovascular endurance without overstressing the body’s systems, particularly the heart.
Chapter II

Review of Literature

This chapter presents a critical discussion of the current research performed over the past 10-15 years, which pertains to three particular benefits of exercise being discussed in this study; specifically, improving quality of life, submaximal cardiovascular endurance, and ejection fraction in acute myocardial infarction patients.

Quality of Life

Quality of life is proven to improve with the participation in an exercise program, especially in the acute myocardial infarction population.

Failde et al. (2009) performed a study demonstrating that the SF-12 was comparable to the SF-36 when evaluating health related quality of life in individuals having an acute myocardial infarction and unstable angina. The study was conducted in a Cardiology unit in Spain and consisted of 186 patients that were classified as having an acute myocardial infarction (AMI), unstable angina, or non-ischemic cardiac disease. The participants were given the SF-36 and SF-12 together and these forms were then collected by one trained interviewer. The authors concluded that the SF-12 showed related scores to the SF-36 in acute myocardial infarction patients and unstable angina patients when evaluating health related quality of life. Overall, the SF-12 was a reliable quality of life survey to use in coronary artery disease patients who have had an acute myocardial infarction or have been
diagnosed with unstable angina. It is a shorter survey, less time consuming, and much simpler to administer to a patient compared to the SF-36 survey.

Muller-Nordhorn et al. (2004) conducted a study on the comparison of the SF-12 with the SF-36 in patients with coronary heart disease. The SF-36 is the most widely used health survey to assess an individual’s health related quality of life. Eighteen cardiac rehabilitation centers in Germany were enrolled in this study, having a total of 2,441 patients. Each participant was enrolled in an inpatient cardiac rehabilitation program for three weeks and the inclusion criteria was myocardial infarction, angioplasty, or coronary bypass surgery. A follow-up questionnaire was mailed to each participant six months after discharging from cardiac rehabilitation and then again twelve months after discharge. The authors concluded that the SF-12 and SF-36 were similar in assessing health related quality of life with coronary heart disease patients. The two surveys were also shown to be similar in the populations of congestive heart failure, sleep apnea, and low back pain. The advantages to the SF-12 were that it was less cumbersome, less of a burden for the responder, a shorter survey, and saved resources. The disadvantage was that the SF-12 only allowed for calculations with the main summary scales, but not the subscales as seen in the SF-36. By not including the subscales that are seen within the SF-36, some important feedback may be masked. Using the SF-12 would be at an investigator’s discretion and the factors to be considered would be between a longer, more informative survey compared to a shorter survey and more compliance from the responder. Overall, the SF-12 compliments and was quite compatible with the SF-36 on assessing health related quality of life in individuals with coronary heart disease (Muller-Nordham et al., 2004).
Michie et al. (2005) performed a study which explored psychological changes that predict health outcome and healthy behavior and they explored psychological change, levels of distress and quality of life in a cardiac rehabilitation program. One hundred fifty eight participants averaged 59 years of age and attended a cardiac rehabilitation (CR) center in the United Kingdom. They completed questionnaires three times throughout the study, which took place two weeks before attending CR, eight weeks and eight months after the program was completed. The questionnaires were the Illness Perceptions Questionnaire to assess participants illness perceptions, self efficacy measures relating to exercise, eating, and stress; the Hospital Anxiety and Depression Scales (HADS) to assess anxiety and depression; mental and physical health outcomes using SF-12; and healthy eating questionnaire using four responses to assess each participants diet. The authors demonstrated increased knowledge of the participants on various topics, such as information on coronary heart disease, helping to initiate and maintain lifestyle changes with exercise and diet by goal setting and planning, stress management, improving quality of life by increasing confidence, and increasing adherence to medications. The participants met for seven consecutive weeks for two hours and then an hour about eight weeks after. They then meet again six to eight months after completing the program to emphasize key principles discussed at the beginning of the program. They concluded that cardiac rehabilitation participants improved in their perceived control over their cardiac disease, increased confidence level, decreased anxiety and depression, and decreased distress by an associated increase in mental and physical health over the eight month study period (Michie et al., 2005). The limitation to this study though was that there was not a control group and the results may not possibly be characteristic of a cardiac rehabilitation program. It was an immense study observing the psychological benefits
of cardiac rehabilitation on individuals having a heart attack and the improvements cardiac rehabilitation has on one’s mental and physical health.

Crilley and Farrer (2001) demonstrated the usage of SF-12 survey on self-perceived health status in patients following a myocardial infarction. One hundred sixty five patients who experienced their first heart attack were chosen to participate in this study and were mailed surveys and questionnaires two years after their MI, which included a SF-12 survey, and questionnaires on symptoms, current employment status, current medication therapy, and cardiac interventions. This study concluded that participants who had an MI had a lower self perceived health status compared to individuals of the same age without cardiac disease, which seemed to be due to re-occurring symptoms and a decrease in employment status. It also illustrated that the SF-12 was able to show a decrease in physical and social functioning, with the biggest finding on chest pain occurring with activities of daily living (ADL’s). It is also demonstrated that the SF-12 was useful to use in the cardiac patient population to evaluate self perceived health status and quality of life when compared to the SF-36.

Marchionni et al. (2003) conducted a study in Florence, Italy lasting two months on 270 participants aged 46-86 years old who had suffered a myocardial infarction four to six weeks prior. They used a Sickness Impact Profile to measure the impact of chronic diseases on activities of daily living (ADL’s). They concluded that participants in the younger group of 45-65 year olds improved health related quality of life whether they exercised or not. They also found that the oldest population group of 75 years or older had an enhanced health related quality of life in the exercising group. This supports the fact that exercise improves quality of life, but also augments the fact that exercise is especially important in very old individuals to improve their overall quality of life, particularly within daily activities.
Submaximal Cardiovascular Endurance

Submaximal cardiovascular endurance is a factor that is incorporated in improving exercise capacity and has been shown to increase with exercise training. Dugmore et al. (1999) demonstrated in their study that exercise training, performed three times per week for twelve months, increased the fitness levels in acute myocardial infarction individuals. They divided their study group into a poor prognosis group and good prognosis group. This was determined three weeks after having a myocardial infarction and was based off a five factor criteria as follows: degree of ST segment depression, heart rate response to exercise without medications, number and classification of premature beat, duration of exercise, and symptoms of chest discomfort and/or shortness of breath. If the patient exhibited three negative responses, they were classified as being in the poor prognosis group. The good prognosis group started their exercise program three weeks after their myocardial infarction and the poor prognosis group started their exercise program eight weeks after their myocardial infarction. They concluded that there was a greater improvement in exercise capacity in the poor prognosis group, but both exercising groups did show an increase in their peak oxygen uptake, a valid measurement for determining a person’s fitness level. This study was useful in classifying patients who are stratified as a high risk. It showed that high risk individuals would be able to incorporate an exercise program by maintaining a low to moderate intensity and still have an increase in their fitness level. One of the limitations of this study was the fact that it was a small sample size of only 62 patients.

Giannuzzi et al. (2003) studied 103 males who recently had an anterior myocardial infarction and were evaluated for exercise training 4-8 weeks after their heart attack. They
also published another study using the same exercise training regimen four years later on 80 participants (Giannuzzi et al., 1997). The exercise program that was conducted in both studies was a supervised program for two months, at least three times per week, continuously for thirty minutes on a cycling program. After the two months, the participants maintained a thirty minute cycling program, three times per week at home and reported to the laboratory every two weeks for a re-evaluation of their program. The intensity was based off their heart rate, which was 80% of that achieved in the peak incremental cycle test. The authors concluded that the training group achieved a twenty percent increase in total work capacity after the six months of training and had a delay in achieving anaerobic threshold. Also, systolic blood pressure was decreased at rest. Cardiovascular endurance was shown to improve in these two studies because the participants were able to perform exercise for a longer period of time before reaching their anaerobic threshold. The exercising participants had a decrease in their resting values, the workload of their exercise program increased, and they were able to maintain higher exercise intensity compared to the sedentary group (Giannuzzi et al., 1993, 1997).

The Global Secondary Prevention Strategies to Limit Event Re-Occurrence after Myocardial Infarction (GOSPEL) was conducted to assess the secondary prevention for individuals after a myocardial infarction and to observe the long term effects that secondary prevention had on prognosis and quality of care (Giannuzzi et al., 2008). It was a randomized trial that took place in 78 Italian cardiac rehabilitation centers and included 3,241 participants who had recently had a myocardial infarction three months prior as well as participated in a one month cardiac rehabilitation program. After the participants completed the one month cardiac rehabilitation program, they were randomized to either a three year, multi factorial
intervention group or the control group, which consisted of education to continue a healthy lifestyle. The intervention group had monthly one to one sessions held for the first six months and then every six months for three years. Each meeting consisted of 30 minutes of exercise, one hour of education on lifestyle and risk factor modification, and 30 minutes of encouragement of preventive interventions. A booklet was given to each participant to encourage adherence to the program, which provided them with motivating tips to stay on track, education on reducing risk factors, and recommendations for exercise and diet. The authors concluded that the intensive intervention group was effective in reducing risk factors and increasing medication adherence. They also demonstrated that there was a decrease total mortality by 32% and a decrease in cardiovascular mortality, non-fatal myocardial infarction, and stroke by 33%. This study was shown to have long term positive effects on post myocardial infarction individuals adhering to secondary prevention that improved and maintained a health lifestyle, decreased cardiovascular risk factors, increased medication adherence, and decreased mortality.

Otuska et al. (2003) showed that introducing an exercise program fourteen days after a myocardial infarction increased the cardiovascular capacity in moderate to severe left ventricular dysfunction patients. One hundred twenty six participants, both males and females, who recently had an acute myocardial infarction (10-14 days prior to enrollment) participated in a supervised cardiac rehabilitation program for two weeks. They then participated 1-2 times per week in supervised sessions in combination with a home based exercise program for a total of three months. The supervised cardiac rehabilitation exercise program was performed 3-5 times per week, 50-90 minutes per session and included cycling, walking, and aerobic dancing. The home exercise program included a brisk walk and was
performed 3-5 days per week for 30-60 minutes. Early intervention of exercise has been shown to improve exercise capacity by an increase in peak work rate and decrease in resting heart rate.

**Ejection Fraction**

A controversial issue that has arisen in exercise research was if exercise improved left ventricular ejection fraction (LVEF) or if exercise exacerbated the left ventricular remodeling process. Some of the reasons for this controversy may be due to the variations in study population, in particularly the severity of the infarction, age of the participants, training intensity, measurement technique of the LVEF, or a combination of all these possible reasons.

