Multimodal prehabilitation in patients undergoing colorectal cancer resection: The impact of supervised structured perioperative exercise on postoperative functional capacity

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complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

Multimodal prehabilitation in patients undergoing colorectal cancer resection: The impact of supervised structured perioperative exercise on postoperative functional capacity

Rashami Awasthi

Exercise training has been shown to positively affect the maintenance of functional capacity and facilitate recovery from surgery. This thesis proposes that a supervised pre-operative exercise training program would encourage patient compliance, thus maximizing the opportunity to regain functional exercise capacity 4-weeks post-surgery. The supervised group (Group S) received 4 training sessions at the Montreal General Hospital exercise laboratory along with a home-based exercise program during the pre-surgical period and provided daily supervised exercise during the post-surgical hospital stay. The unsupervised group (Group U) received a 4-week home-based exercise program during the pre-surgical period and were not seen by a kinesiologist during the post-surgical in-hospital stay. The exercise programs (both pre and post-surgery) included individualized aerobic, resistance and flexibility exercises. Both groups continued to exercise until 4 weeks post-surgery, after which they returned to the laboratory for evaluation. The primary outcome was functional walking capacity, as assessed by the six-minute walk test (6MWT).

Acknowledgements

I would like to express my gratitude, admiration and respect to my supervisor Dr. Francesco Carli for his continued engagement throughout the learning process of this master's thesis. His expertise, generous guidance and support made it possible for me to work on a topic that was of great interest to me. Furthermore I would like to thank my supervisors Andreas Bergdahl and Celena Scheede-Bergdahl for their useful comments, persistence and support throughout this process. I would not have achieved this milestone if the two of you did not believe in me and for that I am grateful.

To my parents, I thank you for always encouraging me to reach for my dreams, and for always being by my side. To my husband, Abhishek Sharma, I thank you for your patience, your continued support and love. Thank you for being my rock.

Without the support of the Peri-Operative Program and the patients that participated in this project, this journey would not have been possible, and for that I would like to dedicate this thesis to all cancer patients.

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Introduction

Biology and Epidemiology of Colorectal Cancer

Colorectal cancer is the third most common cancer in North America and is the second leading cause of death. Commonly seen in individuals aged 60 and over, 23,900 new cases of colorectal cancer were diagnosed in Canada in 2013 [1]. A patient who is diagnosed with cancer experiences a variety of conditions that impacts physical function: loss of muscle mass, lack of appetite/malnutrition and extreme fatigue. This functional decline is associated with mental distress such as anxiety, depression and loss of self-esteem. Loss of physical function and mental distress, taken together, contribute to a rapid and significant decrease in quality of life [2,3].

Colorectal Cancer

Colorectal cancer is a tumor that commences in cells of the large intestines. The tumor easily invades the surroundings and causes metastasis in other organs. There are five different stages of cancer. With each stage, the tumor progresses and begins to affect other areas of the body (Figure 1).

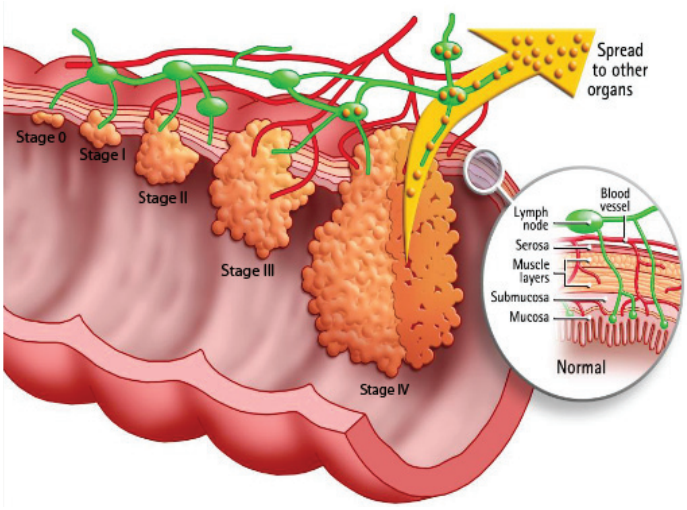

Figure 1. Cancer Stages

Stage 0 = Abnormal cells in the innermost layer of the colonic walls; *Stage I* = Spread from innermost layer to the muscle layer; *Stage II* = Spread to the serosa layer to nearby organs; *Stage III* = Spread to at least one ore more lymph nodes; *Stage IV* = Progressed to distant lymph nodes, organs that are further from the colon or into the lining of the abdominal wall1.

Adapted from: http://singaporeoncology.com.sg/images/4.png

The tumor cell causes the release of multiple cytokines that also affects the liver, muscle and the central nervous system. This impacts the control of satiety, as well as the perception of taste and smell, resulting in decreased appetite and the inability to consume a well-balanced diet [4]. Metabolic changes due to the cancerous cells lead to increased gluconeogenesis, changes in muscle protein turnover [4], insulin resistance and protein catabolism, further depleting physiologic reserves [4] and resulting in sarcopenia [5]. This cluster of inflammatory and

metabolic changes severely impacts the functional status of the cancer patient, and can further impair treatment strategies for these individuals.

Therapeutic Strategies

Surgery

Surgical resection can be performed through laparotomy (an open abdominal incision), or laparoscopy (less invasive, small incisions). Surgical procedures include resection of the tumor followed by an anastomosis of the two ends of the colorectal sections. If the affected area requires time to heal then an ileostomy (a stoma formed by passing the ileum through an opening made in the abdominal wall) or colostomy (a stoma formed by attaching the large intestine or colon through an opening made in the abdominal wall) is created. Surgical resection is associated with a complication rate of 21-45% [6] and can lead to a longer length of hospital stay (6 to 10 days) [7]. The extended bed rest that often follows surgery during the hospitalization period has been associated with almost 60% loss of muscle strength, 17-88% incidence of postoperative pulmonary dysfunction due to decreased movement of the thoracic diaphragm [8] and have a slower return of bowel function which increases the risk of weight loss and malnutrition. Older patients can also experience fatigue [9] delirium, cognitive and functional decline [3] because of the aforementioned. Despite surgical resection being the primary treatment for colorectal cancer, it may be necessary to reduce the size of the tumor through neoadjuvant chemotherapy/and or radiotherapy to facilitate surgical resection.

Adjuvant Chemotherapy and Radiotherapy

In thirty percent of the surgical population adjuvant chemotherapy may be required after surgery to eliminate any cancerous cells that may have not been successfully removed from the surgical procedure. Chemotherapy and radiotherapy sessions last from 6 to 8 weeks and cause considerable stress to the body as a result of the toxic effect of the chemotherapy medications and ionizing radiation.

The side effects include fatigue, nausea, vomiting, constipation, low levels of hemoglobin, peripheral neuropathy [10] and infections [11].

Due to the range of cancer treatments (surgery, chemotherapy and radiotherapy) the relative survival rate of this population is 60% [12]. As a result of the physical and mental stress

patients' encounter during the treatment process, it remains critical that these individuals are in optimal physical condition. Ninety-six percent of cancer patients have complained about fatigue during as well as after treatment [13] which can further cause functional decline and affect quality of life.

Metabolic and Hormonal Response to Surgical Stress

The surgical stress response is a systemic reaction to surgical incision that involves hormonal, inflammatory and haematological changes with the aim to maintain homeostasis within the body. The extent of metabolic changes depends on the severity of the surgical intervention [14]. During this response, the hormones released from the pituitary are released in higher concentrations along with an increased activation of the sympathetic nervous system [15]. These changes in the secretion of hormones from the pituitary have secondary effects on other hormones released from target organs such as the adrenal cortex (cortisol, aldosterone), pancreas (insulin and glucagon), and thyroid (thyroxine, tri-iodothyronine) [15].

Afferent impulses from the surgical site are sent to activate the hypothalamus facilitating the release of corticotropin-releasing factor, stimulating the pituitary to release pro-opiomelanocortin, prolactin, vasopressin and growth hormone. Pro-opiomelanocortin metabolizes into adrenocorticotropic hormone (ACTH) and β-endorphin within the pituitary. ACTH stimulates the release of cortisol and aldosterone from the adrenal cortex [16].

The release of cortisol is controlled through negative feedback inhibition. As the level of cortisol rises, ACTH is inhibited and further prevents the release of cortisol. After surgery, this feedback is impaired and both cortisol and ACTH is elevated [4]. Cortisol also stimulates gluconeogenesis and sensitizes adipose tissue to growth hormone, which reduces the inflammatory response. Cortisol also has the ability to inhibit insulin thus causing hyperglycemia and protein catabolism.

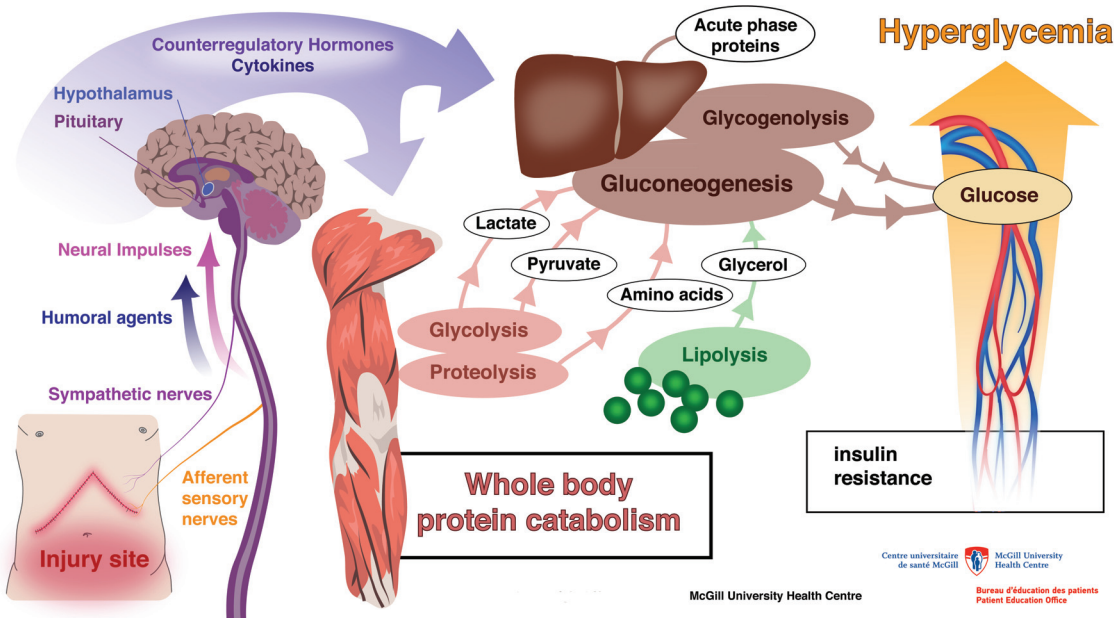

Figure 2. Hyperglycemia and whole body protein catabolism following surgical injury, and mediated by insulin resistance.

Hyperglycemia is characterized by a higher level of blood glucose that has been shown to cause an increase in infection rate if not treated with delay in recovery. Protein catabolism causes the loss of lean body mass which is seen in patients after major traumatic injury and surgery. This loss in lean body mass can cause complications, and lead to delayed recovery after surgery (Figure 2). Postoperative insulin resistance, which is mediated by the endocrine (cortisol and catecholamines) and inflammatory (cytokine) responses, has been reported in adipocytes, skeletal myocytes and hepatic tissue. With regards to skeletal muscle in particular, these inflammatory and hormonal mediators reduce insulin-mediated glucose uptake through either a defect in the insulin signaling pathways or a defect in the translocation of an insulin-regulated glucose transporter (GLUT-4) to the plasma membrane [17]**.** This reduction in insulin sensitivity combined with the effect of counter-regulatory hormones stimulates hepatic glucose production even with the presence of hyperglycemia [18].

Glucagon and insulin are released by the pancreas (α and β cells) and have an inhibitory effect on each other. A high level of glucagon promotes the synthesis of glucose by using liver glycogen and thus stimulates lipolysis (gluconeogenesis). An increase in glucagon stimulates glycogenolysis and also increases gluconeogenesis from amino acids in the liver, and this inactivates glycogen synthase which is responsible for the stimulation of glycogenesis [16]. On

the contrary, insulin, which is a key anabolic hormone [19] aids in the cellular uptake of glucose and amino acids, stimulates the synthesis of glycogen, inhibits lipolysis and also increases protein synthesis in muscle and liver. Depending on the intensity of surgery, levels of glucagon are notably higher whereas insulin levels are reduced [4].

The hormonal changes that occur as a result of surgery allow conversion of triglycerides to glycerol and free fatty acids through lipolysis [4]. The glycerol that is now produced is a substrate for the process of gluconeogenesis. Due to the lack of insulin in the blood, fatty acids, when oxidized are converted to ketone bodies [4].

The inflammatory response is characterized by a release of cytokines such as interleukins and interferons [19] that are secreted from local inflammatory cell tissues into the blood as a response to surgical injury [20]. These aid in maintaining the inflammatory response, help to initiate homeostatic changes and are thus involved with the immune system to help regulate the response to surgery and infections. After surgery, the main pro-inflammatory cytokines releases are interleukin-1 (IL-1), tumor necrosis factor-α (TNFα), and interferon- γ (INT- γ) from macrophages in the affected tissue that stimulates the release of more cytokines (interleukin-6) [15,19]. Interleukin-6 is the main cytokine that is detected after surgery and causes the systemic metabolic changes in the body, attempting to control tissue damage and maintain homeostasis, also known as the "acute phase response" [19]. The proteins that are produced as a result of the acute phase response have a stimulating effect on the release of ACTH in the pituitary and hypothalamus. A rise in fibrinogen and ferritin (positive acute phase reactants) concentrations and a reduction in transferrin and albumin (negative acute phase reactants) occur as a result of surgery. In addition, C-Reactive Protein (CRP) is a positive acute-phase plasma protein used as a marker of inflammation and cytokine release [3].

