Pre-habilitation Program for Elective Coronary Artery Bypass Graft Surgery Patients: A Pilot Project

by

Dustin Scott Kehler

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Department of Kinesiology and Recreation Management

University of Manitoba

Winnipeg, Manitoba, Canada

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Abstract

This study determined whether a pre-operative cardiac "pre-habilitation" (Prehab) program improves the health of elective coronary artery bypass graft (CABG) surgery patients to a greater extent than standard care (StanC). Seventeen elective CABG patients were randomized to StanC (n= 9) or Prehab (n= 8) at Baseline and were followed at 1-2 weeks pre-operatively (Preop) and Three months post-operatively. Functional walking ability was assessed using the 6-Minute Walk Test (6MWT) and 5-meter Gait Speed Test. Baseline data was not different between groups. Patients in StanC did not improve 6MWT scores; whereas Prehab patients improved 6MWT distance by 35% and 39% at Preop and Three months post-operatively, respectively ($p<0.05$). Gait speed scores were 25% and 27% lower in Prehab patients at Preop and Three months post-operatively, respectively, as compared to StanC ($p<0.05$). These data suggest that Prehab is an attractive intervention for enhancing functional walking ability before and after elective CABG surgery.

Dedication

I would like to dedicate my Master's thesis work to my family and friends. To my parents, Larry and Margaret, for supporting me through the good times and bad. To my sister Courtney who is special to me. To all my friends who have supported me throughout my Master's degree.

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Abbreviations

ACE – angiotensin converting enzyme

ACSM – American College of Sports Medicine

AHA – American Heart Association

ARB - angiotensin receptor blocker

BPH – benign prostatic hyperplasia

CAD – coronary artery disease

CABG – coronary artery bypass graft

CAQ – Cardiac Anxiety Questionnaire

CCB – calcium channel blocker

CESEI – Cardiec Exercise Self-Efficacy Index

CHaRM - Cardiovascular Health Research in Manitoba

CI – confidence interval

COPD – chronic obstructive pulmonary disease

CR – cardiac rehabilitation

CVA – cerebrovascular accident

ECG – electrocardiogram

FBS – fasting blood sugar

FEV1 – forced expiratory volume in one second

FVC – forced ventilatory capacity

GWTG – Get with the guidelines

HADs – hospital anxiety depression scale

HDL – high density lipoprotein

LDL – low density lipoprotein

METs – metabolic equivalents

MI – myocardial infarction

NSAID – non-steroidal anti-inflammatory drug

PHQ-9 – Patient Health Questionnaire – 9

PVD – peripheral vascular disease

Prehab – prehabilitation

SF-36 – Short-Form 36 item quality of life questionnaire

SD – standard deviation

StanC – standard care

TIA – transient ischemic attack

VO_{2peak} – peak oxygen consumption

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Chapter 1: Introduction

Cardiovascular disease accounts for almost a third of all deaths of men and women in Canada and approximately 17 million deaths annually worldwide [1, 2]. Cardiovascular disease refers to more than one disease affecting the circulatory system, including the heart and blood vessels, and whether the blood vessels are affecting other organs of the body, including the brain, lungs, or kidneys [3]. Coronary artery disease (CAD) is the most common form of cardiovascular disease and is characterized by atherosclerotic plaque build-up within the coronary arteries, limiting the blood supply to the heart [4]. Symptoms of CAD include chest pain (or angina), fatigue, and dizziness. Heart disease has a major economical impact in Canada. According to the Public Health Agency of Canada, cardiovascular disease costs amounted to $22.2 billion in 2000 [5].

Behavioural risk factors associated with heart disease include physical inactivity, smoking, an unhealthy diet and psychological risks, including depression and anxiety. Biological risk factors associated with heart disease include type 2 diabetes, high cholesterol, and high blood pressure. Pharmacological therapies are often used to treat CAD, which include, but are not limited to, antiplatelet drugs, lipid-lowering drugs (e.g. statins) angiotensin-converting enzyme (ACE) inhibitors, and beta-blocking drugs. Patients with more severe disease may require surgical interventions to alleviate symptoms as well as to improve prognosis [6]. One of the most common surgeries for heart disease is coronary artery bypass graft (CABG) surgery. The goal of CABG surgery is to not only to prolong life expectancy, but to improve overall quality of life and functional status. The procedure involves the surgical removal of a healthy blood vessel from the patient's leg, arm, or chest, to bypass a blocked coronary artery [7]. Evidence supporting

the effectiveness of CABG surgery was reviewed by Hampton, indicating that the 4-year mortality of CABG patients was only 7% and was significantly lower than the 33% mortality rate in patients with pharmacological treatment only [8]. However, despite the survival and quality of life benefit of CABG surgery, it does not cure the underlying heart disease.

The biological risk factors for heart disease can be modified through the behavioural risk factors. Evidence indicates that exercise therapy programs significantly reduce type 2 diabetic complications [9], improve blood lipid profile [10] and significantly improve both systolic and diastolic blood pressure [11] amongst patients with these underlying conditions as well as otherwise healthy adults. Moreover, patients who attend cardiac rehabilitation (CR) programs significantly reduce their risk of cardiac and all-cause mortality compared to those who do not attend CR [12]. However, 70% of patients who are referred to CR do not attend CR programs [13]. Additionally, most patients are not referred to CR prior to cardiac surgery. The following sections will review the importance of physical activity and fitness as well as the effectiveness of CR programs for patients with cardiovascular disease. This literature review will then put the importance of CR programs in the context of patients who require CABG surgery and the rationale for developing a "pre-habilitation" program before CABG surgery.

Chapter 2: Literature Review

Physical fitness and activity influence health cardiovascular outcomes

Physical fitness and activity are important prognostic factors for major cardiac events and all-cause mortality amongst cardiac patients as well as otherwise healthy adults [14, 15]. Patients with cardiovascular disease with the highest level of fitness have a 4-fold lower relative risk of death compared to patients with the lowest level of fitness [14]. Moreover, patients with established cardiovascular disease who participate in daily moderate to vigorous physical activity reduce the risk of mortality 1.6-fold, as compared to sedentary patients [16]. Thus, interventions designed to enhance physical fitness and activity amongst cardiac patients as well as otherwise healthy adults are warranted.

Cardiac rehabilitation programs aim to enhance cardiovascular health of cardiac patients by providing patients with the supports they require to increase their physical fitness and reduce other cardiovascular risk factors through education [17]. By promoting healthier behaviours, like a more physically active lifestyle, a healthy diet, and providing education on cardiovascular health, CR programs reduce adverse health outcomes through the modification of biological risk factors for cardiovascular disease. Notably, there is a growing body of evidence indicating that CR programming reduces the risk of mortality and major cardiac events amongst cardiac patients [18-21]. In fact, CR reduces mortality and major cardiac events by up to 34% and 31%, respectively [18, 20]. Therefore, it is evident that CR is a powerful health intervention for patients with established heart disease.

Despite the protective effect of CR programming on mortality and major cardiac events, the majority of cardiac patients do not attend a CR program [22]. Cardiac rehabilitation attendance estimates in North America are known to be as low as 15-20%

of the referred population [22]. Furthermore, based on local CR program statistics, less than 30% of cardiac patients attend a CR program in Manitoba [13]. Therefore, CR programs need to develop novel strategies to enhance patient enrolment.

Exercise capacity is a strong predictor of adverse outcomes in cardiac patients.

Evidence indicates that exercise capacity is one of the most important prognostic factors for mortality and cardiac death [14, 15]. In fact, it has been demonstrated that low levels of physical fitness increases the risk of cardiac death up to three-fold [23]. Myers *et al.* [14] assessed 6,213 men with and without a history of cardiovascular disease who were referred for exercise testing due to clinical reasons and found that over a mean 6.2 year follow up period, men with cardiovascular disease who had an exercise capacity of 4.9 metabolic equivalents (METs) or lower were four times more likely to die from all causes than patients who had an exercise capacity of 10.7 METs or greater. Interestingly, every one MET increase in exercise capacity was associated with a 12% improvement in mortality. Therefore, improvements in exercise capacity reduced the risk of death in patients with cardiovascular disease.

In a similar study, Kavanagh *et al.* [15] analyzed 12,169 men referred to CR and determined whether exercise capacity, as directly measured by peak oxygen consumption (VO_{2peak}), exerts a major long-term influence prognosis after major cardiac events. Over a median follow up of 7.9 years, patients who had a VO_{2peak} of greater than 22 ml O_2/kg/min (i.e.; greater than 6.3 METS) demonstrated a 63% reduction in cardiac mortality, as compared to patients who had a $V0_{2peak}$ of less than 15 ml O_2/kg/min (i.e.; less than 4.3 METS). This evidence further suggests that exercise therapy interventions that enhance physical fitness can influence the health status of cardiac patients.

What is cardiac rehabilitation?

More than a half a century ago, cardiac patients who suffered from an acute coronary event were restricted to approximately six to eight weeks of bed rest [24]. The fear was that any physical activity would exacerbate the condition and cause another heart attack. Approximately 80% of people in the 1930's on disability were those with cardiac problems [24]. In 1952, the need for prolonged bed rest and physical inactivity was criticized, as many cardiac patients experienced significant cardiovascular de-conditioning [25]. Specifically, it was later discovered that prolonged bed rest decreases functional capacity by up to 33% and provoked further complications due to physical inactivity [26]. Several studies in the 1960s examined the benefits of physical activity after cardiac complications [27-29]. For example, Dr. Herman Hellerstein was the first to incorporate a medically supervised exercise program in an outpatient setting following hospital discharge, which later developed into CR [30].

Cardiac rehabilitation, as we know it today, has developed into a systematic process of clinical and research knowledge translated into clinical practice. As such, CR may be the ultimate representation of patient-centred, individualized care within the practice of cardiovascular medicine [17]. Secondary prevention provided through CR requires the identification and modification of the behavioural and biological risk factors for cardiovascular disease through the delivery of exercise interventions, patient assessment and counselling, and patient education programs. In fact, CR programs enhance cardiovascular health through individualized programs, which are designed to optimize physical, psychological, social, vocational, and emotional status [17].

The optimal cardiac rehabilitation program.

After 70 years of CR research, it appears that an optimal CR program would consist of either home-based or centre-based CR delivery models, exercise training that utilizes high-intensity aerobic interval training combined with resistance training and patient education and counselling that promote healthy behaviours [17]. The following sections will briefly describe what an optimal CR program might look like.

Program delivery

Cardiac rehabilitation services have been traditionally offered in centre-based or institutional settings and utilized supervised group exercise [17]. Programs have now grown to become more comprehensive in nature with additional patient care services in education and therapeutic interventions, risk factor modification, psychosocial counselling, nutrition management, and vocational counselling. After referral to CR, patients usually undergo a medical assessment and a graded exercise test to determine the appropriate exercise prescription for each patient. Participation in a standard 12-week CR program is known to result in positive changes in health-related quality of life and cardiac risk factors, such as high cholesterol, high blood pressure, diabetes, smoking and exercise capacity [21, 31]. However, this type of model requires cardiac patients to participate in the CR program on site.

It has been shown that cardiac patients maximize cardiovascular health through centre-based CR; however, patients living in rural areas without a CR centre may not be given the opportunity to participate in center based programs due to the lack of infrastructure [17]. Thus, the development of home-based CR emerged to broaden access and participation. In fact, home-based CR models have been described and researched for over 20 years [32,

[33]. Home-based CR programs utilize limited hospital or clinical visits with regular follow up by mail or telephone by a cardiovascular nurse or exercise specialist that facilitate risk factor modification. These programs are potentially less costly, more readily available, and may attract individuals who are at risk for drop out due to inconvenience in attending a centre or facility-based program.

A recent Cochrane Review by Taylor *et al.* [34] compared the effects of home versus centre-based CR, with 12 randomized controlled trials (1,938 participants) included in the analysis. Specifically, amongst the five studies that compared home versus centre-based CR on death rates, participation and completion of either CR program resulted in a 25% relative reduction in mortality [34]. Additionally, there appear to be no significant differences for risk of death, major cardiac events, exercise capacity improvements, or modifications of the biological risk factors between both program delivery models.

Exercise interventions

After being medically cleared for exercise, patients attending a centre-based CR program usually participate in group exercise classes one to three times per week at the CR program centre for as brief as only a few weeks to as long as a year [17]. Typically, CR programs utilize aerobic exercise training of moderate intensity three times per week for 12 weeks. Although this mode of exercise has demonstrated improvements of 11-36% in exercise capacity [35], there are a number of cardiac patients who do not receive any benefit, or demonstrate reductions in exercise capacity [36]. Behavioural factors, such as poor program attendance and insufficient frequency and intensity of exercise, usually contribute to the lack of improvement in health outcomes [17]. Therefore, it is important that CR programs develop new and innovative models of program delivery to enhance

CR program attendance in order to enable the exercise training program to enhance the patients' exercise capacity.

High-intensity aerobic interval training has been shown to be more effective than continuous moderate intensity aerobic training for enhancing exercise capacity in cardiac patients as well as otherwise healthy adults [37]. A recent systematic review by Cornish *et al.* [37] analyzed interventions utilizing high-intensity aerobic interval training versus continuous moderate intensity aerobic exercise in patients with cardiovascular disease. It was found that high intensity aerobic interval training yielded larger improvements in exercise capacity, when compared with standard continuous moderate intensity aerobic exercise. Specifically, Warburton and colleagues [38] observed a 30% improvement in exercise capacity after 16 weeks when high-intensity aerobic interval training was utilized and only a 9% improvement in continuous moderate intensity training. Moreover, in all of the trials examined, there were no observed adverse outcomes for the cardiac patients participating in high intensity aerobic training. Thus, there is evidence to suggest that high-intensity aerobic interval training has a superior effect compared to continuous moderate intensity aerobic training. To review the trials analyzed by Cornish *et al.* [37], see the articles referenced as [38-44].

The benefits of resistance training in CR have not been as well-documented as aerobic training [17]. However, a recent meta-analysis by Marzolini *et al.* [45] indicate that cardiac patients who participated in combined aerobic and resistance training had greater improvements in exercise capacity, upper and lower body strength, greater reductions in total body fat, and a greater perception of quality of life. One of the main concerns with resistance training is the risk of significant elevations in blood pressure; however, these

risks are to be associated with the intensity of resistance training. For example, blood pressure elevations of greater than 100 mmHg have been documented with intensities of 80% to 100% of a person's 1 repetition maximum [46]. However, there were no reported adverse outcomes associated with resistance training in any of the twelve studies meeting inclusion criteria in the meta-analysis [45]. Furthermore, the American Heart Association (AHA) recommends that cardiac patients complete resistance training exercises 2-3 times per week within a 40% to 60% repetition maximum range for 8-10 exercises because it has been determined to be safe for cardiac patients [46].

Patient education and counselling

In order to promote healthy behaviours, CR utilizes patient education and counselling. Behaviours that are currently targeted through patient education include weight reduction, smoking cessation, dietary and nutrition habits, and adherence to prescription and non-prescription medications [17]. A review of lifestyle change interventions in CR programs by Cobb *et al.* [47] found that frequent follow ups by health care providers were successful in enhancing adherence to lifestyle change and for modification in the behavioural risk factors and thus the biological risk factors for heart disease. Specifically, patients who received intensive lifestyle counselling for a five year period were 2.5 times more likely to adhere to healthy lifestyle behaviours promoted in CR programs, as compared to patients receiving standard follow up over a 12 week period [48]. Therefore, patient education that promotes modification of the behavioural and biological risk factors should be included in a CR program.

Lifestyle coaching appears to be beneficial for modification of the biological risk factors. In the Coaching patients On Achieving Cardiovascular Health trial, patients

attending CR were given five telephonic coaching sessions over a six month period by a dietician or nurse plus CR, which was compared to CR alone [49]. Patients who received the coaching intervention reduced their total cholesterol by 0.54 mmol/L (95% confidence interval (CI), 0.42-0.65 mmol/L) and patients who received CR only reduced their total cholesterol by 0.18 mmol/L (95% CI, 0.07-0.29 mmol/L). Therefore, it is evident that lifestyle coaching by an allied health care provider should be included to optimally promote healthy living initiatives amongst cardiac patients attending CR.

Cardiac rehabilitation programs improve quality of life, depression, and anxiety.

Over seventy years of CR program research indicates that CR enhances the cardiovascular and overall health of cardiac patients. Specifically, CR programs have been shown to improve patient quality of life, depression, and anxiety in the short-term. Duarte-Freitas and associates [50] completed a prospective observational study, which assessed the effects of an intensive four-week CR program on quality of life and mood status. The CR intervention consisted of an average 5.5 sessions per week and education sessions aimed at smoking cessation and to help patients with anxiety and depression. Upon completion of the program, quality of life and depression scores improved after the four weeks of CR by 11% for physical scores and 14% for mental scores according to the Short-Form-36 quality of life questionnaire (SF-36), and by 29% for anxiety and 32% for depression, according to the Hospital Anxiety Depression scale (HADs). Improvements in depression may translate into long term benefits, as depression has been shown to be an independent risk factor for heart disease and is at least as detrimental as the traditional risk factors for heart disease [51].

Patients who participate in a CR program enhance their quality of life and mood status

after participation in CR. A prospective observational study by Yohannes *et al.* [52] was able to show that patients maintain quality of life and enhanced mood status 12 months after participation in a CR program. Specifically, anxiety and depression scores were significantly lower at 12 months (14 versus 12) compared to baseline based on the HADs.

Cardiac rehabilitation reduces the risk of mortality and major cardiac events.

Several clinical trials and meta-analyses have demonstrated that CR significantly improves survival after a major cardiac event. In a Cochrane Review by Joliffe and colleagues [18], it was found exercise-only CR reduced all-cause mortality and major cardiac events by 27% and 36%, respectively, as compared to patients not attending a CR program. Taylor *et al.* [53] have conducted a more recent meta-analysis and review of randomized controlled trials of comprehensive CR programs and found that patients attending CR had a 20% and 26% relative reduction in all-cause and cardiac mortality, respectively, for cardiac patients attending CR, as compared to patients not attending CR.

Cardiac rehabilitation reduces the risk of mortality and major cardiac events for patients with heart failure.

Patients with heart failure have been considered to be higher risk cardiac patients, as compared to CABG patients, and participation in CR amongst this higher risk population had previously been considered to be detrimental [17]. In the multi-centre Heart Failure: A Controlled Trial Investigating Outcomes of Exercise Training, 2331 patients with heart failure were randomized to usual care or usual care plus aerobic exercise training to determine the safety and efficacy of CR in patients with heart failure [54]. Interestingly, there were 15% fewer re-hospitalizations due to major cardiac events for the patients participating in aerobic exercise training. Moreover, CR appears to be safe for patients

with heart failure, with no adverse events occurring in over 60,000 exercise hours [55]. Therefore, patients with heart failure should participate in CR programs to promote cardiovascular health and improve overall quality of life.

There is evidence to suggest that CR programs reduce the risk for all-cause mortality for patients with heart failure. Belardinelli *et al.* [56] were the first to demonstrate long-term health outcomes in patients with heart failure. They randomized 110 patients to 12 months of exercise training performed in a CR program and found that those who exercise had a relative risk of 0.37, as compared to standard care. Moreover, in the Exercise Training Meta-Analysis of Trials in patients with Chronic Heart failure of nine randomized controlled trials and a mean follow up 705 days after exercise training found that heart failure patients who participated in CR had a 45% reduced likelihood of dying compared to patients who did not participate in CR [57].

As exercise capacity is an important prognostic factor for mortality in patients with and without cardiovascular disease, it also appears to be a strong independent prognostic factor for adverse outcomes in patients with heart failure [36]. Tabet and associates [36] conducted a prospective cohort study of 155 patients with heart failure attending CR and found that heart failure patients who did not improve exercise capacity were 8.2 times more likely to have a major cardiac event 16 month after CR attendance. Conversely, heart failure patients who improved their exercise capacity by at least 6% had approximately 13% fewer adverse cardiac events than those who did not improve their exercise capacity.

Older cardiac patients who attend cardiac rehabilitation reduce their risk for mortality and major cardiac events

Most studies examining the benefits of CR programming are performed on low-risk,

middle-aged cardiac patients and less attention has been given to examine older cardiac patients [17]. A recent longitudinal study by Onishi *et al.* [19] followed cardiac patients who were over 65 years old attending a CR program and examined its effects on major cardiac events and mortality. Patients were followed for a median 9.5 years. Notably, it was found that the older cardiac patients who did not attend CR were more than twice as likely to experience a major cardiac event compared to older cardiac patients who attended CR. Mortality also tended to be lower in the CR group; however, this did not reach statistical significance ($p = 0.08$).

In another study with 601,099 United States Medicare beneficiaries hospitalized for coronary conditions or cardiac revascularization procedures, Suaya *et al.* [20] examined one and five year mortality rates of cardiac patients older than 65 years who did and did not attend CR. Notably, only 12% of the total cohort attended CR. For cardiac patients attending CR, there was up to a 34% relative reduction in mortality. Moreover, for cardiac patients attending 25 or more CR sessions, there was a 19% relative reduction in mortality compared to patients attending less than 25 sessions of CR. Thus, older cardiac patients appear to derive similar benefits from attending CR as middle-aged cardiac patients. Furthermore, there appears to be a dose-response relationship between health outcomes and CR program attendance.

