Strategies for Minimizing Bed Rest in Post-Operative Colorectal Cancer Patients: Exercising to ERAS

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Abstract (English)

Introduction: Post-surgical patients are at risk of long periods of bed rest, which has been associated with poor pain management, insulin resistance, loss of lean muscle mass and an enhanced surgical stress response. This is detrimental for their health status and subsequent recovery process. With post-operative quality of life and treatment dependent on recovery, optimizing functional capacity throughout the surgical process is essential. This project proposes an in-hospital exercise program for colorectal resection patients that is adaptable to their physical capacities in the immediate post-surgical period. After undergoing a prehabilitation program prior to surgery, patients received daily in-hospital resistance training that was initiated within the first 24 hours of surgery. The in-hospital exercise program consisted of a series of adapted resistance exercises (either in-bed, seated or standing) targeting all major muscle groups of the body.

Aim of the study: The aim of this project was to evaluate the feasibility of a progressive resistance exercise program initiated within 24-hours of surgery, supporting patients in attaining the mobilization goals outlined in the Enhanced Recovery After Surgery (ERAS) guidelines. Current guidelines for post-surgical patients encourage between four and six hours of ambulation over each post-operative day in hospital. With adherence to this component of ERAS remaining low, it is critical to increase the number of patients who attain this goal.

Results: Compliance to the in-hospital program was high on post-operative day one (POD1) (90%), with main symptoms deterring exercise being: fatigue, nausea and vomiting. These results suggest initiating a resistance-based exercise program within the first 24-hours of surgical intervention is feasible. Patients were closer to attaining the ERAS mobilization guidelines before discharge, while experiencing early discharge (3 days) compared to 4.16 days in a historical control group. Overall, length of time spent in bed was diminished, and sedentary time was broken up.

Conclusion: Encouraging resistance exercise over the hospital stay is feasible and may enhance adherence to ERAS early mobilization guidelines.

Abstract (French)

Introduction : Les patients chirurgicaux sont exposés à de longues périodes de repos au lit, ce qui est associé à une mauvaise gestion de la douleur, à une résistance à l'insuline, à une perte de masse musculaire maigre et à une réponse accrue au stress chirurgical. Ceci est préjudiciable à leur état de santé et à leur processus de rétablissement. Avec la qualité de vie postopératoire et le traitement dépendant de la récupération, l'optimisation de la capacité fonctionnelle tout au long du processus chirurgical est essentielle. Ce projet propose un programme d'exercice durant l'hospitalisation pour les patients de résection colorectale qui s'adapte à leurs capacités physiques dans la période postopératoire immédiate. Après avoir subi un programme de préhabilitaton avant la chirurgie, les patients ont reçu des formations d'exercices qui ont été initiés dans les 24 premières heures de la chirurgie. Le programme d'exercices d'hospitalisation consistait en une série d'exercices de résistance adaptée (soit dans le lit, assis ou debout) ciblant tous les principaux groupes musculaires du corps.

Objectif de l'étude : Le but de ce projet était d'évaluer la faisabilité d'un programme d'exercices de résistance progressive initié dans les 24 heures de la chirurgie et d'aider les patients à atteindre les objectifs de mobilisation décrits dans les consignes du programme de récupération rapide après une chirurgie (RRAC). Les consignes actuelles pour les patients chirurgicaux encouragent entre quatre et six heures de déambulation sur chaque jour postopératoire à l'hôpital. Avec le respect de cette partie du RRAC restant faible, il est essentiel d'augmenter le nombre de patients qui atteint cet objectif.

Résultats : La conformité au programme hospitalier a été élevée à la première journée (POD1) (90%) postopératoire, les principaux symptômes étant la fatigue, les nausées et les vomissements. Ces résultats suggèrent l'initiation d'un programme d'exercice basé sur la résistance dans les premières 24 heures d'intervention chirurgicale est faisable. Les patients étaient plus près d'atteindre les consignes de mobilisation du RRAC avant la sortie, tout en éprouvant un congé précoce (3 jours) comparativement à 4,16 jours dans un groupe de contrôle historique. Dans l'ensemble, la durée de séjour au lit a diminué et le temps sédentaire a été rompu.

Conclusion : Il est possible d'encourager les exercices de résistance pendant le séjour à l'hôpital et de renforcer le respect des consignes de mobilisation précoce du RRAC.

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Table of Contents

Preface and Contribution of Authors

Alexandra Schram B.Sc : Conception, performance of studies, data acquisition, analysis and preparation of manuscript

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I

Introduction

Colorectal cancer remains the second leading cause of cancer mortality in Canada, and third most diagnosed cancer type in North America[1,2]. With its high prevalence, a considerable amount of health care resources are continuously devoted to prevention and screening[3]. Fortunately, a greater understanding now exists in the pathogenesis of the disease, thus contributing to more effective prevention strategies over the years[2]. One cost-effective strategy for disease prevention is the incorporation and maintenance of regular physical activity into individuals' regular routines[4]. Many benefits are associated with adherence to standardized exercise guidelines, from prevention through survivorship in cancer patients.