Giallauria et al. (2006) conducted a study on 40 patients 65 years and older who recently had an acute myocardial infarction. Brain natriuretic peptide (BNP) and inactive N terminal fragment (NT-pro BNP) was an indicator of left ventricular impairment or dysfunction and were shown to be a strong predictor of mortality in patients with heart failure and coronary heart disease. These peptides are released from the ventricles when there is an increase in wall stress of the left ventricle. NT-pro BNP was the particular peptide chosen to be incorporated in this study because it was unknown as to what the predictive role of NT-pro BNP has to do with exercise training and left ventricular dimensions in acute myocardial infarction patients who participate in a regular exercise program. The authors choose to examine the effects that exercise training has on NT-pro BNP levels and cardiopulmonary function in older acute myocardial infarction patients having moderate left ventricular systolic dysfunction. The participants were divided into two groups: group A and group B. Group A consisted of 20 participants who performed a three-month exercise training program and
group B consisted of 20 participants who were instructed to maintain regular physical activity and perform lifestyle modifications. Group A performed exercise three days per week, completing a 30-minute cycle session at 60% of VO$_{2\text{peak}}$ including a five minute warm-up and five minute cool down. NT-pro BNP was collected at baseline and then again after three months of exercise training. They concluded that NT-pro BNP decreased in the older trained participants compared to no change seen in NT-pro BNP levels in group B, which was the control and sedentary group. They also found that in acute myocardial infarction patients, there was not any left ventricular remodeling that occurred within the exercising group which was possibly due to a decrease in left ventricular wall stress. This conclusion demonstrated that there were not any negative effects of exercise on the heart muscle after a heart attack. Finally, they observed that exercise performed in a cardiac rehabilitation program showed an increase in cardiorespiratory function and VO$_{2\text{peak}}$ in patients who have had an acute myocardial infarction.

Another study by Giallauria et al., (2008) was conducted on 61 individuals who recently had a myocardial infarction with moderate left ventricular dysfunction. It was similar to his earlier study, but was a six month protocol where NT-pro BNP was assessed during the initial evaluation and six months later. The exercise group had the same protocol as his earlier study, performing exercise three times per week for 40 minutes a session on a stationary cycle. They demonstrated that exercise training did not cause an increase in the left ventricular remodeling process after a myocardial infarction in patients with only moderate left ventricular dysfunction. Also, NT pro-BNP was decreased in the exercising group which, may be possibly due to a decrease in left ventricular wall stress from improved arterial endothelial function. The other two factors that may potentially play a role in the reduction of
left ventricular wall stress due to exercise were an “improvement in sympathetic and non sympathetic nervous system balance or an increase in the contractility of hibernating myocardium” (Giallauria et al. 2008). The limitation to this study, though, was that it had mainly young male participants and would not be appropriate to extrapolate the results an older individuals, women, or individuals with a poor ejection fraction left ventricular dysfunction. The authors provided two proven research studies that showed the same conclusions, individuals with moderate left ventricular dysfunction after a myocardial infarction can safely participate in an exercise program to decrease the progression of left ventricular remodeling and have an increase exercise capacity.

One other study completed by Giallauria et al. (2009) was on 60 participants, with an average age of 58 years old, predominantly men, who recently had an acute ST-elevated myocardial infarction. They wanted to see the effects that a six month cardiac rehabilitation exercise program have on individuals having had an acute ST-elevated myocardial infarction on left atrial remodeling in mild to moderate left ventricular dysfunction. The exercise group participated in exercise training for 30 minutes of cycling at 60-70% peak VO$_2$, three days per week. A five minute warm-up and cool down was incorporated in the exercise program and took place in a hospital cardiac rehabilitation facility. They found that the early initiation of a six month cardiac rehabilitation exercise program in individuals having had a recent acute myocardial infarction as well as mild to moderate left ventricular dysfunction, were shown to increase their functional capacity, improve left atrial and left ventricular remodeling, improve in ejection fraction, and improve in left ventricular diastolic filling. This was the first study to demonstrate positive effects that exercise had on left atrial volume in acute myocardial infarction individuals and this study suggested future studies look at the long term effects that
exercise may have on left atrial volumes. Though the authors cautioned the extrapolation of these conclusions obtained from this study to other older populations because this population was younger men.

Giannuzzi et al. (1993) initially conducted a study that consisted of 103 males who recently had an acute anterior myocardial infarction 4-8 weeks prior to study and did not have any contraindications to exercise. The exercise program consisted of a 30 minute continuous cycling session in a supervised clinical setting, three times a week for two months. After the two months, the exercise program was continued at home for four more months, 30 minutes of cycling per session, three times per week. Also, as part of the home exercise program, participants were prescribed to perform a daily 30 minute brisk walk. Each participant was to report to the lab when performing the home exercise sessions in order to have their training intensity re-adjusted as the exercise training continued. The authors concluded that long term exercise training did not exacerbate the left ventricular remodeling process and improved exercise capacity. They also found that participants with a low ejection fraction of less than 40%, did not have an increase in left ventricular dilation and progression of the left ventricular remodeling, but instead had a 4 % improvement in their ejection fraction. There were, however a few participants with a low ejection fraction that participated in this study and there was very little statistical significance to accept this finding. Overall, they demonstrated that long term exercise in participants with a large infarcted area and possible evidence of ischemia can benefit from exercise without worsening or increasing the left ventricular remodeling process.

Another study conducted by Giannuzzi et al. (1997) involved 80 participants who recently had an acute myocardial infarction, about 3-5 weeks prior and had an ejection fraction...
fraction less than 40%. The exercise program was the same program as the previous study performed in 1993. This study also concluded that long term exercise training in acute myocardial infarct individuals with a poor ejection fraction stopped the progression of the left ventricular remodeling process and improved left ventricular function (Giannuzzi et al., 1997). The ejection fraction of these participants improved by 12% and was most likely due to an increase in contractility of the heart and a decrease in regional wall motion abnormalities and end-systolic volume. Other possible mechanisms for the increase in left ventricular function and a decrease in the progression of left ventricular remodeling could potentially be due to a decrease in sympathetic nervous system stimulation and decrease in the release of catecholamines, a decrease in ventricular wall stress, and an increase in blood flow to all areas of the body, including the infarcted area (Giannuzzi et al., 1997). The increase in blood flow to the infarcted heart muscle may be the reason for an increase in left ventricular function, but this study could not prove it due to the inaccuracy of using exercise electrocardiography to measure the left ventricle. Exercise electrocardiography has a low sensitivity and was not very accurate in measuring for exercise induced ischemia. Overall, performing a home based exercise program was safe and beneficial in improving quality of life, exercise capacity, and decreasing the progression of left ventricular remodeling in acute myocardial infarction individuals. They also stated that cardiac rehabilitation should be considered in post infarction individuals with left ventricular dysfunction in conjunction with medical therapy to increase functional capacity and improve the function of the heart, decreasing the progression of left ventricular remodeling, morbidity, and mortality (Giannuzzi et al., 1997).

Otsuka et al. (2003) showed an increase in exercise capacity, but also concluded that a moderate intensity exercise training program, introduced fourteen days after an acute heart
attack did not exacerbate left ventricular remodeling. Left ventricular ejection fraction was measured using contrast left ventriculography 3-4 weeks post heart attack. The participants were grouped into three groups, according to their left ventricular ejection fraction (LVEF) as follows: $\text{LVEF} \geq 45\%$, $35\% \leq \text{LVEF} < 45\%$ and $\text{LVEF} < 35\%$. They demonstrated that individuals after an acute myocardial infarction having moderate to severe left ventricular dysfunction had an improvement in their exercise capacity that was very similar to an individual with mild left ventricular dysfunction. The possible reasons for exercise not exacerbating left ventricular remodeling in acute myocardial infarct patients with left ventricular dysfunction were, for one, possibly due to “other determinants of left ventricular remodeling process, such as the size of the infarcted area, being such powerful determinants that exercise may have been hidden” (Otsuka et al., 2003). Another reason may possibly be due to the intensity of the exercise being prescribed at a proper level so as to not exacerbate the left ventricular remodeling process. High exercise intensity may be too aggressive for an individual with left ventricular dysfunction who may also have damaged heart muscle due to the recent heart attack. The heart may not be able to keep up the higher exercise intensity because the workload will exceed what the heart can pump and keep up with. One limitation to this study was that it was not a prospective study and did not have a control group. It was a study that was evaluating exercise on three different groups of individuals with left ventricular dysfunction. Another limitation to this study was that the LVEF $< 35\%$ group was such a small group that determination of the progression of left ventricular remodeling may have been inaccurate. A final limitation was that left ventricular end-diastolic dimension was measured using an echocardiogram, but measurements on the thickness of the left ventricle
wall, end systolic dimension, and the shape of the left ventricle was not taking because it may not be reliable to use an echocardiogram in a severely non synchronized heart.
Chapter III

Methods and Procedures

This chapter presents the methods and procedures used to test the hypotheses, including subject selection, description of test instruments used, treatment of subjects, procedure used for data collection, and statistical analysis of data.

Subject selection

This was a retrospective study of fifty participants who attended a Southern New Hampshire Community Hospital outpatient cardiac rehabilitation program for a three month period between January 1, 2007 and September 30, 2009. The criteria used to include subjects into this study included men and women between 40 and 75 years of age, who in the previous four weeks had an uncomplicated inferior or anterior myocardial infarction with a left ventricular ejection fraction (LVEF) between 25-45%. They also had to have pre and post cardiac rehabilitation testing, which included an echocardiogram, a six-minute walk test (6MWT), and a Short Form 12 Health Survey (SF-12). Participants had to be willing to participate in a three-month cardiac rehabilitation program, three times per week for twelve weeks. An approval from their cardiologist was required to participate in the cardiac rehabilitation program.

The exclusion criteria for this study included participants with severe peripheral vascular or peripheral arterial disease, severe orthopedic limitations, severe arthritis, severe diabetic neuropathy, high risk unstable angina/angina at rest, pericarditis, acute myocarditis,
decompensated heart failure, active endocarditis, inability to attend the three-month program due to occupation or personal reasons, uncontrolled cardiac arrhythmias, or any other co-morbidity that precluded cardiac rehabilitation.

Methodology

This study was approved by the St. Joseph Hospital’s Institutional Review Board (IRB) and the Northeastern University Institutional Review Board (IRB). The medical records were reviewed and had to include each participant’s initial (prior to entering cardiac rehabilitation) and post (following participation in a three-month cardiac rehabilitation) echocardiogram, six-minute walk test (6MWT), and Short Form 12 Health Survey (SF-12) for inclusion in the study.