Cardiac rehabilitation is underutilized

Despite the significant health benefits of CR, only 15-20% of North American cardiac patients attend CR [22]. In Manitoba, local data indicates that less than 30% of cardiac patients actually attend a CR program [13]. Factors contributing to low patient enrolment into a CR program are multi-factorial, consisting of barriers at the health system level [58],

health care provider level [22] and patient level [59]. Arguably, one of the primary reasons for the significant underutilization of CR in some jurisdictions is the failure to refer cardiac patients to CR [60]. In the United States, the AHA initiated a program called, "Get With The Guidelines" (GWTG) and examined referral rates across the United States. Recently, GWTG found that only 56% of eligible cardiac patients with cardiovascular disease were referred to CR. In fact, over a third of hospitals participating in the GWTG program referred less than 20% of eligible cardiac patients to CR [61]. In Canada, similar results were found, with only 43% of patients referred to CR and only 37% enrolled in CR [22]. In Manitoba specifically, due to an automatic referral strategy (which will be discussed in the following paragraph), almost 100% of cardiac patients are referred to CR programming [62]. Even so, attendance is only 30% after referral.

Recent CR initiatives have been developed in an attempt to maximize participation in CR through alternative referral strategies. Two strategies for promoting patient uptake into CR have been through automatic referrals and liaison referral. Automatic referrals utilize standard discharge orders to prompt CR referral in cardiac patients; whereas liaison referral is completed through a personal discussion with a healthcare professional. Grace and colleagues [60] conducted a prospective controlled study to determine the effects of a combined automatic and liaison referral compared with usual referral. Compared to usual referral, cardiac patients were 8.4 times more likely to attend CR when automatic referrals were combined with liaison referrals. Notably, 73% of the patients that participated in the innovative referral strategy made the decision to enrol in CR.

Research is needed in cardiac rehabilitation to provide the best care for cardiac patients.

Although we have summarized data from the literature to address a number of important questions regarding what constitutes a good CR program, less emphasis has been placed on how to provide the best cardiovascular care [17]. Future CR research should examine how to promote the utilization and adherence to CR, especially in lower socioeconomic and higher risk cardiac patient populations. The effects of other training modalities should be investigated further, and determine if alternative exercise training methods, such as tai chi and yoga, can also promote cardiovascular health in the cardiac patient population. Moreover, there is a need to develop new methods and interventions to change health behaviours of cardiac patients as well as target ways to educate health care professionals on the importance of CR. There is also a need to develop methods to evaluate programs across the country and globally through CR registries and national database initiatives to improve CR program tracking and reporting. Additional effort must also be made to determine the cost benefit of CR, which is needed to influence policy makers and stakeholders so they invest in a health intervention that can improve cardiovascular health amongst cardiac patients. However, these issues are beyond the scope of the current project due to resource limitations. Thus, the remainder of this literature review will focus on our project and to examine issues that we can more easily address. Specifically, we are interested in identifying strategies to provide patients with the best cardiovascular care by optimizing the utilization of exercise therapy for the management and treatment of patients with established cardiovascular disease.

Surgery wait lists increase the risk of mortality for patients with established heart disease.

Wait times for cardiac surgery are a major issue that impacts the cardiovascular health of patients. Depending on the severity of the patients' angina symptoms, coronary anatomy, and left ventricular function, a patient will be classified as urgent, semi-urgent, or elective. Urgent patients will receive surgical care within hours to a few days; semi-urgent patients will be placed on a wait list that typically lasts for less than 10 weeks; whereas, elective patients will be placed on a wait list that is approximately 10-16 weeks in most cases [13]. Notably, almost a third of patients waiting for CABG surgery are placed on a wait list for more than a month [63]. During this wait period, many patients experience anxiety and are fearful of participating in physical activity and, thus, may become sedentary and experience further cardiovascular de-conditioning. Sobolev *et al.* [63] examined a cohort of 8966 semi-urgent and elective cardiac patients who were waiting for CABG surgery and found that patients who waited for more than a month for their surgery had a 64% increased risk of dying while waiting for surgery compared to patients waiting less than a month. This is troubling because wait times for elective cardiac surgery are 10-16 weeks in Manitoba [13]. Therefore, it is imperative that the health care system identifies innovative interventional strategies to maintain the cardiovascular health status of cardiac patients while they wait for surgery. Given that CR can enhance cardiovascular health post-operatively, there may be an opportunity to utilize exercise therapy to maintain the cardiovascular health status of cardiac patients while they wait for surgery.

When is the optimal time to start exercise therapy?

Inpatient exercise therapy immediately after cardiac surgery improves functional capacity.

Post-operative cardiac surgery patients who begin an exercise therapy program one day after surgery improve their functional walking ability. Hirschhorn *et al.* [64] analyzed 93 patients waiting for first time CABG and were either randomized to 1) walking exercise, 2) walking and breathing exercise, or 3) standard care, for four days while recovering in hospital from CABG. Walking exercises were progressed over the four day period from walking on the spot for two minutes, four times a day, to walking for two 10 minute periods a day. Breathing exercises consisted of using an incentive spirometer and combined lateral basal expansion (deep breathing exercises). The goal of the breathing exercises was to determine if they had an additive effect to total distance walked, compared to walking only. After the four day intervention, the walking exercise group as well as the walking and breathing exercise group increased their total average 6 minute walking distance to 444 ± 84 meters and 431 ± 98 meters, respectively, and there were more significant improvements than the standard care group (377 ± 90 meters). However, there were no significant differences between the two intervention groups (i.e. walking exercise group vs. walking and breathing exercise group) in total distance walked after the intervention; therefore, the breathing exercises did not have an additional effect. Notably, there were no adverse events in the intervention (i.e. walking exercise group vs. walking and breathing exercise group) and standard care groups. Thus, an exercise therapy program initiated one day after cardiac surgery appears to be safe and effective in improving functional walking ability in CABG surgery patients. Based on these data, it appears that functional walking ability is a parameter that should be optimized as early as possible after surgery.

Post-operative outcomes are more favourable in cardiac patients with higher levels of aerobic and muscular fitness before cardiac surgery.

The physical fitness of cardiac patients pre-operatively is known to influence post-operative outcomes after CABG surgery [65-67]. Cook *et al.* [65] conducted an analysis of 200 patients scheduled for initial CABG and assessed levels of grip strength, exercise capacity, and body fat percentage using skin fold measurements. Patients with the lowest level of strength, exercise capacity, and highest level of body fat pre-operatively tended to have longer hospital stays (13.4 days versus 5.8 days) and were more likely to have at least one complication post-operation (52% vs. 36%), as compared to patients with the highest level of strength, exercise capacity, and lowest percent body fat.

Evidence to indicate that pre-operative physical activity behaviors influence post-operative CABG surgery clinical outcomes was shown by Nery and Barbisan [66]. In a cohort of 202 patients waiting for CABG, the effects of pre-operative leisure-time physical activity on early outcomes after CABG were analyzed using the Baecke Usual Physical Activity Questionnaire, which investigates the physical activity behaviour over the last 12 month period. Based on the results, it appears that patients who participated in 30 minutes or more of physical activity 3-4 times per week had a 33% shorter hospital stay and were 78% less likely to have a major cardiac event after surgery, compared to patients who were sedentary before surgery. Interestingly, there is a negative correlation between total distance walked during a 6MWT and length of hospital stay, where patients that walk longer distances tend to exit the hospital sooner ($r= -0.62$) [68].

Further evidence indicates that regular physical activity prior to cardiac surgery reduces the risk of adverse outcomes after surgery. A retrospective analysis by Nery and Barbisan

[66] analyzed the medical records of 110 cardiac patients who were older than 80 years of age, who had a myocardial infarction (MI) and underwent an urgent percutaneous coronary intervention. Physical activity status was retrospectively analyzed by reviewing medical records. It was found that patients with higher levels of physical activity pre MI had significantly lower rates of in-hospital mortality compared to patients with lower levels of physical activity (4% vs. 15%). Based on these data, it appears that physical fitness and functional walking ability are parameters that should be optimized prior to surgery. In fact, we suggest that the utilization of cardiac "pre-habilitation" (i.e. Prehab) prior to cardiac surgery may be an effective intervention to enhance physical fitness and functional walking ability and, thereby, promote a healthy and faster recovery from cardiac surgery. However, to our knowledge, pre-surgery exercise therapy is not a part of standard care for elective CABG surgery patients.

Do clinicians recommend exercise interventions before surgery for other disease or injury conditions?

Although cardiac patients appear to have a more favourable prognosis if they have higher levels of aerobic and muscular fitness, there are few studies examining the effects of exercise therapy before cardiac surgery. Even so, a review of the literature provides evidence indicating that other disease and injury conditions do utilize exercise therapy before surgery to improve clinical outcomes. Much like cardiac patients, pre-operative exercise capacity is a strong predictor of morbidity amongst lung cancer patients requiring lung resection. Specifically, lung cancer patients who had an exercise capacity below 15 ml O_2/kg/min all had at least one postoperative complication in a study by Bobbio and colleagues [69]. A prospective observational study examining whether a

cardiopulmonary rehabilitation program could improve exercise capacity amongst 12 lung cancer patients requiring lung resection received a pre-operative intervention, which consisted of immediate smoking cessation, optimization of pharmacological treatment, prescription of bronchodilators, inspiratory muscle training, and aerobic training on a cycle ergometer five times per week for four weeks. At baseline, patient VO_{2peak} was 13.4 ml/kg/min. The mean improvement in aerobic capacity following the program was 2.8 ml O_2/kg/min (21% improvement) and improved mean exercise capacity above 15 ml O_2/kg/min.

Exercise therapy before major abdominal surgery appears to promote patient health. In a recent systematic review by Valkanet and colleagues [70], the effects of pre-operative exercise therapy in knee, hip, cardiac, and abdominal surgery on post-operative complication rate and length of hospital stay were analyzed. The effects of inspiratory muscle therapy or exercise training pre-operatively were pooled for cardiac and abdominal surgery, and it was found that inspiratory muscle training significantly reduces the length of hospital stay as well as reduces pulmonary complications after surgery. In contrast, Dronkers et al [71] had mixed findings of exercise therapy pre-operatively in abdominal surgery. They conducted a randomized controlled trial of 42 patients aged 60 years or older requiring elective abdominal oncological surgery and determined the effects of a 3-4 week exercise therapy intervention on pre-operative functional capacity and post-operative complications. The intervention consisted of two 60 minute sessions per week, consisting of lower limb resistance training exercises at 60-80% one-repetition maximum, 20-30 minutes of aerobic exercise prescribed at 55-75% heart rate maximum and inspiratory muscle training. The intervention group was compared with a group that

received exercise advice. Although the exercise therapy program was feasible and improved respiratory function, there were no differences in length of hospital stay between the two groups. Moreover, functional capacity did not significantly change in the patients participating in the exercise therapy program compared to the exercise advice group and was not significantly different between the two groups after the intervention. The short-term exercise therapy program may have not been of sufficient duration and intensity to observe significant differences between the intervention and advice only group. Therefore, this evidence suggests that exercise therapy interventions must be designed to specifically target functional capacity to have a significant benefit.

The same systematic review by Valkenet *et al.* [70], which examined the effects of pre-operative exercise therapy in joint replacement, abdominal, and cardiac surgery, found no significant effects on length of hospital stay and post-surgery complications when the pooled effects of knee and hip joint replacement were analyzed. The studies of knee and hip joint replacement therapy, however, were heterogeneous and the interventions were not well reported; therefore, it appears as though exercise therapy in joint replacement therapy needs higher quality randomized controlled trials to further analyze the effects on clinical outcomes. Conversely, a recent study by Brown et al [72] on total knee arthroplasty was conducted utilizing a case study approach in a female patient who underwent two separate total knee arthroplasty procedures. The first surgery preceded usual care on her right knee, while surgery on the left knee was preceded by Prehab. When compared to the left knee, strength of the right knee was 50% higher before surgery measured by isokinetic knee flexion and extension and functional walking ability was 30% higher prior to surgery. Moreover, these improvements were maintained after surgery, which

may facilitate the rehabilitation process post-surgery. Therefore, larger randomized trials should investigate the effects of this exercise therapy program on total knee arthroplasty in a large cohort.

Pre-operative education interventions improve the quality of life in cardiac patients.

Patients with heart disease may experience anxiety prior to their surgical intervention and, thus, may become sedentary and experience further cardiovascular deconditioning. Therefore, interventions to prevent unhealthy behaviours in cardiac patients waiting for cardiac surgery should be advocated. Educational interventions prior to cardiac surgery appear to improve overall quality of life and enhance mood status [73]. For example, Goodman *et al.* [73] conducted a nurse-led randomized controlled trial of 188 cardiac patients waiting for CABG and determined the effects of lifestyle counselling and education on risk factor modification and health care utilization. Patients were randomized to either a monthly nurse-led education program group while on the waiting list for cardiac surgery or to a routine care group. There were no differences in any of the traditional risk factors after the intervention between the intervention and usual care groups. Moreover, anxiety and depression according to the HADs did not change and was not different between the two groups after the intervention. However, cardiac patients in the education group required fewer readmissions to hospital after CABG. As a result, the education group had lower health care costs due to readmissions after CABG, as compared to the standard care group (i.e. £10,754 vs. £13,047) [73].

Has anyone utilized Prehab for the treatment of pre-operative cardiac patients?

Very few published clinical trials have utilized a Prehab intervention to optimize

cardiovascular health amongst elective cardiac surgery patients while they are waiting for surgery [74-77]. Hadj *et al.* [74] examined the effects light exercise, antioxidant and mental therapy in 16 pre-operative CABG patients in a randomized controlled trial and compared its effects on quality of life, blood pressure, and oxidative stress by measurement of malondialdehyde with an antioxidant placebo group (n=59) and a historical control group receiving usual care (n=74) who had their quality of life assessed previously. Cardiac patients in the intervention group received on average a 36 day intervention, which included a 20 day supply of antioxidants, a home-based exercise program consisting of 30 min per day of light exercises including stretches and walking and a mental therapy program consisting of relaxation techniques and lifestyle modification counselling. The intervention significantly reduced systolic blood pressure from 140 mmHg to 132 mmHg and improved the physical (33.5 to 41.0) and mental quality of life (44.3 to 54.1) composite scores on the SF-36 questionnaire, as compared to the control groups. Therefore, an intervention that utilizes light exercise, antioxidant and mental therapy may have beneficial effects for risk factor modification and to improve patient quality of life.

Herdy *et al.* [75] conducted a randomized controlled trial of 56 patients waiting in hospital for cardiac surgery and randomized 29 patients to an exercise intervention group and the remaining 27 patients to usual care. The intervention consisted of a five day minimum pre-operative and five day minimum post-operative exercise program, where patients were asked to complete a series of progressive exercises, initially starting with exercises at an intensity of two METs on the first day to four METs on the fifth day. Physical activities utilized were not reported. In the group receiving the exercise intervention, the prevalence of pneumonia was significantly lower (0 vs. 7 cases) compared to usual care.

Notably, patients receiving usual care were five times more likely to experience atrial fibrillation perioperatively compared to the exercise therapy group. Moreover, the length of hospital stay after cardiac surgery was significantly lower in the exercise intervention group (6 days versus 10 days) compared to the control group. Therefore, based on this evidence, it appears that exercise therapy is safe for patients waiting for cardiac surgery and can be utilized to promote the health of cardiac patient populations waiting for cardiac surgery.

The strongest data indicating that a Prehab program is appropriate for the management of pre-surgery patients was provided by Arthur *et al.* [76] Specifically, they conducted a randomized controlled trial, consisting of 249 cardiac patients waiting at least 10 weeks for elective CABG. Cardiac patients were randomized to an eight week CR program prior to cardiac surgery and completed 2 exercise sessions per week, education classes on risk factor modification, and monthly nurse telephone calls to answer questions and provide reassurance. The primary outcome was length of hospital stay and secondary outcomes included exercise capacity, quality of life, mood status, and utilization of health care services. Patients were then followed one week before surgery, eight weeks post-surgery, and six months after surgery. Length of hospital stay after CABG differed significantly between groups, with the intervention group staying one less day in the hospital and a median of 2.1 less hours in the intensive care unit. Economically speaking, the use of the Prehab intervention translated into a net cost savings of $133 per patient per day [76]. Moreover, patients who received the intervention had a better quality of life than the control group. However, this study failed to report an improvement in physical fitness and did not report a change in this parameter over time between the two groups. Even so,

this is the strongest evidence that a Prehab program reduces the total length of hospital stay for patients waiting for elective CABG surgery. Furthermore, the study by Arthur *et al.* [76] highlights the potential cost savings that a Prehab program may provide the Canadian health care system.

The study by Arthur *et al.* [76] inspired another study to examine patient perceptions of a CR intervention before cardiac surgery by Mooney *et al.* [77]. The interviews conducted by Mooney *et al.* [77] indicated that much of the anxiety due to cardiac surgery wait lists can be alleviated through a Prehab program. Specifically, when patients were given instruction on how to exercise safely and effectively before cardiac surgery, the patients reported having confidence and motivation to initiate physical activity into their daily lives.

Based on the data presented in this literature review, physical fitness predicts health outcomes. Specifically, cardiovascular disease patients with lower levels of fitness have an increased risk of mortality, as compared to patients with higher levels of fitness [14, 15]. This literature review also cites evidence indicating that longer wait times negatively impact the health of patients waiting for cardiac surgery. Specifically, wait times longer than a month are associated with a 64% increased risk of mortality [63, 78], as compared to a wait time shorter than a month. The data presented also shows that Prehab for patients waiting for CABG surgery reduces anxiety as well as reduces length of hospital stay. However, based on the reviewed studies, there is little evidence to suggest that a structured cardiac Prehab program will improve functional walking ability of patients that are scheduled to undergo CABG surgery. Moreover, there is little evidence to indicate whether Prehab promotes a more physically active lifestyle before and after elective

CABG surgery. Therefore, we would like to address these gaps and determine if a Prehab program can improve the health status of patients waiting for CABG surgery.

Chapter 3: Study Design

Rationale, objectives and hypotheses

Based on the literature review presented, we believed that there was an opportunity to utilize a cardiac Prehab program to enhance the cardiovascular health status for patients waiting for CABG surgery. Therefore, we designed a randomized, controlled trial to demonstrate the feasibility of conducting a Prehab program for patients waiting for elective CABG surgery. Furthermore, we determined if functional walking ability, healthy behaviors and the amount of daily physical activity is enhanced to a greater extent amongst patients who complete the Prehab intervention, as compared to those who receive standard care.

Specifically, we hypothesized that:

1) A Prehab intervention will improve functional walking ability to a greater extent one to two weeks pre-operatively and three months post-operatively, as compared to patients who receive standard care only; and,

2) patients who receive Prehab will promote a healthier lifestyle, enhance quality of life, reduce anxiety related to heart health, improve mood status (i.e. the signs of depression) and enhance exercise self-efficacy amongst patients waiting for CABG surgery, as compared to standard care.

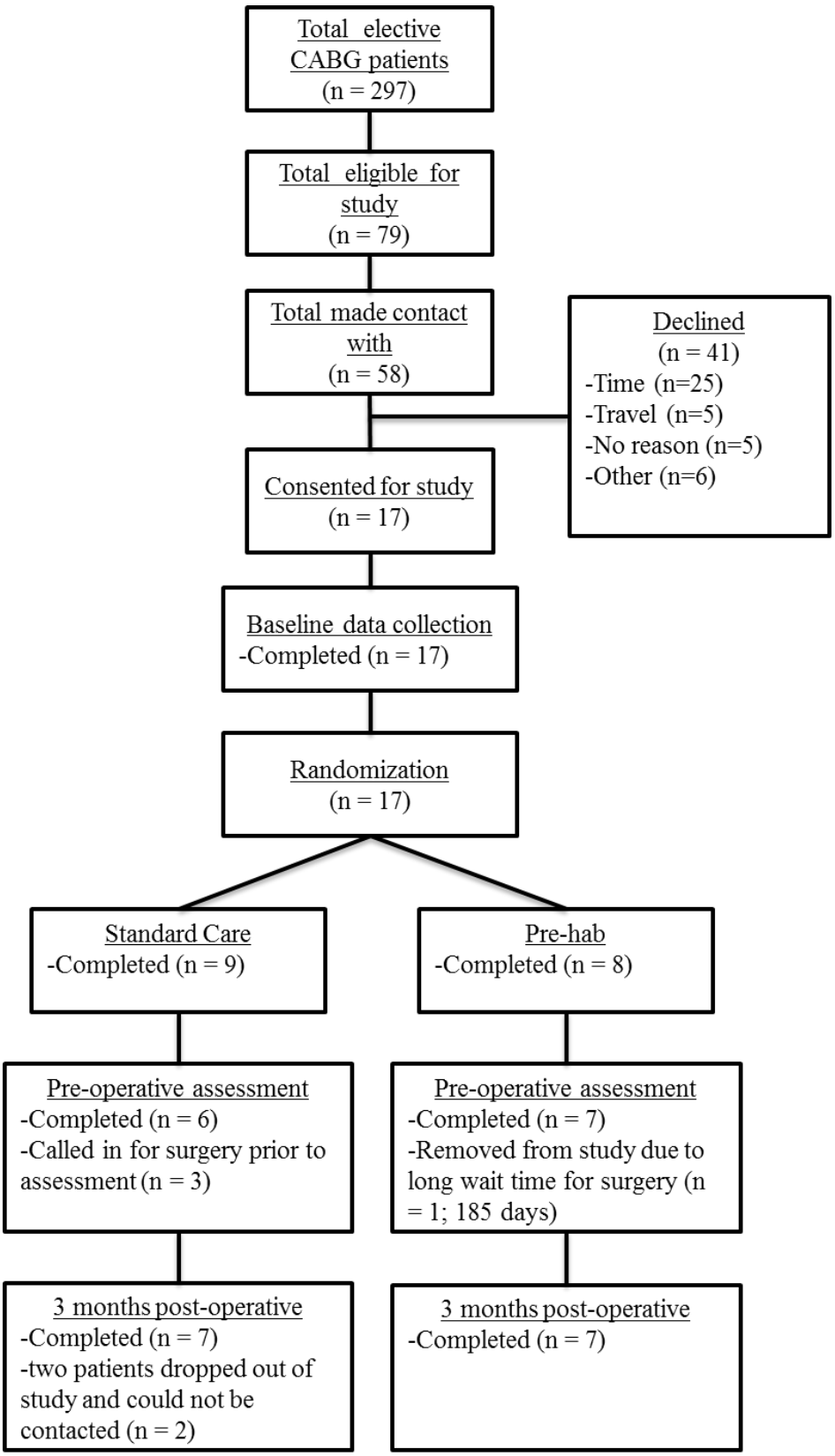
Ethics approval

The study was approved by three ethics review panels, namely 1) the University of Manitoba Health Research Ethics Board; 2) the St. Boniface Hospital Clinical Research Committee; and, 3) the Winnipeg Regional Health Authority Cardiac Rehabilitation Research Review Board.