Among the well-established physiological adaptations that result from regular structured exercise, benefits for the colorectal cancer patient include reduced intestinal transit time, modulated immune function and reduced prevalence of polyps[4–6]. Notably, for all the benefits of exercise there are an equal amount of detrimental effects that result from extended periods of sedentary behavior or bed rest[7]. One population at risk of extended periods of bed rest are surgical patients: many nervous to perturb the healing process and some experiencing pain and fatigue. Due to advancements in laparoscopic surgery techniques, the length of hospital stay following many colorectal resection procedures is, on average, 3-4 days[7]. However, despite these advances, many patients are still reluctant to mobilize after surgery and remain in bed[8]. Already coping with the stress of surgery, bed rest may exacerbate their depleted physical state by inducing low state inflammation and insulin resistance[9]. With the increased risk of post-operative complications due to extended periods of bed rest[10], it seems counterintuitive not to encourage mobility and exercise in post-operative patients. Furthermore, despite an already low adherence to evidence-based exercise guidelines, in many patients, physical activity levels tend to further decrease after cancer diagnosis[11]. Although patients resume activities of daily living post treatment, physical activity levels remain lower than pre-diagnosis[11]. This trend can be, in part, explained by the stressful nature of this period and the preconceived notion that “rest is best”.

There are minimal guidelines available to post-operative patients during their hospital stay, which can also be a contributing factor to their sedentary state. This may result in accelerated deconditioning and an unnecessarily prolong the recovery process[7], which subsequently delays the initiation of further treatments[12]. The start of chemo- or radiotherapy will depend on the patient’s health status and may be postponed beyond the typical one-month wait-time after surgery[13]. Following the delayed start, initiation of these treatments may also lead to skeletal muscle dysfunction and consequently further decreased engagement in physical activity and exercise[14]. Patients are therefore at a disadvantage by not being encouraged to recommence engaging in exercise as soon as possible after their surgeries.

The Enhanced Recovery After Surgery (ERAS) guidelines have been widely adopted in the attempt to minimize the traumatic effects of surgery and mitigate the physiologic decline experienced by post-surgical patients[7]. As part of a multimodal strategy, the protocol outlines recommendations for early mobilization during the hospital stay[15]. The guidelines encourage patients to be moved out of bed as soon as possible and ambulate between four and six hours daily over each post-operative day in the hospital[16]. Albeit the good intentions of the guidelines, our lab has seen that many patients do not attain these recommendations. It is therefore critical to assess the current status of post-operative patients and tailor to their needs based on physical status after surgery. The goal of this thesis is to address the gap of knowledge in the post-operative care system of colorectal cancer patients in order to prevent extended periods of bed rest and further enhance functional recovery.

Review of Literature

Colorectal Cancer Population

Colorectal cancer is normally diagnosed in later age, with over 50% of cases diagnosed in individuals over the age of 70[3]. This cancer is more prevalent in men than in women[3] and the average age of these individuals is associated with an abundance of age-related health issues[17,18]. Older cancer patients are more susceptible to involuntary weight loss resulting from low dietary intake, which can be linked to decreased quality of life and mortality[19]. This weight loss can be exacerbated with sarcopenia, characterized specifically by a loss of skeletal muscle[19]. Colorectal cancer patients may also experience cancer cachexia in addition to sarcopenia: a multifactorial syndrome resulting from decreased food intake and a series of metabolic abnormalities such as hypermetabolism[20]. Cancer cachexia is experienced by approximately half of all cancer patients, which can lead to 75% loss of skeletal muscle mass once an individual has lost 30% of their body weight[19,21], negatively impacting their functional ability[20].

Sarcopenia and cachexia may ensue prior to diagnosis and are enhanced by the numerous metabolic changes the body undergoes after developing cancer[22]. As tumor cells begin to form in the large intestines, metabolic changes occur that can drastically alter normal bodily functions[19], resulting from the Warburg effect. The Warburg effect is defined by a metabolic process characterized by an increased glucose uptake and lactate excretion by the tumour cells, resulting in a decreased pH balance in surrounding tissues[23]. Typically, an increased inflammatory response follows, in addition to metabolic changes such as gluconeogenesis, diminished insulin sensitivity, altered muscle protein turnover and protein catabolism[21]. These changes can exacerbate the depletion of physiologic reserves such as protein, fatty acids and ketone bodies[21], thereby enhancing the effects of sarcopenia. This is of particular concern in the older population, as many individuals tend to be nutritionally compromised which can negatively impact quality of life as well as reaction to cancer treatment[19].

In addition to physiological stress, the majority of cancer patients also face psychological distress over the course of diagnosis and treatment[24]. This psychological stress can be in part due to the physiologic changes themselves, but may also be related to family and social concerns stemming from the cancer diagnosis[24]. Psychological problems that may result include both anxiety and depression[24,25]. Both psychological and physiological stresses can lead to exaggerated metabolic responses, which can negatively impact the overall health status of the individual[25]. Psychological influences may further exacerbate the physiological state of the patients and further deter them for engaging in physical activity. Fortunately, both physiologic and psychological barriers faced with a cancer diagnosis can be combated with structured exercise throughout the cancer trajectory[5,26–30].