Postoperative Period and Functional Recovery

During the post-operative period, patients experience a decrease in their functional capacity (activities of daily living) by approximately 20-40% [16]. Although attempts have been made to attenuate the stress of surgery, such as minimally invasive techniques (laparoscopy) the incidence, of surgical and medical complications still remains fairly high and varies from 25% to 60% [21]. Complications, as a result of surgery can lead to an increased length of hospital stay, slower recovery and higher levels of fatigue for 6-8 weeks post hospital discharge. It is suggested

that patients who are malnourished and have decreased lean muscle mass before surgery, are less able to withstand the stress of surgery, with increased risk of developing complications [9]. The combination of surgical resection with adjunct chemotherapy and radiotherapy can have an impact on the return to basic functions. It is often the case to witness that patients who experience complications after their surgical procedure and are in need of adjunct chemotherapy are at a higher chance of having their treatment postponed, as the body is not physically ready to undergo another stressful intervention.

Although efforts have been made to emphasize the role of education in informing patients about surgery [22] and the postoperative period, less focus has been placed on the enhancement of functional capacity prior to surgery. Studies have shown that low baseline functional capacity increases the risk of complications after major surgery lengthening the recovery process [3].

Most studies related to programs that would accelerate the recovery process, such as the Enhanced Recovery After Surgery (ERAS) protocol, have focused on improving both the intra- and postoperative periods; however, emerging evidence shows that patients' physiological and metabolic reserve can be increased in the preoperative period [23].

Presently patients are given little advice by the surgical team on the day of discharge about postoperative rehabilitation; they are instructed to avoid lifting for 6 weeks and to minimize any effort that may disturb the process of wound healing. Similarly no instructions are given to patients with regards to nutrition and activities of daily living. Needless to say, the postoperative period is not the most salient time to commence a rehabilitation program as patients are tired, worried about the pending results from the surgical resection, and lack self-esteem.

Optimizing Patients for the Stress of Surgery

There is sufficient evidence from the literature that poor physical status is an independent predictor of poor recovery [3, 21]. Therefore, efforts should be made to optimize the patients' health status before the stress of surgery, thus facilitating the recovery process.

The Role of Physical Activity

Physical activity in an elderly population has been shown to lessen all-cause mortality, morbidity, and disability, and is beneficial in diseases such as cardiovascular, respiratory and cancer [24]. The American College of Sports Medicine and the American Heart Association recommend that regular physical activity is essential for healthy aging and should include moderate-intensity aerobic activity for 30 minutes five times per week along with strengthening, balance, and flexibility exercise [25]. Engaging in regular physical activity helps to provide a protective effect against many functional limitations [26]. An elevated level of physical activity is associated with significantly reduced risk for incidence in colorectal cancer, and lower physical activity is known to be a risk factor for the development of colorectal cancer [27,28]**.** Those with low physical activity levels are also more prone to postoperative complications after major surgery [23]. Physical activity has also been associated with improved short-term surgical outcomes [29] thus facilitating early recovery. Therefore attempts to improve quality of life should be made be enhancing the level of physical activity patients engage in prior to surgery.

As the population ages, there is a reduction in physical function [30] resulting in frailty. It is thus of importance to preserve and/or enhance cardiopulmonary function, muscle and bone strength and mobility [31] in cancer patients due to the adverse effects of surgery, chemotherapy and radiotherapy. Not only does physical activity have a positive effect physically, but also psychologically [30]. Physical inactivity is known to be the fourth most important risk factor for overall death by the World Health Organization [32] and has an association with different types of cancer, of which colorectal and breast are included [33]**.** It is evident that engaging in physical activity reduces the incidence of the above mentioned cancers [34-38] and is thus important to educate patients about its importance. A cohort study conducted by Nilsson et al on breast cancer patients found that having higher levels of physical activity during the preoperative period was positively associated with enhanced physical recovery after surgery as reported by patients [39].

The Role of Nutrition

Malnutrition in cancer patients is responsible for the loss of body weight. Insufficient amounts of nutrients and energy can lead to an early onset of satiety resulting in a reduced amount of food intake [40], reduction in lean muscle mass, weakness, fatigue and impaired immune function. Nutritional status can influence postoperative morbidity and mortality [41] .

Prehabilitation

A literature review on the role of optimizing functional exercise capacity in the surgical population during the pre-operative time frame has demonstrated that this approach can have a positive impact on reducing postoperative complications, decrease the length of stay in hospital, and improve quality of life [42]. Prehabilitation is an emerging concept and can be defined as the process enabling patients to withstand the stressor of inactivity associated with an admission to surgery though augmenting functional capacity [42] (Figure 3).

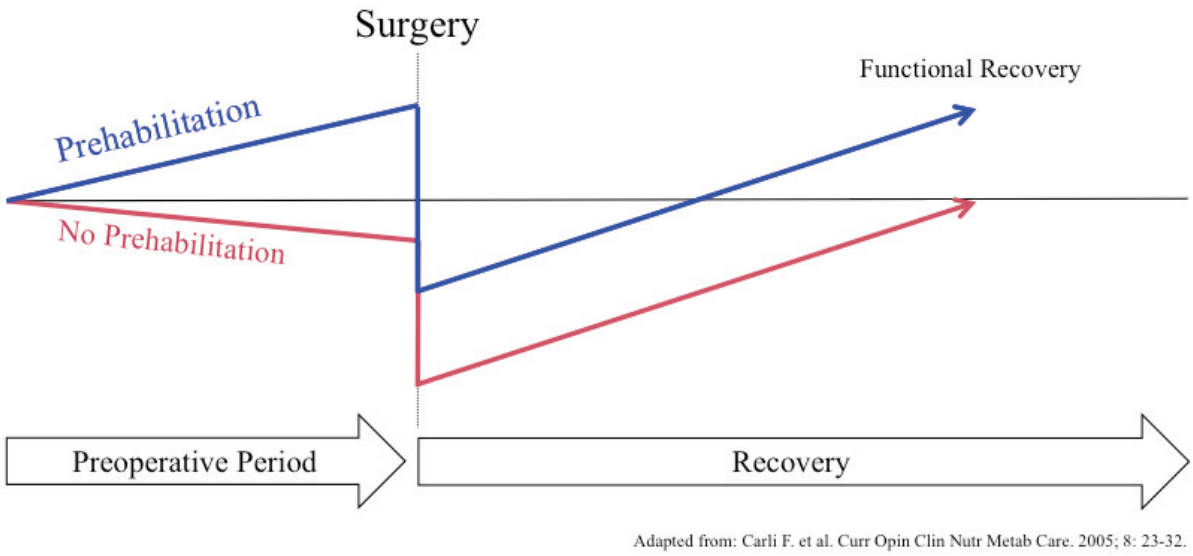

Figure 3. Trajectory of Functional Recovery. The blue line represents the trajectory of patients who follow the prehabilitation program. In the preoperative phase, functional capacity increases due to physical activity. As a result of surgical stress, functional capacity decreases, but less than the non-prehabilitation patients (red line). After surgery the prehabilitation patients recover faster and return to baseline earlier than the non-prehabilitation patients.

A randomized controlled trial (RCT) was previously conducted to determine the impact of preoperative intense exercise on postoperative functional recovery after colorectal surgery [43]. There have been various studies conducted with the concept of prehabilitation as a primary

intervention. Based on previous research conducted in our hospital laboratory, intense exercise during the preoperative period was not found to be beneficial or feasible for patients awaiting surgery as compared to a walking and breathing intervention [43]. The results from this study suggested that exercise alone may have not been enough to facilitate recovery after surgery.

The feasibility of implementing a home-based prehabilitation program has already been established based on a pilot study [44] and a randomized controlled trial [45]. These trials consisted of an exercise program, nutritional counseling with whey protein supplementation and relaxation strategies (multimodal program). The results of these studies indicated that at 8-weeks after surgery, patients were able to recover to their baseline functional capacity. Unfortunately, most of the patients in the prehabilitation group were below their baseline measurements at 4 weeks after surgery indicating that the home-based program was not sufficient enough to promote physical activity and modification of activities of daily living. A possibility for not returning to baseline measures could be the lack of guidance and supervision by a kinesiologist amounting to patients not complying to the program as prescribed.

Early mobilization after surgery is also important to optimize recovery after surgery. A study conducted on supervised postsurgical in-hospital resistance exercise demonstrated a reduction in time spent in hospital and improved bowel mobility after colorectal resection [46] however there is no data that has been recorded based on the patients' return to baseline functional capacity after surgery.

Based on these findings, there is a lack of knowledge on the effect of supervised exercise during the preoperative and immediate postoperative period for patients undergoing colorectal resection for cancer. The goal of this thesis is to better understand if supervision can in fact help to attenuate this functional decline 4 weeks after surgical resection.

Aims

The aims of this research project was to:

1. Provide supervised exercise sessions during the pre-operative period and during the first three postoperative days to accelerate the return to functional capacity by 4 weeks after surgical resection.
2. To determine if supervised exercise has an impact on a quicker post-operative functional recovery within 4-weeks.

Methods

Patients

Informed consent was obtained at the preoperative clinic for seventy patients scheduled for elective colorectal surgery of non-metastatic disease. Patients with cardiac, hepatic, renal disease or inability to communicate in English or French were excluded.

Protocol

Initially, patients were randomized to one of two groups using a sealed envelope computer-generated random allocation: Group A, the prehabilitation group received a home based exercise program that includes 4 supervised training sessions at the hospital exercise laboratory (1 per week) during the 4 week pre-surgical period. Group A also received daily-supervised exercise during the post-surgical in-hospital stay and an unsupervised 4-week home-based program initiated upon discharged. Group B, the rehabilitation group, received daily supervised exercise during the post-surgical in-hospital period and an unsupervised home-based exercise program that was continued upon discharge from the hospital for an additional 4-weeks (Figure 4).

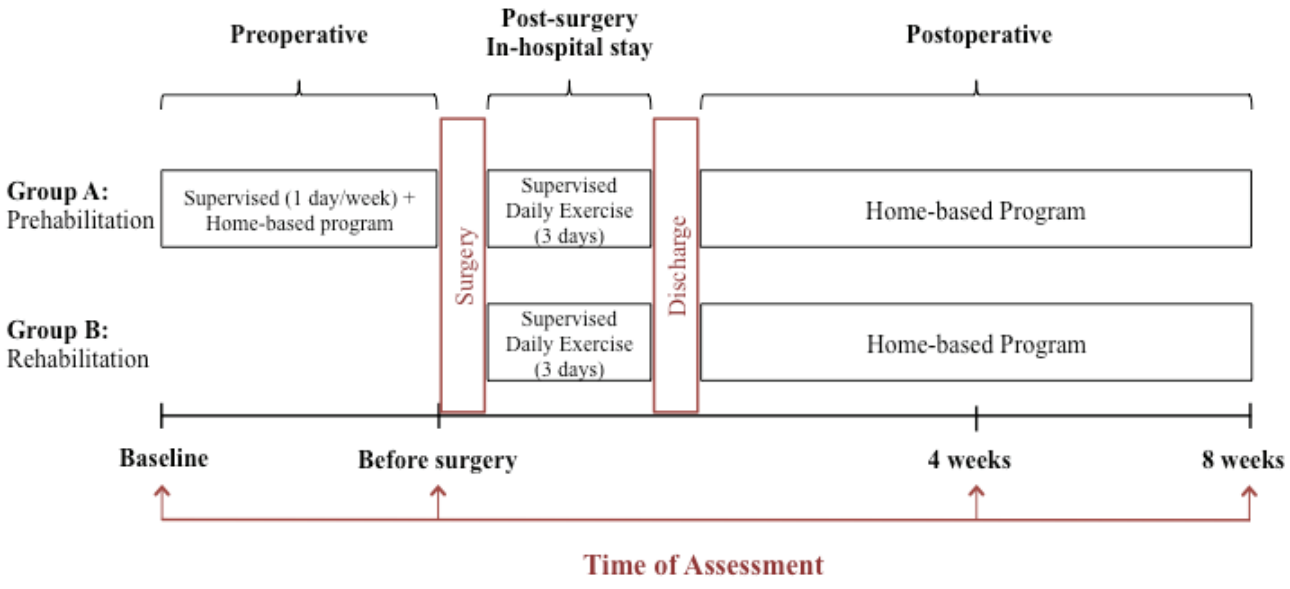

Figure 4. Study Design for supervised prehabilitation *vs* supervised rehabilitation

The exercise programs (both pre and post-surgery) included the following: individualized aerobic, resistance and flexibility exercises. Both groups continued to exercise for 4 weeks after surgery, and were asked to return to the laboratory for their evaluation at 4 weeks. The exercise program was personalized to each patient based on their age, physical status, comorbidities and the capacity to withstand exercise. Patients were instructed to perform moderate (according to the modified BORG scale) aerobic exercise (walking) for at least 30 minutes per day and the resistance portion of the program (Figure 5) was to be performed 3-4 times a week with Therabands. Patients were instructed to do the exercises until volitional fatigue increasing this number to reach 15 repetitions. Those that attended the supervised sessions performed aerobic exercise using a Nustep machine and were instructed to walk on all other days. Patients were also provided with an exercise journal to better track their progress.