Patient recruitment

From February 2011-May 2012, we recruited 17 patients who were scheduled to undergo elective CABG surgery within the Winnipeg Regional Health Authority Cardiac Surgery Program. In the 2009/2010 fiscal year, approximately 863 cardiac patients attend the Cardiac Surgery clinic and 236 undergo elective CABG surgery at the St. Boniface Hospital [79]. A total of 79 patients were eligible for the study. See Figure 1 for flow of recruitment.

Figure 1. Flow of recruitment



Our inclusion and exclusion criteria were similar to the Prehab intervention by Arthur et al [76]. Specifically, the inclusion criteria were:

- On elective Waitlist for CABG surgery with a minimum anticipated wait time of 4-6 weeks or more.
- No history of unstable angina.
- Canadian Cardiovascular Society angina score of less than 4.
- No history of MI within the past seven days.
- Ejection fraction greater than 30%.
- No history of dementia or psychiatric problems.
- No self-reported dizziness or confusion.
- Able to read, speak, and understand English.
- Previously sedentary (reporting accumulating less than 45 minutes of moderate intensity physical activity per day on at least three days per week over the last three months).
- No previous participation in a CR program.
- Lives in Winnipeg or has easy access to the Reh-Fit Centre.

The following patients were excluded from the study:

- If patients cannot attend the intervention due to geographic limitations.
- If patients cannot participate due to physical limitations.
- Diagnosis of exercise-induced arrhythmia.

These criteria were utilized to consider the safety of the participants and were recommended by clinical staff at the Reh-fit Center.

Cardiac patients were identified for inclusion in the study by the Cardiac Surgery Wait List Coordinator after they were assessed by a cardiac surgeon at the St. Boniface Hospital and had their name added to the elective cardiac surgery wait list. The Wait list Coordinator at the St. Boniface Hospital then generated a list of eligible patients that satisfied the inclusion/exclusion criteria for the study. The Wait List Coordinator also made contact with eligible patients to determine if they would be willing to speak with research staff regarding our study and forwarded the names of these potential participants to the research staff. The research staff then contacted the patients by phone to introduce the study and determined if the patient was interested in the study. Information regarding the study was given to each prospective patient at the time of recruitment. Informed consent was obtained in writing from all participants in the study upon the first meeting with the research staff. The informed consent form can be viewed in Appendix A. Data was collected at Baseline (i.e. at least 4-6 weeks before surgery based on the estimated wait time for surgery), one to two weeks before their surgery (Preop), and three months after their surgery (Three months post-operatively). This data collection schedule enabled the research team to determine longitudinal changes in primary and secondary outcome measures.

Data collection schedule

All patients enrolled in the study met with the Research Assistant at the Asper Clinical Research Institute, St. Boniface Hospital in Winnipeg. All patients were asked to complete a 6MWT, to complete a series of questionnaires, to wear an accelerometer for a seven day period and to have research staff collect physical measures (*n.b.; additional detail about these measures will be described in the data collection section of this*

document).

After enrolment into the study (i.e. Baseline), the second and third assessment were completed at Preop and Three months post-operatively. These assessment appointments included the same questionnaires, 6MWT, accelerometry, and physical measures as Baseline. Moreover, a review of the patients' medical chart from the St. Boniface Hospital Cardiac Surgery Program were completed in all study participants. A review of the Reh-Fit client case files was also conducted for participants randomized to the Prehab intervention.

Randomization

After patient consent and baseline measurements were collected, a total of nine patients were randomized to standard care only (StanC) and eight patients were randomized to standard care plus Prehab. The Research Assistant randomized each patient by opening a sealed envelope, containing a random group assignment generated by a third party, in order to assign the patient to either StanC or Prehab group. All patients in the study were automatically referred to participate in a CR program after their cardiac surgery.

Standard care arm

The nine cardiac patients randomized to the StanC group received standard care from their primary health care providers and one of the eight cardiac surgeons at the St. Boniface Hospital. Typically, patients are assessed by a cardiac surgeon to determine if a patient is a candidate for cardiac surgery. Patients with elective status, which is the surgery population that was recruited for participation in this study, receive a three hour cardiac pre-assessment prior to their surgery, where a nurse practitioner and anesthetist

assess their cardiac status and other underlying conditions that may have an impact on their surgical risk. For example, each patient undergoing a pre-assessment completes an angiogram and resting electrocardiogram (ECG) test to assess their coronary anatomy and heart function, and also has their blood work assessed. Cardiac nurses counsel each patient on healthy lifestyle behaviors (e.g. smoking cessation, diet) during the pre-assessment appointment. Advice given by the patients' cardiac surgeon varies during the wait period for surgery. Often patients are told by their cardiac surgeon to rest and participate in very light intensity physical activity while waiting for their surgery. In total six of the eight surgeons at the St. Boniface Hospital interacted with the 17 patients in the study.

Intervention arm

The eight cardiac patients randomized to the Prehab intervention received standard care and additionally participated in a CR program located at the Reh-Fit Centre in Winnipeg. Before the initiation of the program, participants were required to complete a health status assessment appointment and complete a symptom-limited graded exercise stress test at the Reh-Fit Centre. The stress test followed standard procedures according to the *American College of Sports Medicine Guidelines for Exercise Testing and Prescription Seventh Edition* [80] and were supervised by a cardiologist, nurse, ECG technician, and Certified Exercise Physiologist. All cardiac patients referred for CR at the Reh-Fit Centre complete a stress test using the Modified Bruce test, which is completed by walking on a treadmill with the incline (grade) adjusted to increase intensity. Upon completion of the assessment and stress test, participants in the study participated in the CR program provided by the Reh-Fit Centre (*n.b. however, it was a Prehab intervention*

for the study participants since they did not yet have surgery). Patients were asked to complete a minimum of two sessions of supervised, structured exercise per week until they were called for surgery, or for the duration of the 16-week CR program provided by the Reh-Fit Centre. The most common exercise performed at the CR program provided by the Reh-Fit Centre is walking around their track. Other exercises that Prehab patients participated in were treadmill walking, cycling on an ergometer machine, stretching, and light resistance exercise. Patients were also be asked to attend a series of four education sessions provided as a part of the standard CR program, which include topics on, medications, exercise, stress, diet, and other cardiovascular risk factors.

Risks

Medical experts from the Section of Cardiac Surgery, the Heart Failure Program, the Cardiac Surgery Intensive Care Unit, the Cardiovascular Health Research in Manitoba (CHaRM) Investigator Group and the Reh-Fit Centre were involved in the development of this project. In general, the medical professionals agreed that the potential risks to participants were considered to be minimal. This perspective is also supported by the literature examining the efficacy and safety of CR programs, which indicate that one adverse event may occur in every 116,000 exercise hours in CR [81]. Nonetheless, eligible participants were informed that there is a certain degree of risk involved through participation of any exercise program. To mitigate the degree of risk for potential participants, we developed study exclusion criteria to select patients that do not have a diagnosis of exercise-induced arrhythmia, unstable angina, or have other physical limitations that may limit their ability to participate in physical activity. Moreover, all patients randomized to the Prehab intervention had an initial Reh-Fit Centre medical

assessment, including an exercise stress test to identify if they were prone to experiencing exercise-induced arrhythmia, angina, or other adverse symptoms. If they showed signs of exercise-induced symptoms, they were not included in the study. Based on our discussions with medical experts, there was a consensus that the risk of participating in an exercise therapy program is considerably less than the anticipated surgical procedure and, in fact, may decrease the patients' overall surgical risk. Moreover, all exercise classes were conducted and supervised by experienced instructors at the Reh-Fit Centre, which is Canada's first certified medical fitness facility. However, if eligible patients believed that they would be at physical risk of harm/injury through participation in the study, they were informed to decline participation.

Patients had the right to refuse participation during the recruitment process. Potential subjects of the study were encouraged to read through the consent forms carefully before agreeing to participate in the study. The decision not to participate or to withdraw from the study did not affect their level of care provided through the St. Boniface Hospital or any other health care center. Furthermore, medical staff could also exclude them from participation if they felt that the Prehab program could adversely influence their health.

Compensation

All the procedures, which were performed as a part of this study, were provided at no cost to the participants.

Primary outcome measure variable

Functional walking ability was the primary outcome measure of the study. Therefore, we utilized the 6MWT, which is designed to measure a person's ability to perform activities of daily living, including walking, stair-climbing, or shopping [82]. The 6MWT is

a practical and simple test which only requires a patient to walk and according to the American Thoracic Society, it provides the strongest indication for measuring the response to medical interventions amongst patients with moderate-severe heart and lung disease [83]. The 6MWT has previously been used to evaluate exercise capacity within clinical populations, including patients with congestive heart failure and pulmonary disease [84]. Walking ability measured by the 6MWT provides important prognostic information similar to exercise capacity for all-cause mortality [85]. Specifically, cardiac patients who could walk 450 meters had almost a three-fold decreased risk of death compared to patients who could walk less than 300 meters [86]. Rasekaba and associates [87] indicate that a 50 meter increase in walking distance is a clinically significant improvement in most disease states, including heart disease. When physical fitness was assessed with 6-minute walking distance in a group of cardiopulmonary patients and compared with a maximal graded exercise test on a treadmill, a correlation of $r = 0.82$ was found when the means of 11 data sets were pooled [88].

All patients in the study performed the 6MWT indoors on a flat surface and was conducted in accordance with the guidelines from the American Thoracic Society [83]. The dimensions of the square course were 50 x 32 ft. Patients were instructed to use their usual walking aid if they needed one for everyday living. Before the test, patients were asked to cover as much distance as they could during a six minute period and were permitted to stop at any time during the test. When the patient was ready, they started the test with the research staff following the patient and timing the test using a stopwatch. No encouragement was provided for the patients and were only notified of the time in one minute intervals and 15 second intervals for the final minute of the test. Total distance

was recorded in meters.

Secondary outcome measures

Gait speed

Gait speed was assessed in accordance with the protocol utilized by Afilalo and colleagues [89]. Specifically, time (seconds) to complete walking a marked distance of five meters was recorded and averaged over a minimum of three trials. Patients were also instructed to use their walking aid if they required one. Gait speed has been used previously to predict mortality and morbidity in patients undergoing cardiac surgery [89]. For example, patients who required more than six seconds to walk five meters had a three-fold increased risk of mortality and morbidity, as compared to patients who required less than six seconds to walk five meters.

Objective measure of physical activity

Multi-directional accelerometers, which are considered the gold standard for physical activity assessment [90], were used to objectively assess physical activity intensity and duration over a seven-day period. Specifically, we utilized Actical accelerometers (Phillips – Respironics, Oregon, USA). Accelerometers are highly accurate and reliable in measuring the total duration and intensity (i.e. sedentary, light, moderate, and vigorous intensity) in adult populations [91]. Actical accelerometers have a piezoelectric acceleration sensor and when under acceleration (e.g. walking, running), the sensor deforms and bends, causing a conformational change and stores an electrical charge in the device [92]. These electrical charges are then filtered, amplified and converted into a series of numbers, called counts. If more acceleration occurs in a given time (i.e. moderate-vigorous physical activity (MVPA), the more counts are recorded and stored.

Typically, the counts are summed in a specific window of time, called an epoch.

In the present study, we utilized the protocol by Colley *et al.* [93] to analyze physical activity data collected by accelerometry. Specifically, patients were asked to wear an accelerometer over their right hip on an elasticised belt during their waking hours for seven-day periods. A valid day of accelerometer data was defined as 10 or more hours of wear time. Non-wear time was defined as at least 60 consecutive minutes of zero counts between 0 and 100. Wear time was defined by subtracting non-wear time from 24 hours. The level of intensity for sedentary, light, moderate, and vigorous intensity utilized count cut-points per epoch of less than 100, 100-1535, 1535-3962 or more, respectively. All accelerometer data were analyzed in 10 minute intervals (i.e. $LightPA_{10min}$, $MVPA_{10min}$, $TotalPA_{10min}$, MVPA MET-min_{10min}, Total MVPA MET-min_{10min}) as well as physical activity accumulated sporadically in bouts of 30 seconds or longer (i.e. $LightPA_{spor}$, $MVPA_{spor}$, $TotalPA_{spor}$, MVPA MET-min_{spor}, Total MET-min_{spor}). Steps per day were also analyzed sporadically (i.e. $MVPA_{steps}$, $Total_{steps}$).

Surveys

Physical activity behaviour:

The short form International Physical Activity Questionnaire (IPAQ) was used to capture Walking and MVPA behaviours that each patient in the study completed over the last seven days at each data collection time point. This questionnaire has been used internationally to capture physical activity levels of healthy individuals and patients with chronic disease and has been shown to have acceptable validity and reliability [94]. The IPAQ has been validated using accelerometer-based physical activity assessment in an international validation study in 12 countries [95] and found a median correlation of $r = 0.30$. More recently, van Poppel *et al.* [96] systematically reviewed over 85 physical

activity questionnaires and found that the IPAQ was one of the five physical activity questionnaires receiving the highest level of reliability.

Each patient had their IPAQ questionnaire scored according to the IPAQ scoring protocol (www.ipaq.ki.se). Data from the questionnaires were used to calculate the minutes per week of vigorous, moderate, walking, and sitting activity. Data was expressed as Walking, $MVPA_{IPAQ}$, $MVPA_{IPAQ}$ and $Total_{IPAQ}$ for minutes per week of each intensity. A MET score (MET= metabolic equivalent; 1 MET = resting energy expenditure) expressed in MET-min/week was calculated specific to each given category of physical activity: MET level x minutes of activity x events per week. Each category of activity was assigned a given MET level (Vigorous = 8 METs; Moderate = 4 METs; Walking = 3.3 METs). MET-min/week scores were expressed as MVPA $MET\text{-}min_{IAQ}$ and Total $MET\text{-}min_{IPAQ}$. Patients were categorized as "Low Active" if they participated in less than 600 MET-min/week and were considered "Moderately Active" if they participated in a minimum of 600 MET-min/week. Patients were categorized as "High Active" if they either participated in; 1) vigorous intensity physical activity on at least three days and accumulating at least 1500 MET-minutes per week or, 2) seven or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum of at least 3000 MET-minutes per week. To view the IPAQ, see Appendix B.

Quality of life and functional health status:

We assessed perceived quality of life and functional health status utilizing the SF-36 questionnaire version 2. Patients completed a total of 36 questions, asking them to rate their health across four different dimensions: general health, emotional health, social

health, physical health, and their role limitations due to their physical and emotional health. The reliability and validity of the SF-36 have been well-established in previous research [97-99].

Patients were given a score ranging from 0-100% across eight different scales of health in accordance with the standardized SF-36 scoring system (http://www.sf-36.org/tools/sf36.shtml). The eight different scales of health are: general health, physical functioning, role limitations: physical, role limitations: emotional, energy/fatigue, social functioning, pain, and emotional well-being. A lower score indicates a poorer health score while a higher percent score indicates a more favorable health score. To view the SF-36 questionnaire, see Appendix C.

Symptoms of depression:

The Patient Health Questionnaire-9 (PHQ-9) was utilized to assess patient depressive symptoms. The PHQ-9 is based directly on the diagnostic criteria for major depressive disorder in the Diagnostic and Statistical Manual Fourth Edition [100]. This questionnaire is a powerful tool in assisting primary care clinicians in diagnosing major depression as well as selecting and monitoring treatment. The PHQ-9 assesses symptoms and functional impairments to make an initial diagnosis, and derives a severity score to help select and monitor treatment [101].

Patients were asked to report how often they experience the nine symptoms of depression over the last two weeks according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition. Patients were given a numerical score (0-27) according to how often they experience the nine depressive symptoms (i.e. 0 = not at all; 1 = several days; 2 = more than half the days; 3 = nearly every day). Patients were also given a

categorical score depending on how many and how often they experienced depressive symptoms (0-4= None; 5-9= Minimal; 10-14= Mild; 15-19= Moderate; 20-27= Severe). To view the PHQ-9, see Appendix D.

Anxiety:

The 18-item Cardiac Anxiety Questionnaire (CAQ) was developed to specifically measure patient perceptions of their anxiety related to their heart health [102]. This reliable and valid scale has been used to measure heart focused anxiety before and after cardiac surgery [103]. Patients answer 18 questions, which focus on how often they experience heart-related anxiety symptoms on a scale from 0-4, with 0 being never experiencing anxiety related to a specific question and 4 being always experiencing anxiety. The questionnaire scores the patient's anxiety on three subscales (i.e. Fear, Avoidance, and Heart-focused attention) and a total cardiac anxiety score. Scores for each subscale are averaged based the number of questions related to each subscale (eight questions for Fear, five questions for Avoidance, five questions for Heart-focused attention); therefore, scores can range from 0-4. A patient with a lower score would indicate that they experience no or very little heart-focused anxiety symptoms, while a higher score indicates that a patient experiences heart-focused anxiety symptoms often. To view the CAQ, see Appendix E.

Self-efficacy:

The 16-item Cardiac Exercise Self-Efficacy Instrument (CESEI) was utilized to measure patient self-efficacy. This questionnaire has been designed specifically to measure self-efficacy for the cardiac risk factor of physical inactivity [104]. The CESEI has been found to be reliable, with an internal consistency of 0.90. Patients rate 16 items

around their confidence for initiating and continuing to participate in exercise programs and being able to fit regular physical activity in their daily life. All items are rated on a scale from 1-5 with a score of one indicating that the patient has "very little" confidence and 5 experiencing "very much" confidence for each of the 16 items. All items are averaged to give a total score ranging from 1-5, with one indicating little overall confidence and five indicating the patient being very confident. To view the CESEI, see Appendix F.

Assessment of risk factor modification:

We utilized the Healthy Lifestyle Questionnaire, which was specifically designed for the Prehab project by Dr. Jo-Ann Sawatzky. Patients were assessed for changes in their 'heart healthy' lifestyles during the period of the study, which assessed changes in their diet, weight, physical activity and smoking status. Patients completed eight questions rated on a scale from 1-4 (1= No, not at all; 2= Yes, a little; 3= Yes, a lot; 4= Not applicable, changes have been made prior to diagnosis) which ask whether any healthy lifestyle changes have been made since they have found out that they require heart surgery. All questions are averaged and a total score can range from 1-4, with a lower score indicating that no, or few changes have been made towards a healthier lifestyle and a higher score indicating that many changes have been made towards a healthier lifestyle. To view the CSHLQ, see Appendix G.

Health-service utilization:

We tested the Health Service Utilization Questionnaire, which was developed for the Prehab project by Dr. Jo-Ann Sawatzky to assess the use of services over a given time period. Patients were asked how often they visited their family physician, cardiologist,

the emergency department, had a hospital admission, had home care service, or any other visits by a healthcare provider over the last month. To view the HSUQ, see Appendix H.

We also determined whether patients chose to attend CR after their surgical intervention. All cardiac surgery patients are automatically referred to CR after surgery; however patients choose to attend CR after surgery, where local data indicates that only 30% of patients attend CR [79].

Physical measures

The research staff collected the following physical measures: resting blood pressure and heart rate, height, weight, and waist and hip circumference. All procedures were conducted by the research staff and followed the *Advanced Fitness Assessment and Exercise Prescription* procedures for measurement of resting heart rate and blood pressure, height, weight and waist and hip circumference [82]. The research staff has completed the training to collect the described physical measures throughout their Kinesiology degree program.

Blood pressure:

Blood pressure was captured by initially asking the patient to sit quietly in a chair with arm rests. The deflated cuff of a sphygmomanometer 2-3 cm above the anticubital fossa with the midline of the cuff wrapped firmly around the anteromedial aspect of the left arm. The cuff was rapidly inflated to 70 mmHg and then slowly increased 10 mmHg at a time until there was an absence of a radial pulse. The head of a stethoscope was placed over the brachial pulse of the patient. The cuff was slowly deflated 2-3 mmHg per second. The first sound was noted with the stethoscope as the first Korotkoff sound, which corresponds to systolic blood pressure. Diastolic blood pressure was noted when the fourth Korotkoff sound was heard (i.e. a muffled sound).

Resting heart rate:

Resting heart rate was captured by auscultation after the patient was seated quietly for five minutes. Specifically, the head of a stethoscope was placed over the third intercostal space to the left of the sternum. The sounds from the heart were counted for 15 seconds and then multiplied by four. This process was repeated three times and then averaged.

Waist circumference:

Waist circumference was measured at the narrowest part of the torso between the ribs and iliac crest, in accordance with the American College of Sports Medicine (ACSM) guidelines. Anthropometric tape was applied snugly around the torso and measured at the end of normal expiration. Waist circumference was measured in centimeters.

Hip circumference:

Hip circumference was measured at the maximum posterior extension of the buttocks in accordance with ACSM's guidelines. Anthropometric tape was applied snugly around the buttocks and measurement was taken in centimeters.