Structured Exercise in the Colorectal Cancer Trajectory

Exercise as a Prevention Strategy

Incorporating regular structured exercise into daily life has shown positive impacts on psychological and physiologic parameters in healthy individuals and cancer patients alike[4–6]. Engaging in exercise promotes a series of beneficial adaptations in the body, including improved cardiovascular function and preservation of muscle[31], which are essential in optimizing functional capacity defined as: the ability to sustain physically demanding activities of daily living[32,33]. Colorectal cancer has the potential to be prevented and mitigated through means of exercise in prevention stages and throughout the cancer trajectory, with a 40-50% reduction in the incidence of colorectal cancer associated with regular exercise[34]. Unfortunately, often adherence to exercise is low, especially in older adults, despite access to resources enabling physical activity and exercise[35].

Currently, exercise guidelines are available from various organizations, such as the Canadian Society for Exercise Physiology, most agreeing that in order to obtain improvements in health and fitness status, 150 minutes of aerobic exercise per week are needed in addition to a minimum of 2 days of light resistance exercise per week[36]. Abiding to these guidelines has also been linked in the reduction of this incidence of cancer directly, shown clearly in colorectal cancer[37]. With an estimated 24 000 newly diagnosed cases reported in Canada in 2014, colorectal cancer remains a major health concern and economic strain on our society despite best mitigation efforts[3]. It is evidently unavoidable in some cases, therefore, coping strategies have been established to combat the disease and help with repercussions of subsequent treatment.

The Use of Exercise During Cancer Treatment

Treatment strategies for colorectal cancer generally include one or a combination of chemotherapy, radiotherapy or surgical intervention, though surgical resection remains the cornerstone of treatment[7,38]. Chemo- and radiotherapy may be used prior to or following a surgical intervention[13], depending on a variety of factors related to tumor size and location along with comorbidities potentially effecting patient outcomes[13]. Both interventions are also largely dependent on the health status of the patient reflective of their capacity to withstand the physically demanding treatments[14]. In patients where these treatments are executed, the body is subjected to an enormous amount of stress, which can contribute to the onset of cancer related fatigue (CRF)[39].

CRF can be defined as persistent, distressing exhaustion related to cancer and/or cancer treatment, with the degree of metabolic changes suffered by the patient influencing the level of intensity[39,40]. This symptom may have an impact on the psychological well-being of the individual, already dealing with the stress of their diagnosis and prognosis to come[39,41]. Fortunately, engaging in exercise has the potential to diminish the effects of CRF, with evidence suggesting that engaging in regular physical activity and habitual exercise can lead to higher energy levels[5,39]. Structured exercise has also been shown to promote a better quality of life favoring independence, which is of particular relevance in this population as quality of life and fatigue levels can be greatly impacted by a cancer diagnosis and subsequent CRF[39,42].

Rehabilitation Exercise Interventions

In addition to diminishing the side effects of non-operative treatment, structured exercise has been used in the post-operative period for those receiving surgical interventions[33,43]. Exercise has been encouraged in the post-operative period in the form of rehabilitation in attempts to aid patients in the recovery back to their baseline level of functioning[33,43]. Studies have shown that initiating a resistance exercise program post-operatively has the latency to aid in the return to functional capacity, as compared to sedentary controls[41,44]. This is not only important for patient quality of life, but also for preparing the patient for any subsequent chemo- or radiotherapy that may follow surgery[43]. Though improvements have been observed in utilizing rehabilitation, the consensus has been made that intervening post-operatively may not be the most effective time for an intervention, as this period is a stressful and uncertain time for patients[28,41,43]. These conditions are not ideal for the implementation of a lifestyle change and thus a new approach has since been established.

Development of Prehabilitation in the Pre-Operative Period

Building off the success in rehabilitation and noticing that physically fit patients cope better with surgical stress, exercise has been implemented as an interventional strategy in preparation for surgery in colorectal cancer patients[25,43,45]. This process has been termed prehabilitation and can be defined as the process of enhancing an individual's functional capacity in the pre-operative time frame in order to improve his/her ability to cope with an upcoming physical stressor[25,43,45]. Based on the typical onset of colorectal cancer, patient health status becomes an important factor when considering appropriate treatment options, especially in electing for abdominal surgery[7]. The pre-operative period has been deemed a more suitable time to implement a lifestyle change for a number of reasons. Patients may be in better shape prior to a surgical intervention, and are likely subject to a wait period between time of diagnosis and surgery[45,46]. It has been shown that using this time effectively can yield even more positive results than a rehabilitation program alone[43,45] (*Figure 1*). With the goal of preparing patients for surgery, prehabilitation is comprised of a trimodal intervention consisting of nutritional, psychological and exercise intervention focusing on intensity, frequency and modality[45].