Outcome Measures (Dependent Variables)

Quality of Life. Self-reported quality of life was measured using the SF-12 (see appendix). This survey consisted of twelve questions that measured eight health domains. These domains were: physical functioning, role-physical, bodily pain, general health, vitality, social functioning, role emotional and mental health. The survey was given at the initial day of cardiac rehabilitation and then again at the end of the three-month period. The SF-12 health survey was approved by the Medical Outcome Trust’s Scientific Advisory Committee (Ware et al., 1996). The domains are broken down into a mental component score (MCS) and physical component score (PCS). The higher scores in the two components, the better quality or state of health an individual has.
Ware et al., (1996) have shown that the SF-12 survey was an effective way to measure quality of life that closely represents measures of health and well being. The SF-12 is a shorter version of the SF-36 also developed by Ware et al. (1996).

Submaximal Cardiovascular Endurance. Submaximal cardiovascular endurance was measured by performing a six-minute walk test (6MWT) along a 100 foot or 30 meter straight hallway with environmental factors controlled. The purpose of this test was to measure functional capacity and to predict mortality and morbidity in patients with heart failure, chronic obstructive pulmonary disease (COPD), and/or primary pulmonary hypertension. Reasons for stopping the test included: chest pain, excessive shortness of breath, leg cramps, poor balance, diaphoresis, or pale appearance (American Thoracic Society, 2002). One lap was equal to 60 meters, and was measured as two lengths of the hallway. A blood pressure, heart rate, oxygen saturation, and rating of shortness of breath and fatigue were taken at rest and at the end of the test. A warm-up was not needed before the test. Shortness of breath and fatigue was rated using the 1-10 modified Borg CR10 scale (Borg, 1998). The reference range for the six-minute walk test is between 400-700 meters (Enright et al, 2003). Factors that could affect the variability of the 6MWT include height, age, body weight, sex, motivation factor, shorter corridor, oxygen supplementation, orthopedic limitations, COPD, and cardiac disease. Controlling these factors as much as possible can help to decrease any type of variability in the test results.

Left Ventricular Ejection Fraction (LVEF). Each participant underwent an initial resting 3-dimensional (3-D) echocardiogram in multi views before the exercise program was
initiated. Another echocardiogram was taken upon completion of the three-month cardiac rehabilitation program. Left ventricular ejection fraction, left ventricular end-diastolic volume, and end-systolic volume were measured using the long axis view. Stroke volume was then determined by subtracting the end-systolic volume from the end-diastolic volume. LVEF is then computed by dividing the stroke volume by the end-diastolic volume. A normal ejection fraction is considered to be $\geq 50\%$. Cardiac rehabilitation patients enrolled in this study had an ejection fraction of 25-45%.

**Cardiac Rehabilitation Program.** Each participant attended a three-month supervised, outpatient cardiac rehabilitation program, three times per week, for 45-60 minutes of aerobic and resistance exercise. The exercise program consisted of a five minute warm-up period, treadmill program, recumbent cycle, and upper body resistance training, followed by a five minute cool down period. The upper body exercises included 8-10 large muscle groups, 8-12 repetitions, 1-2 sets, 2-3 days per week. Repetitions for each resistance exercise were maintained with proper form and breathing technique. The total time to perform upper body exercises lasted about ten minutes. Each participant had a set target or training heart rate of no greater than 20-30 beats above resting heart rate, not to exceed 110 beats per minute. Also, exercise intensity was measured using a 1-10 Borg RPE scale. The exercise intensity that was to be achieved by every participant was a rating of 3-4 or a moderate intensity. During each exercise session, participant’s heart rate, rating of perceived exertion (RPE), and blood pressure were obtained at rest, during exercise, and during cool down period. Each participant’s exercise intensity was gradually increased by 0.5-1.0 METs, every one to two
weeks if the participant remained asymptomatic, heart rate remained within set target, and RPE remained at a moderate intensity of 3-4 on the Borg scale.

**Confounding Variables (Independent Variables).** The following are confounding variables that will be accounted for as independent variables in the data analysis. Age is defined as participants between the ages of 40-75 years old. This variable will be obtained at the beginning of the study as defined by the inclusion criteria for this study. Gender refers to either a male or female participant and will be obtained at the start of the study as defined by the inclusion criteria for this study. Body mass index or BMI is a measurement of body composition based off an individual’s weight in kilograms (kg) divided by height in meters ($m^2$). Adherence to cardiac rehabilitation sessions will be accounted for as the number of sessions attended during the three-month cardiac rehabilitation program. There are several possible reasons for not adhering to the three-month cardiac rehabilitation program including concurrent illnesses, high fitness level, orthopedic injuries, occupation, loss of health insurance, and/or mortality. Co-morbidity refers to the number of chronic conditions noted in the patient’s medical history. The five most prevalent chronic co-morbidities are diabetes, obesity, hypertension, dyslipidemia, and family history of heart disease.

**Statistical Analysis**

Statistical analyses were carried out using SPSS for Windows version 12.0 (SPSS Inc., Chicago, IL). Data was reported as mean and standard deviation (SD) for normally distributed continuous data, median and interquartile range (IQR) for non-normally distributed continuous variables, and percentages for categorical data. The three outcome
variables or dependent variables were ejection fraction, quality of life, and submaximal cardiovascular endurance.

Results were considered statistically significant with a two-tailed p value $\leq 0.05$. Dependent sample analysis using paired t-test was performed to compare the baseline and three month outcome measures of each of the dependent variables, which were left ventricular ejection fraction (LVEF), submaximal cardiovascular endurance (six-minute walk test), and the mental (MCS) and physical (PCS) components measured using the quality of life (SF-12). Changes in outcome measures before and after cardiac rehabilitation were analyzed based on confounding variables of interest including age, gender, body mass index, attendance (or adherence rate) to cardiac rehabilitation, and the number of co-morbidities.

Univariate Pearson’s correlation analysis between each outcome variable (dependent variable) and the independent variables of interest including age, body mass index, attendance to cardiac rehabilitation sessions, and the number of co-morbidities, were performed. Univariate (Pearson’s or Spearman) correlation analyses were performed to determine the relationships between the independent and dependent variables of interest. Univariate correlation results were considered statistically significant with a p value $\leq 0.10$. These independent variables were entered into a multiple regression analysis model of each outcome variable (dependent variable), in order to determine its possible predictors.

Regression analysis was performed because it this analysis allows to determine whether there is a change in unit of the dependent variable based on the beta coefficient of the independent variable(s). Finally, chi square analysis was performed with gender as the categorical dependent variable and each of the three outcome variables to determine any statistical differences in the outcome variables by gender, if a p value $\leq 0.05$ was obtained.
Chapter IV

Results and Discussion

This chapter is a presentation and discussion of the results of the statistical analysis performed to investigate the central research questions posed in this study, which were:

1. There would be a significant increase in quality of life measures following the completion of a three-month cardiac rehabilitation program.
2. There would be a significant increase in submaximal cardiovascular endurance following the completion of a three-month cardiac rehabilitation program.
3. There would be a significant increase in ejection fraction following the completion of a three-month cardiac rehabilitation program.
4. There would be a significant correlation among the three dependent variables of QOL, submaximal cardiovascular endurance, and ejection fraction after controlling for age, gender, adherence to exercise, and the number of co-morbidities.

Characteristics of Subjects

There were a total of 50 participants (9 women, 41 men) who completed the six-minute walk test at the beginning (pre) and upon completion (post) of the three-month cardiac rehabilitation program. However, there were 36 out of 50 participants (6 women and 30 men) who completed the Short Form 12 Health Survey (SF-12) pre and post study, representing 72% of the total participants. There were only 7 out of 50 (1 woman, 6 men) who completed
pre and post left ventricular ejection fraction (LVEF) measures, representing 14% of the participants.

Table 1 shows the characteristics of the participants at baseline (pre) and compares the men and women for each of the variables. The average age for women was 58.9 years and for men was 58.0 years and there were no statistical differences between gender. There were no differences in body mass index (BMI), with values equivalent to 26.9 kg/m$^2$ for women and 31.0 kg/m$^2$ for men. There were 4 women with an average baseline left ventricular ejection fraction (LVEF) of 53.5% and 17 males with an average LVEF of 50.8%. However, these values were not statistically different between men and women. The six-minute walk test (6MWT) at baseline was 362 meters for women and 406 meters for men, with no differences by gender. The physical component scale (PCS) and mental component scale (MCS) scores of SF-12 survey did not show any statistical difference between men and women. Similarly, resting heart rates was not statistically different between women and men, where women was 70 beats per minutes (bpm) and men was 63 beats per minute (bpm). Average blood pressure readings at rest were 108/64 mmHg for women and 113/65 mmHg for men, indicating blood pressure readings within normal levels. These values were no different between men and women. Women were shown to have less chronic diseases than men, but this was not statistically significant. Women reported two co-morbidities on average while men reported three co-morbidities on average. There were statistically significant differences in the average amount of sessions attended between women and men, which were 23 sessions and 26 sessions, respectively.
Table 1: Baseline subject characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Women (n = 9)</th>
<th>Men (n = 41)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>58.9 ± 8.1</td>
<td>58 ± 9.8</td>
<td>0.640</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.9 ± 4.0</td>
<td>31 ± 6.4</td>
<td>0.557</td>
</tr>
<tr>
<td>LVEF (%) (n = 4)</td>
<td>53.5 ± 13.6</td>
<td>(n = 17)</td>
<td>0.338</td>
</tr>
<tr>
<td>6MWT (meters)</td>
<td>361.7 ± 118.2</td>
<td>405.7 ± 86.3</td>
<td>0.560</td>
</tr>
<tr>
<td>PCS * (n = 6)</td>
<td>39.0 ± 15.3</td>
<td>(n = 30)</td>
<td>0.546</td>
</tr>
<tr>
<td>MCS * (n = 6)</td>
<td>48.4 ± 12.6</td>
<td>(n = 30)</td>
<td>0.497</td>
</tr>
<tr>
<td>HR (beats per minute)</td>
<td>70.3 ± 10.0</td>
<td>63.0 ± 9.1</td>
<td>0.160</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>108.4 ± 8.9</td>
<td>112.6 ± 15.7</td>
<td>0.562</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>63.8 ± 6.4</td>
<td>65.4 ± 8.0</td>
<td>0.137</td>
</tr>
<tr>
<td>Chronic Conditions</td>
<td>2.2 ± 1.6</td>
<td>2.9 ± 1.0</td>
<td>0.685</td>
</tr>
<tr>
<td>Sessions attended</td>
<td>23.3 ± 7.0</td>
<td>25.7 ± 7.1</td>
<td>0.034</td>
</tr>
</tbody>
</table>

Means ± SD for women (n = 9) and men (n = 41), except where noted
* Pre PCS/MCS: measured on a scale from 0-100 derived from SF-12.
Statistically significant differences between women and men with a P value < 0.05 by Chi-square analysis.