Statistical analysis

The primary outcome variable of functional walking capacity was analyzed between STanC and Prehab using a two-way ANOVA using one repeated measure (time) and one between group comparison (control or intervention arm). A Pearson product correlation was used to analyze relationships between functional walking ability and the secondary outcome variables. Moreover, count data (e.g. proportion of patients using beta-blockers, hypertension, previous MI) was also assessed using a 2x2 Chi-Square test. An independent t-test was used to compare differences of Baseline characteristics between

StanC and Prehab. Non-parametric data was analyzed using the Mann-Whitney U-test.

Sample size calculation

We initially selected a sample size of 20 (10 patients per arm) based on previous literature by Fiorina *et al.* [105], where patients who had elective CABG surgery increased their total distance walked by 40% after participation in a CR program. Specifically, approximately 15 days post-surgery, CABG patients were able to walk 281 ± 87 meters (Mean ± SD) during a 6MWT. Notably, those patients were able to walk a total distance of 407 ± 103 meters after CR. Based on these data, we determined that a sample size of 10 patients per group (i.e.; 10 patients in the StanC arm and 10 patients in the Prehab arm) would provide the study with a power of 0.80 and alpha level of 0.05. However, based on preliminary data between six patients in StanC and six patients in Prehab, we found the mean difference in 6MWT distance was statistically different between StanC and Prehab, with Prehab patients walking further than StanC. Therefore, we completed patient recruitment with nine patients in StanC and eight patients in Prehab. We acknowledged that it was possible that our small sample size would not have enough statistical power to provide insights and conclusions about the effectiveness of the Prehab program for modifying some of the secondary outcome variables collected. However, we intended to collect these data points to generate the pilot data required to conduct a sample size calculation to justify a larger clinical trial examining these secondary outcomes.

Chapter 4: Results

Baseline characteristics

Baseline characteristics were collected for all study participants from medical charts at the St. Boniface Hospital and can be viewed in Table 1. Patient demographics, including age, gender, height, weight, BMI and employment status did not differ between StanC and Prehab. Patient risk factors for heart disease and other co-morbidities were not different between StanC and Prehab. These included ejection fraction, Canadian Cardiovascular Society (CCS) class angina score, previous MI, arrhythmia, pre-syncope, hypertension, peripheral vascular disease, dyspnea, chronic obstructive pulmonary disease (COPD)/asthma, hiatus hernia/reflux, peptic ulcer disease, renal disease, prostatism, cerebral vascular accident/transient ischemic attack, seizures, psychiatric diagnosis, osteoarthritis, rheumatoid arthritis and anemia. Beta-blockers were prescribed for 100% and 29% of StanC and Prehab patients, respectively ($p<0.05$). Other medication use did not differ between groups, which included use of non-steroidal anti-inflammatory drugs, smoking cessation drugs, angiotensin converting enzyme inhibitors, angiotensin receptor blockers, statins anti-platelet drugs, nitrates, calcium channel blockers, proton pump inhibitors, insulin, selective serotonin reuptake inhibitors, diuretics, benign prostatic hyperplasia drugs, corticosteroids, anti-metabolites, asthmatic drugs, anti-seizure drugs and anti-anxiety drugs.

Table 1. Comparison of Baseline characteristics between StanC and Prehab patients.

	StanC	Prehab	p-value
Demographics			
Age (years)	63 ± 3	65 ± 4	0.63
Gender (% female per group)	1 (14%)	2 (29%)	0.99
Height (cm)	172 ± 3	173 ± 4	0.79
Weight (kg)	89 ± 2	98 ± 4	0.10
BMI	30.0 ± 1.0	32.6 ± 1.3	0.13
Working while on wait list for surgery	3 (43%)	2 (29%)	0.99
Pre-operative summary			
Ejection fraction	62% ± 4%	57% ± 5%	0.45
CCS class	2.4 ± 0.2	2.4 ± 0.4	1.00
Previous MI	4 (57%)	4 (57%)	1.00
Arrhythmia	3 (43%)	2 (29%)	1.00
Pre-syncope	2 (29%)	3 (43%)	1.00
Hypertension	6 (86%)	5 (71%)	1.00
PVD	1 (14%)	0 (0%)	1.00
Dyspnea	4 (57%)	4 (57%)	1.00
COPD/asthma	1 (14%)	1 (14%)	1.00
Hiatus hernia/reflux	3 (43%)	3 (43%)	1.00
Peptic ulcer disease	0 (0%)	1 (14%)	1.00
Renal disease	0 (0%)	0 (0%)	1.00
Prostatism	0 (0%)	2 (29%)	0.46
CVA/TIA	1 (14%)	1 (14%)	1.00
Seizures	0 (0%)	1 (14%)	1.00
Psychiatric Hx	2 (29%)	1 (14%)	1.00
Osteoarthritis	2 (29%)	1 (14%)	1.00
Rheumatoid arthritis	0 (0%)	0 (0%)	1.00
Anemia	1 (14%)	2 (29%)	1.00
Diabetes	1 (14%)	2 (29%)	1.00
Hyperlipidemia	7 (100%)	6 (86%)	1.00
Steroid use	1 (14%)	0 (0%)	1.00
Medications			
Beta-blocker	7 (100%)	2 (29%)	**0.02**
NSAID	7 (100%)	7 (100%)	1.00
Smoking cessation	1 (14%)	0 (0%)	1.00
ACE inhibitor	2 (29%)	2 (29%)	1.00
ARB	2 (29%)	1 (14%)	1.00
Statin	7 (100%)	7 (100%)	1.00

Table 1. (cont)

	StanC	Prehab	p-value
Anti-platelet	3 (43%)	2 (29%)	1.00
Nitrate	5 (71%)	4 (57%)	1.00
CCB	3 (43%)	2 29%)	1.00
Insulin	2 (29%)	0 (0%)	0.46
Proton pump inhibitor	2 (29%)	1 (14%)	1.00
SSRI	2 (29%)	0 (0%)	0.46
Diuretic	2 (29%)	3 (43%)	1.00
BPH	2 (29%)	1 (14%)	1.00
Corticosteroid	2 (29%)	0 (0%)	0.46
Gout	2 (29%)	0 (0%)	0.46
Anti-metabolite	2 (29%)	0 (0%)	0.46
Asthma	2 (29%)	2 (29%)	1.00
Anti-seizure	2 (29%)	1 (14%)	1.00
Anti-anxiety	2 (29%)	1 (14%)	1.00

Continuous variables expressed as mean ± standard error. Categorical variables expressed in frequencies (percentage of group). StanC n=7; Prehab n=7. CCS, Canadian cardiovascular society angina score; MI, myocardial infarction; PVD, peripheral vascular disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; TIA, transient ischemic attack; NSAID, non-steroidal anti-inflammatory drug; ARB, angiotensin receptor blocker; CCB, calcium channel blocker. ACE, angiotensin converting enzyme; SSRI, selective serotonin re-uptake inhibitor; BPH, benign prostatic hyperplasia.

Surgery parameters

Data collected for surgery parameters can be viewed in Table 2. Time on wait list, cardiopulmonary bypass time, total aortic cross-clamp time, ICU length of stay, operative complications, and length of hospital stay did not differ between StanC and Prehab. Wait times for elective CABG surgery ranged from 27-84 and 40-150 days in StanC and Prehab, respectively. However, wait times for surgery were not statistically different between StanC (57 ± 7 days) and Prehab (80 ± 16 days).

Table 2. Comparison of surgery parameters for StanC and Prehab patients.

	StanC	Prehab	p-value
Time on wait list (days)	57 ± 7	80 ± 16	0.46
2-3x CABG	5 (71%)	4 (57%)	0.99
4-5x CABG	2 (29%)	3 (43%)	0.99
Cardiopulmonary bypass time (minutes)	69 ± 18	68 ± 7	0.97
Total aortic cross-clamp time (minutes)	38 ± 12	48 ± 12	0.53
ICU length of stay (hours)	25 ± 3	27 ± 3	0.60
Operative complications	2 (29%)	0 (0%)	0.46
Length of hospital stay (days)	5.2 ± 0.3	5.0 ± 0.5	0.68

Continuous variables expressed as mean ± standard error. Categorical variables expressed in frequencies (percentage of group). StanC n=7; Prehab n=7. ICU, intensive care unit.

Reh-fit center data

Data from the Reh-Fit Center were collected from the patients who were randomized to Prehab (Table 3). Prehab total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides and total/HDL cholesterol were 3.1 ± 0.2 mmol/L, 1.5 ± 0.2 mmol/L, 0.9 ± mmol/L 1.4 ± 0.2 mmol/L, and 3.4 ± 0.3, respectively. According to the Canadian Cardiovascular Society/Canadian guidelines [106], Prehab patient total cholesterol, LDL cholesterol, triglycerides, and total/HDL cholesterol met the recommended optimal health ranges for these cholesterol total cholesterol (< 4.1 mmol/L), LDL cholesterol (< 2.0 mmol/L), triglycerides (< 1.7 mmol/L), total/HDL cholesterol (< 4.0 mmol/L), respectively. However, HDL cholesterol did not meet the recommended target Prehab patients (>1.6 mmol/L), which indicates that Prehab patients were at a moderately increased cardiovascular health risk.

Fasting blood sugar (FBS) amongst Prehab patients was 6.4 ± 0.5 mmol/L, which was slightly above the healthy range of FBS according to the Canadian Diabetes Association

[107] (i.e. 4.0-6.0 mmol/L). Average hemoglobin levels were 139 ± 5 g/L and were within healthy range (i.e. 120-140 g/L [108]).

Forced ventilator capacity (FVC), forced expiratory volume in one second (FEV1), and FEV1/FVC ratio in Prehab patients were 3.4 ± 0.3 liters, 2.8 ± 0.3 liters, and 81% ± 2%, respectively. Average FVC and FEV1 were in range of healthy values (i.e. 3.3-4.8 liters and 2.5-3.6 liters, respectively [109]). Average values for FEV1/FVC were slightly above normal values (i.e. 74-75% [109]) but did not indicate poor lung function.

Physical fitness as assessed at the Reh-Fit indicated that Prehab patients had an average MET level of 6.0 ± 0.7. Reference values amongst Canadian adults older than 60 years old are 6.9 METs for females and 7.9 METs for males [110]. Therefore, patients from our study were below the normal reference values for their age category. However, data from Kavanagh *et al.* [15] indicate that patients who have had CABG surgery have an average 5.5 ± 1.3 MET score. Therefore, based on these data, our patient cohort was above the MET reference values in CABG surgery patients.

Table 3. Prehab patient health characteristics from Reh-Fit client case file data at Baseline.

	Prehab	Ideal range or value
Blood data		
Total Cholesterol (mmol/L)	3.1 ± 0.2	< 4.1
LDL (mmol/L)	1.5 ± 0.2	< 2.0
HDL (mmol/L)	0.9 ± 0.1	> 1.6
Triglycerides (mmol/L)	1.4 ± 0.2	< 1.7
Total/HDL Cholesterol	3.4 ± 0.3	< 4.0
FBS (mmol/L)	6.4 ± 0.5	4.0 - 6.0
Hgb (g/L)	139 ± 5	120 - 140
Lung function data		
FVC	3.4 ± 0.3	3.3 - 4.8
FEV1	2.8 ± 0.3	2.5 - 3.6
FEV1/FVC	81% ± 2%	74 - 75%
Physical fitness data		
MET level	6.0 ± 0.7	> 5.5 ± 1.3
Attendance data		
Sessions attended	19 ± 7	-
Mean time in Prehab (weeks)	8 ± 2	-

Values are means ± standard error; Prehab n=7. LDL, low density lipoprotein; HDL, high-density lipoprotein; FBS, fasting blood glucose. Hgb, haemoglobin. FVC; forced ventilatory capacity. FEV1; forced expiratory volume in one second. FEV1/FVC; ratio of forced expiratory volume in one second to forced ventilatory capacity. MET; metabolic equivalent.

Physical measures

Physical measures were collected at Baseline, Preop, and Three months post-operatively to determine differences between groups (Table 4). Patient systolic and diastolic blood pressure as well as resting heart rate did not differ between StanC and Prehab at any time point. However, patients in StanC had a smaller waist and hip circumference, as compared to Prehab (main effect, $p<0.05$). A main effect of time was

observed for waist circumference and hip circumference, where Baseline and Preop > Three months post-operatively for both variables ($p<0.05$). A main effect of time was also observed for body weight, where Baseline and Preop > Three months post-operatively ($p<0.05$). Also, differences in BMI were observed over time (Baseline and Preop < Three months post-operatively; $p<0.05$). Waist-to-hip ratios did not change over time in either group.

Table 4. Physical measures data from StanC and Prehab at Baseline, Preop and Three months.

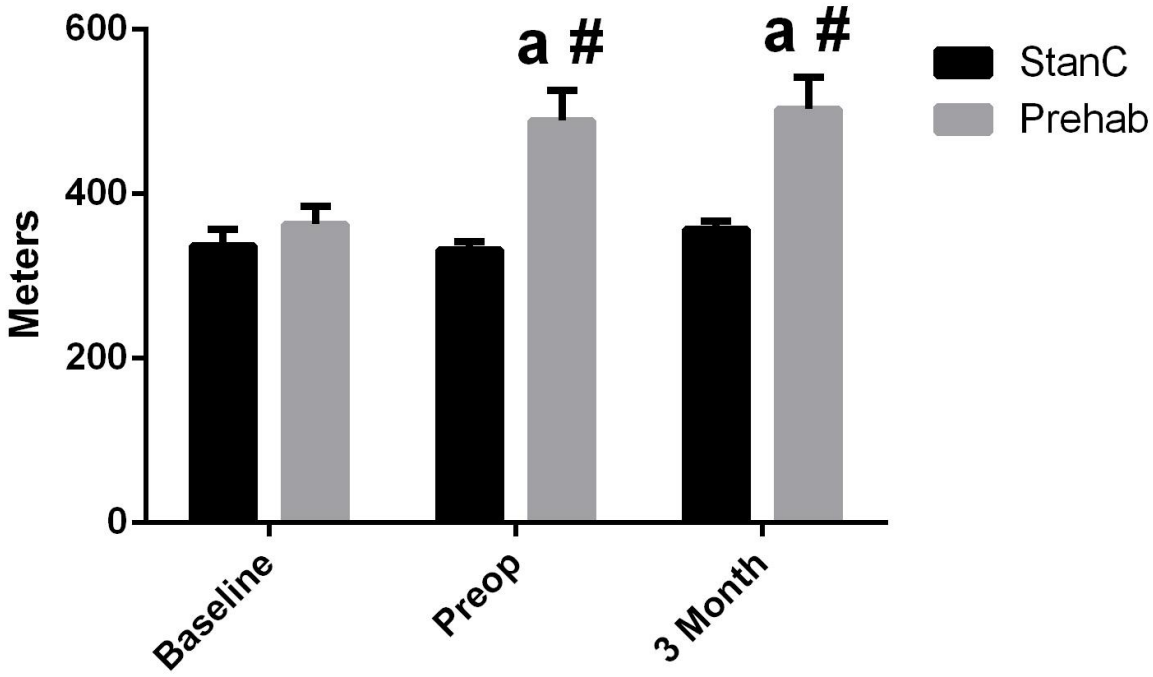
	Baseline	Preop	Three months
Hemodynamics			
Systolic			
StanC	143 ± 9	151 ± 9	140 ± 10
Prehab	126 ± 5	134 ± 5	129 ± 3
Diastolic			
StanC	78 ± 5	79 ± 4	77 ± 3
Prehab	75 ± 3	79 ± 3	75 ± 3
Resting heart rate			
StanC	61 ± 3	60 ± 3	63 ± 3
Prehab	62 ± 4	67 ± 4	63 ± 3
Anthropometric measures			
Waist circumference (cm)			
StanC	103 ± 2	104 ± 2	101 ± 2
Prehab	113 ± 3	112 ± 3	107 ± 3
Hip circumference (cm)			
StanC	108 ± 2	109 ± 2	106 ± 2
Prehab	117 ± 3	116 ± 3	112 ± 3
Body weight (kg)			
StanC	89 ± 2	89 ± 3	87 ± 2
Prehab	98 ± 4	97 ± 5	94 ± 4
BMI			
StanC	30.0 ± 1.0	29.9 ± 1.2	29.0 ± 0.9
Prehab	32.6 ± 1.3	32.3 ± 1.3	31.3 ± 1.2
Waist to hip ratio			
StanC	1.0 ± 0.01	1.0 ± 0.01	1.0 ± 0.02
Prehab	1.0 ± 0.02	1.0 ± 0.03	1.0 ± 0.01

Values are means ± standard error; StanC n=7; Prehab n=7. BMI, body mass index. Group differences were observed for waist and hip circumferences (main effect, where StanC < Prehab; $p<0.05$). A main effect of time was observed for waist and hip circumference, body weight and BMI, where Baseline and Preop > Three months post-operatively ($p<0.05$, all parameters).

Functional walking ability

No differences were observed for total distance walked on the 6MWT between StanC and Prehab at Baseline (Figure 2). Additionally, the total distance walked remained unchanged in StanC over time (Baseline, 337 ± 20 meters; Preop, 332 ± 10 meters; Three months post-operatively, 357 ± 10 meters). In contrast, patients in Prehab walked +126 meters and +140 meters at Preop and Three months post-operatively, respectively, as compared to Baseline ($p<0.05$).

Figure 2. Total walking distance achieved by StanC and Prehab patients during a 6-minute walking test. Values are mean ± standard error; StanC n=7; Prehab n=7. Walking distance was not different at Baseline between StanC and Prehab; [a] different from Baseline ($p<0.05$); [#] different from StanC ($p<0.05$).

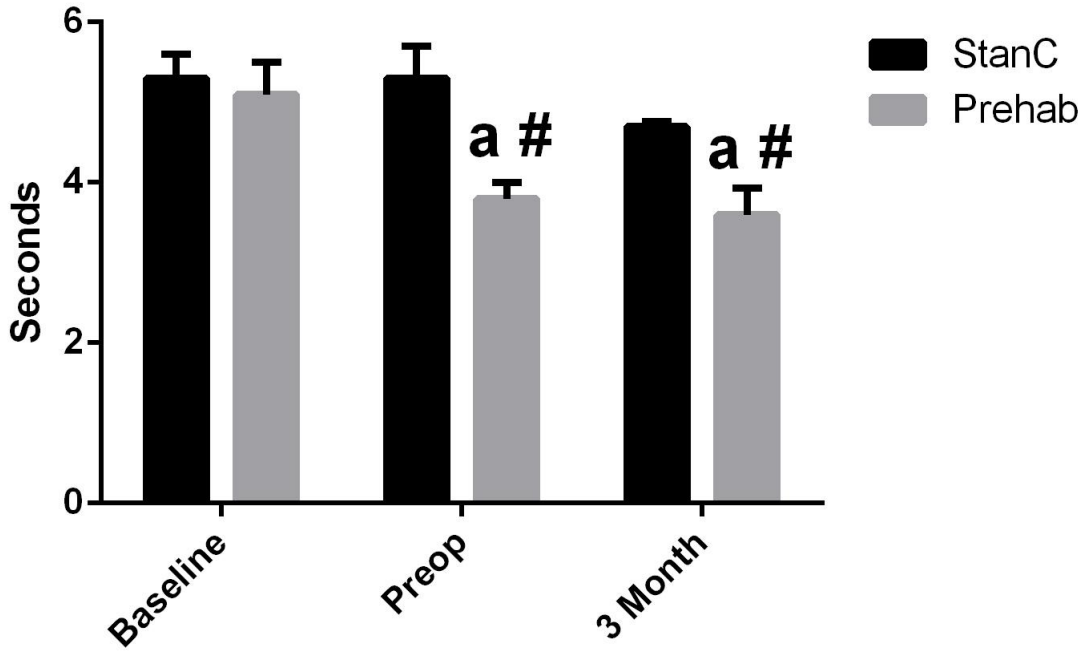


Gait speed

At Baseline, gait speed (Figure 3) was similar between StanC (5.3 ± 0.3 sec) and

Prehab (5.1 ± 0.4 sec). Over time, StanC did not improve gait speed at pre-op (5.3 ± 0.4 sec) or Three months post-operatively (4.7 ± 0.1 sec); whereas, Prehab patients significantly improved gait speed at Preop (3.8 ± 0.2 sec) and Three months post-operatively (3.6 ± 0.3 sec), as compared to Baseline ($p<0.05$). An interaction effect was observed ($p<0.05$) where gait speed was 25% and 27% lower in Prehab patients at Preop and Three months post-operatively, respectively, as compared to StanC.

Figure 3. Total time required by StanC and Prehab patients to complete the 5 meter gait speed test. Values are mean ± standard error; StanC n=7; Prehab n=7. Gait speed was not different at Baseline between StanC and Prehab; [a] different from Baseline ($p<0.05$); [#] different from StanC ($p<0.05$).