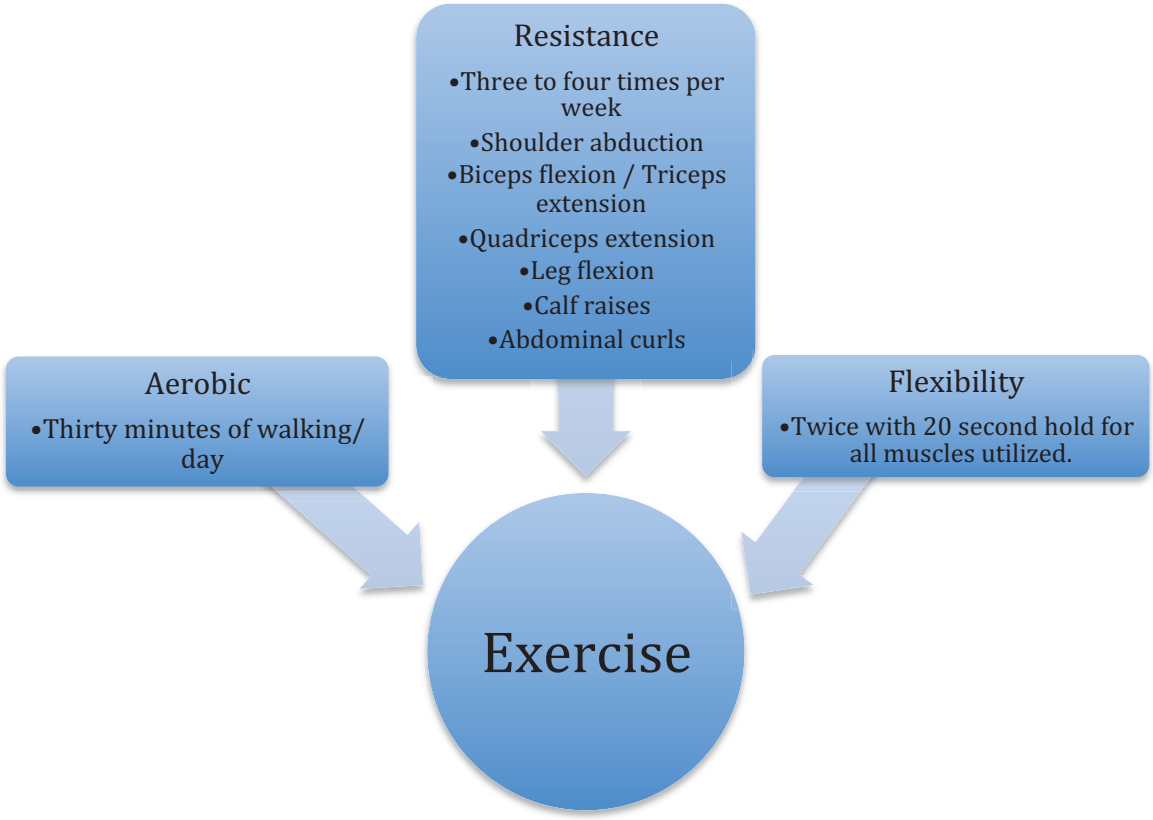

Figure 5. Individualized exercise program

Both groups also received supervised sessions (once a day for three days) during the post-surgical in-hospital stay (Figure 6). The resistance exercises remained the same as that performed

during the pre and post-surgical period however quadriceps extensions and abdominal curls were eliminated due to the surgical site.

Figure 6. Post-surgical in-hospital exercise program

To compliment the exercise program, both groups were seen by a relaxation specialist and registered dietician.

It is expected that patients who will be undergoing a surgical procedure are anxious and experience some form of anxiety and or depression further impairing functional and social activities. Therefore, the relaxation specialist met with all patients to provide coping strategies to the stress of surgery and to optimize psychological well-being. Relaxation techniques, breathing exercises and a relaxation CD were provided.

Nutritional status in colorectal cancer patients is influenced by the tumor and has an impact on protein, carbohydrate and lipid metabolism as well as by other factors such as age and the stage of the disease. A registered dietician saw all patients and assessed their nutritional status and dietary intake with the use of a 3-day food diary. All patients received daily whey protein supplements (Immunocal®, Immunotec Inc, Quebec Canada), in order to match requirements according to the estimated deficit in dietary protein intake. The deficit corresponds to the difference between estimated protein intake (food diaries) and the calculated protein requirements. Protein requirement was estimated at 1.2g/kg/day of body weight as per European Society for Clinical Nutrition and Metabolism guidelines (ESPEN) [41].

Measurements

Preoperative age, gender, body weight and body mass index (BMI) were recorded. Body composition, lean body mass and percent body fat was measured using a hand-to-foot bioelectric impedance analysis (Biospace Inbody 320, Ottawa CA).

Study Outcomes

Primary Outcome

Functional walking capacity, the primary outcome is patient-relevant, functional walking capacity as measured by the 6MWT. The 6MWT evaluates the ability of an individual to maintain a moderate level of physical activity over a time period reflective of activities of daily living [47]. All patients performed a 2MWT before the 6MWT so that there would be a learning effect to the test. Patients were instructed to walk back and forth, in a 15m hallway, for six minutes, at a pace that would make them tired by the end of the walk; encouragement and feedback were given according to published American Thoracic Society guidelines [48]. Patients were allowed to rest during the test if needed, however time spent resting was included within the 6 minutes. Reference equations are available for calculating percent of age- and gender-specific norms [49]. In community dwelling elderly, measurement error was estimated at 20 meters and this will be used as the threshold value for determining true change. The 6MWT correlates with VO_2max, indicating that these two test measures are related but they are not identical constructs [50,51]. Daily activities are mainly performed at a sub-maximal level and functional walking capacity is a more direct measure of daily routines than a maximal test of exercise capacity such as VO_2max, which is more feasible to perform in the perioperative population. The 6MWT has been shown to be reliable and valid in many populations including surgical ones, with a recent paper supporting its validity as a measure of recovery after colorectal surgery [52].

Secondary Outcome

Adherence was monitored to determine whether the prescribed exercises and nutrition advice were being followed and if this would have an influence on postoperative recovery. Adherence was assessed with weekly phone calls and a self-reported journal during both the preoperative and postoperative phases. Standardized questions were asked specifically about the prescribed exercises and nutritional advice. Compliance was graded on a total score of 10 (5 for exercise and 5 for nutrition).

Adherence to exercise was based on the following scores: performed all exercises as prescribed (5/5), walked on all days of the week and did at least two days of resistance exercises (4/5),

walked 4 days of the week and only 1 day of resistance exercises (3/5), walked 3 days of the week with no resistance exercises performed (2/5), walked once a week and no resistance exercises were performed (1/5) and no walking or resistance exercises performed (0/5).

Patient adherence to the nutrition program was based on consumption of the whey protein supplement. Adherence scores for the nutrition component was as follows: patients consumed whey protein every day as prescribed (5/5), patient did not consume whey protein on one day out of the week (4/5), patient did not take protein for two days out of the week (3/5) patient did not consume whey protein for 3 or 4 days out of the week (2/5), patient did not consume why protein for 5 days out of the week (1/5), patient did not consume any whey protein in the week (0/5).

Assessments

All measures were tested at baseline, the week of surgery and 4 weeks after surgery to assess the impact of the intervention throughout the perioperative period.

Sample Size

Sample size calculations were based on a comparison of mean changes at 4 weeks after surgery. Based on a previous study conducted by our group [43], an assumption was made that the average change in 6MWT at 4 weeks after surgery would be increased by approximately 15%. A sample size of 70 (35 per group) was required to detect these differences with a power of 80% and an alpha of 0.05.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). Shapiro-Wilk test was performed to assess the normality data distribution. Results are expressed as mean (SD), median values [IQR], number of patients (percentage). Continuous variables were compared using either a Student's t (2-tailed, unpaired) or a Mann-Whitney test; categorical variables were compared using either a $\chi 2$ test or Fisher exact test. All tests were two sided, and P values < 0.05 were considered to indicate a significant association.

Significance

There is a strong realization that many side effects associated with surgical stress can be attenuated thus facilitating the recovery process. Exercise has been shown to have a positive impact on many medical conditions, attenuation of cancer progression, facilitate cellular utilization of nutrients and calm anxiety in patients with chronic illnesses. However, in view of the mental stress patients with cancer are subjected to and the impact of cancer on nutritional status, it is necessary to control for these factors, which would facilitate the implementation of exercise. This study could provide some direction on how to optimize functional capacity while waiting for surgery and during the in-hospital stay for patients undergoing colorectal surgery. This may also contribute to our understanding of which outcome measures represent a valid index of recovery and are sensitive to change. The model of colorectal surgery for cancer was chosen because of the extensive experience the investigators have in measuring recovery in this specific group, and in assessing the impact various interventions have on the surgical stress response. The results of this randomized study will form the basis for studies in other surgical conditions and aimed at optimizing the perioperative period and minimizing morbidity, thus improving recovery and quality of life in surgical patients. This RCT has been completed and at present statistical analysis is underway.

Supervised versus Unsupervised Exercise Program

A reanalysis of the data from the prehabilitation arms of two RCTs' was performed (Figure 6). These two RCT's were conducted at our institution and precisely the first trial compared unsupervised home-based prehabilitation versus rehabilitation (Gillis et al) and the second trial compared supervised prehabilitation and supervised post-surgical in-hospital exercise versus rehabilitation. Seeing as to how data was collected for patients who underwent a home-based prehabilitation program, a more important question was to see if providing supervision during this period would have a greater effect on postoperative outcomes.

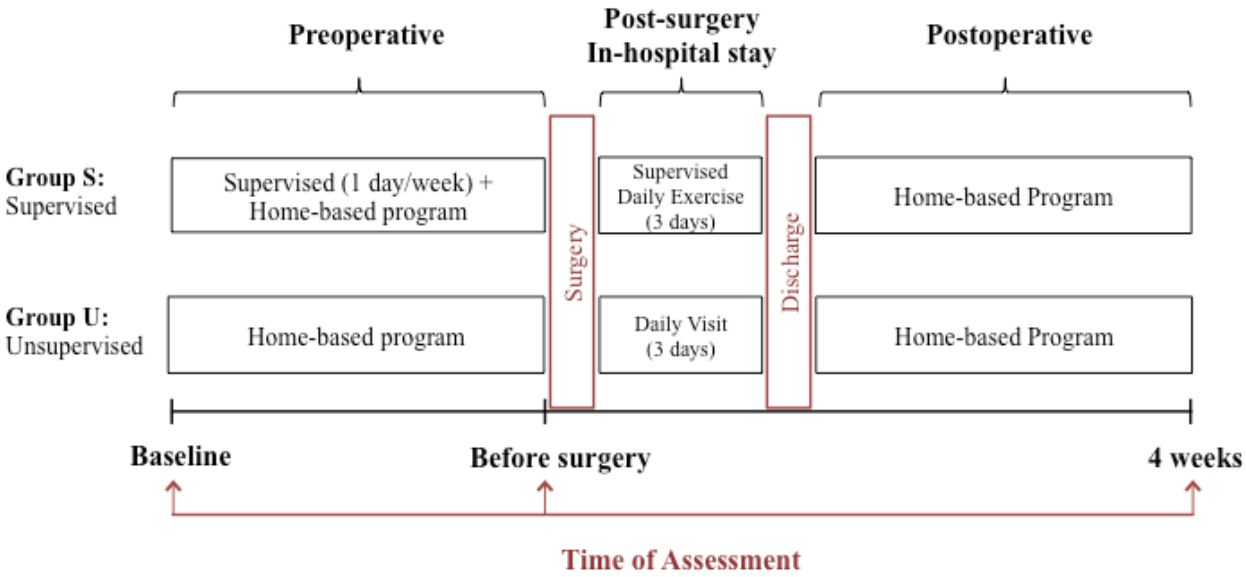

Figure 7. Study design for the prehabilitation arms from two RCT's

This study design provided the basis for the manuscript in Chapter II which is currently under review for publication in the *Journal of Supportive Care in Cancer.*

II

Manuscript

Multimodal prehabilitation in patients undergoing colorectal cancer resection: The impact of supervised structured perioperative exercise on postoperative functional capacity

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Contribution of Authors

Rashami Awasthi: conception, perform studies, data acquisition, analysis, preparation of manuscript.

Enrico M. Minnella: analysis, drafting and reviewing article.

Sarah-Eve Loiselle: perform studies, data acquisition, drafting and reviewing the article.

Chelsia Gillis: conception, drafting and reviewing the article.

Celena Scheede-Bergdahl: conception, analysis, editing the article.

Francesco Carli: conception, data acquisition, analysis, and preparation of manuscript.

Alexander Sender Liberman: conception, analysis and reviewing the article.

Andreas Bergdahl: conception, analysis, drafting and reviewing the article.

Multimodal prehabilitation in patients undergoing colorectal cancer resection: The impact of supervised structured perioperative exercise on postoperative functional capacity

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Abstract

Purpose: The objective of this study was to assess whether supervised exercise in the pre-surgical period and during the first three postoperative days accelerates the return to functional capacity 4-weeks after surgery.
Methods: Data from 2 randomized control trials (RCTs), compared a multimodal prehabilitation program with a rehabilitation program were analyzed. Both prehabilitation arms (unsupervised, U, and supervised, S, groups) of the 2 RCTs received the same home-based prehabilitation program, however group S received 4 supervised exercise sessions before surgery and daily during the first three postoperative days. Both groups continued a home-based regimen for 4 weeks after hospital discharge. Functional walking capacity was assessed by the six-minute walk test (6MWT) 4 weeks, two days before surgery and 4 weeks after surgery. Compliance to the perioperative program was also evaluated.
Results: Analysis of complete data belonging to consecutive 30 patients in groups S and U was performed. During the preoperative period, the 6 minute walk distance (6MWD) increased by the same magnitude in both groups ($p = 0.73$). At four weeks after surgery, the 6MWD in group S was significantly greater than in group U ($p = 0.04$) and 74% of patients in group S were back to baseline. Overall compliance to both the exercise and nutrition components of the program was greater in group S (before $p < 0.001$, after $p < 0.007$).
Conclusion: Supervised structured exercise training initiated during the preoperative period and continued during the first three days after surgery, enhanced functional capacity 4 weeks after surgery capacity.

Keywords: Prehabilitation, Supervision, Exercise, Abdominal surgery, Colon Cancer, Recovery

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Introduction

Colorectal cancer is the third most diagnosed cancer among men and women in the United States. It is expected that in 2024, 1.6 million

Americans will be diagnosed with colorectal cancer (1). The standard and primary treatment for colorectal cancer is surgical resection (2) which, compared to other general surgery procedures, is known to have the highest proportion of complications (3, 4). This type of intervention is associated

with significant physiological stress (5), prolonged recovery, loss of muscle mass (6) and orthostatic impairment (7). Conventionally, attempts have been made to facilitate the recovery process during the postoperative period in the form of rehabilitation, however, patients that have undergone a surgical procedure are tired, anxious, lack confidence, and are fearful of harming themselves. The period before surgery (prehabilitation) might thus be a more opportune time to engage patients in a health intervention and prepare them for the perioperative period (5).