Results

Left Ventricular Ejection Fraction (LVEF) was 45% at baseline and 48% post cardiac rehabilitation for only seven participants (Table 2). This represents an average change of 8.4% over the three-month cardiac rehabilitation program (Table 2, Figure 1). This change, however, was shown not to be statistically significant.
Six-minute walk test (6MWT) results at baseline showed an average of 398 meters completion before the start of the program and 448.5 meters completed after the cardiac rehabilitation program (Table 2). This change represented an average increase in 6MWT of 15% and was statistically significant when compared to baseline values (Table 2, Figure 1). The average score for the physical component score (PCS) on the SF-12 survey was 39.4 on the pre test and increased to 44.5 on the post test, showing a statistically significant improvement of 20.3% after the completion of the three-month cardiac rehabilitation program (Table 2, Figure 1).

The mental component score (MCS) on the SF-12 survey, before starting cardiac rehabilitation was 51.5 and it increased to 54.1 following completion of the three-month cardiac rehabilitation program (Table 2). The average mean percent change for the MCS was 8.5%. However, this increase did not reach statistical significance (Table 2).

Table 2: Cardiac rehabilitation outcome measures

<table>
<thead>
<tr>
<th></th>
<th>Outcome variable</th>
<th>P value</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td></td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>n = 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>45.3 ± 8.9</td>
<td>48 ± 7.7</td>
<td>0.445</td>
</tr>
<tr>
<td>6MWT (meters) n = 50</td>
<td>397.8 ± 93.0</td>
<td>448.5 ± 101.2</td>
<td>0.000</td>
</tr>
<tr>
<td>SF-12: PCS * n = 35</td>
<td>39.4 ± 11.3</td>
<td>44.5 ± 8.55</td>
<td>0.009</td>
</tr>
<tr>
<td>SF-12: MCS * n = 35</td>
<td>51.5 ± 10.9</td>
<td>54.1 ± 7.3</td>
<td>0.107</td>
</tr>
</tbody>
</table>

* Pre PCS/MCS: measured on a scale from 0-100 derived from SF-12. All values are means ± SD. Statistically significant differences between pre and post measures with a P value < 0.05 by paired t-test analysis.
Baseline LVEF was not correlated with age, gender, BMI, the number of chronic conditions or co-morbidities, or the number of attended sessions by univariate Pearson’s correlation analysis (Table 3). Baseline PCS was only correlated with the number of sessions the participants attended (Table 3). There was a positive correlation between baseline MCS and age and BMI (Table 3). There was a negative correlation observed between age and BMI, as well as between baseline BMI and 6MWT (Table 3).

### Table 3: Baseline univariate correlations between baseline dependent and independent variables

<table>
<thead>
<tr>
<th></th>
<th>LVEF</th>
<th>6MWT</th>
<th>PCS</th>
<th>MCS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>P value</td>
<td>r</td>
<td>P value</td>
</tr>
<tr>
<td>Age (y)</td>
<td>-0.013</td>
<td>0.957</td>
<td>-0.396</td>
<td>0.004</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>0.256</td>
<td>0.262</td>
<td>-0.282</td>
<td>0.047</td>
</tr>
<tr>
<td>Gender (F vs. M)</td>
<td>0.191</td>
<td>0.406</td>
<td>-0.138</td>
<td>0.339</td>
</tr>
<tr>
<td># of chronic conditions</td>
<td>-0.052</td>
<td>0.823</td>
<td>-0.164</td>
<td>0.254</td>
</tr>
<tr>
<td># of attended sessions</td>
<td>-0.153</td>
<td>0.508</td>
<td>-0.201</td>
<td>0.161</td>
</tr>
</tbody>
</table>

Statistically significant univariate correlation with a P value <0.05 by Pearson’s or Spearman correlation coefficient analysis.
Based on a multivariate linear regression analysis, younger and lighter individuals were shown to be able to walk a longer distance in six minutes, and to improve their submaximal cardiovascular endurance. However, these independent variables did not predict any of the change observed in the mental component of the SF-12 health survey (MCS) (Table 4).

Table 4: Predictors of the change in six-minute walk test (6MWT) and mental component score (MCS)

<table>
<thead>
<tr>
<th></th>
<th>6MWT</th>
<th></th>
<th>MCS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r</td>
<td>P value</td>
<td>r</td>
<td>P value</td>
</tr>
<tr>
<td>Age (years)</td>
<td>0.495</td>
<td>0.018</td>
<td>0.272</td>
<td>0.431</td>
</tr>
<tr>
<td>Body Mass Index (kg/m²)</td>
<td>0.495</td>
<td>0.009</td>
<td>0.272</td>
<td>0.155</td>
</tr>
<tr>
<td>r²</td>
<td>0.245</td>
<td></td>
<td>0.074</td>
<td></td>
</tr>
</tbody>
</table>

Multivariate linear regression analysis with independent variable entered in model is their univariate correlation (Pearson’s or Spearman) showed a P value <0.10. Statistically significant predictors were considered with a P value <0.05 by multivariate linear regression analysis.
Discussion

Ejection Fraction. The present study observed no statistically significant differences in left ventricular ejection fraction (LVEF) from baseline to three months of a cardiac rehabilitation program, which is consistent with the literature.

Giallauria et al. (2006, 2008, and 2009) reported on three exercise training studies in patients with low ejection fraction. In all three studies, exercise training consisted of cycle ergometry, performed three times per week, for 30 minutes per session at an intensity of 60-70% of VO$_2$ peak in a supervised cardiac rehabilitation program. Each training session also included a five minute warm-up and five minute cool-down. Results of the first study (2006) performed over a three-month period, like the present study, showed that exercise did not
worsen the left ventricular remodeling process following exercise training at a moderate intensity in subjects with an average left ventricular ejection fraction of 43%. They also demonstrated an increase in early left ventricular diastolic filling. The second study (2008) showed that exercise did not increase left ventricular remodeling in individuals following six month of exercise training at a moderate intensity. In addition, they found an increase in early left ventricular diastolic filling and a decrease in left ventricular stress, resulting in a beneficial improvement in left ventricular function.

Reaching the same conclusion as the previous two studies, the final article Giallauria et al. third study (2009) showed that exercise did not increase left ventricular remodeling. However, this final study did reveal an improvement of left atrial volume in the participants that suffered an acute heart attack. Since left atrial size is related to many unfavorable events after a heart attack, it was recommended that future research should be performed using left atrial volume as a tool for risk stratifying and evaluating individuals after an acute heart attack.

Several differences exist between the above three studies and the present study. Two important differences were the type and duration of each training session. More specifically, the exercise training for those three studies was 30 minutes of moderate exercise on a stationary cycle, while the present study was 45 minutes of exercise on three different modes (treadmill, stationary recumbent cycle, and strength training), all at a moderate intensity. Another difference was that in the above studies, participants completed an exercise test at baseline and after the intervention, while the present study did not collect information on exercise testing. Another difference was that the two of those three studies were conducted for a period of six months and the present study was conducted for three months only.
Studies by Giannuzzi et al. (1993 and 1997) on patients with low ejection fraction consisted of a 30 minute continuous cycle exercise in a supervised clinical setting. The training program was over two months, three times a week, at 80% of peak incremental workload. After two months, the exercise program was continued at home over four more months. The program consisted of 30 minutes of cycling per session three times per week and a brisk walk 30 minutes each day. A symptom limited cycling test was used in two studies.

The first study (1993) included male participants who suffered an acute heart attack 4-8 weeks prior to starting the study and had ejection fractions less than 40%. Giannuzzi et al. (1993) concluded that physical activity did not increase left ventricular remodeling nor was there a significant increase in ejection fraction.

The second study (1997) included men and women with an average ejection fraction of 34%. Giannuzzi et al. (1997) demonstrated that there were no adverse effects to the moderately compromised left ventricle due to an anterior heart attack. After the six-month cardiac rehabilitation intervention, there was a 12% increase in ejection fraction and a 10% improvement in wall motion abnormalities.

The difference between the above two studies and the present study was that those two studies incorporated a home-based exercise program for four months in addition to the two months of cycling or walking for 30 minutes per session at an intensity of 80% of peak workload. The present study included walking on the treadmill, using the recumbent cycle, and/or strength training for 45 minutes per session, where exercisers self rated their exercise intensity using the rating of perceived exertion (RPE) scale for three months. Also, the authors found a 12% increase in LVEF while we found no differences in LVEF after our shorter duration program.
Otsuka et al. (2003) studied three groups of participants according to size of their left ventricular ejection fraction (LVEF) as follows: LVEF $\geq 45\%$, 35\% - 45\%, and <35\%. Their exercise program consisted of walking, cycling, and aerobic dancing for 50-90 minutes, three times per week for three months. Exercise intensity was 50-60\% of heart rate reserve, which was determined from the symptom limited exercise test. The authors concluded that participation in a cardiac rehabilitation program two weeks after a heart attack was beneficial and did not increase left ventricular remodeling in individuals with moderate to severely compromised left ventricular function.

The exercise training program for the Otuska et al. study was similar to the present study because it incorporated walking and cycling. In the former study, however, exercise was performed 3-5 days per week for 50-90 minutes each session. In the present study exercise duration per session was 45 minutes, at a frequency of 3 days per week.

The benefit of attenuating the remodeling process of the left ventricle, as demonstrated in these recent studies, could possibly be due to several mechanisms. One mechanism may be an increase in the contractile function of the left ventricle by a decrease in left ventricular wall motion abnormality and decrease in end systolic volume (Giannuzzi et al., 1997). Another possible mechanism may be due to an increase in end diastolic filling, allowing the left ventricle to stretch more because of the Frank Starling mechanism, which would result in increasing the amount of blood ejected out of the left ventricle during one contraction. A third possible mechanism could be due to a decrease in left ventricular wall stress as a result of peripheral adaptations, which would reverse the negative effects of ventricular remodeling observed in participants who were not enrolled in the cardiac rehabilitation exercise programs.
Submaximal Exercise Endurance. We observed a significant increase in submaximal exercise endurance after participating in a three-month cardiac rehabilitation program in the present study, as measured by the 6MWT. This result is consistent with the literature.

Dugamore et al. (1999) reported a study of two groups: a good prognosis group and a poor prognosis group, where the good prognosis group started their exercise program three weeks after their heart attack, while the poor prognosis group started eight weeks after their heart attack. The exercise training was performed for three days per week during a 12-month period. The exercise intensity was based on the participant's results from their stress test, with values ranging between 50-65% peak VO$_2$ in the poor prognosis group, and 65-80% of peak VO$_2$ in the good prognosis group. A greater improvement in exercise capacity was observed in the poor prognosis group, but both exercising groups (poor and good prognosis) showed an increase in peak oxygen uptake. Another observation was that the participants in both groups had a decrease in morbidity after having a heart attack and improved occupational status during a five year follow-up.