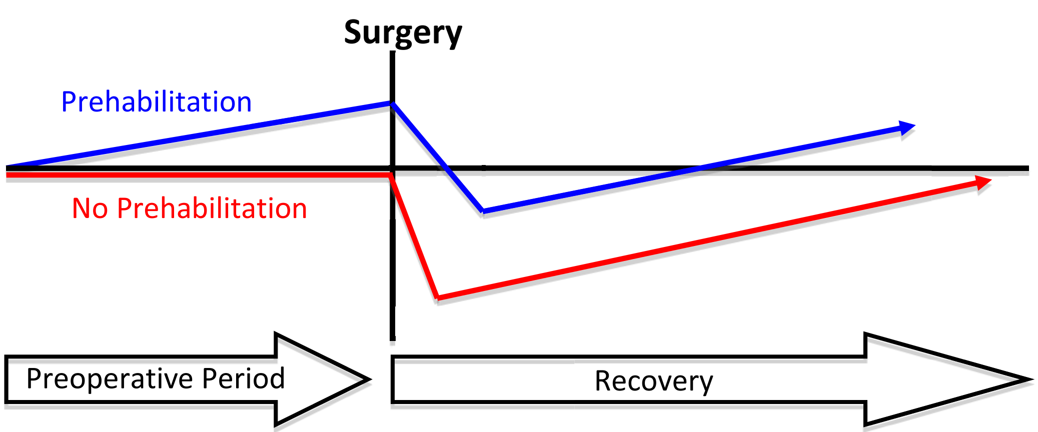

Figure 1. Trajectory of Functional Recovery

Patients following prehabilitation demonstrate a more favorable trajectory in the recovery period than those who do not participate in the program. Prehabilitation patients are able to increase their functional reserve (outlined by the blue line) and thus suffer a lesser decline in the post-operative period compared to the non-prehabilitation patients (outlined by the red line).

Many colorectal cancer patients have a tendency to be frail and deconditioned along with other pre-existing age-related conditions, which can be worsened with a cancer diagnosis[17,19]. With prehabilitation shown to be an efficient method of preparation, it should be implemented whenever possible. The issue is that depending on surgical wait time, not all patients are able to benefit from this intervention, with the typical duration of the intervention being four weeks. Optimizing post-operative care is therefore a topic of concern, with a lack of knowledge on beneficial exercise in the post-operative period and when to initiate the process.

Structured Exercise in Survivorship

Though exercise is promoted from prevention through survivorship along the cancer continuum, there seems to be a gap between post-surgical hospitalization and rehabilitation. Studies investigating adherence to exercise in the remission stage have shown that survivors can benefit from improved physical function, increased strength, reduced fatigue and improved quality of life, should proper adherence be followed[47]. Physically active cancer survivors also have 50% less mortality and overall improvement of disease free survival when engaging in regular structured exercise[48]. Unfortunately, despite the known benefits, a mere 35% of colorectal cancer patients meet the physical activity guidelines recommended by the American Cancer Society following treatment[6]. This statistic is of particular concern, because as mentioned, this disease primarily effects the elderly population, who tend to be inherently more sedentary[3].

It has not yet been established how and when is best to initiate rehabilitation following the surgical intervention in order to effectively benefit from the process. Guidelines are available for cancer survivors who have completed treatments[11,49], but the question remains on how to ensure the best progression from post-op to remission. It has been outlined in this review that exercise is used throughout the cancer continuum (*Figure 2*), though a crucial period has been neglected.

Exercise is not being prioritized in hospital and as such, no guidelines exist for hospitalized patients during their post-operative stay. Encouraging individuals to remain active throughout the cancer trajectory is a positive aspect, though the post-operative hospital stay may be a critical point of this time continuum that can severely impact recovery.

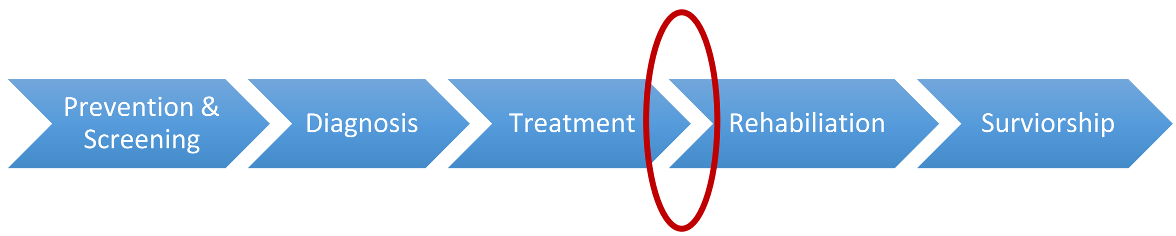

Figure 2. Structured Exercise in the Cancer Continuum

The cancer trajectory is depicted, with an emphasis on the time between treatment and rehabilitation. Currently there is no focus on this short yet crucial time period.
Adapted from Courneya et al. 2007