Surgical prehabilitation is defined as the process used to enhance functional capacity in the pre-operative period in order to better cope with physiological stress of surgery (8). Previous research (9, 10) showed that a prehabilitation program, involving a multimodal approach (i.e.:

moderate intensity exercise program, nutritional counselling together with protein supplementation and anxiety reduction strategies), facilitated a return to preoperative functional capacity by 8 weeks in 81% of the patients, while only 40% of subjects in the control group (no intervention) returned to baseline value. Despite the improvements at 8 weeks seen in the prehabilitation group, there was still a detectable drop on functional walking capacity at 4 weeks post-op (9). This loss of functional capacity remains an issue for patients' quality of life, return to day-to-day living and subsequent delays in further cancer treatment. For these reasons, it is necessary to identify strategies that would attenuate this loss of function after surgery and facilitate a more rapid recovery.

Supervised postsurgical in-hospital resistance exercise has been shown to reduce the length of hospital stay and improve bowel mobility after colorectal resection (11). At the present time, there is no data that tracks the patients' return to baseline functional capacity.

The goal of the present investigation was to determine whether supervised structured aerobic and resistance exercise sessions during the preoperative period and the inclusion of resistance exercises during the first 3 postoperative days (PODs) would impact on preoperative and postoperative functional capacity. It is hypothesized that functional capacity at 4 weeks after surgery would be more likely to return to baseline values as a result of the supervised and in-hospital exercise program.

Materials and Methods

Study Design

Patients scheduled for elective colorectal resection for non-metastatic, localized cancer and enrolled in two randomized controlled trials (RCT; NCT01356264, NCT02586701) investigated the effects of either prehabilitation or rehabilitation on postoperative functional capacity. The data from the prehabilitation arms of these two RCTs were further analyzed and included in this study. Patients with preoperative morbid conditions impairing their ability to exercise, or inability to speak English or French were excluded. Perioperative care in both studies followed the guidelines of the Enhanced Recovery After Surgery (ERAS) program (12).

Program Prescription

Exercise component of prehabilitation and supervision

All patients were seen by a trained kinesiologist during the baseline assessment and were prescribed a personalized structured home-based program, which consisted of at least 30 minutes of moderate aerobic, resistance and flexibility exercises to be performed at home. The full details of the program have been published elsewhere (10). In addition to the individualized program, each patient was provided with an instructional booklet that detailed all exercises and received an elastic resistance band for their strength training (Thera-Band, Akron, OH, USA).

Both groups received all the instructions and necessary material to implement the home-based program as previously published (13). In addition, group S was asked to attend one supervised session per week for 4 weeks prior to surgery. This session was conducted under the supervision of a kinesiologist and in the hospital laboratory setting (Figure 1).

The day following surgery and while in hospital, both groups were encouraged to mobilize out of bed during their postsurgical stay as per ERAS guidelines (12). Both groups were visited daily during the first 3 PODs, but only patients in group S performed exercise (1 set of 12 repetitions: shoulder abduction, biceps flexion, triceps extension, leg flexion and calf raises) under the supervision of the kinesiologist.

Nutritional component of prehabilitation

Following the initial visit with the registered dietician, whey protein powder supplementation (Immunocal®, Immunotec Inc, Veaudreil, Quebec, Canada) was supplied, if needed, in order to meet 1.2g/kg/day of body weight as per the European Society for Clinical Nutrition and Metabolism guidelines (14)

Relaxation component of prehabilitation

At baseline, a trained specialist met with all patients to teach and review relaxation techniques. An instructional CD was provided to each patient for home use.

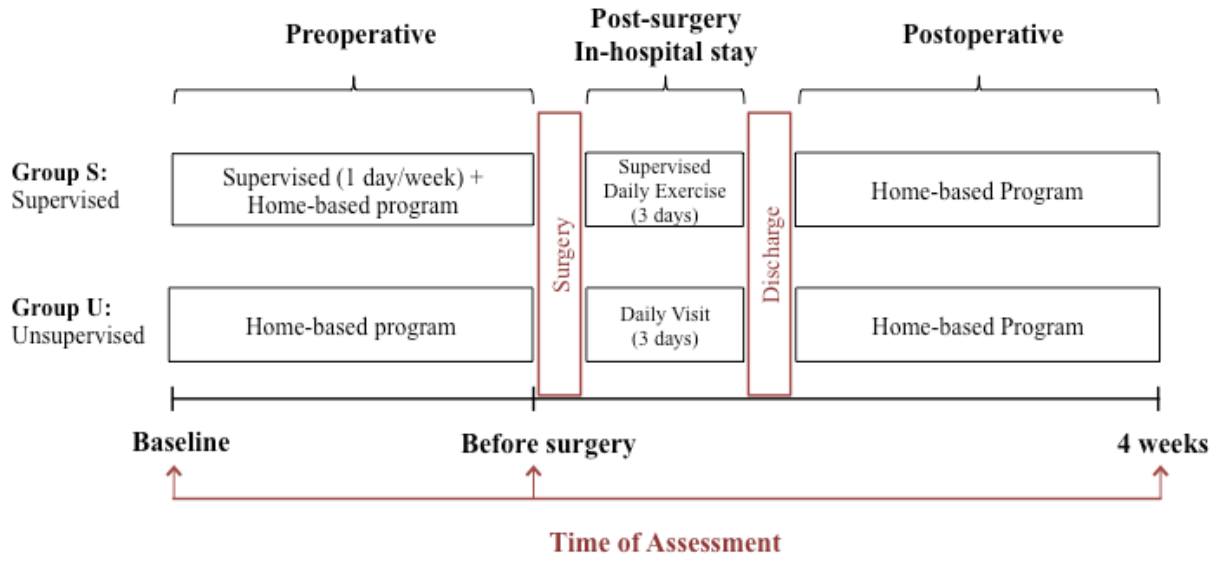

Figure 1. Study design

Outcomes and Measures

All patients were required to attend three evaluation appointments, after surgical decision to operate (baseline), a few days before surgery (preop) and 4-weeks after surgery (4 weeks postop).

Primary Outcome

The primary outcome for this study is functional walking capacity, as measured by the six-minute walk test (6MWT). Meaningful correlation has been found between the 6MWT and maximum oxygen consumption (15). This functional test assesses functional exercise capacity, defined as "the ability to undertake physically demanding activities of daily living"(16), has been validated as an outcome measure for surgical recovery in colorectal cancer patients (17, 18). Patients were instructed to walk back and forth along a 15-m stretch hallway for six minutes at a pace that would make them tired by the end of the test. The total distance covered in six minutes (6MWD) was recorded in meters. Patients were allowed to rest, although any time spent resting was accounted for in the total distance covered during the given timeframe. Standard motivational messages were given at each minute as per guidelines (19). At baseline, each patient was acquainted with the test by means of a practice session in order to avoid a result influenced (20).

Secondary Outcomes

Adherence to the Program

Patient adherence was monitored to determine whether the prescription was followed and had an influence on postoperative recovery. Adherence was assessed with weekly phone calls and a self-reported journal during the preoperative and postoperative periods. Standardized questions pertaining to the prescribed exercises and nutritional advice were asked. Compliance was graded on a total score of 10 (5 for exercise and 5 for nutrition).

Adherence to exercise was based on the following scores: performed all exercises as prescribed (5/5), walked on all days of the week and did at least two days of resistance exercises (4/5), walked 4 days of the week and only 1 day of resistance exercises (3/5), walked 3 days of the week with no resistance exercises performed (2/5), walked once a week and no resistance exercises were performed (1/5) and no walking or resistance exercises performed (0/5).

Patient adherence to the nutrition program was based on consumption of the whey protein supplementation. Adherence scores for the nutrition component was as follows: patients consumed whey protein every day as prescribed (5/5), patient did not consume whey protein on one day out of the week (4/5), patient did not take protein for two days out of the week (3/5) patient did not consume whey protein for 3 or 4 days out of the week (2/5), patient did not

consume why protein for 5 days out of the week (1/5), patient did not consume any whey protein in the week (0/5).

Confounding variables

Patients age, gender, height were recorded at the initial visit. Body weight, lean body mass and fat percent were measured using a hand-to-foot bioelectric impedance analysis (Biospace Inbody 320, Ottawa CA) (21) and body mass index was calculated at each assessment. Nutrition screening was performed using the Nutritional Risk Screening 2000 and the Patient-generated Subjective Global Assessment (22). Risk assessment was performed using the American Society of Anesthesiologists (ASA) health status classification. Perioperative complications were recorded during the first 30 days after surgery. Serum albumin was measured at baseline as an indicator of the inflammatory state of the patients studied.

Sample Size

Sample size calculations were based on a comparison of mean changes at 4 weeks postop. Based on a previous study conducted by our group (10), an assumption was made that the average change in 6MWT at 4 weeks after surgery would be increased by approximately 15%. A sample size of 70 (35 per group) was required to detect these differences with a power of 80% and an alpha of 0.05.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows (IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY: IBM Corp.). Shapiro-Wilk test was performed to assess the normality data distribution. Results are expressed as mean (SD), median values [IQR], number of patients (percentage). Continuous variables were compared using either a Student's t (2-tailed, unpaired) or a Mann-Whitney test; categorical variables were compared using either a $\chi 2$ test or Fisher exact test. All tests were two sided, and P values < 0.05 were considered to indicate a significant association.

Results

Subjects

The data of 70 consecutive patients in the prehabilitation arms of 2 RCTs (38 patients in group U and 32 patients group S) were included in the analysis. Ten patients were excluded due to withdrawing consent, perioperative complications, readmission within 30-days post surgery, or did not undergo resection, leaving 30 patients in each group with full data (Figure 2). Those that were excluded from the analysis had similar clinical characteristics (BMI, age, type of surgery, complications) as those included in the study. The baseline characteristics and clinical measurements are presented in table 1.

The average timeframe between the initial baseline assessment and surgery for group S was 40 ± 24 days and 31 ± 13 days for group U ($p = 0.07$).

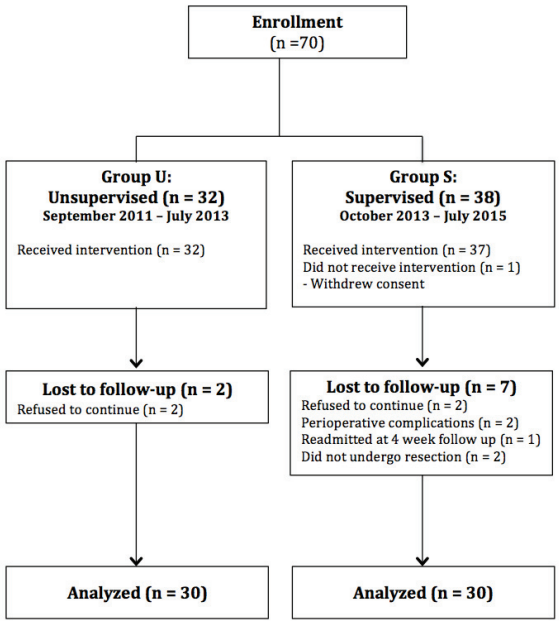

Figure 2. Flow Diagram

Outcomes

Functional Walking Capacity (Figure 3)

A) Preoperative Period

The 6MWD at baseline was 443 m (SD, 107) for group S, and 401 m (SD, 124) for group U respectively ($p = 0.172$). During the preoperative period, the 6MWD increased by approximately 25.0 m (SD, 51.7) for group S and 29.2 m (SD, 51.9) for group U respectively; with no significant difference between the two groups ($p = 0.73$). Before surgery the 6MWD in group S

was 467 m (SD, 110) and 431 m (SD, 118) for group U (NS).

B) Postoperative Period

At four weeks after surgery, the 6MWD decreased in both groups from the preoperative value, in group S by -17.0 m (SD, 48.0) and group U by -44.0 m (SD, 57.0) (p = 0.05), and this corresponded to 57% of patients in group S and 80% in group U. At 4 weeks there was a significant difference in 6MWD between the two groups, 450 m (SD, 111) in group S, and 386 m (SD, 128. in group U (p = 0.04). Group S increased by 7.5 m (SD, 45.0) from baseline, while group U decreased by 15.0 m (SD, 79.7) (p = 0.18)

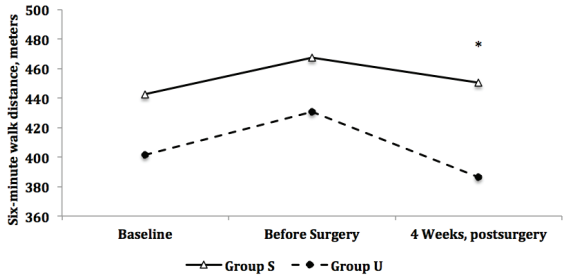

Figure 3. Graphical representation of the 6-minute walk distance at each follow up appointment.

Adherence

A) Adherence during the preoperative period for both groups

During the preoperative period of 4 weeks, there was a greater proportion of patients in group S (99.3%, SD, 3.7) who were adherent to the home-based program compared to group U (76.6%, SD, 22.7) p <0.001. There was also 98.3% (SD, 6.3) compliance to the supervised exercise sessions in group S (1 day per week).

B) Adherence to resistance exercises during the first three postoperative in-hospital days in the supervised group only (Table 2)

Seventy-six percent of patients participated in the resistance exercise sessions over the course of 3 days. More specifically, on POD1, 43% of the patients performed all of the resistance exercises while 57% did not adhere for the following reasons: abdominal pain (2), fatigue (4), low blood pressure (3), nausea (2) and refusal (5). On POD2 10% of the patients were discharged, and out of 20 patients, 27% complied while 73% did not comply for the following reasons: abdominal pain (10), fatigue (4), refusal (4). On POD3, 40% of the patients were discharged from the hospital, and out of 18 patients, 37% did not participate for the following reasons: abdominal pain (4), low blood pressure (1), high blood pressure (1), refusal (5)

C) Adherence during the postoperative period following hospital discharge

After surgery, there was a greater proportion of patients in group S that adhered to the home-based multimodal program from the time of discharge until the 4-week assessment (74% [SD, 29] in group S versus 56% [SD, 26], in group U p = 0.007).

Perioperative Outcomes

There were no differences in the overall 30-day complications, department visits, readmission and median length of stay between the two groups (table 3).