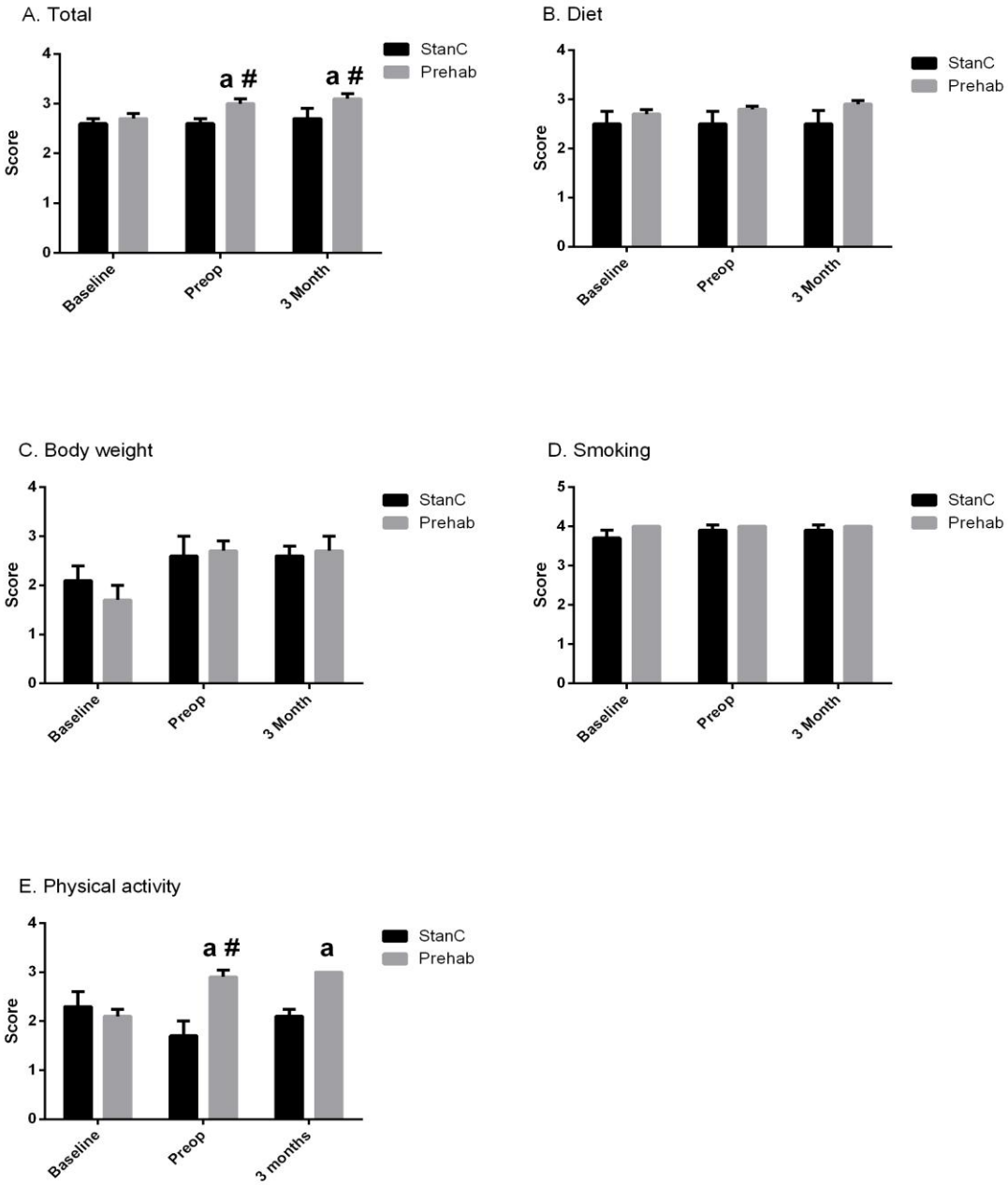


Healthy Lifestyle Questionnaire

The Healthy Lifestyle Questionnaire was utilized to determine whether there were

differences between groups for making healthier lifestyle choices over time. Total scores did differ between StanC (2.6 ± 0.1) and Prehab (2.7 ± 0.1) at Baseline. Furthermore, Total scores in StanC remained unchanged over time (Preop, 2.6 ± 0.1; Three months post-operatively, 2.7 ± 0.2). However, healthy lifestyle choices (Total score) significantly improved by ~7% at Preop and ~15% at Three months post-operatively in Prehab ($p<0.05$), as compared to Baseline. When scores on the Healthy Lifestyle Questionnaire were divided into different aspects of healthy lifestyle choices (i.e. diet, smoking cessation, efforts towards a healthier body weight, and physical activity), there were no differences between StanC and Prehab in any of the different aspects of healthy lifestyle behaviors at Baseline. Additionally, there was no change in the diet subscale over time or between groups. There were no differences between groups for changes towards a healthier body weight; however, there was a main effect of time, where Baseline < Preop and Three months post-operatively ($p<0.05$). There were no changes on the smoking subscale between groups at any time point. Physical activity subscale did not change over time in StanC. In contrast, Prehab patients had increased their physical activity subscale scores by 34% and 40% at Preop and Three months post-operatively, as compared to Baseline ($p<0.05$).

Figure 4. Comparison of changes in healthy lifestyle choices between StanC and Prehab patients using the Healthy Lifestyle Questionnaire. Values are mean ± standard error; StanC n=7; Prehab n=7. A. Total score. B. Diet. C. Body weight. D. Smoking. E. Physical activity. All scores of healthy lifestyle behaviour were not different at Baseline between Prehab and StanC; [a] different from Baseline ($p<0.05$); [#] different from StanC ($p<0.05$).



Accelerometer physical activity

Physical activity was assessed by accelerometry and the different parameters of physical activity behaviour assessed are displayed in Table 5. Physical activity was analyzed in 10 minute bouts or longer and also in sporadic bouts of activity (i.e. activity accumulated in bouts lasting 30 seconds or longer). Steps were also analyzed in sporadic bouts. We attempted to capture accelerometer data at all three time points (i.e. Baseline, Preop and Three months post-operatively); however, 11 of the 14 patients who completed the study had their surgeries scheduled within 1-3 days following the time they received notification of their scheduled surgery. For a valid accelerometer file, a minimum of four days of accelerometer wear time are required. Therefore, we were unable to capture complete physical activity data by accelerometer at Preop for 11 of 14 patients. Based on that limitation, we analyzed accelerometer data for the Baseline and Three months post-operative time points only. Valid accelerometer data was collected in six patients in StanC and six patients in Prehab at Baseline and Three months post-operatively.

When accelerometer data was analyzed in 10 minute bouts (i.e. $LightPA_{10min}$, $MVPA_{10min}$, and $TotalPA_{10min,}$), no differences were observed for any intensity of activity between StanC and Prehab at any time. Likewise, no differences between StanC and Prehab were found for MVPA MET-min_{10min} and Total MET-min_{10min} at any time. Baseline $MVPA_{10min}$ for StanC (82 ± 58 min/week) and Prehab (24 ± 17 min/week) were higher than reference values for $MVPA_{10min}$ in older adults (17 min/week) [92].

When accelerometer physical activity was assessed based on sporadic bouts of activity lasting 30 seconds or longer, there were no differences for $LightPA_{spor}$ between StanC or Prehab at any time. No differences were found between StanC and Prehab for $MVPA_{spor}$; however, a main effect of time was observed for $MVPA_{spor}$ (94% improvement), where

Baseline < Three months post-operatively ($p<0.05$). No differences were found for $TotalPA_{spor}$ between StanC and Prehab at any time. StanC and Prehab were not different when MVPA MET-min_{spor} were analyzed; however, there was a 129% increase in MVPA MET-min_{spor} Three months post-operatively, as compared to Baseline (main effect of time; $p<0.05$). Total MET-min_{spor} was not different between StanC and Prehab and remained unchanged. No differences were observed between StanC and Prehab for $MVPA_{steps}$ at any time point. However, there was a 116% increase in $MVPA_{steps}$ Three months post-operatively, as compared to Baseline ($p<0.05$). $Total_{steps}$ was not different between StanC and Prehab and remained unchanged over time.

Table 5. Comparison of accelerometer physical activity between StanC and Prehab at Baseline and Three months post-operatively.

	Baseline	Three months
10 minute bouts		
$\underline{\text{LightPA}_{10min}}$		
StanC	21 ± 9	68 ± 42
Prehab	3 ± 3	50 ± 29
$\underline{\text{MVPA}_{10min}}$		
StanC	82 ± 58	130 ± 51
Prehab	24 ± 17	159 ± 61
$\underline{\text{TotalPA}_{10min}}$		
StanC	103 ± 66	198 ± 89
Prehab	27 ± 17	208 ± 75
$\underline{\text{MVPA MET-min}_{10min}}$		
StanC	329 ± 230	551 ± 203
Prehab	97 ± 67	1003 ± 478
$\underline{\text{Total MET-min}_{10min}}$		
StanC	398 ± 258	774 ± 325
Prehab	105 ± 68	1166 ± 503
Sporadic bouts		
$\underline{\text{LightPA}_{spor}}$		
StanC	444 ± 60	591 ± 132
Prehab	443 ± 69	563 ± 49
$\underline{\text{MVPA}_{spor}}$		
StanC	132 ± 64	281 ± 72
Prehab	152 ± 74	270 ± 58
$\underline{\text{TotalPA}_{spor}}$		
StanC	576 ± 89	872 ± 197
Prehab	595 ± 116	832 ± 78
$\underline{\text{MVPA MET-min}_{spor}}$		
StanC	530 ± 258	1225 ± 296
Prehab	664 ± 342	1514 ± 450
$\underline{\text{Total MET-min}_{spor}}$		
StanC	1995 ± 330	3176 ± 692
Prehab	2125 ± 469	3370 ± 465

Table 5 (cont)

	Baseline	Three months
Steps		
$\underline{MVPA_{steps}}$		
StanC	2151 ± 1161	4625 ± 1385
Prehab	2323 ± 1127	4369 ± 1122
$\underline{Total_{steps}}$		
StanC	5716 ± 1425	9737 ± 2052
Prehab	6207 ± 1504	9151 ± 1163

Values are means ± standard error; StanC n=6; Prehab n=6. MVPA, moderate to vigorous physical activity; MET, metabolic equivalent. A main effect of time was found for $MVPA_{spor}$, MVPA MET-min_{spor} and $MVPA_{steps}$ where Baseline < Three months post-operatively ($p<0.05$; all parameters).

We conducted a sub-analysis for three Prehab patients who had valid accelerometer data from all three time points (Table 6). When physical activity was analyzed in 10 minute bouts, no differences between groups were found for $LightPA_{10min}$, $MVPA_{10min}$, and $TotalPA_{10min}$ at any time. However, there was a main effect of time for MVPA MET-min_{10min}, where the three patients accumulated ~290% more MVPA MET-min_{10min} at Preop, as compared to Baseline ($p<0.05$). There was a trend towards a significant increase in MVPA MET-min_{10min} Three months post-operatively, as compared to Baseline ($p=0.06$). No differences were over time were found for Total MET-min_{10min}.

When data was analyzed in sporadic bouts (i.e. physical activity in bouts of 30 seconds or longer) for our sub-analysis, no differences were found for any intensity of physical activity (i.e. $LightPA_{spor}$, $MVPA_{spor}$, $TotalPA_{spor}$, MVPA MET-min_{sppor}, and Total MET-min_{spor}) over time. Additionally, no differences were found for $MVPA_{steps}$ or $Total_{steps}$.

Table 6. Sub-analysis of accelerometer physical activity in three Prehab patients with complete data from Baseline, Preop and Three months post-operatively

	Baseline	Preop	Three months
10 minute bouts			
$LightPA_{10min}$	5 ± 5	118 ± 112	32 ± 16
$MVPA_{10min}$	44 ± 31	124 ± 7	100 ± 40
$TotalPA_{10min}$	49 ± 30	242 ± 108	131 ± 40
MVPA $MET\text{-}min_{10min}$	177 ± 126	685 ± 131	472 ± 153
Total $MET\text{-}min_{10min}$	194 ± 122	1074 ± 492	577 ± 174
Sporadic bouts			
$LightPA_{spor}$	527 ± 39	923 ± 278	623 ± 65
$MVPA_{spor}$	262 ± 119	263 ± 52	298 ± 21
$TotalPA_{spor}$	789 ± 128	1186 ± 247	921 ± 53
MVPA $MET\text{-}min_{spor}$	1157 ± 572	1261 ± 214	1333 ± 91
Total $MET\text{-}min_{spor}$	2895 ± 607	4308 ± 939	3390 ± 144
Steps			
$MVPA_{steps}$	3991 ± 1853	6070 ± 1982	3859 ± 839
$Total_{steps}$	9119 ± 1554	12866 ± 2865	8378 ± 1800

Values are means ± standard error; StanC n=6; Prehab n=6. MVPA, moderate to vigorous physical activity; MET, metabolic equivalent. Time effect for MVPA $MET\text{-}min_{10min}$ where Baseline < Preop ($p<0.05$).

Self-reported physical activity

Patient self-reported physical activity was captured using the IPAQ (Table 7). For $Walking_{IPAQ}$, there were no differences between StanC and Prehab at Baseline. However, there was a main effect of time ($p<0.05$) for $Walking_{IPAQ}$, where Baseline < Three months post-operatively. A main group effect was observed for $MVPA_{IPAQ}$, where StanC < Prehab ($p<0.05$), but this effect did not change over time. A main effect of time was observed for $TotalPA_{IPAQ}$, where Baseline and Preop < Three months post-operatively ($p<0.05$). A group main effect was observed for Total $MET\text{-}min/week_{IPAQ}$, where StanC < Prehab ($p<0.05$). A main effect of time for Total $MET\text{-}min_{IPAQ}$ was found, where pooled data indicated that all patients were accumulating +1405 Total $MET\text{-}min_{IPAQ}$

Three months post-operatively, as compared to Baseline (Baseline < Three months post-operatively; $p<0.05$). When patients were categorized for their activity level based on their self-reported physical activity (i.e. Low active, Moderate active, High active), no differences were observed between StanC and Prehab at any time. Although not statistically significant, it should be indicated that fewer participants were classified as Low active at Three months post-operatively (StanC = 1 and Prehab = 0), as compared to Baseline (StanC = 3 and Prehab = 6).

Table 7. International Physical Activity Questionnaire data reported by patients during the study.

	Baseline	Preop	Three months
$Walking_{IPAQ}$			
StanC	110 ± 49	223 ± 62	203 ± 41
Prehab	100 ± 20	225 ± 53	422 ± 147
$MVPA_{IPAQ}$			
StanC	33 ± 28	53 ± 29	143 ± 60
Prehab	146 ± 105	220 ± 66	318 ± 98
$TotalPA_{IPAQ}$			
StanC	143 ± 62	276 ± 78	347 ± 65
Prehab	246 ± 103	445 ± 112	740 ± 167
Total $MET\text{-}min_{IPAQ}$			
StanC	576 ± 261	948 ± 273	1358 ± 265
Prehab	1119 ± 611	1911 ± 544	3059 ± 694
IPAQ classification			
StanC			
Low active	3 (43%)	2 (29%)	1 (14%)
Moderate active	3 (43%)	5 (71%)	6 (86%)
High active	1 (14%)	0 (0%)	0 (0%)
Prehab			
Low active	6 (86%)	1 (14%)	0 (0%)
Moderate active	0 (0%)	5 (71%)	4 (57%)
High active	1 (14%)	1 (14%)	3 (43%)

Continuous variables are means ± standard error. Categorical variables are frequencies (percentage of group). StanC n=7; Prehab n=7. IPAQ; International Physical Activity Questionnaire; MVPA, moderate to vigorous physical activity; MET, metabolic equivalent. Time effect for walking where Baseline < Three months post-operatively ($p<0.05$). Main group effect for $MVPA_{IPAQ}$ where StanC < Prehab ($p<0.05$). Time effect for $TotalPA_{IPAQ}$ where Baseline and Preop < Three months post-operatively ($p<0.05$). Group main effect for Total $MET\text{-}min_{IPAQ}$ where StanC < Prehab ($p<0.05$). Time effect for Total $MET\text{-}min_{IPAQ}$ where Baseline < Three months post-operatively.

Self-efficacy, Anxiety, Depressive symptoms and Health care utilization

Baseline self-efficacy as measured by the CESEI (Table 8) was not different between StanC and Prehab. However, a main effect of time was observed for self-efficacy, where Baseline and Preop < Three months post-operatively ($p<0.05$). In fact, patients increased

their self-efficacy scores by 23% Three months post-operatively, as compared to Baseline.

Data from the CAQ (Table 8) showed no differences between groups at any time point. Total CAQ score, Fear and Avoidance showed a main effect of time, where Baseline and Preop > Three months post-operatively ($p<0.05$). Heart-focused attention CAQ scores remained unchanged between groups at all time points.

Depressive symptoms did not differ between StanC and Prehab at Baseline, Preop, and Three months post-operatively (Table 8). However, a main effect of time was found, where PHQ-9 scores were 47% lower Three months post-operatively, as compared to Baseline and Preop ($p<0.05$). The number of patients in StanC and Prehab who reported symptoms of depression did not differ at Baseline and did not change over time.

Total health care visits (Table 8), which included family physician visits, cardiologist visits, emergency walk-ins, hospital admissions, home care services, and other visits, did not differ between StanC and Prehab. After surgery, 3 out of the 7 patients (43%) in StanC and 6 of 7 (86%) patients in Prehab were attending CR. Although this was not statistically different, there was a trend indicating that more Prehab patients subsequently attending CR after their CABG surgery ($p= 0.09$). Mean time from referral to entry into CR after surgery was not different between StanC (67 ± 4 days) and Prehab (69 ± 7 days). Mean time that patients were enrolled in CR Three months post-operatively was not different between StanC (1.0 ± 0.6 weeks) and Prehab (1.0 ± 0.4 weeks).

Table 8. Comparison of confidence, anxiety, depressive symptoms, and health care utilization between StanC and Prehab at Baseline, Preop, and Three months post-operatively.

	Baseline	Preop	Three months
CESEI			
Total self-efficacy score			
StanC	3.6 ± 0.2	3.5 ± 0.3	4.1 ± 0.2
Prehab	3.0 ± 0.4	3.6 ± 0.3	4.0 ± 0.3
CAQ			
CAQ Total score			
StanC	1.6 ± 0.1	1.5 ± 0.1	1.1 ± 0.1
Prehab	1.8 ± 0.0	1.6 ± 0.2	1.3 ± 0.1
CAQ Fear			
StanC	1.6 ± 0.2	1.4 ± 0.2	1.0 ± 0.2
Prehab	1.8 ± 0.2	1.6 ± 0.1	1.3 ± 0.2
CAQ Avoidance			
StanC	2.3 ± 0.3	2.0 ± 0.1	1.4 ± 0.2
Prehab	2.6 ± 0.3	2.1 ± 0.3	1.7 ± 0.3
CAQ Heart- focused attention			
StanC	1.0 ± 0.3	1.1 ± 0.2	1.0 ± 0.2
Prehab	1.0 ± 0.2	1.2 ± 0.3	1.0 ± 0.2
PHQ-9			
Total score			
StanC	6.6 ± 1.4	6.6 ± 1.8	3.1 ± 0.8
Prehab	7.7 ± 2.3	5.4 ± 1.7	4.4 ± 1.4
Categorical score			
Symptoms of depression			
StanC	2 (29%)	3 (43%)	2 (29%)
Prehab	3 (43%)	1 (14%)	1 (14%)
Health care utilization			
Total health care visits			
StanC	2.4 ± 0.3	1.4 ± 0.6	1.0 ± 0.2
Prehab	2.3 ± 0.5	1.6 ± 0.6	2.9 ± 1.0

Table 8 (cont)

	Baseline	Preop	Three months
Attending cardiac rehab after surgery			
StanC	-	-	3 (43%)
Prehab	-	-	6 (86%)
Time from referral to entry in CR (days)	-	-	
StanC			67 ± 4
Prehab			69 ± 7
Time that patients were enrolled in CR after Three months post-operatively (weeks)			
StanC			1.0 ± 0.6
Prehab			1.0 ± 0.4

Continuous variables are means ± standard error. Categorical variables are frequencies (percentage of group). StanC n=7; Prehab n=7. CESEI, Cardiac Exercise Self-efficacy Instrument; CAQ, Cardiac Anxiety Questionnaire; PHQ-9, Patient Health Questionnaire 9. Time effect for CESEI where Baseline and Preop < Three months post-operatively ($p<0.05$). Main effect of time for CAQ Total score, Fear and Avoidance, where Baseline and Preop > Three months post-operatively ($p<0.05$). Main effect of time for PHQ-9 scores where Baseline and Preop > Three months post-operatively ($p<0.05$).

Quality of life

Data from all eight subscales of quality of life from the SF-36 (Table 9) were not significantly different between StanC and Prehab at any time point. However, a main effect of time was observed for General health, Physical functioning, Role limitations due to physical health, Role limitations due to emotional problems, Energy/fatigue and Social functioning ($p<0.05$), where Baseline and Preop < Three months post-operatively. Emotional well-being and Pain subscales remained unchanged at each time point in both

groups.

Table 9. Comparison of self-reported quality of life between StanC and Prehab using the Short-form 36 quality of life questionnaire at Baseline, Preop and Three months post-operatively.

	Baseline	Preop	Three months
General health			
StanC	54% ± 8%	59% ± 8%	68% ± 10%
Prehab	53% ± 8%	58% ± 6%	67% ± 7%
Physical functioning			
StanC	56% ± 7%	59% ± 7%	80% ± 5%
Prehab	48% ± 6%	65% ± 7%	72% ± 8%
Role limitations: physical			
StanC	25% ± 11%	29% ± 11%	61% ± 12%
Prehab	4% ± 4%	25% ± 11%	50% ± 14%
Role limitations: emotional			
StanC	57% ± 14%	57% ± 12%	90% ± 6%
Prehab	48% ± 14%	33% ± 13%	67% ± 15%
Energy/fatigue			
StanC	41% ± 1%	44% ± 9%	63% ± 6%
Prehab	41% ± 11%	43% ± 10%	56% ± 10%
Social functioning			
StanC	61% ± 10%	63% ± 11%	86% ± 11%
Prehab	43% ± 10%	54% ± 4%	71% ± 7%
Pain			
StanC	62% ± 8%	64% ± 8%	72% ± 5%
Prehab	71% ± 5%	71% ± 7%	75% ± 7%
Emotional well-being			
StanC	74% ± 5%	71% ± 6%	74% ± 6%
Prehab	68% ± 9%	79% ± 5%	78% ± 7%

Values are means ± standard error; StanC n=7; Prehab n=7. SF-36, Short-form 36 Questionnaire. Main effect of time for Physical functioning, Role limitations due to physical health, Role limitations due to emotional problems, Energy/fatigue, Social functioning, and General health where Baseline and Preop < Three months post-operatively ($p<0.05$ for all subscales).