<u>Status of Post-Operative Patients</u>

Metabolic Response to Surgery

Regardless of the patients' health status prior to surgery, they experience a number of post-surgical psychological and physiological responses during their stay on the surgical floor *(Figure 3*). The surgical stress response, characterized by a series metabolic changes, can severely impact patient functioning and subsequent recovery process[25,50], which as described above, has already been altered by the cancer itself[19,21]. A primary result of the stress response is a decrease in insulin sensitivity which can consequently impact protein and glucose metabolism favoring the production of endogenous glucose[7,25,50]. In order to supply amino acids for gluconeogenesis, there is an increase in the breakdown of protein resulting in a loss of lean muscle[7]. The breakdown of muscle protein can lead to a loss of between 50-70g of protein per day[50]. Surgical stress also causes an increase in cytokine production, which can negatively impact the regular inflammatory response[7,50]. The magnitude of this inflammatory response is related to the insult of surgery: those with an increased pro-inflammatory response subject to more complications[50]. Furthermore, patient physical condition prior to the intervention can impact reaction to the stress response, those with higher inflammation, in the case of diabetic patients for example, have more difficulty coping with these imbalances and are more likely to have complications[38].

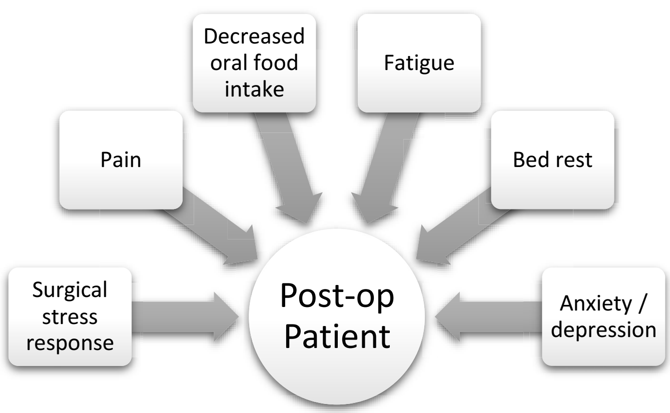

Figure 3. Status of Post-Operative Patients

Common symptoms associated with post-operative in-hospital patient, which can vary in number and intensity

Consequences of the Stress Response

Due to the nature of the post-surgical period being associated with physiological responses influencing the ability to mobilize, patients have a tendency to stay in bed for long periods during their hospital stay[44]. This may be due to a lack of support from hospital staff on the crowded ward, or simply a lack of motivation from the patients, unknowing of the importance of mobilizing after surgery. Long periods of bed rest increase the risk for further complications associated with immobility such as venous thromboembolism, weakness, loss of orthostatic control and decreased peristalsis with ileus formation[7,43]. Bed rest patients are also prone to metabolic abnormalities, which lead to decreased functional capacity, cardiac stroke volume, cardiac output and endothelial dysfunction[7]. Furthermore, the onset of muscle atrophy and weakness begins after only one day of bed rest in healthy populations, with an exaggerated effect in older individuals[7]. By remaining in bed during the hospital stay, the recovery process is prolonged due to delayed initiation of rehabilitation[7].

Psychological Implications of Surgery and Hospitalization

A surgical intervention can be stressful for even the most fit individuals, thus deconditioned individuals may have heightened concerns about their health following this type of procedure[16,25,27]. After surgery, patients often have concerns and are unsure about ensuing treatment processes. They may also be anxious about being discharged, adding to their emotional stress and influencing their recovery[6,38]. The effects of emotional stress on the body may exacerbate physiological symptoms[38]. Metabolic disturbances may lead to discomfort, sleep inhibition and amplified pain[11]: all of which may contribute to the avoidance of engaging in physical activity following surgery. In addition to these tangible symptoms, patients may also be told by others to rest and take it easy for a swift recovery. Unfortunately, this information is false and as mentioned above, this approach may in fact delay recovery. Fortunately, efforts have been made in the previous years to optimize patient recovery and attenuate some of the negative effects associated with hospitalization[15,50].

Mitigating the Post-Operative Stress Response

Enhanced Recovery After Surgery (ERAS)

Over the last decade, the ERAS protocol has been well developed and implemented in many hospitals worldwide[7,15,50]. The goal of ERAS is to mitigate the effects of the surgical stress response and accelerate the recovery process in order to promote early discharge from hospital[38]. The protocol begins in the weeks prior to surgery and is followed until discharge from hospital, encompassing effective perioperative care (*Figure 4*). Patients experience early removal of catheters, receive oral nutrition and no routine nasogastric tubing following surgery[7,50]. These strategies, along with others, utilize a multimodal approach to perioperative care targeting physiologic regulation in order to diminish the stress response and maintain preoperative bodily composition and organ function[7]. The ERAS pathway has been major breakthrough in surgical care, yielding positive results when implemented properly.