Table 1. Patient Baseline, Operative Characteristics and Measurement

	Group S (n = 30)	**Group U (n = 30)**	**P-value**
Age, y	72.5 (9.1)	69.5 (11.8)	0.270
Male, n	23 (77%)	18 (60%)	0.267
Body Mass Index, kg/m^2	27.7 (4.2)	27.0 (4.2)	0.487
ASA physical status			0.580
I-II	19 (63%)	22 (73%)	
III-IV	11 (37%)	8 (27%)	
Comorbidities, n			
Anemia	7	2	0.052
Arthritis	6	3	0.472
Asthma	1	0	1.0
Cardiovascular Disease	5	10	0.233
Chronic Obstructive Pulmonary	2	0	0.492
Diabetes	9	4	0.209
Hypothyroidism	0	2	0.492
Hypertension	13	10	0.596
Obstructive Sleep Apnea	5	0	0.052
Charlson Comorbidity Score	3 [2.75-5]	2.5 [2-4]	0.077
Cancer stage			0.108
0-1	20 (67%)	16 (53%)	
2	10 (33%)	10 (33%)	
3	0 (0%)	4 (13%)	
Laparoscopic procedure, n (%)	29 (97%)	30 (100%)	1.0
Type of resection, n (%)			0.064
Colon[w]	22 (73%)	14 (47%)	
Rectum[§]	8 (27%)	16 (53%)	
Baseline 6MWT (m)	443 (107)	401 (124)	0.172
Patients with 6MWD < 400m, n (%)	8 (27%)	12 (40%)	0.412
LBM, (kg)	55.8 (11.2)	52.8 (11.3)	0.322
Fat percentage, (% of weight)	29.5 (8.5)	31.0 (8.9)	0.515
Albumin, (g/l)	41.0 [39.3-42.0]	40 [35.5-42.5]	0.188
CRP (mg/L)	2.75 [0.83-7.11]	2.1 [1.3-6.6]	0.988

Data are represented as mean (SD), median [IQR], or n (%).

[w]Includes right and left hemicolectomy and sigmoid resection. [§] Includes anterior resection, low anterior resection, and abdominoperineal resection.

ASA = American Society of Anesthesiologists; TNM = tumor-node-metastasis; 6MWT = 6-minute walk test.

Table 2. Daily adherence of patients in the supervised group who performed resistance exercise during the first 3 postoperative days.

		Group S (n = 30) Number of patients that performed each exercise		
Resistance Exercises		**POD1**	**POD2**	**POD3**
Upper Body	Pushups	13	8	5
	Seated Row	13	8	5
	Chest	13	8	5
	Shoulder abduction	13	8	5
	Biceps flexion	13	8	5
	Triceps extension	13	8	5
Lower Body	Leg flexion	14	9	3
	Calf raises	14	9	3
Reasons for not performing exercise				
	Abdominal pain	2	10	4
	Low blood pressure	3	0	1
	High blood pressure	0	0	1
	Nausea	2	0	0
	Fatigue	4	4	0
	Weakness	0	0	1
	Shortness of breath	0	0	1
	Refused	5	4	5
	Discharged	0	3	12

POD = postoperative day.

Table 3. Perioperative outcomes, within 30 days after surgery.

	Group S (n = 30)	**Group U (n = 30)**	**P-Value**
Patients with complications	11 (36.7)	5 (16.7)	0.143
Congestive heart failure, n (%)	1 (3.3)	0	
GI bleeding, n (%)	0	1 (3.3)	
Ileus, n (%)	4 (13.3)	2 (6.7)	
Urinary retention, n (%)	5 (16.7)	0	
Anemia, n (%)	1 (3.3)	0	
Wound infection, n (%)	0	2 (6.7)	
LOS, days, Median [IQR]	3 [2-4.25]	4 [3-5]	0.127
30-day emergency department visits, n (%)	3 (10)	4 (13.3)	1.0
30-day readmission, n (%)	2 (6.7)	4 (13.3)	0.671

GI = gastrointestinal; LOS = Length of stay

Discussion

A supervised prehabilitation program before surgery and during the in-hospital time frame significantly improved 6MWD at 4-weeks after surgery compared with patients who did not receive the same intervention.

In addition, the program is feasible as indicated by the over 95% compliance, but there remain challenges during the first 3 postoperative days.

In the present analysis, functional walking capacity before surgery improved to the same extent in both groups and independently of whether patients received supervised exercise sessions or not. A possible explanation for the similar increase in 6MWD in both groups might be due to the low number of sessions (1 day/week) that patients in group S attended before surgery, but it also may be that group U was performing the same amount of exercise without supervision at home. Furthermore, it is possible that patients in group S were not performing their home-based exercises to the same intensity as under supervision. In fact, a higher number of supervised sessions (two to five sessions per week) for cancer patients undergoing surgical resection showed greater functional walking capacity (23) and better quality of life (24) in comparison to patients receiving standardized care.

In the present study, moderate exercise intensity was prescribed for both home and supervised sessions in order to facilitate compliance. This was done in light of a previous study where patients undergoing colorectal resection were prescribed a high intensity exercise program (25). Only 16% of these patients complied with the program, and as a result, functional walking capacity decreased in 30% of patients before surgery. These findings led to subsequent studies whereby a structured exercise program of moderate intensity, nutrition counseling and protein supplementation, and relaxation strategies demonstrated better patient compliance (75%) to the program and increased functional walking capacity during the preoperative period.

In order to emphasize the role of mobilization out of bed, as recommended by the ERAS guidelines, we introduced a supervised resistance exercise program on the surgical ward during the first 3 PODs. This was to determine whether this regimen together with the preoperative one would facilitate earlier mobilization, and have a possible impact on functional capacity. As a result, we observed that approximately 76% of these patients completed the resistance exercises during the first 3 PODs. Abdominal pain (30%) and refusal with no explanation (17%) were the most common reasons for no participation on the second postoperative day. A possible reason for inability to perform in hospital exercise in those patients who complained of abdominal pain could be the inadequate pain relief patients received prior to mobilization, and therefore every effort must be made to provide optimal analgesic strategies.

In a previous study the effect of an inpatient, twice daily, 15-minute exercise sessions on length of hospital stay (11) showed an accelerated discharge by 2 days and earlier resumption of bowel function. Patient adherence to the exercise session was reported at 84.5%, however it was not specified as to when the patients started to exercise during the hospital stay. Length of hospital stay ranged from 7-9 days, much longer than in our institution (3-4 days) (26). Also the study did not look at the effect of the inpatient exercise program on functional recovery after discharge. In another study early mobilization in patients admitted to a surgical/trauma intensive care unit, led to improved functional status and decreased length of hospital stay (27).

During the period from surgery to 4 weeks, the average 6MWD decreased from the preoperative value in group U by 44 m, which is well above the clinical significant value of -20 m, thus implying poor walking capacity (28). Over 80% of patients in this group dropped below their preoperative 6MWD. In contrast, the average 6MWD in group S decreased by 17 m. A possible reason for this difference can be explained by the significantly higher postoperative adherence (74%) in the latter group. In addition, as patients in group S were shown how to perform resistance exercises safely before surgery and during the time immediately after surgery, they would feel encouraged to continue the prescribed regimen at home, and this gave more confidence in commencing their exercises upon discharge earlier.

The implication of the present results has an impact on patient postoperative functional improvement, and could accelerate the time for further cancer treatment if necessary.

All patients were cared for within an enhanced recovery pathway previously described (12) in order to standardize the perioperative care and minimize confounding factors that might impact

on postoperative outcome. There was no difference in complications and hospital readmission after surgery between group S and group U, and the length of hospital stay was similar.

This study does have some limitations. Firstly, it is difficult to identify if the greater functional walking capacity in the supervised group at 4 weeks after surgery was the result of the supervised exercise sessions either during the preoperative period, or during the in-hospital stay after surgery or a combination of the two. One would assume that patients would have benefited of the supervised exercise sessions during the first 3 postoperative days with a significant impact on their postoperative functional capacity. However, it has to be said that future studies should look at increasing the number of supervised sessions during the preoperative period and modify resistance exercises during the postoperative period so that even patients unable to move out of bed can participate. Secondly, there was no collection of data on physical activities performed during the hospital stay by patients in group U, and therefore direct comparison with group S cannot be made.

In conclusion, the introduction of supervised resistance exercises during the first three days after surgery is feasible and lead to enhanced functional capacity 4 weeks after surgery.

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III

Conclusions and Future Direction

The aim of this thesis was to determine whether providing supervised exercise sessions to patients during the preoperative period, and continued during the post-surgical in-hospital stay would optimize functional capacity 4 weeks after surgery.

The results of this project indicate that the implementation of supervised exercise sessions minimizes the decrease in functional walking capacity 4 weeks after surgery. Furthermore the adherence to the postoperative home-based program was greater. It is plausible that a supervised exercise program encourages and gives confidence to patients in commencing the exercise program upon discharge and promoted an earlier return to baseline functional walking capacity.

Although patients in the supervised group increased functional walking capacity to the same extent of the unsupervised group during the preoperative period, it can be assumed that encouraging early mobilization right after surgery aided in this return to baseline functional walking capacity within 4 weeks. Patients under supervision during the perioperative program were more adherent to the program overall, further having a positive impact on functional capacity. It is however unclear as to if this significant increase was due to the supervised exercise sessions prior to surgery, during the in-hospital stay or a combination of the two.

Based on the findings of this project, future direction should explore both the preoperative period and in-hospital period separately. During the preoperative period, the number of supervised exercise sessions should be augmented to potentially increase functional walking capacity to a greater extent than that of only one supervised session per week. As for the exercise program during the post-surgical in-hospital stay, a more structured exercise program that takes body position (i.e. lying down, sitting or standing) into consideration should be proposed. This type of program would allow more patients to participate despite being unable to get out of bed, or being unable to participate due to abdominal pain or other symptoms. These interventions could have a positive impact on accelerating postoperative recovery.

Future studies will be conducted to determine if patients that do not have enough time during the preoperative period can attenuate functional decline 4 weeks after surgery by commencing an in-hospital supervised exercise program immediately after surgical resection, versus a group that would be asked to commence a home-based program upon discharge.

IV

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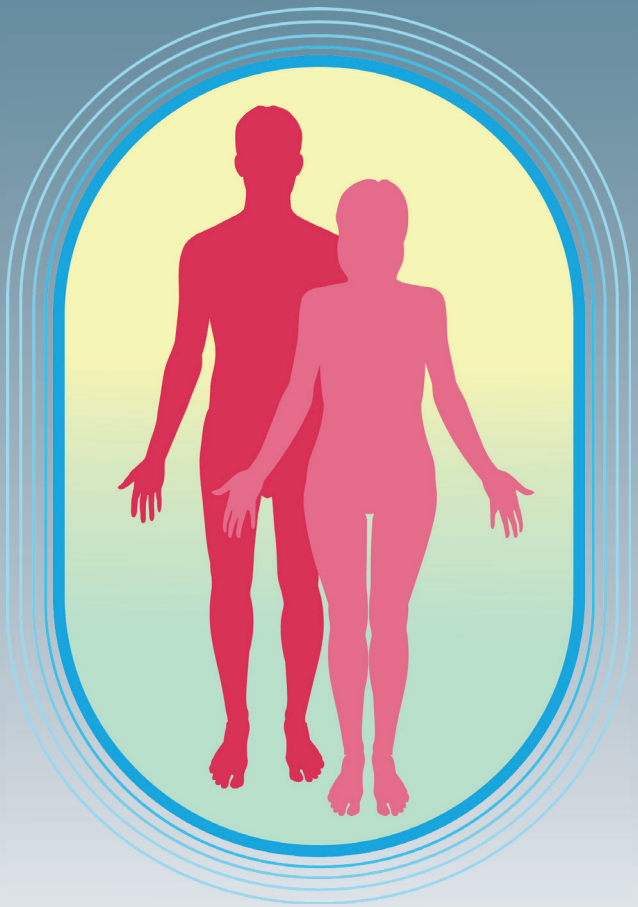
Appendix

PREHABILITATION FOR ELECTIVE SURGERY



A patient friendly booklet for:

PRET SURE
Parcours de rétablissement chirurgical du CUSM
MUHC Surgery Recovery Program

Office d'éducation des patients du CUSM
MUHC Patient Education Office

Centre universitaire de santé McGill
McGill University Health Centre

PERI OPERATIVE PROGRAMME
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Projet d'informatique médicale Molson de McGill
McGill Molson Medical Informatics

PREHABILITATION FOR ELECTIVE SURGERY

Understanding the Role of Exercise in Post Operative Functional Capacity Following Resection

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Chelsia Gillis
Rashami Awasthi

Centre universitaire de santé McGill

McGill University Health Centre

Dear Mr/Mrs. _____

Thank you for choosing to be part of our Prehabilitation for Surgery study. This is a study to determine whether there are added benefits in terms of accelerated recovery time and decreased complication rates when patients are active and have good nutritional and mental status prior to surgery. In this booklet you will find information regarding Prehabilitation and what is expected of you during this period of time.

We are a group of anesthesiologists, surgeons, nurses, physiotherapists, kinesiologists, nutritionists, and psychologists. We will all work together to make this an enjoyable experience for everyone involved. The intent of this program is to improve your ability to cope with stressful situations, to gain muscular strength and aerobic endurance, and to improve your nutritional status prior to surgery.

If you have questions at any time throughout your enrollment in this study, please do not hesitate to contact me, or one of the project coordinators. We will be happy to respond to any questions or concerns you may have.

Thank you very much for your time and cooperation in this study.

Sincerely,

Dr. Franco Carli
Principal Investigator
Department of Anesthesia
Montreal General Hospital

contacts: .....