One difference between the exercise training in the above referenced study and the present study was that the former study included sit ups, step ups, cycling, and walking/jogging and did not have a predetermined length of exercise time. Additionally, that study was conducted for 12 months and had a five year follow-up while the present study was shorter in duration (only three months) and did not have a follow-up.

Giannuzzi et al. (1993 and 1997) performed two long-term studies examining the effects of physical training on the cardiovascular system and the left ventricle function in patients with low ejection fraction (<40%). In the first study by Giannuzzi et al. (1993), the training group achieved a twenty percent increase in total work capacity after six months of
training and experienced a delay in anaerobic threshold. In addition, cardiovascular endurance improved because participants were able to perform exercise for a longer period of time. In comparison to the sedentary group, the exercising participants had a decrease in their resting heart rate and blood pressure, the workload of their exercise program increased, and they were able to maintained higher exercise intensity compared to the sedentary group.

The differences between these exercise training and the present study were that the former studies had a six-month exercise training program, incorporated a home-based exercise program, performed exercise for 30 minutes per session, and included two modes of exercises (walking and stationary cycle). In comparison, the present study utilized several modes of exercise, which included walking, cycling, and strength training. In addition, the present study was conducted for three months, in a supervised exercise facility, and the exercise sessions were carried out for about 45 minutes each.

Giannuzzi et al. (2008) presented the global secondary prevention strategies to limit event recurrence after myocardial infarction or the GOSPEL study. This was a three year study that aimed to evaluate the effects of a long-term intensive cardiac rehabilitation program on post heart attack individuals. The ultimate goal of the study was to prevent another cardiac event. The participants completed a standard supervised cardiac rehabilitation program for one month. Once the program was completed, participants were either randomized into the intervention group which consisted of monthly supervised meetings or into a control group. The intervention group consisted of 30 minutes of exercise, counseling on risk factors for an hour, and 30 minutes on information regarding prevention. During the six-month re-evaluation, the intervention group increased their physical activity by 24.3%, and decreased their cholesterol, which stayed consistent until the end of the three year study (Giannuzzi,
The GOSPEL study showed a decrease in cardiovascular mortality, non-fatal heart attack and stroke by 33% and a decrease by 36% in cardiac related death. In addition, better adherence to medications was observed over the three year study period. The GOSPEL study was the first multifactorial study to show that a continually reinforced individualized intervention after a heart attack was effective in preventing further cardiovascular events.

The differences between the GOSPEL study and the present study included the length (three years vs. three months, respectively) and the timing of entry into the study (after one month of cardiac rehabilitation was completed versus four weeks after a heart attack, respectively). In addition, the GOSPEL study unlike the present study, individualized education and counseling was provided in the intervention group and participants continued exercising on their own while keeping a journal of their diet and exercise.

Otsuka et al. (2003) showed that exercise training was effective in participants enrolled in an exercise program fourteen days after having a heart attack. The beneficial effect shown was an increase in functional capacity due to an increase in peak work rate and a decrease in resting heart rate. The exercise training, which included cycling, walking, and aerobics, occurred for two weeks in a supervised cardiac rehabilitation program, 3-5 times per week for 50-90 minutes. The participants then performed a home-based exercise program consisting of a brisk walk 3-5 days per week for 30-60 minutes each time for an additional three months. Early intervention of exercise has been shown to improve exercise capacity by an increasing peak work rate and decreasing resting heart rate.

Otsuka et al. (2003) was different from the present study because a home-based exercise program was incorporated after completing two weeks of supervised exercise;
however, in both studies similar modes of exercise were utilized (walking and cycling) and the duration of three months was also similar.

Quality of Life. The quality of life instrument, Short Form 12 Survey (SF-12), consists of eight health domains that are divided into two main component scores of physical and mental. The physical component score (PCS) was shown to be statistically different while the mental component score (MCS) was not. Baseline MCS correlated with BMI and age.

The PCS was consistent with the previous studies performed on quality of life, while the MCS was not. Previous studies have shown an improvement in both mental and physical components when performing an exercise program for at least three days per week consisting of at least 30 minutes of exercise per session.

Following the completion of a cardiac rehabilitation program, Michie et al. (2005) investigated psychological changes, levels of distress, and quality of life. The participants completed several questionnaires two weeks before starting the cardiac rehabilitation program as well as at 8 weeks and 8 months after completing the program. The questionnaires assessed the participants' perception about illness, self efficacy, emotional status, quality of life, and healthy eating. Over the eight-month study period, cardiac rehabilitation participants showed an improvement in their perceived control of their cardiac disease, an increased in confidence level, a decrease in anxiety and depression, and a decrease in distress due to an associated increase in mental and physical health.

While the study by Michie et al. (2005) measured several variables, provided several self reported questionnaires, and was eight months longer than the present study, we measured
quality of life before the participants started cardiac rehabilitation and after the three months of cardiac rehabilitation. Our results showed a significant improvement in the physical component of quality of life, but no improvement in the mental component.

Marchionni et al. (2003) conducted a study over a two-month period with participants between the ages of 46-86 who had suffered a myocardial infarction four to six weeks prior to the study enrollment. Participants in the younger group (45-65 years of age) improved their health related quality of life whether they exercised or not. However, the older population (over 75 years of age) enhanced their health related quality of life only if they were in the exercise group.

The difference between the Marchionni et al. (2003) and the present study was that the former study was based on 4-8 weeks of supervised training, included 16 one hour sessions of flexibility; and it had exercise cycle ergometer symptom limited test prior to cardiac rehabilitation, at the end of two months, six months and 12 months after completing the study.
Chapter V

Summary, Conclusions, and Recommendations

Summary

This retrospective study examined the left ventricular ejection fraction (LVEF), six-minute walk test (6MWT), and the Short Form 12 Health Survey (SF-12) of 50 individuals following a three-month cardiac rehabilitation program. After receiving approval by the two participating institutional review boards, medical records were examined. Men and women between 40 and 75 years of age who in the past four weeks prior to commencing cardiac rehabilitation had an uncomplicated myocardial infarction and LVEF between 25-45% were included in this study. Participants who have undergone LVEF, 6MWT, and SF-12 measures at baseline and following the three-month cardiac rehabilitation program were also included. The cardiac rehabilitation program consisted of the treadmill, recumbent cycle, upper body resistance training and was performed three times per week, 45-60 minutes per session. There was no statistically significant change in LVEF after the three-month program (pre: 45% and post: 48%) in seven participants. The results of the SF-12, completed by 36 participants, indicated that the physical component scale (PCS) improved significantly after cardiac rehabilitation (pre: 39.4 and post: 44.5), while the mental component score (MCS) did not (pre: 51.5 and post: 54.1). Submaximal exercise endurance, measured by 6MWT, completed by all 50 participants, improved significantly after the program, with an average increase of 15% on the 6MWT.
Conclusions

Based on the hypotheses set forth in the present study the following conclusions are warranted:

1. The physical component score (PCS) of the SF-12 survey was shown to have a significant increase following a three-month cardiac rehabilitation program, but the mental component score (MCS) was not. Therefore, the first hypothesis is partially accepted.

2. There was a significant increase in submaximal cardiovascular endurance, as measured by the six-minute walk test, following the completion of a three-month cardiac rehabilitation program. Therefore the second hypothesis is accepted.

3. There was no significant increase in left ventricular ejection fraction (LVEF) following the completion of a three-month cardiac rehabilitation program. Therefore the third hypothesis is rejected.

4. There were no significant correlations between quality of life and ejection fraction after controlling for age, gender, adherence to exercise, and the number of co-morbidities. The submaximal exercise endurance was shown to be significantly correlated with age and BMI. Therefore, individuals who are younger and have a smaller BMI seem to be those that are able to walk a greater distance and to have a larger endurance capacity compared to the older and heavier individuals.

Recommendations for future research

Some limitations/recommendations of the present study include the following:

- The use of submaximal exercise endurance to measure work capacity. A graded exercise test using the Bruce protocol could have been used to get more accurate information on work capacity instead of using the six minute walk test as the
surrogate. A graded exercise test would be more accurate in detecting maximal effort and would be more sensitive in showing changes in resting and peak heart rate, blood pressure, and maximal metabolic equivalence (MET level).

- The six minute walk test is a subjective test that involves the motivation of the patient in order to perform the test to his/her maximal ability.

- The present study had a small sample size and short length of time. Future research should be performed with a larger subject population to observe the effects of a longer-term supervised cardiac rehabilitation program on left ventricular remodeling and left ventricular ejection fraction.

- It would be useful to incorporate a home-based exercise program following the supervised cardiac rehabilitation program.

- The use of only resting echocardiograms to assess each participant’s ejection fraction. A cardiac catheterization, stress echocardiogram, and/or MIBI stress test would have been more reliable diagnostic procedures to evaluate ejection fraction. If available, these procedures could have been incorporated in this study, increasing the number of participants with pre and post ejection fractions.

- Overall, exercise training has been shown to be quite beneficial to help improve the physiological function of the heart after an acute heart attack without worsening the effects of a mild to moderately compromise left ventricular.
APPENDIX A

Human Subjects Research Applications

i. St. Joseph Hospital IRB Human Subjects Research Application and Consent Form

ii. Northeastern University IRB Human Subjects Research Application
August 25, 2009

Kerry Dinnon  
Exercise Physiologist  
St. Joseph Hospital  
172 Kinsley Street  
Nashua, NH 03060

Dear Ms. Dinnon:

On August 18, 2009, The St. Joseph Hospital Institutional Review Board Chairperson reviewed your application and request for approval of the study, “The Effects of a Three-Month Cardiac Rehabilitation Program on Submaximal Cardiovascular Endurance, Ejection Fraction, and Quality of Life”, SJH IRB 2009-03.

It was determined that the information submitted is exempt from IRB review. Attached is a completed copy of the Expedited Review Form that you submitted with your application. Please note the last page of the application form, which contains the signature of Dr. Roger Dionne, Chairperson and his comments.

If you have any questions concerning this determination, please contact me at (603) 595-3106.