Correlations between Prehab sessions attended at selected parameters

We utilized Pearson correlations to determine if the number of Prehab sessions attended was associated with a change in a series of selected Preop parameters (Table 10; Figure 5). No significant associations were observed between the number of Prehab sessions attended and a change in waist circumference, body weight, BMI, Waist-to-hip ratio, 6MWT, five meter gait speed test, Healthy lifestyle questionnaire score, or the CESEI. Even so, it is worth noting that there was a trend towards statistical significance for the number of Prehab sessions attended and PHQ-9 score (Figure 5, Panel A; p= 0.09; r= -0.67) as well as a change in hip circumference (Figure 5, Panel B; p= 0.10; r= -0.65).

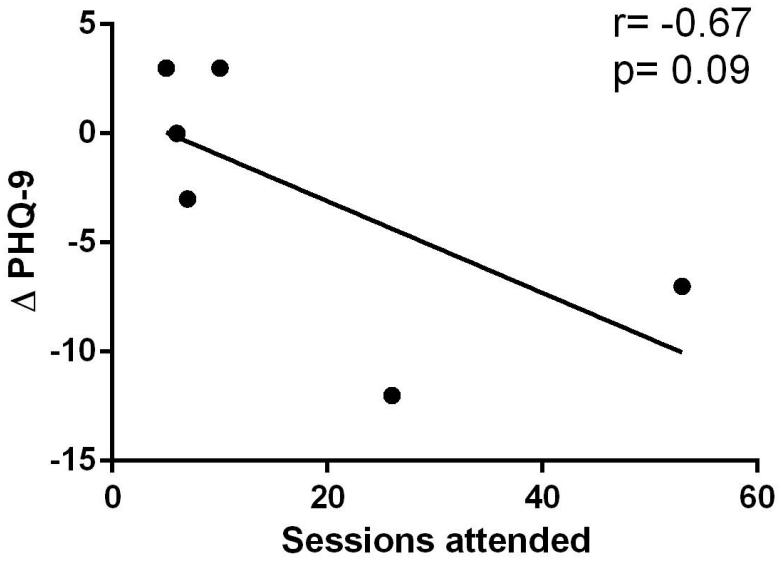
Table 10. Relationships between number of Prehab sessions attended and selected parameters.

	p-value
Δ Waist circumference	0.77
Δ Body weight	0.82
Δ BMI	0.64
Δ Waist-to-hip ratio	0.67
Δ 6-minute walk test	0.38
Δ 5-meter gait speed test	0.97
Δ Healthy lifestyle questionnaire	0.37
Δ CESEI	0.97

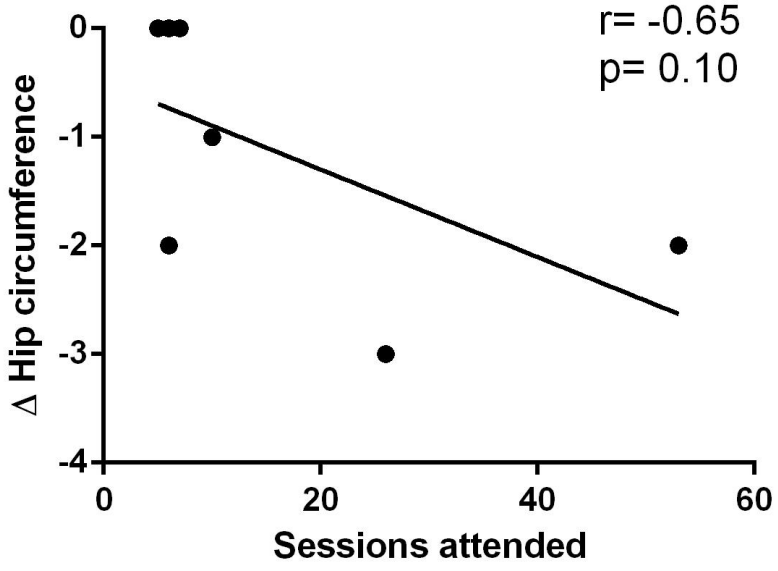
Pearson correlations; p-values shown. BMI, body mass index; CESEI, cardiac exercise self-efficacy questionnaire.

Figure 5. Associations between number of Prehab sessions attended and changes in PHQ-9 depression scores and hip circumference. Prehab sessions attended and change in PHQ-9 scores (Panel A). Prehab sessions attended and change in Hip circumference (Panel B). Prehab n=7. Trend towards significance for PHQ-9 (p= 0.09; r= -0.67) and hip circumference (p=0.10; r= -0.65).

A. PHQ-9



B. Hip circumference

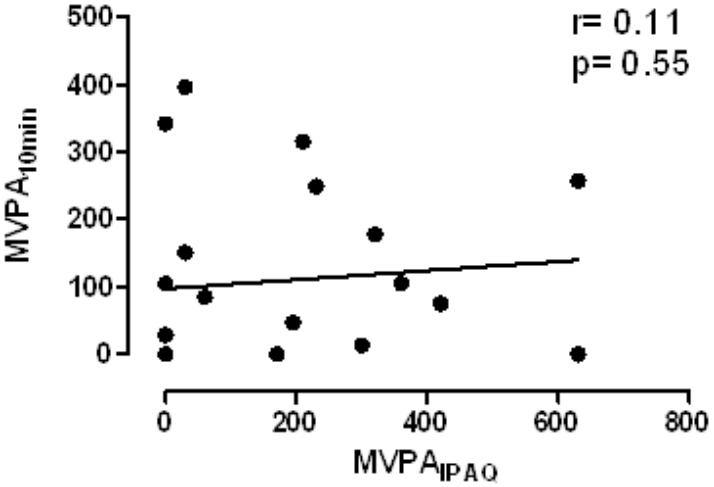


Correlations between objectively measured and self-reported physical activity

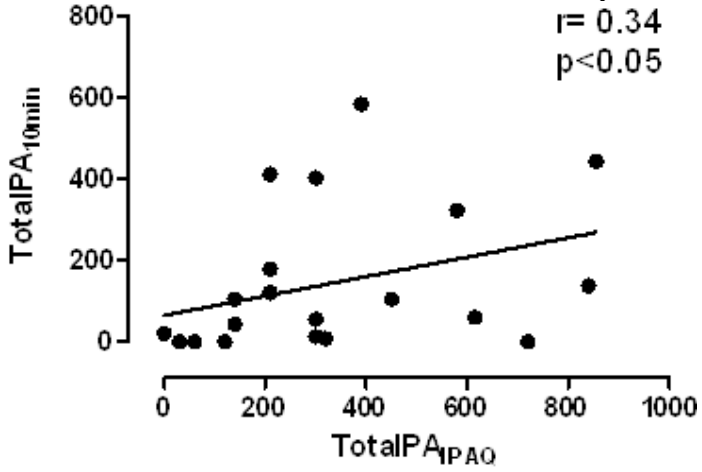
Correlation between accelerometer $MVPA_{10min}$ and $MVPA_{IPAQ}$ were not significant (Figure 6, Panel A). In contrast, a significant correlation was found between accerometer $TotalPA_{10min}$ and $TotalPA_{IPAQ}$ (Figure 6, Panel B; r= 0.34; $p<0.05$).

Figure 6. Correlations between accelerometer physical activity and self-reported physical activity. Association between accelerometer $MVPA_{10min}$ and $MVPA_{IPAQ}$ (Panel A). Association between accelerometer $TotalPA_{10min}$ and $TotalPA_{IPAQ}$ (Panel B). n= 21 XY data points. No significant correlation between accelerometer $MVPA_{10min}$ and $MVPA_{IPAQ}$ (r= 0.11; p=0.55). Significant correlation between accelerometer $TotalPA_{10min}$ and $TotalPA_{IPAQ}$ (r= 0.34; $p<0.05$).

A. Accelerometer $MVPA_{10min}$ and $MVPA_{IPAQ}$



B. Accelerometer $TotalPA_{10min}$ and $TotalPA_{IPAQ}$

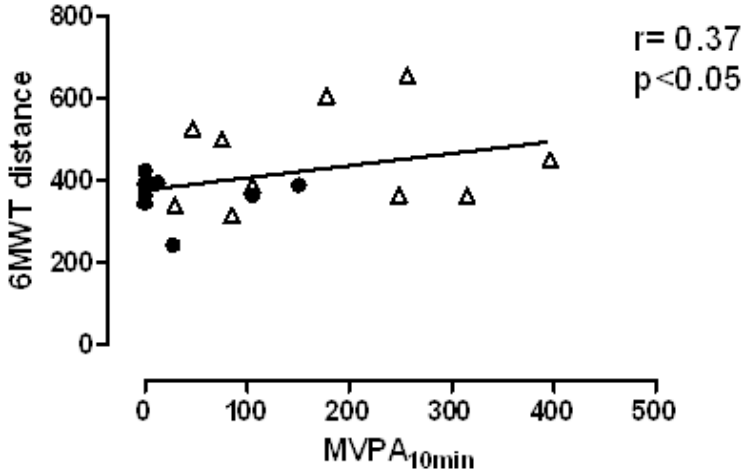


Correlations between functional walking ability and objectively measured physical activity

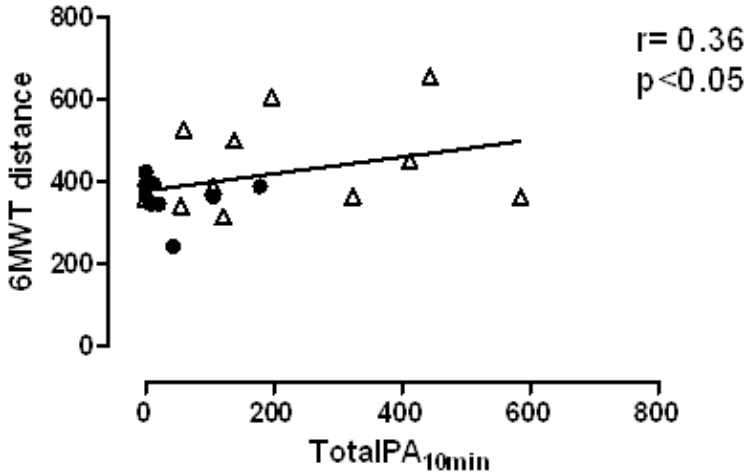
Functional walking ability as assessed by the 6MWT was significantly correlated with $MVPA_{10min}$ (Figure 7, Panel A; r= 0.37; p<0.05). There was also a correlation between 6-minute walking distance and $TotalPA_{10min}$ (Figure 7, Panel B; r= 0.36; p<0.05).

Figure 7. Correlations between functional walking ability and accelerometer physical activity. Association between six minute walking distance and accelerometer $MVPA_{10min}$ (Panel A). Association between six minute walking distance and accelerometer $TotalPA_{10min}$ (Panel B). n= 21 XY data points. Circles are Baseline data. Trangles are Three months post-operative data. Significant correlation between six minute walking distance and accelerometer $MVPA_{10min}$ (r= 0.37; p<0.05). Significant correlation between six minute walking distance and accelerometer $TotalPA_{10min}$ (r= 0.36; p<0.05).

A. 6MWT and $MVPA_{10min}$



B. 6MWT and $TotalPA_{10min}$

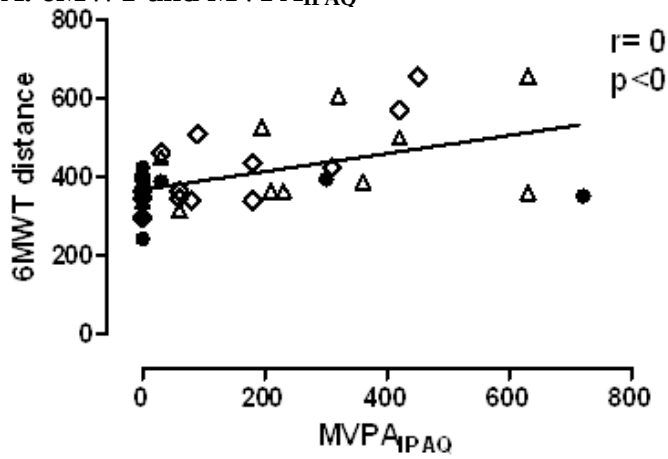


Correlations between functional walking ability and self-reported physical activity

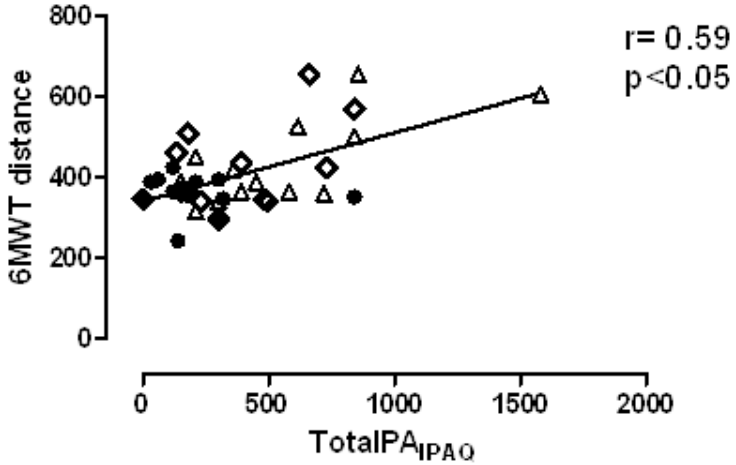
Functional walking ability as assessed by the 6MWT was significantly correlated with $MVPA_{IPAQ}$ (Figure 8, Panel A; r= 0.50; p<0.05). There was also a correlation between six minute walking distance and $TotalPA_{IPAQ}$ (Figure 8, Panel B; r= 0.59; p<0.05).

Figure 8. Correlations between functional walking ability and self-reported physical activity. Association between 6MWT and $MVPA_{IPAQ}$ (Panel A). Association between 6MWT and $TotalPA_{IPAQ}$ (Panel B). n= 37 XY data points. Circles are Baseline data. Diamonds are Preop data. Triangles are Three months post-operative data. Significant correlation between 6MWT and $MVPA_{IPAQ}$ (r= 0.50; p<0.05). Significant correlation between 6MWT and $TotalPA_{IPAQ}$ (r= 0.59; p<0.05).

A. 6MWT and $MVPA_{IPAQ}$



B. 6MWT and $TotalPA_{IPAQ}$



Chapter 5: Discussion

Evidence to support the feasibility and safety of Prehab

Wait times for cardiac surgery are an issue that negatively impacts the health status of patients. Specifically, elective CABG surgery patients have a 64% increased risk of mortality before surgery if their wait time is more than one month, as compared to patients who wait less than one month [63]. This statistic is troubling because wait times for elective CABG surgery in Manitoba range from 10-16 weeks [13]. During this wait period, many patients experience anxiety related to their heart health prior to surgery [103] and may be fearful of participating in physical activity and thus experience further cardiovascular deconditioning. Furthermore, most cardiac surgery patients are not referred to CR until after their surgical intervention. Therefore, we saw an opportunity to utilize an innovative cardiac Prehab program, which utilizes exercise therapy and patient education, to improve the health status of patients waiting for elective CABG surgery. Our novel data shows for the first time that patients who are on a wait list for elective CABG surgery improve their functional walking ability at Preop and Three months post-operatively, as compared to a group that received standard care. This finding is important because current standard care does not provide patients with an intervention to specifically enhance their functional walking ability or an education program to influence their health behaviors while on the waiting list for CABG surgery. The novel data presented in this study demonstrate the feasibility and efficacy of utilizing a Prehab program as an intervention to improve the functional walking ability of patients who are waiting for elective CABG surgery.

Prehab significantly improves functional walking ability

Functional walking ability is an important prognostic factor for predicting cardiac events and mortality. Specifically, Beatty *et al.* [111] found that amongst patients with stable CAD who walked more than 481 meters on the 6MWT had two-fold fewer adverse cardiac events and deaths, as compared to patients who walked less than 419 meters during a 6MWT over a median eight year follow up. Our data showed that Prehab improved the total walking distance of elective CABG surgery patients to a greater extent at Preop and Three months post-operatively, as compared to StanC. Specifically, patients in StanC walked 337 ± 20 meters at Baseline, which did not change at Preop and Three months post-operatively, whereas Prehab patients improved their total walking distance from 363 ± 22 meters at Baseline to 489 ± 37 meters at Preop (35% improvement) and was maintained Three months post-operatively. Based on the evidence reported by Beatty *et al.* [111], Prehab patients in in the current study reduced their risk of adverse cardiac events and deaths by two-fold; whereas, StanC patients continued to have a higher risk of adverse events throughout the study. Previous data from Fiorina *et al.* [105] indicates that patients who participate in a 15 day intensive CR program after CABG surgery improve functional walking ability by ~40% as assessed by the 6MWT [105]. However, prior to our study, it was not known if a Prehab program prior to elective CABG surgery has a similar benefit. Therefore, our novel data adds to the literature because it is the first to demonstrate that a Prehab program enhances functional walking ability amongst a cohort of patients waiting for elective CABG surgery.

Gait speed was significantly enhanced by Prehab

Gait speed is an important predictor of morbidity and mortality in patients waiting for

cardiac surgery [89]. Specifically, patients requiring more than six seconds to walk five meters have a three-fold increased risk of morbidity and mortality after discharge from cardiac surgery [89]. In fact, the utilization of gait speed in combination with the Society of Thoracic Surgeons Predicted Risk of Mortality or Major Morbidity scale, which is considered the gold standard risk scoring tool for assessing mortality and morbidity after cardiac surgery, served as a better model for predicting mortality and major morbidity, than the model using only the Society of Thoracic Surgeons scale on its own [112]. Previous data have shown that gait speed is enhanced by 62% after 12 weeks of exercise rehab in stroke patients [113]. However, it is not yet known if gait speed can be enhanced prior to surgery amongst patients on the elective CABG surgery wait list. Therefore, our novel data adds to the literature and is the first to show that a Prehab intervention significantly enhances five meter gait speed amongst a cohort of patients waiting for elective CABG surgery. It should also be pointed out that two patients in StanC and one patient in Prehab had gait speed scores higher than six seconds (i.e. 21% of the study cohort) at Baseline. Notably, the one high risk patient in Prehab improved their gait speed from 7.4 seconds at Baseline to 4.2 seconds at Preop, which was maintained Three months post-operatively. However, neither of the two high risk patients in StanC improved their gait speed score at Preop. Although the other six patients in Prehab required less than six seconds to complete the gait speed test, a Prehab intervention was able to improve this parameter during the wait period for elective CABG surgery, which could have further health benefit implications. Thus, it appears that Prehab may help patients to improve their gait speed enough to move from a high risk to a lower risk group.

Patients in Prehab made healthier lifestyle choices

Heart disease is a major global health concern and is one of the leading causes of death, disability, and health care costs [114]. Additionally, the aging population is expected to increase this burden due to an increased incidence of heart disease [115]. Individuals with more cardiovascular risk factors (i.e. smokers, BMI > 25 kg/m^2, < 150 min of MVPA/week, an unhealthy diet, total cholesterol > 5 mmol/L, blood pressure > 120/80 mmHg, and fasting blood glucose > 4.6 mmol/L) have a ~2.5-fold higher risk of developing cardiovascular disease, as compared to those with fewer cardiovascular risk factors [116]. However, it is not yet known if exercise therapy or educational interventions prior to cardiac surgery promote healthier lifestyle behaviors amongst a cohort of patients waiting for elective CABG surgery. Notably, our data show that Prehab patients made healthier lifestyle choices, as compared to StanC. Specifically, our Healthy Lifestyle Questionnaire data indicates that a Prehab program does promote a more physically active lifestyle behaviors prior to and after elective CABG surgery, as compared to StanC. Furthermore, there was a trend suggesting that Prehab patients were more likely to utilize health care services (p= 0.17) and attend CR Three months post-operatively (p= 0.09), as compared to StanC. Furthermore, all patients did not report making healthier diet choices over time; however they all reported making efforts towards a healthier body weight at Preop. Even so, all patients did significantly reduce their waist and hip circumference, as well as their body weight and BMI Three months post-operatively. Furthermore, our objectively measured physical activity assessment showed that all patients did accumulate 94% more $MVPA_{spor}$ at Three months post-operatively, as compared to Baseline. Collectively, these data indicate that Prehab helped patients on the wait list for CABG surgery to adopt a more physically active lifestyle and Prehab patients

were more likely to utilize health services, which will be discussed in this next paragraph.

One aspect in the management of patients after elective CABG surgery involves follow up with their cardiac surgeon and also their family physician. Cobb *et al.* [117] reviewed evidence indicating that patient risk factor reduction goals were more likely to be achieved by frequent patient follow up with their health care providers after CABG surgery. Although not statistically significant, our data show a trend (p= 0.17) that Prehab patients were more likely to follow up with their health care providers, as compared to StanC. In fact, Prehab patients tended (p= 0.17) to visit their cardiologist and family physician more often than StanC patients Three months post-operatively. Collectively, these data suggest that pre-operative intervention may influence how often CABG surgery patients adhere to medical follow up after surgery. However, the project was underpowered to support such a conclusion. Even so, this possibility is intriguing because the potential health benefits of this type of pre-operative intervention for elective CABG surgery patients could go beyond the program itself and enhance the healthy behaviors made by this patient cohort after surgery.