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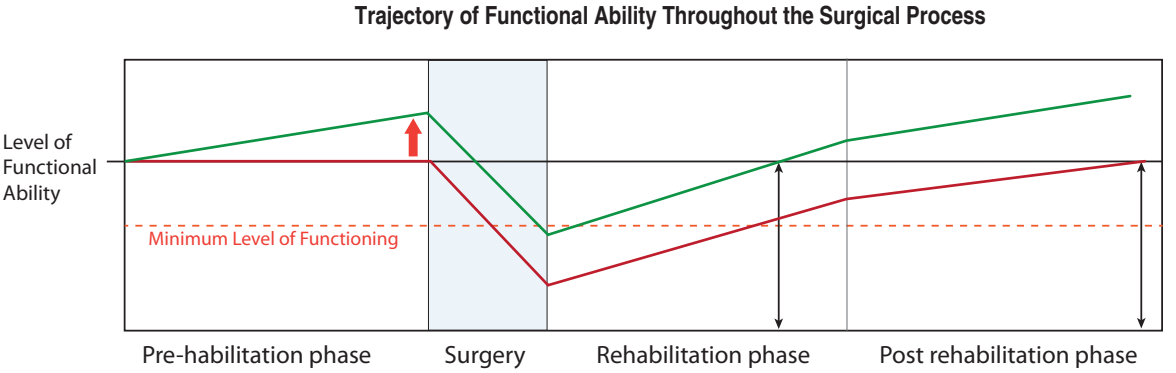
Table of Contents

Your Guide to Prehabilitation

What is Prehabilitation?

Prehabilitation is a home-based program. The purpose of the program is to accelerate recovery time.



What does Prehabilitation Involve?

After a medical visit, you will meet with a kinesiologist who will propose a program you can do at home. During this appointment your body strength, nutritional state, and mood will be assessed by the project coordinator. You will also be asked to answer a few questionnaires.

The following is a brief overview of the programs:

A Physical Activity Program

- The kinesiologist will prescribe a moderate intensity aerobic and resistance exercise program that will be performed 3 times per week.

A Nutrition Program

- The nutritionist will provide advice on optimal nutrition and prescribe nutritional supplements as needed.

Measurements

- With the help of our project coordinator we will assess your strength, mood, and nutritional state at each visit

Prehabilitation Schedule

Prior to Surgery

You will be contacted by the project coordinator who will arrange your appointment with the kinesiologist and a nutritionist. At this appointment, you will fill-out a number of questionnaires, and have your physical strength, mood, and nutrition assessed. At this time, we ask that you start your first week of training. Please keep track of your progress by writing in the "log" section of this booklet daily. Remember, if you have any questions, please do not hesitate to contact the project coordinator. You will be contacted from time to time to discuss your program.

1 Week Prior to Surgery

During the week prior to your surgery, you will meet the project coordinator for a short reassessment. Please bring your booklet at each visit so we can track your progress! **Remember to only stop your exercise the day before your surgery.**

In Hospital Stay

During the days you are in hospital we will visit you regularly, and before you go home, the kinesiologist will visit you to remind you what you need to do when you are discharged from hospital and return home.

4-8 Weeks Post Surgery

You will be asked to return to the hospital for your final assessments. The same tests and assessments will be performed as in the first two meetings. **Remember to bring your booklet** so that we can track your progress, and **please return your heart rate monitor and pedometer to us at the 8 week appointment.**

Nutritional Program

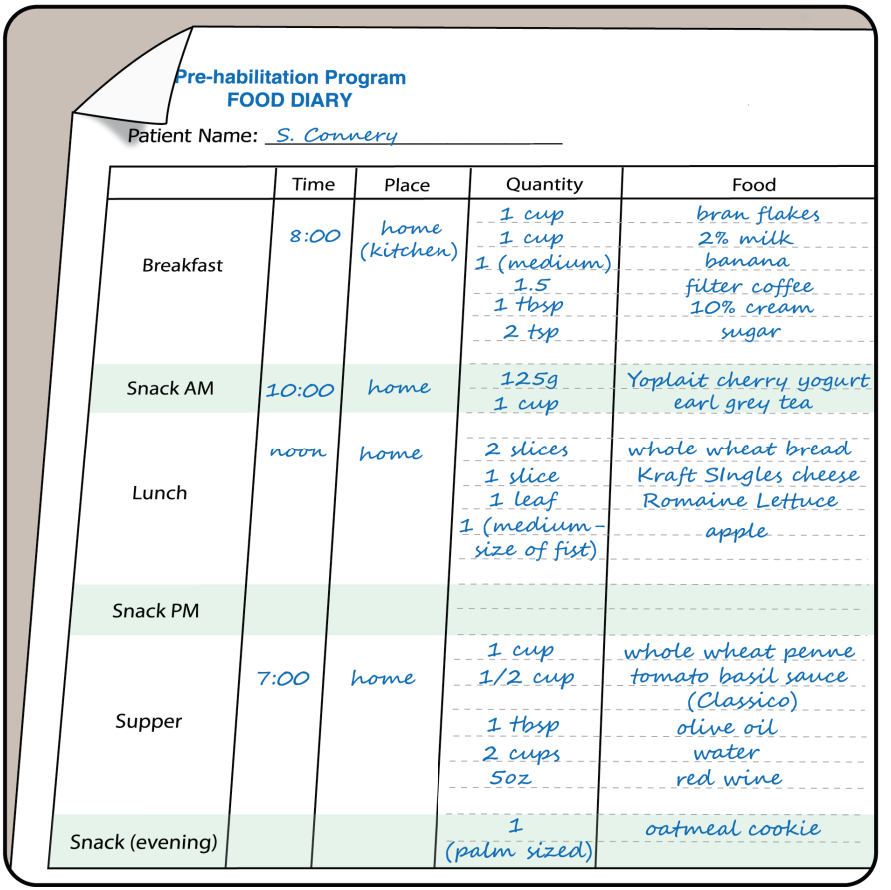
A nutritionist is a health professional who teaches you about food and nutrition.

He or she will assess your nutritional state, what you eat regularly, your appetite, weight loss, and your likes and dislikes.

You will be asked to keep a diary of everything you eat and drink for 3 days. This will include **ALL** foods, supplements, and liquids that you eat or drink over a *3 day* period. Be as specific as you can. Write down brand names and the amounts you eat or drink. You can use our serving size guide to help you figure out how much you eat or drink. To fill out your food diary precisely, you may also measure all your food and beverages with measuring cups and spoons at home. The nutritionist will ask you to bring in your diary on your first visit.

Recording what you eat in your food diary

- Write absolutely everything that you eat and drink during the day
- Be as precise as possible when recording the types of foods you are eating (i.e. percentage of fat in your milk, salted or unsalted nuts etc.)
- Remember to indicate the quantities, trying to be as precise as possible (i.e. 1 apple the size of a fist, 1 cup of raisin bran cereal, I cube of cheese 3cm x 3cm etc.)
- Also, indicate how the food is cooked (i.e. roasted, sautéed with butter or oil, baked etc.)
- It is best to complete the journal when you eat to assure the most accurate representation of your diet



Pre-habilitation Program
FOOD DIARY

Patient Name: S. Connery

	Time	Place	Quantity	Food
Breakfast	8:00	home (kitchen)	1 cup 1 cup 1 (medium) 1.5 1 tbsp 2 tsp	bran flakes 2% milk banana filter coffee 10% cream sugar
Snack AM	10:00	home	125g 1 cup	Yoplait cherry yogurt earl grey tea
Lunch	noon	home	2 slices 1 slice 1 leaf 1 (medium-size of fist)	whole wheat bread Kraft SIngles cheese Romaine Lettuce apple
Snack PM				
Supper	7:00	home	1 cup 1/2 cup 1 tbsp 2 cups 5oz	whole wheat penne tomato basil sauce (Classico) olive oil water red wine
Snack (evening)			1 (palm sized)	oatmeal cookie

Learning Serving Sizes

Your hands can help you with portion sizes.

The best way to find out how much food you are eating, or your portion size, is to use measuring cups, spoons or a scale. Sometimes, such as when you eat out, you can't do this. Here are a number of ways you can use your hands to help you find out about how much you are eating.

*** The portion sizes in each food group use an adult *woman's* hand as a guide**

1 fist = 8 fluid oz
cold and hot beverages

1 hand = 1/2 cup
pasta, rice
hot cereal (oatmeal)
fruit salad
tomato sauce
beans
mashed potatos
cottage cheese

2 thumbs = 1 tbsp
peanut butter
salad dressing
sour cream
dips
margarine
mayonnaise

palm of hand = 3 oz
cooked meats
canned fish

2 hands = 1 cup
breakfast cereal
soup
green salads
mixed dishes (chili, stew etc.)
Chinese food

Eating Healthy

What is healthy eating?

Healthy eating means choosing among different foods, and not over-eating any one type of food (i.e., controlling your portions), so that you get all the nutrition required for your body to work at its best. The three major nutrients found in food are carbohydrates, protein, and fat. Ideally, half of the food you eat should contain carbohydrates and the other half should be split between food that are rich in protein and fats. The concept is simple, but it can be hard to put into practice. This guide will help make it easier for you to eat healthy.

Why is this important for surgery?

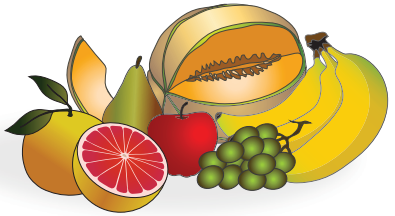
Surgery puts a stress on your body. The goal is to prepare your body for this stress, similar to the way athletes prepare for a marathon. By eating healthy you can make sure your body has all the nutrients it needs to work well before and after surgery. By following the healthy eating guidelines listed below and our exercise program, you will build up your muscular strength to prepare your body for the stress of surgery.

We may ask you to take a whey protein supplement. This protein supplement comes from milk, is easily digested, and helps build muscles when you exercise. You will be asked to take this supplement before and after your exercise program. The nutritionist will explain how much you should take and will ask you to keep a diary.

The Plate Method:

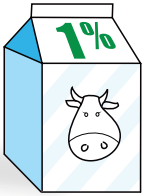
This is a guide to help you naturally meet your daily nutrient requirements and maintain portion control

Your lunch and dinner plate should look like this! Follow the same example at breakfast, although the vegetables are optional at breakfast time.



Milk & Alternatives:

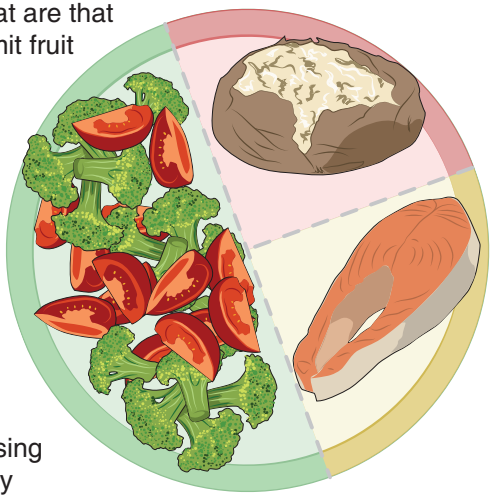
Milk (including milk-based soups and sauces), fortified soy beverages, yogurt, kefir, cheese, cottage cheese, homemade pudding/custard (made with milk). These foods also contain protein.



Tip aim for 1%

Fruit:

Try fresh or frozen fruit that are that are bright in colour and limit fruit juices



Starch:

Pasta, rice, quinoa, barley, couscous, bread, tortilla, pita bread, cereal, oats, crackers corn, potato, sweet potato, peas, parsnips, pumpkin

Tip: Make at least half of your choices whole grain. Choose barley, brown or wild rice, oats, and quinoa more often.

Fats:

Limit butter, margarine, mayonnaise & salad dressing to two tablespoons per day

Non-Starchy Vegetables

Yellow or green beans, broccoli, brussels sprouts, cabbage, cauliflower, celery, kale, cucumber, eggplant, palm hearts, endive, leeks, lettuce, spinach, mushrooms, okra, onion, peppers, radish, tomatoes, zucchini

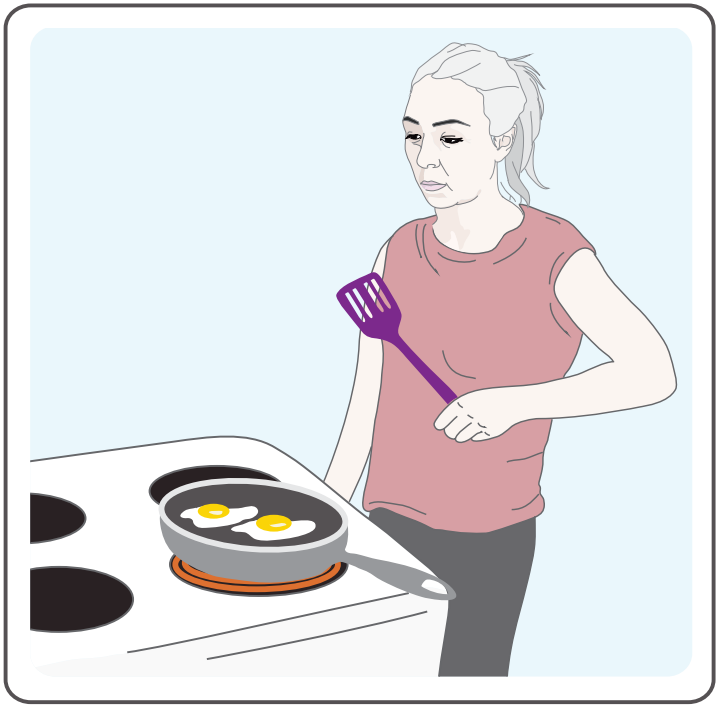
Tip: Try salad, vegetable soup, stir fry, boiled or steamed vegetables.

Protein:

Eggs, fish, seafood, meat, poultry, nuts, nut butters, seeds, soy products, beans lentils, chickpeas.

Tip: Choose lean meats, trim fat and remove skins from animal products before cooking. Try natural peanut butter without added sugar or salt. Choose beans, lentils and fish more often.

Cooking Tips:



- Instead of frying foods with oil or butter, use a vegetable oil cooking spray, a little water, non-fat soup broths, or herbal teas.
- Try baking, broiling, and steaming instead of frying.
- When you cook with oil, grease your pan with a small amount of oil on a paper towel.
- Line baking pans with parchment paper or cooking spray instead of oil.
- Instead of cooking with cream use evaporated skim milk.
- Thicken soups with puréed carrots, lentils, or silken tofu instead of cream.
- Yogurt can often be used to replace sour cream or mayonnaise. For example, replace 1/2 the mayonnaise in an egg salad recipe with low fat plain yogurt.
- Reduce 1/2 the oil in marinades or salad dressing recipes and increase ingredients like wine vinegar, balsamic vinegar, fruit juice, or fat-free broth.
- Use a smaller amount of a sharp or strong tasting cheese instead of a larger amount of a mild tasting one.
- Buy tuna packed in water instead of oil and fruit packed in juices instead of syrup.