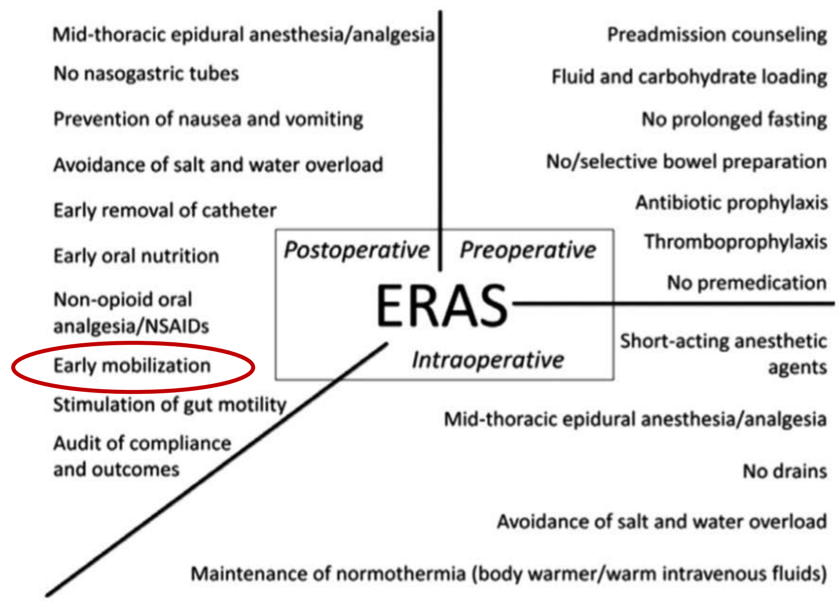

Figure 4. ERAS protocol (Varadhan et al. 2010)

Figure outlines the different components of ERAS in each period of the perioperative time frame. All patients in our hospital are subject to this protocol. Early mobilization is circled as it will be emphasized in the following section.

Guidelines to Early Mobilization in ERAS

An important component of ERAS is early mobilization, which involves getting patients out of their beds as early as possible (*Table 1)*[15]. Early mobilization promotes insulin sensitivity[16] and has also been associated with improved functional status at discharge despite a shortened length of stay (LOS)[15]. It has been shown to attenuate the negative side effects associated with prolonged bed rest and its effect on the physiological stress response by preventing long periods of immobilization[7,15]. Early post-operative mobilization has thus been identified as a beneficial intervention in the surgical population, with adherence over the LOS associated with a successful outcome of ERAS[16].

Unfortunately, there is a clear lack of knowledge regarding the best time and manner in which to initiate ambulation. Furthermore, in our experience, patients are not always capable of early mobilization. Failure to engage in early mobilization has been linked with inadequate pain management, persisting intravenous fluid intake and urinary catheter along with adequate motivation, which can be related back to poor follow up by nurses or attending physicians[16]. The current ERAS guidelines state the following regarding early mobilization:

ERAS Guidelines for Early Mobilization
Patients should dangle their legs on the day of surgery
Patients should eat all of their meals in a chair
Patients should ambulate 4 to 6 hours each day while they are awake until discharge

Table 1. ERAS Guidelines for Early Mobilization[51]

Table explains the early mobilization guidelines for surgical patients during their stay on the ward. Historically, our patients have not been able to attain these goals, highlighting the need for a more adaptable set of guidelines, individualized to patient needs.

Though overall adherence to ERAS protocols has promoted positive results in the surgical population, the guidelines describing mobilization over the hospital stay are non-specific. No time frame is mentioned regarding when to initiate ambulation, nor any information on the intensity of exercise and level of exertion expected. Based on this, the positive effects resulting from early mobilization are difficult to quantify as there has been no standardization to the protocol. Furthermore, this component of ERAS has a low compliance rate, therefore meriting further investigation and potentially modification[52]. In addition to the benefits of walking, ERAS does not provide any regard for aerobic training and disregards resistance and flexibility exercises.

Post-Operative Exercise… When to Initiate?

There has been little investigation on the effects of structured exercise immediately after surgery, with most of the focus in the intensive care unit (ICU), despite this population arguably being most difficult to mobilize given their unstable state[10,53,54]. Many studies investigating early mobilization have yielded positive results, though there has been minimal research regarding implementation of a post-operative in-hospital resistance based exercise program[26]. Initiating structured in-hospital exercise in the ICU has been evaluated by only a few research groups, but has been deemed feasible and safe by all[10,53,54]. The shift towards structured exercise aimed to address some of the more severe issues associated with prolonged bed rest, such as neuromuscular weakness, in patients in critical condition: experiencing cardiac complications or mechanical ventilation[55]. Based on the fact that critically ill patients in the ICU are safely able to engage in structured exercise during their stay, patients on the regular ward should equally be able to safely engage and benefit from exercise[53]. Despite uncertainty on when and how to best initiate ambulation after surgery, there exists psychological and physiological benefits for those who succeed[26,29,50]. Exercise training patients during their hospital stay has the potential to further prevent and mitigate negative effects associated with the in hospital stay, coupled with the already suggested mobilization from ERAS[26]. Initiating the recovery process as soon as possible after surgery allows for patients to regain their independence and return to normal daily activities more quickly and with more ease.