Sincerely,

[Signature]

Lorie A. Lusignan  
IRB Secretary
November 12, 2009

Kerry Dinon
Exercise Physiologist
St. Joseph Hospital
172 Kinsley Street
Nashua, NH 03060

Dear Ms. Dinon:

On November 10, 2009, on behalf of the St. Joseph Hospital Institutional Review Board (SJH IRB), I reviewed and approved your request to extend the date range for the retrospective medical record review project, "The Effects of a Three-Month Cardiac Rehabilitation Program on Submaximal Cardiovascular Endurance, Ejection Fraction, and Quality of Life", SJH IRB 2009-03.

At this time, the project will remain exempt from IRB review; please note that the "Waiver of Patient Authorization" previously completed in August 2009 will apply to the extended dates.

If you have any questions concerning this determination or for any future changes to your project, please contact Lorie Lusignan, SJH IRB Secretary at (603) 595-3106.

Sincerely,

[Signature]

Roger R. Dionne, MD
IRB Chairperson
October 26, 2009

To: Dr. Roger Dionne, St. Joseph Hospital IRB
Nan Regina, Northeastern University IRB

Title of Project: The effects of a three month cardiac rehabilitation program on submaximal cardiovascular endurance, quality of life, and ejection fraction

As I began the process of collecting data for my thesis, I have discovered that the dates of January 1, 2008 – December 31, 2008 do not provide enough patients that qualify for my study's population. I am requesting from the Institutional Review Board of St. Joseph Hospital and Northeastern University to allow me to review the dates of January 1, 2007 to September 30, 2009. These new dates will allow me to achieve my research project's objective of obtaining fifty participants for this retrospective study.

Sincerely,

Kerry Dinon

Kerry Dinon
St. Joseph Hospital Institutional Review Board

Request for Expedited from IRB Review – IRB Form 2

Instructions: If you believe that your research may qualify for expedited IRB review, please attach this form to Initial Review Application or Continuing Review Report. Please contact the SJH IRB office if you have any questions at (603) 595-3106.

Expedited IRB Review: Expedited review is conducted by one or more IRB members (usually including the Chair) instead of the full IRB. It may be used for research that (1) presents no more than minimal risk to subjects and (2) involves only procedures described in the list provided in Section 2 below.

Minimal Risk means that the risks anticipated in the research are not greater in probability and magnitude than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

Note: The qualification for expedited review does not replace the federal requirements for informed consent and for authorization for the use and disclosure of patient health information under HIPAA, as applicable.

Please contact the IRB Office for additional information and examples of what qualifies for expedited IRB review.

Section 1 – General Information

1. Date: July 28, 2009

2. Title of Project: The Effects of a Three-Month Cardiac Rehabilitation Program on Submaximal Cardiovascular Endurance, Ejection Fraction, and Quality of Life.

   SJH IRB File 2009-03

3. Principal Investigator (name): Kerry Dinon, Exercise Physiologist

   Signature: [Signature]

   Date: 7/28/09

IRB Form-2
Expedited Review
Approved: 3/24/05

2009-03
4. **Responsible Investigator (name):** None

5. **Research Coordinator (name):** None

---

### Section 2 – Expedited Categories

Please check all applicable categories below:

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<td>1a.</td>
<td>Clinical studies of drugs and medical devices when condition (a) or (b) is met:</td>
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<td>a) Research on drugs for which an investigational new drug application is not required. (Note: Research on marketed drugs that significantly increases the risk or decreases the acceptability of the risk associated with the use of the product is not eligible for expedited review.) OR</td>
</tr>
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<td></td>
<td>b) Research on medical devices for which (i) an investigational device exemption application is not required or (ii) the medical device is cleared/approved for marketing and the medical device is being used in accordance with its cleared/approved labeling.</td>
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| 2a. | Collection of blood samples by finger stick, heel stick, ear stick, or venipuncture from: |
|  | a) Healthy, nonpregnant adults who weigh at least 110 pounds. Fore these subjects, the amounts drawn may not exceed 550 ml in an 8 week period and collection may not occur more frequently than 2 times per week: OR |
|  | b) Other adults and children, considering the age, weight, and health of the subjects, the collection procedure, the amount of blood to be collected, and the frequency with which it will be collected. For these subjects, the amount drawn may not exceed the lesser of 50 ml or 3 ml per kg in an 8 week period and collection may not occur more frequently than 2 times per week. |

**NOTE:** Children are “Persons who have not attained the legal age for consent for treatments or procedures involved in the research under the applicable law of the jurisdiction in which the research takes place.”

| 3. | Prospective collection of biological specimens for research purposes by noninvasive means. |
|    | Examples include the following: |
|    | a) Hair and nail clippings in a nondisfiguring manner; |
|    | b) Deciduous teeth at exfoliation or if routine care indicates a need for extraction; |
|    | c) Permanent teeth if routine care indicates a need for extraction; |
|    | d) Excreta and external secretions (including sweat); |
|    | e) Uncannulated saliva collected in an unstimulated fashion or by chewing gum base or way or by applying a dilute citric solution to the tongue; |
|    | f) Placenta removed at delivery; |
|    | g) Amniotic fluid obtained at rupture of the membrane prior to or during labor; |
|    | h) Supra- and subgingival dental plaque and calculus, provided the collection procedure is not more invasive than routine prophylactic scaling of and the process is accomplished in accordance with accepted prophylactic techniques; |
|    | i) Mucosal and skin cells from buccal scraping/swab, skin swab, mouth washing; and |
|    | j) Sputum collected after saline mist nebulization. |
4. Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving X-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indication.) Examples:
   a) Physical sensors applied to the surface of the body or at a distance and not involving input of significant amounts of energy or an invasion of privacy;
   b) Weighing or testing sensory acuity;
   c) Magnetic resonance imaging;
   d) Electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, echocardiography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography; and
   e) Moderate exercise, muscular strength/flexibility testing, and body composition assessment appropriate for the subject’s age, weight, and health.

5. Research involving materials (data, documents, records, or specimens) that:
   a) have already been collected for some other purpose, OR
   b) will be collected for non-research purposes (such as medical treatment or diagnosis).

NOTE: Such research may also be exempt under some conditions.

6. Collection of data from voice, video, digital, or image recordings made for research purposes.

7. Research on:
   a) individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior), OR
   b) research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

NOTE: Such research may also be exempt under some conditions.

8. Continuing review of research previously approved by the convened IRB as follows:
   a) Where (i) the research is permanently closed to the enrollment of new subjects; (ii) all subjects have completed all research-related interventions; and (iii) the research remains active only for long-term follow-up subjects; OR
   b) Where no subjects have been enrolled and no additional risks have been identified; OR
   c) Where the remaining research activities are limited to data analysis.
9. Continuing review of research, not conducted under an investigational new drug application or investigational device exemption where categories two (2) through (8) do not apply but the IRB has determined and documented at a convened meeting that the research involves no greater than minimal risks and no additional risks have been identified.

IRB#: 3007-03
(Assigned by IRB Office)

Title of Project

FOR IRB USE ONLY

☐ Verified as Expedited Review under Category: 
☒ Verified as Exempt under Category: 2A
☐ Forwarded for Convened (Full) Review.
☐ Net Exempt. Resubmission Required.

Comments

Would like to request presentation of findings.

Signature of Chair or Designee

Name: 

Date: 8/18/09

IRB Form 2
Expedited Review
Approved: 3/24/05
Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that Kerry Dinon successfully completed the NIH Web-based training course “Protecting Human Research Participants”.

Date of completion: 09/24/2008

Certification Number: 103344
The Effects of a Three Month Cardiac Rehabilitation Program on Cardiovascular Endurance, Ejection Fraction, and Quality of Life

I have read the Belmont Report, “Ethical Principles and Guidelines for the Protection of Human Subjects of Research” and subscribe to the principles it contains. In light of this Declaration, I present for the Board’s consideration the following information, which will be explained to the subject about the proposal research:

Signature: [Signature]
Date: [Date]
Site Principal Investigator

1. SELECTION AND SOURCES OF SUBJECTS

A. Source and Number

- Fifty participants, men and women, who attended a Southern New Hampshire Community Hospital outpatient cardiac rehabilitation program for a three-month period between the dates of January 1, 2008 and December 31, 2008 will be reviewed.

B. Method of Recruitment and Selection

- A convenience sample of medical records that meet the following inclusion criteria will be selected:
  - The participant will have had an uncomplicated inferior or anterior myocardial infarction.
  - Left ventricular ejection fraction (LVEF) 25-45%
○ Pre and post rehabilitation data, which included a pre (before entering) and post (three months after) echocardiogram, six-minute walk test, and SF-12 survey.
○ Participation in the three-month cardiac rehabilitation program, three times per week for about twelve weeks.

• Exclusion criteria includes patients with the following:
  ○ Severe peripheral vascular or peripheral arterial disease
  ○ Severe orthopedic limitations or severe arthritis
  ○ Severe Diabetic neuropathy
  ○ High risk unstable angina/angina at rest
  ○ Pericarditis
  ○ Acute myocarditis
  ○ Decompensated heart failure
  ○ Individuals unable to attend the three-month program due to occupation or personal reasons.
  ○ Uncontrolled cardiac arrhythmias, or any other co-morbidity that precludes participation in cardiac rehabilitation.

C. Ages and Gender

• Retrospective medical record review of fifty men or women between 40 and 75 years of age.

D. Compensation

• There is no compensation offered.

E. Location and Duration of Experiment
• The study will be conducted by a retrospective medical record review on men and women who completed a three-month cardiac rehabilitation program at a Southern New Hampshire Community Hospital.

• It is expected that the study will take six months to be completed.

F. Specific Steps to Ensure Confidentiality or Anonymity of Responses or Results

• Data collected during this investigation will be performed in a confidential and secure setting. Access to the data will be limited to individuals with key access to the file cabinet, which will be kept in the investigator’s office. Minimal identifying information will be collected from the medical records.

• All data collected during this investigation will be stored in locked file cabinets in the investigator’s office.

G. Investigators Relationship to Subjects

• There is no current relationship between the investigator and any of the study’s participants. While the patients were enrolled in the cardiac rehabilitation program (January – December 2008), the investigator may have been involved in their care as an exercise physiologist.

2. EXPERIMENTAL PROCEDURE

A. Study Objectives

• To examine the effects that a three-month cardiac rehabilitation program has on ejection fraction, submaximal cardiovascular endurance, and quality of life following an acute uncomplicated heart attack.
• To examine the correlation among quality of life, submaximal endurance, and ejection fraction with age, gender, adherence to exercise, and the number of comorbidities.

• Provide great investigative experience to prove or disprove the thesis being proposed.

• Understand the investigational process and use the gained knowledge for possible future research.

• Gain knowledge on the process of obtaining cardiac rehabilitation outcomes.

B. Experimental Design

• A retrospective, medical record review will be used in this investigation.