Exercise Program

During your first visit with the kinesiologist (an exercise specialist), he or she will help develop the right physical activity program for you. You will be shown how to perform your exercise program that will consist of 3 components: **strength training, aerobic, and flexibility.**

- **Duration of Each Session:** Approximately 1 hour
- **Frequency:** 3x/week

Questions about Strength Training

Why do we Perform Strength Training?

Strength training helps to develop muscular strength. As your muscles become stronger, performing chores and activities of daily living should become easier.

Where can the Exercises be Performed and with what Equipment?

All your exercises can be performed at home or at a gym (if you have a membership) with the use of elastic bands, a mat and a towel.

What if I Forget my Exercises?

All your exercises with pictures and cues are included in this pamphlet. Please refer to **the Exercise Prescription** Section for your personalized program.

Questions about Aerobic Training

What is Aerobic Training?

Aerobic training consists of performing an activity such as walking, cycling, or swimming for a period of time at a prescribed intensity. The kinesiologist will prescribe an appropriate duration and intensity that will be beneficial for you.

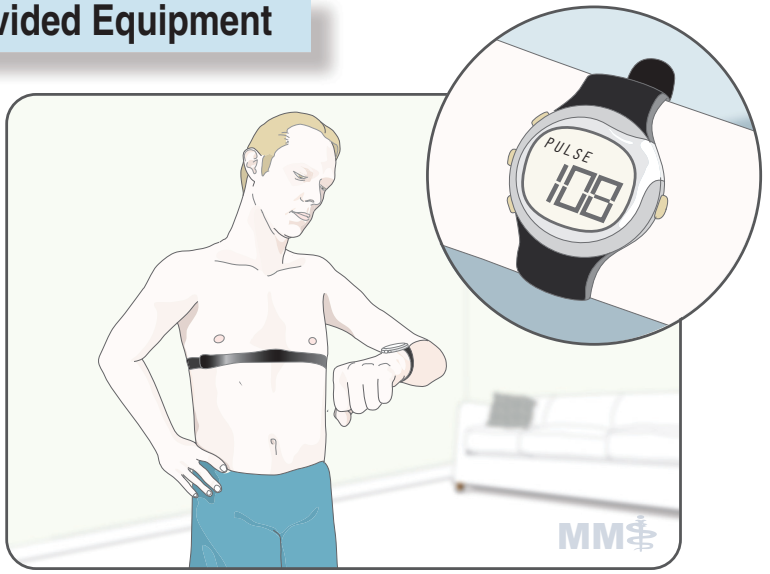
How do I know if I am Working at the Right Intensity?

The kinesiologist will prescribe a target heart rate that is specific to your age and ability. He or she will then instruct you on using a **Heart Rate Monitor** and the **Borg Scale** (a scale that rates how hard you feel that you are working).

Heart Rate

Your Heart Rate is how quickly your heart is beating per minute.

How to Use the Provided Equipment

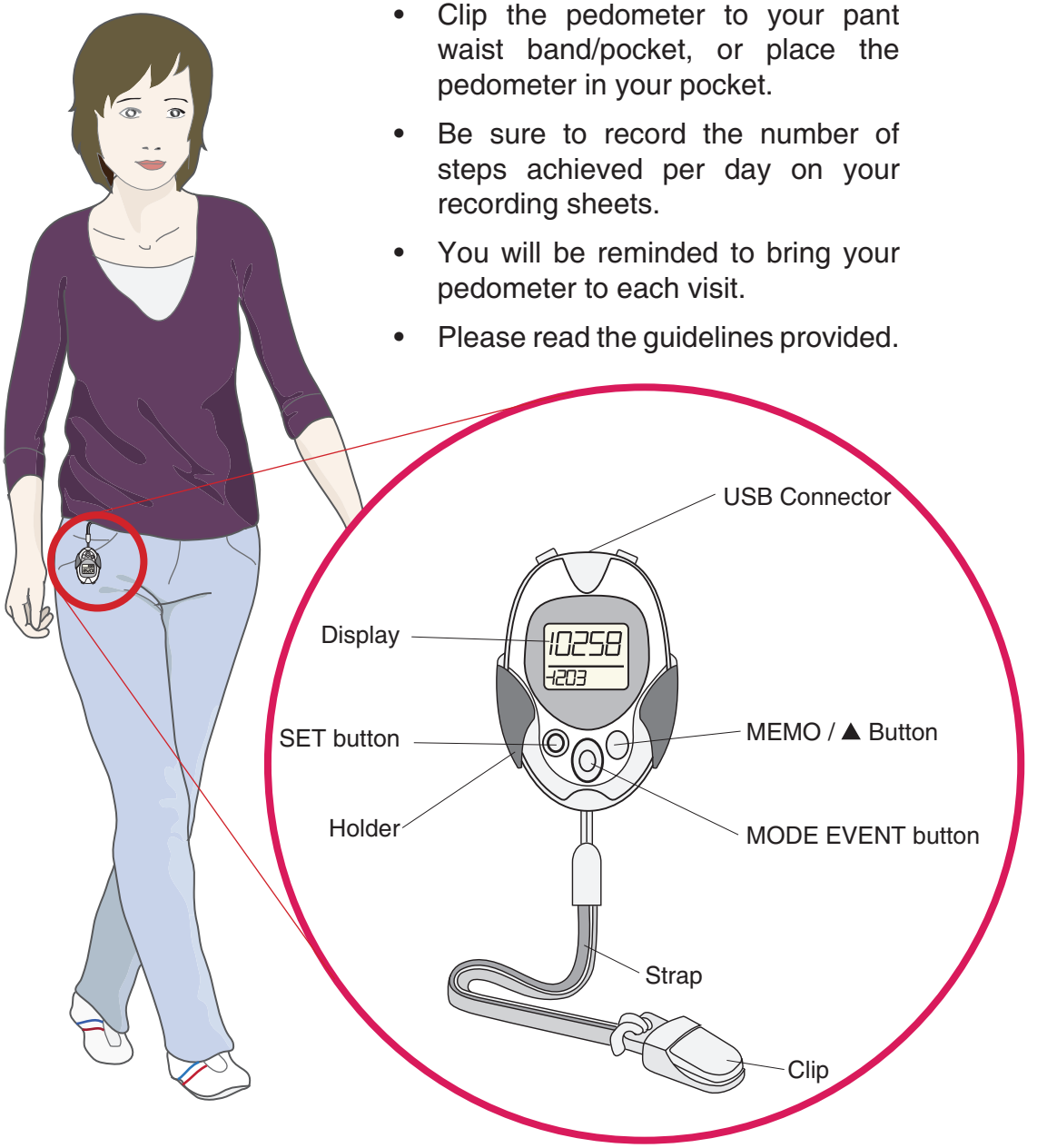


1. Heart Rate Monitor

- Used to determine your Heart Rate before, during and after exercise.
- Wet the plastic part of the heart rate monitor strap.
- Place the Heart Rate Monitor directly on your skin just below the breastbone.
- Place the watch on your wrist and press the button once to turn it on.
- After a few seconds, numbers will appear.

2. Pedometer

- Clip the pedometer to your pant waist band/pocket, or place the pedometer in your pocket.
- Be sure to record the number of steps achieved per day on your recording sheets.
- You will be reminded to bring your pedometer to each visit.
- Please read the guidelines provided.



The Borg Scale

0	nothing at all
0.5	very very easy
1	
2	very easy
3	easy
4	moderate
5	somewhat hard
6	hard
7	very hard
8	
9	very very hard
10	very very hard

Borg Scale

Perceived Exertion

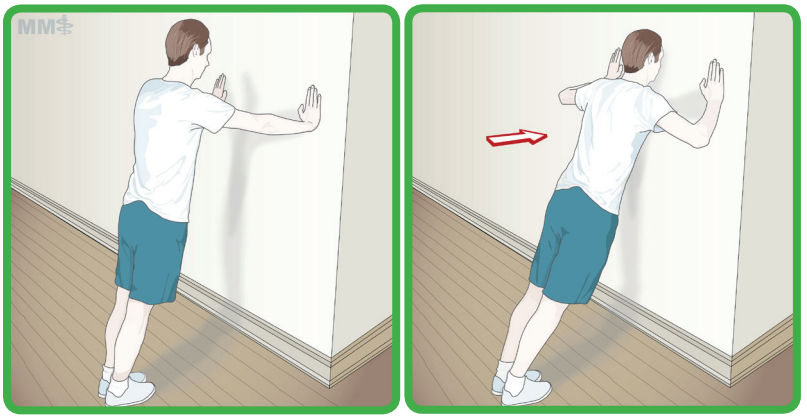
The Borg Scale measures how hard you feel that you are exercising.

After your exercise, identify which number corresponds to how hard you worked throughout your training. A number 6 represents **very, very easy** exertion while number 10 signifies a **very very hard** effort.

Use these cues to help determine how hard you worked.

Resistance Exercises

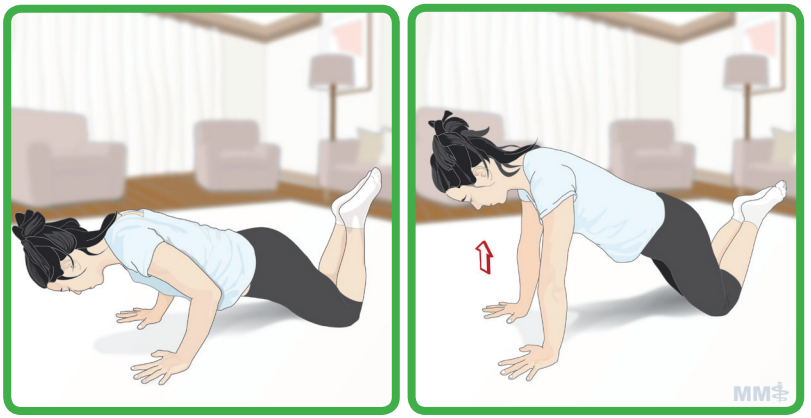
☐ Push-up Against the Wall



Instruction: Place hands at shoulder height on a wall. Stand slightly angled towards the wall. Keeping your back straight, bend your elbows to allow your upper body to come close to the wall.

Reminder: Keep your neck inline with your spine. Make sure to fully extend your arms.

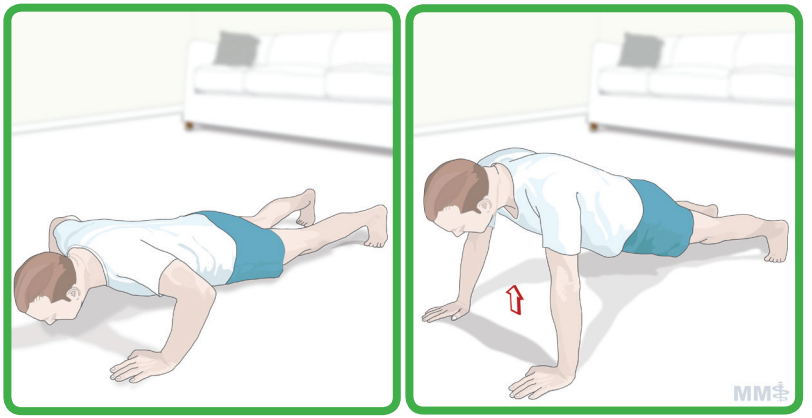
☐ Modified Push-up



Instruction: Put both hands on the floor and push yourself up from your knees.

Reminder: Try to keep the body in a straight line.

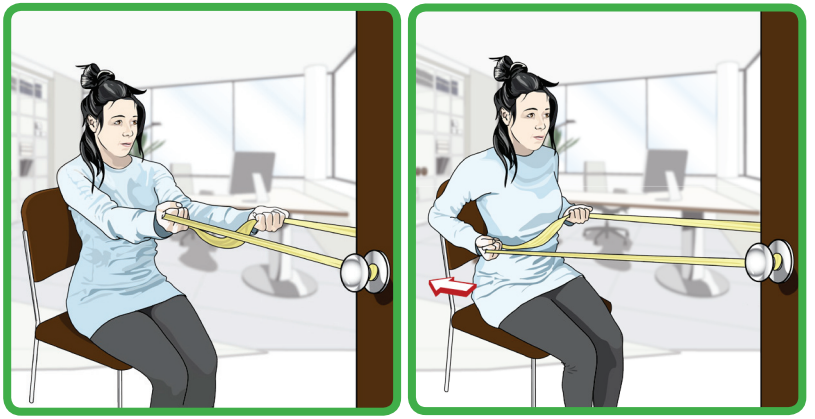
☐ Full Push-up



Instruction: Put both hands on the floor shoulder width apart Extend your legs and place your toes on the floor with your back straight.

Reminder: Make sure to fully extend your arms.

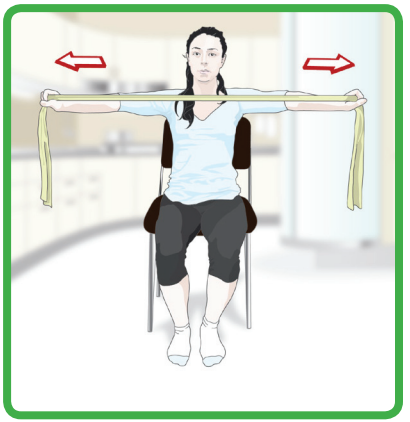
☐ Seated Row (with theraband)



Instruction: Holding the band, bend your elbows to 90 degrees. Without changing the angle in your arms, swing your arms backward so that your elbows are now behind you. Squeeze your shoulder blades together.

Reminder: Try to keep your back straight.

☐ Chest (with theraband)



Instruction: Hold elastic up at shoulder height with both hands. Pull the elastic out to the sides.