Cardiac rehabilitation programs are known to enhance the cardiovascular health status of patients post-operatively [15], [17]. Specifically, patients who attend CR have up to a 34% and 31% reduction in all-cause and cardiovascular mortality, respectively [18, 20]. Despite the cardiovascular health benefits of CR, attendance rates remain low. Specifically, only 30% of patients attend CR in Manitoba [79]. Notably, our data show that 86% of Prehab patients who participated in Prehab were attending CR, whereas only 43% of StanC patients were attending CR after surgery; however, these data were not statistically significant, which can likely be explained by the small sample size utilized in the current

study. Even so, these data match relatively well with the study by Arthur *et al.* [76], where they found that 70% of patients enrolled in their pre-operative intervention before elective CABG chose to attend CR after surgery, as compared to only 57% of the patients who received StanC. Therefore, our data in combination with Arthur *et al.* [76] indicate that Prehab promotes the utilization of CR after elective CABG surgery. However, we must acknowledge that only 17 of 58 (29%) elective CABG surgery patients who were contacted chose to participate in the study. Therefore, this limitation must be considered when interpreting our CR attendance data. Even so, our data suggest that early referral to pre-operative exercise therapy and educational programming may influence a patient's decision to attend CR after surgery.

All patients were more physically active post-operatively

This is the first study to objectively determine whether a Prehab intervention for elective CABG patients increases the amount of physical activity a patient accumulates in the pre-operative period. Approximately 15% of Canadian adults do not accumulate 150 minutes of $MVPA_{10min}$ on a weekly basis and, therefore, do not meet the Canadian Physical Activity Guideline recommendations for health benefits [93]. This statistic is alarming because regular physical activity appears to reduce the risk of developing over 25 chronic conditions, including heart disease [118]. Our data failed to show that patients accumulated more physical activity at any intensity in 10 minute bouts (i.e. $LightPA_{10min}$, $MVPA_{10min}$ and $TotalPA_{10min}$). However, the variability in the accelerometer data analyzed in 10 minute bouts may have prevented the identification of significant differences between StanC and Prehab. Moreover, our data show that our patient cohort was accumulating +370% more physical activity at Baseline than reference values for

Canadian older adults [93]. This could partially be explained by 4 of the 14 patients having jobs that required them to be physically active. Even so, only two patients (14%) of the entire cohort at Baseline were meeting the recommended about of MVPA for optimal health benefits.

Although patients did not accumulate more physical activity in 10 minute bouts (i.e. $Light_{10min}$, $MVPA_{10min}$, $Total_{10min}$), which is the shortest bout of physical activity currently recommended by the Canadian Physical Activity Guidelines, our data do indicate that all patients accumulated 94% more $MVPA_{spor}$ (i.e. in bouts of 30 seconds or longer) Three months post-operatively, as compared to Baseline. Notably, recent evidence has shown a significant association between $MVPA_{spor}$ and physical fitness (r= 0.45) and was an independent predictor of physical fitness after controlling for gender, age, BMI and intensity of sporadic physical activity, in obese adults [119]. These data suggest that $MVPA_{spor}$ may enhance cardiovascular health status. Evidence from Glazer *et al.* [120] provide data to support the notion that physical activity accumulated sporadically does promote cardiovascular health to a similar extent as $MVPA_{10min}$. Specifically, they showed that for every 10 minute increase per day in $MVPA_{spor}$, there was a 0.11 mmol/L reduction in triglycerides, a 0.02 mmol/L increase in HDL cholesterol, a 0.30 cm reduction in waist circumference, a 0.28% reduction in Framingham Cardiovascular Disease Risk Score, and a 15% decreased prevalence of obesity . Furthermore, the improvements in cardiovascular health from the accumulation of $MVPA_{spor}$ and $MVPA_{10min}$ were similar. Therefore, these data suggest that $MVPA_{spor}$ may be at least as effective as physical activity accumulated in 10 minute bouts for enhancing cardiovascular health.

Data from Nery and Barbisan[66] indicate that patients who report accumulating more physical activity prior to CABG surgery have a 33% shorter hospital stay and a 78% decreased risk of a major cardiac event post-operatively. Although our data shows that all patients accumulate more $MVPA_{spor}$ Three months post-operatively, we could not make a comparison on the effectiveness of Prehab to StanC at the Preop time point due to the fact that many patients had their surgeries scheduled 1-3 days after being notified by surgical staff. Even so, we conducted a sub-group analysis of three Prehab patients who had valid accelerometer data at Baseline, Preop, and Three months post-operatively. Notably, these patients accumulated more MVPA MET-min_{10min} at Preop, as compared to Baseline. This observation is interesting because our data demonstrate that Prehab enabled patients to increase the total amount of MVPA MET-min_{10min} they accumulated on a daily basis before their surgical intervention. Evidence shows that physical activity accumulated in MVPA MET-min_{10min} is associated with enhanced physical fitness (r= 0.45) [121]. Furthermore, MET-min accumulated in moderate-to-vigorous intensities are associated with a reduction in the prevalence of the metabolic syndrome, which are a combination of several risk factors for cardiovascular disease, that include: high waist circumference (men, > 94 cm; women, > 80 cm), high triglycerides (> 1.7 mmol/L), low HDL cholesterol (men, < 1.0 mmol/L; women, < 1.3 mmol/L), elevated blood pressure (systolic, > 130 mmHg; diastolic, > 85 mmHg or hypertension medication use), and elevated blood glucose (> 5.6 mmol/L or diagnosed with diabetes). Specifically, Janssen and Ross [122] show that compared to the "inactive" group in this study (i.e. accumulating < 500 MVPA MET-min_{10min}), adults who were classified as "active" (i.e. accumulating 500-999 MVPA MET-min_{10min}) had a ~2-fold decreased risk of having the metabolic

syndrome. Our data showed that Prehab patients with complete accelerometer data (i.e. Baseline, Preop, Three months post-operatively) were inactive at Baseline. Notably, all three Prehab patients with accelerometer data at all three time points were classified as active at Preop according to the classification method utilized by Janssen and Ross [122], which suggests that Prehab patients reduced their risk for the metabolic syndrome before their surgery.

Physical activity was associated with functional walking ability

Evidence indicates that physical activity is associated with physical fitness as assessed by a maximal exercise test [119, 121]. Furthermore, the previous literature also indicates that physical activity status assessed by accelerometer amongst cardiopulmonary patients is associated with total distance walked on 6MWT (r= 0.44 – 0.65) [123]. Our data support the existing literature, where our data also show that accelerometer physical activity is associated with functional walking ability as assessed by the 6MWT ($MVPA_{10min}$, r= 0.37; $TotalPA_{10min}$, r= 0.36) in patients waiting for elective CABG . Our data also add to the existing literature indicating that self-reported physical activity is also associated with total distance walked on a 6MWT ($MVPA_{IPAQ}$, r= 0.50; $TotalPA_{IPAQ}$, r= 0.59) in this patient cohort, which to our knowledge has not been investigated previously. It is possible that functional walking ability was significantly associated with physical activity due to the exercises prescribed in Prehab. Specifically, walking was the primary mode of exercise that was completed during Prehab. Collectively, these data suggest that higher amounts of objectively measured and self-reported physical activity are associated with an enhanced functional walking ability as assessed by the 6MWT in elective CABG patients.

Prehab seemed to have an effect on overall mood status

A growing body of evidence indicate that mild-severe symptoms of depression are associated with a worse prognosis in patients with CAD (as reviewed by Blumenthal *et al.* [51]). Specifically, the combination of CAD and elevated depressive symptoms increases the risk of cardiac mortality by ~3-fold, as compared to CAD patients without elevated depressive symptoms [124]. These data are troubling because local data from the Cardiac Sciences program at the St. Boniface Hospital indicates that 24% of cardiac surgery patients have mild-severe symptoms of depression pre-operatively [125]. Although data indicates that CR programs reduce the prevalence of depression in cardiac patients post-operatively [126], there are few data to indicate that a Prehab intervention for patients on the wait list for elective CABG surgery reduces depressive symptoms pre-operatively. Notably, our novel data indicates that 36% of all patients reported symptoms of depression at Baseline, where patients in StanC and Prehab had PHQ-9 scores of 6.6 ± 1.4 and 7.7 ± 2.3, respectively. However, Prehab did not reduce PHQ-9 scores at Preop. Even so, all patients reduced their depression scores by 47% Three months post-operatively. Although not statistically significant, our data also showed a trend indicating that the number of Prehab sessions attended was associated with fewer signs of depressive symptoms ($r= -0.65$; $p= 0.09$). In fact, there was a 63% reduction in depressive symptoms from Baseline amongst the two Prehab patients who attended more than 25 sessions at Preop. However, we cannot make conclusions on these data because our data do not show statistical significance. Even so, existing evidence indicates that nurse-led patient education [127] and patient counselling [128] prior to surgery reduces depression scores on the HADs by 2.1 and 7.8 points, respectively, as compared to those

who received usual care. Therefore, the benefits of Prehab may go beyond enhancing traditional parameters of cardiovascular health by also influencing mental health.

CABG enhances exercise self-efficacy

Cardiac rehabilitation programs are designed to enhance the self-efficacy of patients with CAD [17]. Evidence indicates that patients who enhance their self-efficacy are more than three times more likely to meet the physical activity guidelines, as compared to patients who do not enhance their self-efficacy [129]. Our data did not show that self-efficacy for exercise was enhanced to a greater extent in Prehab, as compared to StanC. However, all patients enhanced their exercise self-efficacy scores Three months post-operatively, as compared to Baseline. These data would suggest that their CABG surgery enhanced self-efficacy, rather than Prehab. One of the goals of CABG discussed previously is to reduce angina symptoms. Sarkar and colleagues [130] have shown that lower self-efficacy scores are independently associated with worse angina symptoms. Therefore, although Prehab does show improvements in functional walking ability, it does not seem to enhance exercise self-efficacy.

CABG enhances overall quality of life

One of the goals of CABG surgery is to improve the quality of life of patients [131]. Evidence reviewed by Jokinen *et al.* [132] support this statement and indicate that CABG surgery is effective for enhancing quality of life over a six week to one year period post-operatively. However, there are few data indicating the effectiveness of Prehab on parameters of quality of life pre-operatively amongst elective CABG surgery patients. Our study failed to show that Prehab enhances any of the components of the SF-36

quality of life questionnaire from Baseline to Preop, as compared to StanC. These data are in contrast with Arthur *et al.* [76], where they reported that patients in Prehab reported increased Physical Functioning at Preop, as compared to StanC. However, our data did show a trend for Prehab enhancing Physical Functioning at Preop, as compared to StanC ($p= 0.10$). Our data could have differed from the Arthur *et al.* [76] study because the larger sample size used in their study (i.e. $n = 249$), as compared to our study (i.e. $n= 14$). Nonetheless, patients in the current study did report higher General health, Physical functioning, Role limitation due to physical health, Role limitations due to emotional problems Energy/fatigue, and Social functioning Three months post-operatively, as compared to Baseline and Preop.

CABG reduces anxiety

Anxiety is a major concern amongst patients requiring cardiac surgery. Studies have shown that up to 30% of patients experience a form of anxiety (e.g. post-traumatic stress, 9%; general anxiety disorder, 10%; or panic disorder, 11%) prior to surgery [133, 134] and is associated with a 3.3-fold increased risk of operative morbidity and 30 day mortality in cardiac surgery patients [134]. Furthermore, 31% of patients experience clinically elevated CAQ scores (i.e. Fear, 2.5; Avoidance, 2.8; Attention, 2.1; Total score, 2.1) prior to cardiac surgery. Based on our data set, we did not observe any patients reporting clinically elevated heart-focused anxiety symptoms on the CAQ. However, based on our medical chart review from the St. Boniface Hospital, two patients in StanC and one patient in Prehab were prescribed anti-anxiety drugs at Baseline, which could have influenced their scores on the CAQ. Even so, our data indicate that Fear, Avoidance, and total CAQ scores were reduced Three months post-operatively in StanC and Prehab, as

compared to Baseline. These data support the findings by Hoyer *et al.* [103] who found significant reductions in Fear and Avoidance scores six weeks and six months post-operatively after cardiac surgery. However, our data did not show differences between StanC and Prehab for any of the anxiety symptoms related to heart health. Therefore, our data suggest that CABG surgery reduces anxiety symptoms related to heart health.

Length of hospital stay was not affected by Prehab

Arthur *et al.* [76] have demonstrated that a similar Prehab intervention significantly reduces length of hospital stay by one day (Standard care, 6 [5-7; interquartile range] days; Intervention group, 5 [5-6] days) and showed a potential cost-savings of Prehab, as compared to usual care. In contrast, our data did not show a significant difference in length of hospital stay (StanC, 5.2 ± 0.3 days; Prehab; 5.0 ± 0.5 days). This discrepancy may be explained because the length of hospital stay from our entire cohort was similar to that reported for the Prehab group in the Arthur *et al.* [76] study. Furthermore, our study was not powered to detect a change in length of hospital stay and did not have the larger sample size utilized by Arthur *et al.* [76] Recent advances in medical therapy and surgical procedures for patients requiring CABG could have accounted for this difference. For example, atrial fibrillation is one of the most common post-operative complications following cardiac surgery, which occurs in approximately 20-40% of CABG patients [135] and is also associated with a longer hospital stay [136]. It has more recently been confirmed that pre-operative statin therapy reduces the incidence of post-operative atrial fibrillation by approximately 2.5-fold and has also been shown to reduce the length of hospital stay by approximately 0.5 days [137]. Notably, all patients in our study were using statins prior to surgery; however, the prevalence of statin use was not reported in the Arthur *et al.* [76]

study. Evidence indicates that over the past decade, the CABG only surgery population have more co-morbidities, including diabetes and hypertension [138]. Despite this, 30 day risk of adverse health outcomes have declined by 24% amongst CABG surgery patients over the last decade. Furthermore, length of hospital stay has declined from an average seven days to five days [138], which matches well with the average length of hospital stay of all patients in our study. Therefore, the utilization statin therapy and advances in surgical techniques could account for the differences observed in our study, as compared to the Arthur *et al.* [76] study published in 2000.

Although we did not have a large enough sample to detect a change in length of hospital stay between StanC and Prehab, it should be noted that despite the longer wait times for surgery, although not statistically significant, may be clinically significant. Even so, patients in Prehab had a similar length of hospital stay, as compared to StanC. Furthermore, there were more slightly more patients in Prehab with 4-5 vessel disease, as compared to StanC, although this was not statistically different. Therefore, it is possible that Prehab patients had more severe CAD based on these surgical parameters and that Prehab was able to enhance their cardiovascular health status and shorten their length of hospital stay. However, it should also be noted that all other Baseline characteristics (besides beta-blocker use) were not significantly different between groups.

Limitations

It is important that we acknowledge the limitations of this study. First, we specifically powered our study to detect a change in total distance walked as assessed by the 6MWT. However, our sample size may not have been large enough to detect differences in some

of the secondary outcome variables. Even so, it is notable that several secondary outcome variables were significantly different (i.e. five meter gait speed, Healthy Lifestyle Questionnaire) while other variables showed a trend towards significance (e.g. SF-36 Physical Functioning, CESEI, IPAQ, change in waist and hip circumference) at Preop and Three months post-operatively in Prehab, as compared to StanC. These data will help inform our future work to examine the effects of a Prehab intervention by enabling us to calculate sample size and power analyses for these parameters.

Another limitation of our study was the inclusion and exclusion criteria utilized to identify potential candidates for the study. Specifically, our inclusion and exclusion criteria limited us to 79 out of a possible 297 elective CABG patients (27% of the total elective CABG surgery cohort). Moreover, from the 79 elective CABG patients who were eligible for the study, we made contact with 58 of these patients (79% of eligible patients) and only 17 patients (30% enrolment rate of patients contacted) consented for the study. The reasons for low participation rates based on patients' comments were time, travel concerns, and various other reasons. Furthermore, we only offered the program in the morning when there was a cardiologist at the intervention site, a design feature utilized to support patient safety. Some of these limitations could be addressed by offering a Prehab intervention that better fits into the patients' schedule and to offer the Prehab program at different sites, times, or alternative methods of delivery. For example, a home-based or community based Prehab program could enhance enrolment into Prehab; however, safety for the patient and finding appropriate medical expertise would need to be considered before developing these types of approaches for this patient population. It should be noted that three out of the seven Prehab patients were still

working, but made the choice to enrol in the study and complete the Prehab program until their surgery was scheduled. Another strategy to increase patient participation would be to develop a recruitment strategy where the cardiac surgeon may introduce the project to the patient when the patient already has a scheduled meeting with the patient. It is possible that this strategy would positively influence patients to at least hear more about the study.

Another limitation was that we did not recruit patients who were scheduled for other types of cardiac surgeries (i.e. valve repair and replacement, combination surgeries) and therefore our data may not be generalizable to the entire cardiac surgery patient population. However, we chose this patient population based on the inclusion and exclusion criteria from the Arthur *et al.* [76] study. Moreover, based on discussions with local medical experts (i.e. cardiac surgeons and a cardiologist), the general consensus was that the potential risks of Prehab did not support the inclusion of valve and combination cardiac surgery procedures at this time. It is possible that Prehab could also be effective for patients requiring other types of surgeries. Notably, guidelines by the ACSM [139] recommend that patients with valvular heart disease requiring surgery can exercise at low to moderate intensity to prevent symptoms such as shortness of breath, unexplained coughing, and swollen legs or feet.

Another limitation of our study was that research staff were not blinded to which patients were in StanC and Prehab. Specifically, research staff completed all patient data collection and conducted the 6MWT with each patient. Even so, all research staff conducted the 6MWT in accordance with the American Thoracic Society Guidelines [83] where patients are not to be provided with any motivation during testing.

There are several personal characteristics that could have affected the outcomes in our study that we did not collect. For example, we did not determine the stage of behavior change for a healthier lifestyle in the elective CABG patient population, which has been shown to positively influence healthy lifestyle behaviors [140]. Other factors that could have influenced our data which we did not collect were socioeconomic status [141] and type A personality [142], which could be collected for a future Prehab study. Furthermore, we could not make a comparison for those patients who chose not to enroll in the study and patients who agreed to participate.

Future directions

Our data demonstrate that Prehab for patients waiting for elective CABG surgery enhances pre-operative functional walking ability, as compared to StanC. Moreover, these Prehab improvements were maintained Three months post-operatively. Based on this data, we suggest that a Prehab intervention should be utilized as a part of standard care for patients waiting for elective CABG surgery. Further work in this field should focus on designing and implementing a more optimal Prehab delivery model so that this intervention can be optimized. For example, the use of an automated referral in combination with a liaison follow up could enhance the utilization of Prehab. It may also be beneficial to determine the optimal Prehab duration required to achieve health behaviour improvements prior to elective CABG surgery. Interestingly, two patients participated in Prehab for only 3.5 weeks but still improved their total distance walked by an average of 174 meters (43% improvement). It is possible that the structure of the Prehab program could have accounted for these short-term improvements. Specifically, the first four weeks of Prehab offer an intensive exercise therapy program. Furthermore,

all educational classes are offered in the first four weeks of the program. Thereafter, patients are given a less-structured exercise therapy program and are followed up periodically throughout the remaining 12 weeks of the Prehab program. Therefore, it is possible that the four week intensive Prehab program could enhance the health behaviors of patients waiting for elective CABG surgery over the short term. Our data are supported by Fiorina and associates [105] and indicate that as few as 15 days of CR can improve total distance walked by as much as 40%. Therefore, some participants may achieve significant improvements in functional walking ability by attending 2-4 weeks of exercise therapy plus education classes. Even so, greater health benefits are known to occur by participants who attend more than 25 sessions of CR [20]. Additionally, our data demonstrated that a trend existed where patients who attended more Prehab sessions reduced their hip circumference to a greater extent than patients who attended fewer Prehab sessions.

Data collected from this study would support a larger clinical trial to determine if Prehab has a significant effect on other outcomes prior to elective CABG surgery as well as post-operatively. For example, a larger study may be able to determine if patients will accumulate more physical activity during participation in Prehab or post-operatively. Another example would be to determine if Prehab has an effect on 30 day mortality and morbidity after surgery, which are quality indicators of surgery post-operatively [143].

It is possible that Prehab promotes sustained healthy lifestyle behaviors post-operatively. For example, 86% of Prehab patients in our study chose to attend CR post-operatively, which is well above the 30% of patients who normally attend CR [79]. However, it is not known if Prehab would promote sustained healthy lifestyle change

after CR enrolment. One of the CR quality indicators currently under consideration by the Canadian Association of Cardiac Rehabilitation (CACR) is to assess physical activity behaviors six and 12 months after the completion of CR [17]. However, the CACR cite evidence indicating that physical activity levels significantly decline one month after CR enrolment [17]. Data from Guiraud *et al.* [144] also indicate that only 41% of patients are accumulating at least 150 minutes of MVPA per week one year after completing CR. Therefore, based on the high enrolment rates in CR after Prehab, it is possible that Prehab could also help support patients maintain their healthy lifestyle learned in Prehab and CR. This possibility should be examined in the future.

Conclusion

Our novel study shows that Prehab can significantly enhance the health status of elective CABG surgery patients pre-operatively, as compared to StanC. Specifically, functional walking ability (i.e. 6MWT and five meter gait speed) was significantly improved at Preop and maintained Three months post-operatively amongst patients who attended Prehab, as compared to patients who received standard care. Furthermore, patients in Prehab reported adopting a more physically active lifestyle at Preop, as compared to StanC. Our novel data also indicate that there was a trend towards significance for the number of Prehab sessions associated with fewer signs of depressive symptoms. In summary, the novel data presented in this study demonstrate the feasibility and efficacy of utilizing a Prehab exercise and education intervention to improve the functional walking ability and healthy physical activity lifestyle choices of patients who are waiting for elective CABG surgery.