An unpublished multimodal prehabilitation/rehabilitation study conducted in 2014 from our lab utilized the in-hospital period to offer patients a standardized resistance exercise program during their stay. This program was comprised of a whole body standing resistance exercise routine initiated on POD1 (no other time specification)[56]. Compliance was 47% on post-operative day one[56], however this program was only feasible for those able to get out of their beds. Those who were not able to move into a seated position were unable to execute any exercises, as they were not given the same opportunities to commence exercise as others were. Furthermore, these patients did not achieve the minimum amount of ambulation suggested in the ERAS protocol throughout their entire LOS[56]. Primary reasons for non-compliance listed by the patients included abdominal pain, fatigue, low blood pressure and refusal[56].

A study conducted by another group addressed the feasibility of initiating resistance exercise in hospital, though this program was not coupled with prehabilitation nor an ERAS protocol[26]. The exercise program was divided into three phases, progressing from in-bed to standing[26]. The results demonstrated that getting patients to exercise the day following their surgery was feasible, and contributed to shorter LOS[26]. To the best of our knowledge, apart from these few studies, there have been no other post-operative in-hospital resistance exercise based programs established for non-ICU colorectal patients.

Proposed In-Hospital Exercise Program

Building on our previous experience with prehabilitation and post-surgical in-hospital exercise, providing an inclusive exercise program for patients who may not be able to get out of bed in the period following surgery is an important next step in the development of post-operative care. It is hypothesized in this thesis that by modifying the post-operative in-hospital exercise program from our previous study design, patients will be able to engage in resistance exercise 24h post-surgically, regardless of physical state. By engaging in resistance exercise while still in-hospital, they may develop confidence in their capabilities and will be more likely to adhere to their rehabilitation program upon discharge. It has been shown that a single bout of 10 minutes of exercise can positively influence morale, promoting positive affect and decreasing anxiety[29]. Initiating exercise prior to discharge, patients may be psychologically reassured of the safety and normalcy of performing exercises within a short time after their surgery. Additionally, there is a physiological potential of preventing loss of lean muscle mass among other negative effects of surgical stress[22,57].

Structured in-hospital exercise has the potential to minimize the negative effects associated with extended bed rest, while breaking up sedentary time during the hospital stay[26,55]. The positive physiological adaptations associated with regular exercise are numerous and well known, though as mentioned, the effects of acute exercise also beneficial[29]. Post-operative in-hospital exercise has been found to reduce length of hospital stay as well as improve bowl motility following colectomy procedures in colon cancer patients[26]. By encouraging patients to engage in a resistance based exercise program over the hospital stay, they may be more likely to attain the early mobilization goals of ERAS, reducing their sedentary time.

Despite the continuing advances in optimizing patient health care, there remains a lack of knowledge about how the post-surgical in-hospital stay specifically can be targeted in order to optimize patient recovery. The results of this study will be the basis of future research in the domain of immediate post-operative care, highlighting potential intervention strategies based on patient ability to enhance the recovery process. Structured exercise is encouraged throughout the cancer trajectory, though the post-operative in-hospital time frame has been neglected in terms of guidelines and support. The implementation and feasibility of a structured post-surgical in-patient resistance exercise program will be investigated in this thesis. A structured in-hospital exercise program, comprised of a progressive resistance routine that is adapted to the individual needs and abilities of each patient, will be studied. The goal of increased compliance to the exercise program is to enhance attainment of the early mobilization guidelines outlined in ERAS. Providing patients with an alternative to walking in the hospital hallway may be more appealing for some, and an opportunity to participate for those unable to leave their beds.

Aims & Research Question

The purpose of this study was to investigate the feasibility of a post-surgical in-hospital exercise program, implemented within twenty-four hours of surgery in patients undergoing colorectal resection (*Figure 4*). Coupled with prehabilitation, it was hypothesized that initiating patients' rehabilitation within 24hrs post-operatively would be feasible for all subjects, tailoring to their individual physical status. It was further hypothesized that this would diminish time spent in bed and increase adherence to the ERAS recommendations for early mobilization.

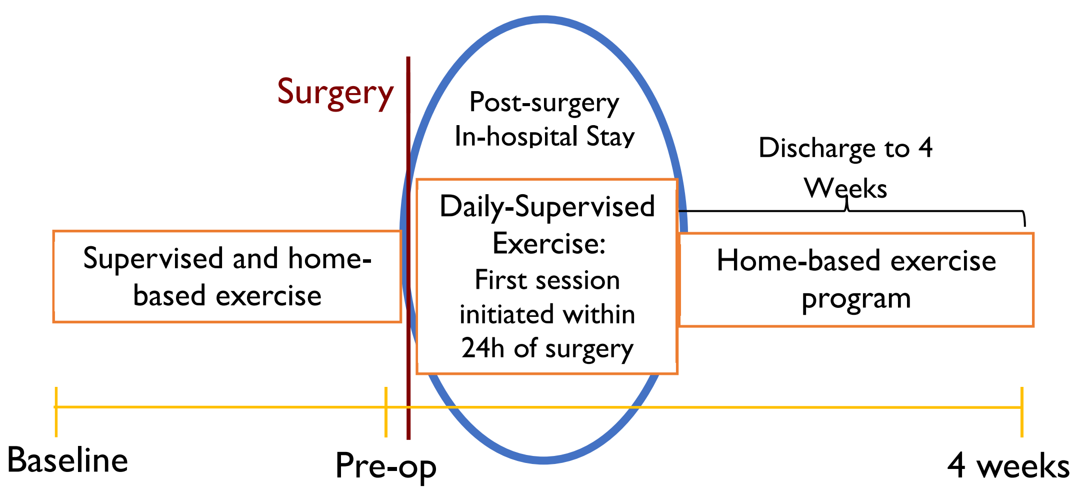

Figure 5. Study Design

Progression patients follow during the proposed program. Along the bottom yellow line are the assessment time points (baseline, pre-op and 4-weeks). The blue circle illustrates the emphasis on the in-hospital period.