C. Procedure

• Past medical records of patients who meet the inclusion and exclusion criteria will be reviewed by the investigator. Data extraction will be of certain unidentifiable elements, which are SF-12 results, six-minute walk test results, age, gender, resting heart rate, and resting blood pressure. See attached data analysis tools.

3. RISKS AND BENEFITS TO SUBJECTS

A. Risks and Discomforts

• There are no known discomforts associated with this study.

• There is minimal risk to confidentiality of protected health information (PHI). Investigator has taken steps to ensure information is kept in a secured and confidential location on site where the information is reviewed.

B. Potential Benefits
It is hoped that the knowledge gained in this investigation will demonstrate the outcomes of attending a three-month cardiac rehabilitation program on improving quality of life, submaximal cardiovascular endurance, and ejection fraction following uncomplicated heart attack.

It is hoped that in this investigation we achieve correlation among the three dependent variables of quality of life, submaximal cardiovascular endurance, and ejection fraction controlling for age, gender, adherence to exercise, and the number of co-morbidities.

4. PLAN FOR REPORTING TO THE IRB

A termination of research will be submitted to the IRB within 30 days of termination of research project.
PRINCIPAL INVESTIGATOR'S REQUEST
TO USE AND DISCLOSE PROTECTED HEALTH INFORMATION
WITHOUT AUTHORIZATION
for
RESEARCH PURPOSES
[HIPAA -- 45 CFR 164.512 (i)]

Principal Investigator: Kerry Dixon
IRB Protocol # (if applicable): 

Title of Study: The Effects of a Three Month Cardiac Rehabilitation Program on Cardiovascular Endurance, Ejection Fraction, and Quality of Life

Protected Health Information ("PHI") may be used and disclosed without authorization for research purposes under one of the following criteria (check one and complete appropriate section below):

X A. Waiver of authorization approved by Institutional Review Board / Privacy Board.
_____ B. This is a review of PHI in preparation for research or to prepare a research protocol.
_____ C. This is research on PHI of decedents.

A. WAIVER OF AUTHORIZATION

(If N/A to this study ______)

As Principal Investigator, I certify there is no risk to the privacy of research participants in this study because:

1) I will protect personal identifiers from improper use and disclosure of Protected Health Information by (describe):

Extracting of the data will be done in a confidential and secure setting. Access to the data will be limited to individuals with key access to the file cabinet, which will be my self, the principal investigator and my faculty/research advisor. Minimal identifying information will be collected from the medical records. All data collected during this investigation will be stored in locked file cabinets in the investigator’s office. The data that I will be collecting includes age, gender, echo results, six minute walk test results,
SF-12 health survey results, and resting blood pressures and heart rates, strictly for research purposes.

2)

a. I will destroy personal identifiers at the earliest opportunity consistent with conduct of the research (describe): All information will remain in a secure location for a period of three years after the study is completed or as applicable by policy rules.

OR

b. I cannot destroy identifiers because there is a health or research justification for retaining the identifiers or such retention is otherwise required by law (describe): N/A

3) I will not allow reuse or disclose protected health information except:
   • as required by law,
   • for authorized oversight by the Study Sponsor or its authorized representatives
   • for other research which would be permitted under the same conditions as this Study.

   Describe any re-use or disclosure:

There will be no re-use or disclosure of information.

4) As Principal Investigator, I further certify that:
   • this research could not practically be conducted without a waiver of authorization, and
   • this research could not practically be conducted without access to and use of the PHI.

   Describe why:

Given the quantity of patients in the outpatient cardiac rehabilitation program that meet the inclusion criteria, it would be unachievable to get HIPAA authorization on all the patients due to lack of resources available during this study.

The patients will not be contacted and HIPAA authorization will be waived. The direct identifier, which will be medical record number (MRN), will be obtained and guaranteed during this study to make sure that the patient is in the study only once.

5) Description of the Protected Health Information for which use or access is necessary for this study. Medical record numbers (MRN) will be collected to make certain that the patient is used in the study only once. Direct identifiers will not be presented in the study’s data extraction form, will not be presented in the study’s final report, and will not be offered to the coordinating center. Instead, a coded patient
identification will be utilized for each patient when submitting the final report to the coordinating center.

Please refer to data collection tools and data collection form.

B. PREPARATION FOR RESEARCH  
(Check if N/A to this study _N/A_)

As Principal Investigator, I certify that:

- use and disclosure is requested solely to review PHI to prepare a research protocol or other similar preparation for research,
- no PHI will be removed from SJH or its affiliates in the course of the review, and
- access to the PHI is necessary for the research purposes.

Describe:

C. RESEARCH ON DECEDENT'S PHI  
(Check if N/A to this study _N/A_)

As Principal Investigator, I certify that:

- use and disclosure is requested solely for research on PHI of decedents,
- documentation of the date of death of each decedent is immediately available upon request, and
- access to the PHI is necessary for the research purposes.

Describe:

__________________________  ___________________________
Signature of Principal Investigator  Date
Notification of NU IRB Action

Date: October 14, 2009
IRB# 09-09-10

Principal Investigator: W. Jay Gillespie
Kerry Dinon

Department: Clinical Exercise Physiology

Address: 316 Robinson
Northeastern University

Title of Project: The Effects of a Three Month Cardiac Rehabilitation Program on Cardiovascular Endurance Fraction and Quality

Approval Status: Approved

Participating Site: St. Joseph Hospital – IRB approval received

DHHS Review Category: Exempt, Category #4

C. Randall Colvin, Ph.D., Chair
Northeastern University Institutional Review Board

Nan C. Regina
Director, Research Integrity

This approval applies to the protection of human subjects only. It does not apply to any other university approvals that may be necessary.

No further action or IRB oversight is required, as long as the project remains the same. However, you must inform this office of any changes in procedures involving human subjects. Changes to the current research protocol could result in a reclassification of the study and further review by the IRB.

Northeastern University FWA #: 4630
APPLICATION FOR APPROVAL FOR USE OF HUMAN PARTICIPANTS IN RESEARCH

Before completing this application, please read the Application Instructions and Policies and Procedures for Human Research Protections to understand the responsibilities for which you are accountable as an investigator in conducting research with human participants. The document, Application Instructions, provides additional assistance in preparing this submission. Incomplete applications will be returned to the investigator. You may complete this application online and save it as a Word document.

If this research is related to a grant, contract proposal or dissertation, a copy of the full grant/contract proposal/dissertation must accompany this application.

Please carefully edit and proof read before submitting the application. Applications that are not filled out completely and/or have any missing or incorrect information will be returned to the Principal Investigator.

REQUIRED TRAINING FOR RESEARCH INVOLVING HUMAN SUBJECTS

Under the direction of the Office of the Vice Provost for Research, Northeastern University is now requiring completion of the NIH Office of Extramural Research training for all human subject research, regardless of whether or not investigators have received funding to support their project.

The online course titled "Protecting Human Research Participants" can be accessed at the following url: http://jitp.nihtraining.com/users/login.php. This requirement will be effective as of November 15, 2008 for all new protocols.

Principal Investigators, student researchers and key personnel (participants who contribute substantively to the scientific development or execution of a project) must include a copy of their certificate of completion for this web-based tutorial with the protocol submission.

☐ Certificate(s) Attached
☐ Certificate(s) submitted previously – on file with the NU’s Office of Human Subject Research Protection

A. Investigator Information

Principal Investigator (PI cannot be a student)  Dr. W. Jay Gillespie

Investigator is: NU Faculty  x  NU Staff  Other

College: Bouve College of Health Sciences

Department: Clinical Exercise Physiology

Address: 360 Huntington Ave Boston, MA 02115

Telephone (617) 373-5695  Email  w.gillespie@neu.edu
Is this student research? YES  X  NO  If yes, please provide the following information:
Student Name  Kerry Dinon  Undergrad  _  MA/MS  X  PhD  
Mailing Address  23 King St  Nashua, NH 03060  
Anticipated graduation date  May 2010  
Telephone (603) 459-8663  Primary Email: Kerry_612@yahoo.com  
Cell phone (978) 877-0855  Secondary Email Kdion@neu.edu  

B. Protocol Information
Title:  The Effects of a Three Month Cardiac Rehabilitation Program on Cardiovascular
Endurance, Ejection Fraction, and Quality of Life  
Projected # subjects  50  
Approx. begin date of project  Sept 9, 2009  Approx. end date  April 15, 2010  

It is the policy of Northeastern University that no activity involving human subjects be undertaken until those activities have been reviewed and approved by the University’s Institutional Review Board (IRB).

- Anticipated funding source for project (or none)  None  
- Has/will this proposal been/be submitted through:  DSPA  ___  Provost  ___  Corp & Foundations  ___  

C. Will Participants Be:  
<table>
<thead>
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<th>Children (&lt;18)</th>
<th>Yes</th>
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<td>___</td>
<td>___</td>
<td>X</td>
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<tr>
<td>Northeastern University Students?</td>
<td>___</td>
<td>X</td>
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<tr>
<td>Institutionalized persons?</td>
<td>___</td>
<td>X</td>
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<td>Prisoners?</td>
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<td>Cognitively Impaired Persons?</td>
<td>___</td>
<td>X</td>
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<td>Non or Limited English Speaking Persons?</td>
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<td>People Living outside the USA?</td>
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<tr>
<td>Pregnant Women/Fetuses?</td>
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<tr>
<td>Other? (Please provide detail)</td>
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 Does the Project Involve:  
<table>
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<th>Blood Removal?</th>
<th>Yes</th>
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<td>Investigational drug/device?</td>
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<td>Audiocassettes/ videotapes?</td>
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Northeastern University  
Human Subject Research Protection  
Rev 5/7/08
Please answer each of the following questions using non-technical language. Missing or incomplete answers will delay your review while we request the information.

D. What are the goals of this research? Please state your research question(s) and related hypotheses.

The goal of this research is to investigate the effects a three month cardiac rehabilitation program has on improving submaximal cardiovascular endurance, ejection fraction, and quality of life following an uncomplicated heart attack at St. Joseph's Cardiac Rehabilitation Center in Nashua, NH.

For the purpose of this study, the following hypotheses will be examined after a three-month cardiac rehabilitation program:

1. There will be a significant increase in eight quality of life measures following a three month cardiac rehabilitation program.

2. There will be a significant increase in submaximal cardiovascular endurance following a three month cardiac rehabilitation program.

3. There will be a significant increase in ejection fraction following a three month cardiac rehabilitation program.

4. There will be a significant correlation among the three dependent variables of QOL, submaximal cardiovascular endurance, and ejection fraction controlling for age, gender, adherence, and the number of co-morbidities.