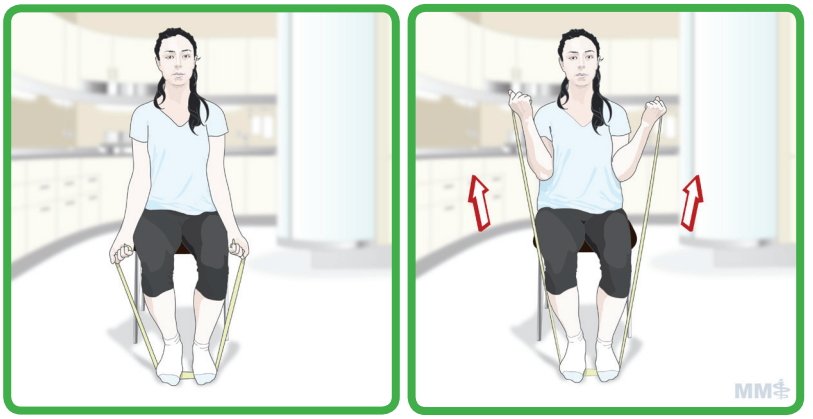
Reminder: Keep your back straight against the seat of the chair

☐ Deltoid Lift (with theraband)

Instruction: Place your feet on the band and raise your arm to the side so that your arm is now parallel to the floor.

Reminder: Keep a small bend in your elbow throughout the movement. Perform the exercise one arm at a time.

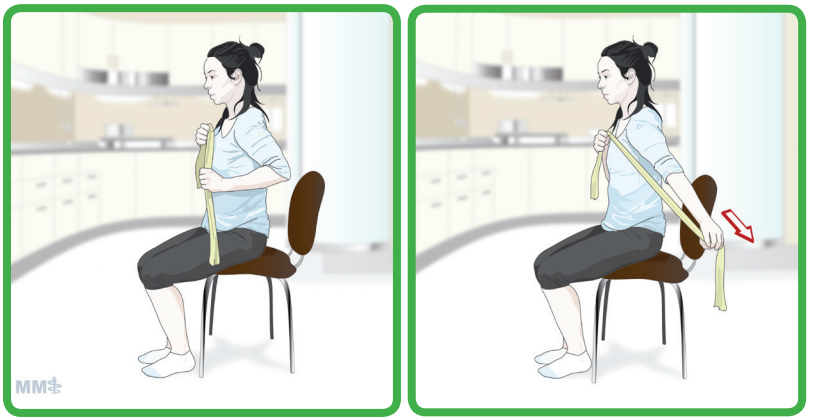
☐ Biceps Curls (with theraband)



Instruction: Place both feet on the band. Keeping your elbows attached to your sides, bend your elbows.

Reminder: Try to keep your back straight. Keep your wrists inline with your forearm.

☐ Triceps Extensions



Instruction: Hold the elastic in one hand at your chest. Pull the elastic back down to your side with the other hand.

Reminder: Keep the elbow of the moving arm glued to your body during the entire movement.

☐ Chair Squats

Instruction: Sit at the edge of the chair with your legs at an angle of 90 degrees. Stand up without using your hands.

Reminder: Always keep your legs at an angle of 90 degrees. The feet should not move at the beginning of the movement.

☐ Touch Squats

Instruction: Stand relatively close to the edge of your chair (facing away from it). Slowly lower your body to a sitting position.

Reminder: Do not fully sit on your chair.

☐ Hamstring Curls

Instruction: Hold the back of a chair. Kick your heels back one at a time.

Reminder: Do not put all of your body weight on the chair but on the standing leg instead. Keep your knees close together.

☐ Standing Calf Raises

Instruction: Stand facing the wall and hold for support. Lift your heels at the same time so that you are standing on your toes.

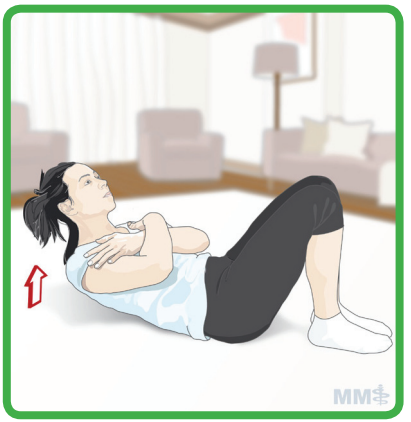
Reminder: Keep your body straight (perpendicular to the floor)

☐ Abdominal Crunches (chair) : *to be done only before surgery*

Instruction: Sit at the edge of your chair with your hands crossed over your chest. Lower your back to the back of the chair. Hold for two seconds and then come back to a seated position.

Reminder: Keep your back straight during the entire movement. Do not let your feet come off of the floor.

☐ Abdominal Crunches (floor) : *to be done only before surgery*



Instruction: Lie down on the floor/bed with both hands on the chest and slightly lift your shoulder off the floor/bed

Reminder: Try not to curve your neck and keep your head straight.

Flexibility Exercises

Repeat 2 times per exercise.
Hold the position for at least 20 seconds

☐

Chest

Instruction: Keep hands at shoulder height.

Reminder: Try to keep your back straight.

☐

Biceps

Instruction: Extend one arm with the palm of your hand facing upwards. With the other hand, push the fingers backwards

Reminder: Keep your arm at shoulder height.

☐

Triceps

Instruction: Raise your arm up, and bend your elbow so that your hand is now touching between your shoulder blades. With the opposite hand, slightly pull your elbow to the opposite side.

Reminder: Do one arm at a time.

☐

Quadriceps

Instruction: Place one leg onto a chair behind you while holding on to an object in front of you for support.

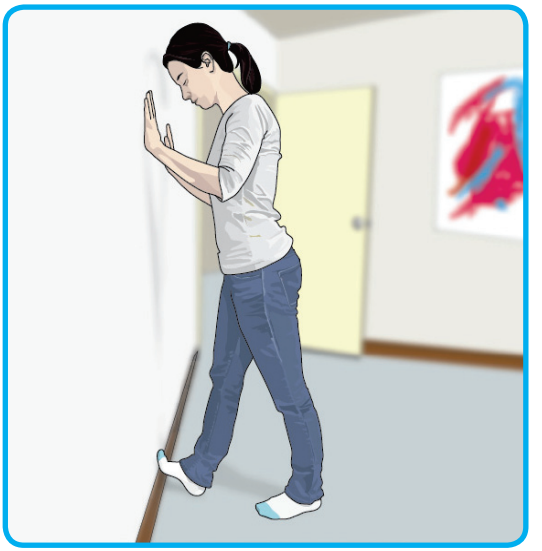
Reminder: Make sure to place your leg as far back as you can on the chair.

☐

Hamstrings

Instruction: Sit at the end of a chair with one leg fully extended. Place the heel of your foot on the floor and lean forward.

Reminder: Go as far as you can without feeling pain.



☐

Calf Stretches

Instruction: Stand with your hands against a wall. Place the toes of one of your feet on the wall in front of you and slightly push.

Reminder: Only do one foot at a time.

Journal
(before surgery)

Aerobic Training Journal: Example

Below is an example of how to fill out your training journal.

Meet Ms. Anna Tremblay.

On **Sept. 2nd, 2011**, Ms. Tremblay met with the physiotherapist/ kinesiologist and was prescribed to walk **(W)** or bike **(B)** for **20 minutes, 3 times per week.**

It was recommended that she take 1 packet of protein powder **before and after** resistance training.

It was recommended that she work at **50%** of her **Heart Rate Reserve** (a value calculated by the kinesiologist), and to aim for a **Target Heart Rate of 118 Beats per minute.**

It was recommended that she walk 5000 steps.

Please see her prescription in the box at the bottom of the page**.**

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate		85		80		82	
Type of Exercise		W		B		W	
Duration		20 min		20 min		20 min	
Exercise Heart Rate		118		118		118	
Perceived Effort (BORG scale)		6		6		6	
Post Exercise Heart Rate		115		115		115	
Pedometer : number of steps		5650		6760		8450	

Dates Sept 5 to Sept 12
Target Heart Rate: 118
% of Heart Rate Reserve: 50%

Duration: 20 min
Frequencey: 3 times / week
Number of Steps: 5000

Aerobic Training

- Remember to take your heart rate before, during, and after your aerobic exercise
- Target Heart Rate is the heart rate at which you should aim to be working during your aerobic activity. Monitor this by using the Heart Rate Monitor.
- For aerobic exercise you can choose an activity that you like. In your exercise journal, indicate which activity you did by writing the first letter of that activity.
- During your exercise, you will rate your exertion level in your exercise

Resistance Training Journal: Example

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder	✓		✓		✓		

Exercises	p.	SUN sets	SUN reps	MON sets	MON reps	TUES sets	TUES reps	WED sets	WED reps	THURS sets	THURS reps	FRI sets	FRI reps	SAT sets	SAT reps
Wall Push-Ups	17	1	10			1	10			1	10				
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18	1	12			1	12			1	12				
Chest	19	1	10			1	10			1	10				
Deltoids	19	1	12			1	12			1	12				
Biceps Curls	20	1	10			1	10			1	10				
Triceps Curls	20	1	10			1	10			1	10				
Chair Squats	21	1	12			1	12			1	12				
Touch Squats	21														
Hamstring Curls	22	1	10			1	10			1	10				
Standing Calf Raises	22	1	10			1	10			1	10				
Abdominal Crunches (chair)	23	1	10			1	10			1	10				
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24	✓		✓		✓		
Biceps	24	✓		✓		✓		
Triceps	25	✓		✓		✓		
Quads	25	✓		✓		✓		
Hamstrings	26	✓		✓		✓		
Calfs	26	✓		✓		✓		

Nutrition - Protein Powder		✓		✓		✓		

Resistance Training

- Remember to record the number of repetitions and sets you performed for each strength training exercise.
- Remember to breathe throughout the entire exercise (breathe out when you push, and breathe in when you are not exerting force).

week 1 before surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 1 before surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder								

Notes:

week 2 before surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 2 before surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

week 3 before surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 3 before surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

week 4 before surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 4 before surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

After Surgery

Nutrition Program

Make sure you drink plenty of fluids!

The nutritionist recommends you drink _____ cups each day. Fluids include water, flavored water, juice, milk, broth, non-caffeinated herbal teas.

You will also require extra **protein** to heal your wounds and recover your strength.

Dietary protein is required by the body for growth, repair, immune function, preserving muscle mass, making essential hormones, and can be used as a source of energy when carbohydrates are unavailable.

All snacks should include 1 food rich in protein

- **Cheese** & crackers
- Toast with **ricotta cheese** or **peanut butter**
- **Cottage cheese** with fruit
- **Plain yogurt** with fruit and sweetened with honey or maple syrup
- **Tuna, crab, or egg** salad dip with carrot and celery sticks
- **Hard-boiled egg**
- **Bean dip** and pita bread
- Slices of apple with ¼ cup **almonds**
- Banana and a glass of **milk**
- Tomato slices with **parmesan cheese**
- Baked apple with **ricotta cheese**
- **Protein bar**
- Fruit smoothie made with **whey protein or yogurt**

All meals should include at least 2 foods rich in protein

- Cereal with **milk** and smoothie made with berries, **whey protein**, and juice
- Toast with **baked beans, yogurt**, and glass of **milk**
- Yogurt parfait made with plain Greek **yogurt**, All Bran buds®, and banana & **poached egg** on rye toast
- Western omelet made with **2 eggs** and diced cooked **ham**
- **Cream** of mushroom soup & 1/2 **chicken**, tomato, and avocado sandwich
- Tomato, cucumber, **tofu**, and **goat cheese** salad & slice of bread with **almond butter**

- **Tuna** melt made with whole grain bread, **tuna, hard-boiled eggs, cheese** melted on top
- Alfredo pasta made with evaporated skim **milk** and **chicken** & side salad
- **Salmon**, rice, and broccoli with **cheese** sauce
- **Haddock fish** with **yogurt** dill sauce, green beans, and mashed potatoes
- **Chicken** casserole made with **milk** and **cheese**
- Grilled vegetable panini with **hummus** & vegetable salad with **walnuts** and **black beans**

Exercise Program

After surgery you may notice that your body feels tired. You may not feel like doing the aerobic or resistance exercises. It is okay if you are unable to do the same amount of exercise as you were doing before your surgery. The goal is to keep your body moving to help speed your healing. It is safe to continue the exercise program.

You will notice that your exercise program has been changed slightly to help with the stress on your body from your surgery.

Here are a few things to remember:

- It is important to walk as much as you can.
- Avoid lifting anything that weighs 5 lbs (2 kilos) or more.
- Abdominal exercises should be avoided until the 3rd week after your surgery.
- Stretching exercises should be done after each exercise session.

Do as much as you can without feeling pain. As the weeks go by, you will see that your program will become easier and easier because you are becoming stronger and stronger!

Journal
(after surgery)

week 1 after surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 1 after surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

week 2 after surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 2 after surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder								

Notes:

week 3 after surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 3 after surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

week 4 after surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 4 after surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

week 5 after surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 5 after surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

week 6 after surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 6 after surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

week 7 after surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 7 after surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
Deltoids	19														
Biceps Curls	20														
Triceps Curls	20														
Chair Squats	21														
Touch Squats	21														
Hamstring Curls	22														
Standing Calf Raises	22														
Abdominal Crunches (chair)	23														
Abdominal Crunches (floor)	23														

Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

week 8 after surgery

Aerobic Training

	SUN	MON	TUES	WED	THUR	FRI	SAT
Resting Heart Rate							
Type of Exercise							
Duration							
Exercise Heart Rate							
Perceived Effort (BORG scale)							
Post Exercise Heart Rate							
Pedometer : number of steps							

Dates _____ to _____
Target Heart Rate: _____
% of Heart Rate Reserve: _____

Duration: _____
Frequencey: _____
Number of Steps: _____

Notes:

week 8 after surgery

Resistance Training

	SUN	MON	TUES	WED	THURS	FRI	SAT
Nutrition - Protein Powder							

Exercises	p.	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps	sets	reps
Wall Push-Ups	17														
Modified Push-Ups	17														
Full Push-Ups	18														
Seated Row	18														
Chest	19														
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Flexibility		SUN	MON	TUES	WED	THURS	FRI	SAT
Chest	24							
Biceps	24							
Triceps	25							
Quads	25							
Hamstrings	26							
Calfs	26							

Nutrition - Protein Powder							

Notes:

Notes