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Appendices

Appendix A: Patient informed consent

Appendix B: Short Form International Physical Activity Questionnaire

Appendix C: Short Form 36 Questionnaire

Appendix D: Patient Health Questionnaire-9

Appendix E: Cardiac Anxiety Questionnaire

Appendix F: Cardiac Exercise Self-Efficacy Instrument

Appendix G: CABG Surgery Healthy Lifestyle Questionnaire

Appendix H: Health Care Resources Utilization Questionnaire

Appendix A: Patient informed consent

RAKESH C. ARORA* MD, PhD, FRCSC

Cardiac Surgeon / Intensivist
Medical Co-Director - Intensive Care Cardiac Surgery
Rudy Falk Clinician-Scientist
Assistant Professor – Department of Surgery & Physiology
*Denotes Medical Corporation

RESEARCH PARTICIPANT INFORMATION AND CONSENT FORM

Title of Study: Coronary Artery Bypass Graft Surgery Pre-habilitation Pilot Project.

Principal Investigators: **Dr. Rakesh Arora MD PhD FRCSC FACS**
Research Director – Section of Cardiac Surgery
Research Director – Translational Research – Dept. of Surgery
St. Boniface Hospital
Ph# 204-258-1031

Dr. Jo-Ann V. Sawatzky RN, PhD
Associate Professor
Faculty of Nursing
University of Manitoba
Ph#: 204-474-6684

Co-Investigators: **Dr. Todd Duhamel PhD**
Assistant Professor
Faculty of Kinesiology & Recreation Mgmt
University of Manitoba
Ph#:204- 235-3589

Ms. Sue Boreskie MPE
CEO Reh-Fit Centre
#1390 Taylor Avenue
Winnipeg, MB
Ph#: 204-488-8023

Sponsor: **Cardiovascular Health and Research in Manitoba (CHaRM)**

You are being asked to participate in a research study. Please take your time to review this consent form and discuss any questions you may have with the study staff. You may take your time to make your decision about participating in this

study and you may discuss it with your friends, family or (if applicable) your doctor before you make your decision. This consent form may contain words that you do not understand. Please ask the study staff to explain any words or information that you do not clearly understand.

Purpose of Study

This research study is being conducted to study the effects of pre-operative exercise and education on the outcomes of coronary artery bypass graft (CABG) surgery. The primary purpose of this study is to further establish safety of this program. A total of 20 patients will participate in this study.

Study Procedures

In this study, you will be "randomized" into one of the 2 study groups described below. "Randomized" means that you are put into a group by chance, like flipping a coin. You will have an equal chance of being placed in either group.

Usual Care Group Procedures:

If you are selected for the **'current standard care'** group, you will be asked to complete the following 3 appointments with the Research Assistant:

Appointment #1: This appointment will take place within the next week. You will be asked to come to the St. Boniface Hospital/I.H. Asper Clinical Research Institute, Rm 369. During this appointment you will complete a questionnaire, and a 6-minute walk test. For the 6-minute walk test you will be asked to walk in hallway, at your own pace, for a total of 6 minutes. This simple test will provide information regarding your physical fitness level; it is routinely used for clients participating in cardiac rehabilitation programs across Canada. In addition, your blood pressure, heart rate, waist and hip measurements and weight will be taken by the Research Assistant. The Research Assistant will also provide you with a Physical Activity Monitor, which is a small device that is about the size of a watch (4 cm x 4 cm) and is worn on a belt. This device measures the amount and intensity of physical activity that you complete on a daily basis. Given the small size and placement of the accelerometer at belt level, you will be able to participate in your normal daily routine without alteration. It is important to note that the monitor will only measure the amount of physical activity that you accumulate and does not store personal information. Therefore, your privacy will not be adversely affected by wearing the unit. The monitor will be given to you by research staff at each of the three meetings and you will be asked to return the unit to the St, Boniface Hospital seven days later. This appointment will take approximately 1 hour of your time.

Appointment #2: this appointment will be combined with your cardiac surgery pre-operative assessment clinic appointment at St Boniface Hospital, approximately 1 week prior to your surgery. During this appointment you will be asked to complete a questionnaire and the 6-minute walk test. In addition, your blood pressure, heart rate, waist and hip measurements and weight will be taken by the Research Assistant. The Research Assistant will also provide you with a

Physical Activity Monitor; you will be asked to wear this Monitor for a period of 7 days. This part of the pre-op assessment appointment will take approximately 1 hour of your time.

Appointment #3: about 3 months after your surgery, the Research Assistant will contact you to make an appointment to come back to the St Boniface Hospital/I.H. Asper Clinical Research Institute. During this appointment you will complete a questionnaire and the 6-minute walk test. In addition, your blood pressure, heart rate, waist and hop measurements and weight will be taken by the Research Assistant. The Research Assistant will also provide you with a Physical Activity Monitor; you will be asked to wear this Monitor for a period of 7 days. This appointment will take approximately 1 hour of your time.

Intervention Group Procedures:

If you are randomized to the **'intervention' group**, you will be asked to complete **the same 3 appointments** outlined for the usual care group above. In addition, you will be asked to participate in the "**Pre-hab Program for Cardiac Surgery Patients"** at the Reh-Fit Centre, #1390 Taylor Avenue, Winnipeg, MB. This unique program has been developed to meet
individualized exercise and education needs of patients waiting for coronary artery bypass graft surgery. Before you start the Program, you will receive a baseline health and fitness
assessment by the Reh-Fit professionals. This assessment includes a questionnaire, as well as a stress test, body measurements [waist, hip measurement & weight] and a blood test [glucose & lipid levels]. If the Reh-Fit staff identifies any concerns regarding your participation in the Pre-hab Program, based on this assessment, you may be removed from the study. The RA will also collect this information as part of the study.

The education part of the pre-hab program will be made up of a series of weekly classes at the Reh-Fit Centre. The goal of these classes is to help you to make improvements and/or changes in your heart healthy lifestyle. Topics for these classes include self-management strategies for cardiac rehabilitation: medications, exercise, stress, diet, and other risk factors, as well as anatomy and physiology of the cardiovascular system. Participants in the intervention group will also receive an informational class on cardiac surgery. Additional classes may be recommended, based on the individual needs of the participants, to include topics such as weight loss strategies, diabetes management, and quitting smoking strategies. The education sessions will be conducted by the staff of the Reh-Fit Centre and/or the RA.

The exercise part of the pre-hab program will consist of an individualized exercise program, based on your Reh-Fit Centre health assessment. If you choose to participate in the study and are randomized to the intervention group, we will request that you commit to attending the Reh-Fit Centre for 2 supervised exercise sessions each week until you are called for your surgery or for the duration of your 16-week program, whichever comes first. We will also ask you to keep a record of your visits to the Reh-Fit Centre.

Education and exercise classes are typically held during daytime hours, when a physician is on site. If you are unavailable during daytime hours, during your initial assessment at the Reh-Fit Centre, the medical director will assess you to determine if you can attend classes when a physician is not on site.

There is NO cost to you for participating in this Pre-hab Program, other than your time and your transportation costs. Participation in this Pre-hab Program entitles you to a 16-week membership at the Reh-Fit Centre.

All study participants: If you agree to participate in this study, we will also be obtaining information from your hospital chart. This will include information about your past medical history and details regarding your surgery/hospital stay. Participation in the study will continue for approximately 3 months after your cardiac surgery. If you are interested in receiving a summary of the study results, please designate this on the form below.

Risks and Discomforts

The risks to participating in this research are considered to be minimal. However, there is a certain degree of risk involved in the initiation of any exercise program. If you are randomized to the intervention group, you will be carefully assessed by the Reh-Fit Centre staff prior to the initiation of an exercise program; as well, the symptom limited, graded program of exercise would be individualized according to your personal health status. Although the exercise classes will be conducted by certified and experienced instructors, if you have reason to believe that you would be

at physical risk of harm/injury by participating in the exercise program, you are asked to decline participation in this project. The Reh-Fit Centre has trained exercise specialists on site to supervise the exercise programs offered at the Centre. Additionally, trained healthcare personnel are also on site at all times. The researcher may decide to take you out of this study if your health status changes to prevent you from being able to continue to participate. For example, if your heart condition gets worse before your surgery, it may not be appropriate for you to continue being in the study. Your participation in the study may also be discontinued upon the advice of a medical doctor.

Benefits

There may or may not be direct benefit to you from participating in this study. We hope the information learned from this study will benefit other people who are awaiting coronary artery bypass graft surgery in the future.

Costs

All the procedures, which will be performed as part of this study, are provided at no cost to you. The cost to you will be transportation to St. Boniface Hospital for

the assessment appointments; you will be reimbursed for your parking costs at the hospital during these appointments. If you are randomized to the intervention group, the cost will also include transportation to the Reh-Fit Centre.

Confidentiality

Information gathered in this research study may be published or presented in public forums, however your name and other identifying information will not be used or revealed. Despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed. Your personal information may be disclosed if required by law. Medical records that contain your identity will be treated as confidential in accordance with the Personal Health Information Act of Manitoba.

Organizations that may inspect and/or copy your research for quality assurance and data analysis include groups such as: The University of Manitoba Health Research Ethics Board; St. Boniface Hospital Office of Clinical Research.

All study related documents will bear only your assigned study number. All data will be entered into a computer and transmitted electronically to members of the research team only. All hard copy records will be kept in a locked secure area and only those persons identified will have access to these records. If any of your medical/research records need to be copied to any of the above, your name and all identifying information will be removed. No information revealing any personal information such as your name, address or telephone number will leave St. Boniface Hospital. If deemed necessary by the research staff, information regarding your health status may be shared with medical staff at St. Boniface Hospital and/or the Reh-Fit Centre.

Voluntary Participation/Withdrawal from the Study

Your decision to take part in this study is voluntary. You may refuse to participate or you may withdraw from the study at any time. However, if you decide to stop participating in the study, we encourage you to talk to the study staff first. There are no consequences to withdrawing from the study. Your decision not to participate or to withdraw from the study will not affect your care at this centre. If the study staff feels that it is in your best interest to withdraw you from the study, they will remove you without your consent. We will tell you about any new information that may affect your health, welfare, or willingness to stay in this study.

Questions

You are free to ask any questions that you may have about your treatment and your rights as a research participant. If any questions come up during or after the study or if you have a research-related injury, contact the Study Coordinator: Dr. Jo-Ann Sawatzky @ 474-6684 or
joannne_sawatzky@umanitoba.ca.

For questions about your rights as a research participant, you may contact The University of Manitoba, Bannatyne Campus Research Ethics Board Office at (204) 789-3389. Do not sign this consent form unless you have had a chance to ask questions and have received satisfactory answers to all of your questions.

Statement of Consent

I have read this information/consent form. I have had the opportunity to discuss this research study with Dr. Rakesh Arora and/or his study staff. I have had my questions answered by them in language I understand. The risks and benefits have been explained to me. I believe that I have not been unduly influenced by any study team member to participate in the research study by any statements or implied statements. Any relationship (such as employer, supervisor or family member) I may have with the study team has not affected my decision to participate. I understand that I will be given a copy of this consent form after signing it. I understand that my participation in this study is voluntary and that I may choose to withdraw at any time. I freely agree to participate in this research study.

I understand that information regarding my personal identity will be kept confidential, but that confidentiality is not guaranteed. I authorize the inspection of any of my records that relate to this study by The University of Manitoba Research Ethics Board and St. Boniface Hospital Office of Clinical Research for quality assurance purposes.

By signing this consent form, I have not waived any of the legal rights that I have as a participant in a research study.

I agree to be contacted for future follow-up in relation to this study - YES__ NO ___

I would like to receive a summary of the study findings – YES__NO___

If Yes, please provide mailing or e-mail address

_____

Participant signature_____ Date_____
(day/month/year)

Participant printed name: _____

I, the undersigned, have fully explained the relevant details of this research study to the participant named above and believe that the participant has understood and has knowingly given their consent

Printed Name: _____ Date _____
(day/month/year)

Signature: _____

Role in the study: _____

Appendix B: International Physical Activity Questionnaire

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that

you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Appendix C: Short Form 36 Questionnaire

CABG Surgery Pre-habilitation Pilot Study Questionnaire [SF-36]

INSTRUCTIONS: THIS SURVEY ASKS FOR YOUR VIEWS ABOUT YOUR HEALTH. THIS INFORMATION WILL HELP KEEP TRACK OF HOW YOU FEEL AND HOW WELL YOU ARE ABLE TO DO YOUR USUAL ACTIVITIES. ANSWER EVERY QUESTION BY MARKING THE ANSWER AS INDICATED. IF YOU ARE UNSURE ABOUT HOW TO ANSWER A QUESTION, PLEASE GIVE THE BEST ANSWER YOU CAN.

1. In general, how would you say your health is now? Check one (T)
   - Poor .....1( )
   - Fair .....2( )
   - Good.....3( )
   - Very good.....4( )
   - Excellent ..... 5( )

2. *Compared to one year ago,* how would you rate your health in general now? Check one (T)
   - Much better now than one year ago.....1( )
   - Somewhat better now than one year ago .....2( )
   - About the same now than one year ago .....3( )
   - Somewhat worse now than one year ago.....4( )
   - Much worse now than one year ago .....5( )

3. The following items are about activities you might do during a typical day. Does *your health* now limit you in these activities? If so, how much? (Circle one number on each line)

Activities	Yes, limited a lot	Yes, limited a little	No, not limited at all
a. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	1	2	3
b. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
c. Lifting or carrying groceries	1	2	3
d. Climbing **several** flights of stairs	1	2	3
e. Climbing **one** flight of stairs	1	2	3
f. Bending, kneeling, or stooping	1	2	3
g. Walking **more than a mile**	1	2	3

h. Walking **several blocks**	1	2	3
i. Walking **one** block	1	2	3
j. Bathing or dressing yourself	1	2	3

3. During the *past 4 weeks* have you had any of the following problems with your work, or other regular daily activities *as a result of your physical health?*

(Circle one number on each line)

	Yes	No
a. Cut down on the **amount of time** you spent on work and other activities	1	2
b. **Accomplished** less than you would like	1	2
c. Were limited in the **kind** of work or other activities	1	2
d. Had **difficulty** performing the work or other activities (for example, it took extra effort)	1	2

4. During the *past 4 weeks,* have you had any of the following problems with your work or other regular activities *as a result of any emotional problems* (such as feeling depressed or anxious)?

(Circle one number on each line)

	Yes	No
a. Cut down on the **amount of time** you spent on work or other activities	1	2
b. **Accomplished less** than you would like	1	2
c. Didn=t do work or other activities as **carefully** as usual	1	2

5. During the *past 4 weeks*, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

Check one (T)

Not at all.....1( )

Slightly.....2( )
Moderately.....3( )
Quite a bit.....4( )
Extremely.....5( )

6. How much *bodily* pain have you had during the *past 4 weeks?*

Check one (T)

None.....1( )
Very mild.....2( )
Mild.....3( )
Moderate.....4( )
Severe.....5( )
Very severe.....6( )

7. During the *past 4 weeks*, how much did *pain* interfere with your normal work (including both work outside the home and housework?

Check one (T)

Not at all.....1( )
A little bit.....2( )
Moderately.....3( )
Quite a bit.....4( )
Extremely.....5( )

8. These questions are about how you feel and how things have been with you *during the past 4 weeks.* For each question, please give one answer that comes the closest to the way you have been feeling. How much time during the *past 4 weeks*

(Circle one number on each line)

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
a. Did you feel full of pep?	1	2	3	4	5	6
b. Have you been a very nervous person?	1	2	3	4	5	6
c. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
d. Have you felt calm and peaceful?	1	2	3	4	5	6
e. Did you have a lot of energy?	1	2	3	4	5	6

f. Have you felt downhearted and blue?	1	2	3	4	5	6
g. Did you feel worn out?	1	2	3	4	5	6
h. Have you been a happy person?	1	2	3	4	5	6
i. Did you feel tired?	1	2	3	4	5	6

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

Check one (T)

All of the time .....1( )
Most of the time .....2( )
Some of the time .....3( )
A little of the time .....4( )
None of the time.....5( )

10. How TRUE or FALSE is each of the following statements for you?

(Circle one number on each line)

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
a. I seem to get sick a little easier than other people	1	2	3	4	5
b. I am as healthy as anybody I know	1	2	3	4	5
c. I expect my health to get worse	1	2	3	4	5
d. My health is excellent	1	2	3	4	5

12. Using the visual scale below, on the scale from 0 to 10, with 0 being very poor and 10 being excellent, please circle the number would best describe your quality of life

today:

1---------2---------3---------4---------5---------6---------7---------8---------9---------10

Very Poor *Excellent*

Appendix D: Patient Health Questionnaire-9

PHQ-9 QUESTIONNAIRE

Over the past 2 weeks, how often have you been bothered by any of the following problems? Please circle the best response, according to the following scale:

0 1 2 3

_____

_

Not at all Several days More than half the days Nearly every day

	Not at all	Several days	More than half the days	Nearly every day
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual	0	1	2	3
9. thoughts that you would be better off dead, or of hurting yourself in some way	0	1	2	3

10. If you checked off any problems, how difficult have these problems made it for your to do your work, take care of things at home, or get along with other people? please check (√) your response	Not difficult at all _____ Somewhat difficult _____ Very difficult _____ Extremely difficult _____

Appendix E: Cardiac Anxiety Questionnaire

CARDIAC ANXIETY QUESTIONNAIRE

Please rate each item by circling the answer (number) that best applies to you:

	Never	Rarely	Sometimes	Often	Always
1. I pay attention to my heart beat	0	1	2	3	4
2. I avoid physical exertion	0	1	2	3	4
3. my racing heart wakes me up at night	0	1	2	3	4
4. chest pain/discomfort wakes me up at night	0	1	2	3	4
5. I take it easy as much as possible	0	1	2	3	4
6. I check my pulse	0	1	2	3	4
7. I avoid exercise or other physical work	0	1	2	3	4
8. I can feel my heart in my chest	0	1	2	3	4
9. I avoid activities that make my heart beat faster	0	1	2	3	4
10. if tests come out normal, I still worry about my heart	0	1	2	3	4
11. I feel safe being around a hospital, physician or other medical facility	0	1	2	3	4
12. I avoid activities that make me sweat	0	1	2	3	4
13. I worry that doctors do not believe my symptoms are real	0	1	2	3	4
14. I worry that I may have a heart attack	0	1	2	3	4
15. I have difficulty concentrating on anything else	0	1	2	3	4
16. I get frightened	0	1	2	3	4
17. I like to be checked out by a doctor	0	1	2	3	4
18. I tell my family or friends	0	1	2	3	4

Appendix F: Cardiac Exercise Self-Efficacy Instrument

Cardiac Exercise Self-Efficacy Instrument

Beside each item below, please circle the number that represents how much confidence you have about performing it using the following scale:

1 2 3 4 5

Very little confidence **Very much confidence**

1. “Warming up” before exercise	1	2	3	4	5
2. Exercising without getting chest pain	1	2	3	4	5
3. Knowing when I have exercised too much and need to stop	1	2	3	4	5
4. Exercising when it is inconvenient	1	2	3	4	5
5. Knowing what my heart rate should be before and after exercise	1	2	3	4	5
6. “cooling down” after exercise	1	2	3	4	5
7. Fitting exercise in to a busy day	1	2	3	4	5
8. Enduring strenuous exercise	1	2	3	4	5
9. Knowing what exercise is healthy for me	1	2	3	4	5
10. Knowing when I can increase my exercise level	1	2	3	4	5
11. Enduring moderate exercise	1	2	3	4	5
12. Taking my heart rate before and after exercise	1	2	3	4	5
13. Resuming my pre-hospital level of activity	1	2	3	4	5
14. Enduring light exercise	1	2	3	4	5
15. Exercising for at least 20 minutes three times each week	1	2	3	4	5
16. Exercising at home by my self	1	2	3	4	5

Appendix G: CABG Surgery Healthy Lifestyle Questionnaire

CABG Surgery Healthy Lifestyle Questionnaire

The following questions are related to 'heart healthy' lifestyle changes that you may have made since your diagnosis of heart disease. Please circle the most appropriate response. N/A indicates you have made healthy lifestyle prior to your diagnosis.

	no, not at all	yes a little	yes, a lot	N/A
1. Have you generally made 'heart healthy' Changes to your diet?	1	2	3	4
2. increased fruit & vegetables in your diet?	1	2	3	4
3. reduced the amount of red meat in your diet?	1	2	3	4
4. decreased the amount of salt in your diet?	1	2	3	4
5. decreased the amount of fat in your diet?	1	2	3	4
6. made a conscious effort to achieve a healthy weight?	1	2	3	4
7. increased your level of physical activity?	1	2	3	4
8. taken steps to quit smoking?	1	2	3	4

Appendix G: Health Care Resources Utilization Questionnaire

HEALTH CARE RESOURCES UTILIZATION QUESTIONNAIRE*

*Note: time frame will be adapted for the 1 week pre-op and 3 month follow-up interviews

We are interested in any contact you have had with the healthcare system since your discharge/since we contacted you last. Have you had contact with any of the following since that time?

1. Family physician YES___ NO___ # of visits_____

   Reason for visit[s]_____

2. Cardiologist YES___ NO___ # of visits_____

   Reason for visit[s]_____

3. Emergency Dept or YES___ NO___ # of visits_____

   Walk-in Clinic

   Reason for visit[s]_____

4. Hospital Admission YES___ NO___ # of admits_____

   Reason for admission[s]_____

5. HomeCare Services YES___ NO___ # of visits_____

6. Cardiac Rehab appt? YES___ NO___ # of visits_____

   If no – plans to contact? YES___ NO___

If no, why not?

_____

7. Other? Please specify_____