E. Provide a brief summary of the purpose of the research in non-technical language.

The purpose of the research will be to look retrospectively at how a three-month outpatient cardiac rehabilitation program improves submaximal cardiovascular endurance, ejection fraction, and quality of life following an uncomplicated heart attack. This study will involve the

3

Northeastern University
Human Subject Research Protection
Rev. 07/2009
collection of data from medical records of previous cardiac rehabilitation patients who met the inclusion criteria and there will not be any contact with the patient.

F. Identify study personnel on this project. Include name, credentials, role, and organization affiliation.
   - Dr. W. Jay Gillespie Ed. D, FACSM is my major thesis advisor. He is the director of the graduate program in Clinical Exercise Physiology and also an associate professor of Health Sciences. He is affiliated with Northeastern University.
   - Dr. Carmen Sceppa, MD, PhD will also be another one of my thesis advisors. She is an associate professor in Health Sciences and is affiliated with Northeastern University.
   - Kirk Perry MS, RTR will be my other thesis advisor. He is the Intern Director of Cardiovascular Services at St. Joseph Hospital and is affiliated with St. Joseph Hospital in Nashua, NH.

G. Identify other organizations or institutions that are involved. Attach current Institutional Review Board (IRB) approvals or letters of permission as necessary.

Institutional Review Board (IRB) at St. Joseph Hospital (see attached approval).

H. Recruitment Procedures

Describe the participants you intend to recruit. Provide all inclusion and exclusion criteria. Include age range, number of subjects, gender, ethnicity/race, socio-economic level, literacy level and health (as applicable) and reasons for exempting any groups. Describe how/when/why of whom inclusion/exclusion criteria will be determined.

Describe the procedures that you will use to recruit these participants. Be specific. How will potential subjects be identified? Who will ask for participation? If you intend to recruit using letters, posters, fliers, ads, website, email etc., copies must be included as attachments for stamped approval. Include scripts for intended telephone recruitment.

What remuneration, if any, is offered?
I. Consent Process

Describe the process of obtaining informed consent. Be specific. How will the project and the participants' role be presented to potential participants? By whom? When? Where? Having the participant read and sign a consent statement is done only after the researcher provides a detailed oral explanation and answers all questions. Please attach a copy of informed consent statements that you intend to use, if applicable.

If your study population includes non-English speaking people, translations of consent information are necessary. Describe how information will be translated and by whom. You may wait until the consent is approved in English before having it translated.

If your population includes children, prisoners, people with limited mental capacity, language barriers, problems with reading or understanding, or other issues that may make them vulnerable or limit their ability to understand and provide consent, describe special procedures that you will institute to obtain consent appropriately. If participants are potentially decisionally impaired, how will you determine competency?

If incomplete disclosure during the initial consent process is essential to carrying out the proposed research, please provide a detailed description of the debriefing process. Be specific. When will full disclosure of the research goals be presented to subjects (e.g., immediately after the subject has completed the research task(s) or held off until the completion of the study's data collection)? By whom? Please attach a copy of the written debriefing statement that will be given to subjects.

J. Study Procedures

Provide a detailed description of all activities the participant will be asked to do and what will be done to the participants. Include the location, number of sessions, time for each session, and total time period anticipated for each participant, including long term follow up.

Who will conduct the experimental procedures, questionnaires, etc? Where will this be done? Attach copies of all questionnaires, interview questions, tests, survey instruments, links to online surveys, etc.

K. Risks

Identify possible risks to the participant as a result of the research. Consider possible psychological harm, loss of confidentiality, financial, social, or legal damages as well as physical risks. What is the seriousness of these risks and what is the likelihood that they
Describe in detail the safeguards that will be implemented to minimize risks. What follow-up procedures are in place if harm occurs? What special precautions will be instituted for vulnerable populations?

L. Confidentiality

Describe in detail the procedures that will be used to maintain anonymity or confidentiality during collection and entry of data. Who will have access to data? How will the data be used, now and in the future?

How and where will data be stored? When will data, including audiotapes and videotapes, be destroyed? If data is to be retained, explain why. Will identifiers or links to identification be destroyed? When? Signed consent documents must be retained for 3 years following the end of the study. Where and how will they be maintained?

M. If your research is HIPAA-protected, please complete the following:

Individual Access to PHI

Describe the procedure that will be used for allowing individuals to access their PHI or, alternatively, advising them that they must wait until the end of the study to review their PHI.

N. Benefits

What benefits can the participant reasonably expect from his/her involvement in the research? If none, state that. What are potential benefits to others?

It is hoped that the knowledge gained in this investigation will demonstrate the outcomes of attending a three-month cardiac rehabilitation program on improving ejection fraction, submaximal cardiovascular endurance, and quality of life following an uncomplicated heart attack.

O. Attachments

Identify attachments that have been included and those that are not applicable (n/a).

n/a Copy of flyers, ads, posters, emails, web pages, letters for recruitment *
P. Health Care Provision During Study

Please check the applicable line:

X I have read the description of HIPAA “health care” within Section 3.0 of the Policies & Procedures for Human Research Protection. I am not a HIPAA-covered health care provider and no health care will be provided in connection with this study.

I am a HIPAA-covered health care provider or I will provide health care in connection with this study as described in Section 3.0 of the Policies & Procedures for Human Research Protection. This health care is described above under “Study Procedures,” and the Informed Consent and Health Information Use and Disclosure Authorization form will be used with all prospective study participants.

If you have any questions about whether you are a HIPAA-covered health care provider, please contact Nan C. Regina, Director, Human Subject Research Protection at nregina@neu.edu or (617) 373-4588.

Please return the completed application to:
Nan C. Regina, Director
Human Subject Research Protection
413 Lake Hall
Northeastern University
Boston, MA 02115-5000
Tel: 617.373.7570; Fax: 617.373.4595
n.regina@neu.edu

The application and accompanying materials may be sent as email attachments or in hard copy. A signed Assurance of Principal Investigator Form may be sent via fax or in hard copy.
Northeastern University
Institutional Review Board

ASSURANCE OF PRINCIPAL INVESTIGATOR

Investigator(s): William J. Gallen, Carolee Scorer, Nancy Strand

Title of Proposal: The effects of a three month course on ADHD

To give assurance, please read and initial each statement, then sign below.

1. I have read and understand Northeastern University's Policies and Procedures Concerning the Protection of Human Subjects and the Federal Wide Assurance. I give my assurance that I, and all members of the research team, will adhere to the policies in this research.

2. I assure that no participants will be recruited or enrolled, and no data will be collected, without current, written approval from Northeastern University, and other sites as required.

3. I assure that the rights and welfare of all participants will be protected according to the procedures approved for this project by the NU IRB.

4. I assure that all risks or discomforts to subjects will be clearly explained, and that I will demonstrate how risks are outweighed by potential benefits to the subject or by the importance of the knowledge to be gained.

5. I assure that the informed consent of all participants will be obtained by methods that meet the requirements of Northeastern University's policy and assurance procedures.

6. I assure that no changes in research activity will be initiated without prior NU IRB review and approval, except where necessary to eliminate apparent immediate hazard to the subjects.

7. I assure that I will report any problems involving risks to human subjects or others promptly to the Office of Human Subject Research Protection.

8. I assure that there are no financial or other relationships (e.g., stock ownership, advisory board, speaker's bureaus, honoraria) that might be viewed as creating a conflict of interest.

Signature: __________________________ Date: 9/16/09

Principal Investigator / Faculty Advisor

For student research, the faculty advisor is the principal investigator for the study and is primarily responsible for the ethical conduct of the research. Faculty must review and approve student research prior to submission for NU IRB review. Student investigators must sign this Assurance also.

Signature: __________________________ Date: 9/16/09

Student Investigator

Please return completed form to: Human Subject Research Protection
415 Lake Hall
Northeastern University
Boston, MA 02115
Tel: 617.373.7570

IRB #
APPENDIX B

Assessment Form and Survey

i. Physical Activity
   Six-minute walk test datasheet

ii. Quality of Life
    Short Form 12 Health Survey (SF-12)
CARDIO PULMONARY SIX MINUTE WALK TEST
DATA SHEET

Lap Counter: ____________________________

Walk #: ____________________________ Date: ____________________________

Gender: M  F  Age: ____________________________ Weight: ____________________________ Height: ____________________________

Blood Pressure at Rest: ____________________________ / ____________________________

<table>
<thead>
<tr>
<th>Baseline</th>
<th>End of Test</th>
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<tbody>
<tr>
<td>Heart Rate</td>
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<tr>
<td>Dyspnea</td>
<td>____________________________ (Borg Scale)</td>
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<tr>
<td>Fatigue</td>
<td>____________________________ (Borg Scale)</td>
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Stopped or paused before 6 minutes? No ____________________________________________ Yes, reason: ____________________________________________

Other symptoms at end of exercise: angina  dizziness  hip, leg, or calf pain

Number of laps: ____________ (X 60 meters) + final partial lap: ____________ ____________ meters = ____________

Comments: ____________________________________________

Tech Signature: ____________________________________________

ST JOSEPH HOSPITAL

CARDIOPULM PATIENT ASSESSMENTS
CARDIOPULM REHABILITATION
QUALITY METRIC-SF-12 HEALTH SURVEY

This survey asks for your views about your health and usual activities.

Answer every question by selecting the answer as indicated. If you are unsure about how to answer a question, please give the best answer you can.

1. In general, would you say your health is: [Check in box that best describes your answer]
   - Excellent
   - Very Good
   - Good
   - Fair
   - Poor

2. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much? [Check in box that best describes your answer]
   - Yes, limited a lot
   - Yes, limited a little
   - No, not limited at all
   a. Moderate Activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf
   b. Climbing several flights of stairs

3. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?
   - All of the time
   - Most of the time
   - Some of the time
   - A little of the time
   - None of the time
   a. Accomplished less than you would like
   b. Were limited in the kind of work or other activities.

4. During the past 4 weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?
   - All of the time
   - Most of the time
   - Some of the time
   - A little of the time
   - None of the time
   a. Accomplished less than you would like
   b. Didn’t do work or activities as carefully as usual

5. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and household)?
   - Not at all
   - A little bit
   - Moderately
   - Quite a bit
   - Extremely

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Page 1 of 2
CARDIOPULM PATIENT ASSESSMENTS
6. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling.

How much of the time during the past 4 weeks

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a. Have you felt calm and peaceful?  

b. Did you have a lot of energy?  

c. Have you felt downhearted and depressed?

7. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc.)?

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NAME: ___________________________
(please print first and last name)

For Office Use On

MR #: ___________________________

☐ Cardiac  ☐ Pulmonary

☐ Pre-Program  ☐ Post-Program

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CARCIPULM PATIENT ASSESSMENTS
REFERENCES