Methods

Subjects

This study was approved by the Research Ethics Board of the McGill University Health Centre, Montreal, Quebec, Canada (NCT 02586701). Patients scheduled for laparoscopic colorectal resection were recruited from the preoperative clinic at the Montreal General Hospital from June 2015 to October 2016. Exclusion criteria dismissed those unable to speak English or French as well as those with metastases and contraindications to exercise. All patients were screened and cleared by the physician for exercise risks.

Protocol

Pre-Operative Period

Once recruited, patients completed a baseline assessment and subsequently received a trimodal prehabilitation program consisting of three interventions: nutritional counseling and support, an individualized exercise program and relaxation techniques. The baseline assessment consisted of a series of functional tests (*Table 2*), as well as a psychological and nutritional assessment. Patients met with a registered nutritionist in order to assess their nutritional status and determine the amount of whey protein supplementation required to meet current European Society for Clinical Nutrition and Metabolism (ESPEN) recommendations (1.2g/kg/day of body weight)[58]. Nutritional status was obtained through a self-reported three-day food diary provided by the patients. The supplement was also used as a complement to exercise, in order to ensure amino acid availability[57]. Patients were instructed to take the supplement in the hour following the performance of their exercises, thereby optimizing increases in muscle mass through protein synthesis. The supplement was encouraged to be taken for the entire length of the program, excluding the post-surgical in-hospital stay.

Anthropometric Measurements	Age, gender, body weight, body composition, BMI		
Functional Tests	**Conditions**	**Assessment time point**	**Reason for test**
2-minute walk test (2MWT)	• 15m corridor • Timer	Baseline, Pre-op, Intra-op, 4-weeks	• Practice prior to 6MWT • Replace 6MWT in-hospital
6-minute walk test (6MWT)	• 15m corridor • Timer	Baseline, Pre-op, 4-weeks	• Evaluate functional walking capacity
30 Second Arm-curl Test	• 5lbs weight (women) • 7lbs weight (men)	Baseline, Pre-op, Intra-op (modified), 4-weeks	• Representation of upper body strength • Assess number of repetitions capable in 30-seconds
Sit-to-stand (STS)	• Chair • Timer	Baseline, Pre-op 4-weeks	• Representation of lower body strength • Assess number of repetitions capable in 30-seconds

Table 2. List of Assessments

List of functional tests and time-points administered. These tests are standard in prehabilitation practice and were thus utilized despite not being the main focus of the intervention being tested in this thesis. The conditions under which the tests were administered remained consistent with previous groups tested in our lab (i.e.: use of a 15m corridor to administer the walking tests).

For a complete list of results regarding these tests, please see Appendix 1

Patients were then provided with an appropriately weighted resistance band based on their strength and encouraged to begin the individualized exercise program immediately. The exercise program performed during the prehabilitation phase (approximately 4 weeks in duration) consisted of individualized aerobic and resistance-based exercises, along with a stretching routine developed by a kinesiologist. During this period, patients were asked to come in for weekly supervised exercise sessions in order to assure proper form, technique and to progress the program as determined by the kinesiologist. The sessions were approximately one hour in length and consisted of a moderate aerobic and resistance component (Borg 13/20). Aerobic exercise was performed on a NuStep (Gatineau, QC, Canada) between 10 and 20 minutes, with a 5-minute warm up and 5-minute cool down (not included in actual exercise time). Following the aerobic exercise, a resistance exercise routine was performed. The resistance component consisted of 10 exercises targeting major muscle groups at a moderate intensity of between 1 to 3 sets of 8-15 repetitions (*Table 3*). In addition, patients were instructed to exercise at home every other day until the date of their surgery, while being followed through weekly phone calls and recording their exercise progress in a provided journal. The journal was used to monitor compliance, and also provided the patients with guidelines about the exercises, complete with a Borg scale to keep track of their exertion at home (*Appendix 2*). Using the Borg scale and patient volition, the intensity of the work outs was increased in order to maintain a moderate level of exertion throughout the program.

Program		
Aerobic Training	• NuStep (in-hospital) • Walking/other (home based)	30 mins daily moderate intensity (Borg 13)
Resistance Exercises	• Push-ups • Chest fly • Shoulder abduction • Biceps flexion • Triceps flexion • Knee flexion • Squats • Calf raises • Seated row • Abdominal crunches	1-3 sets of 10-15 repetitions (progressed by Kinesiologist)

Table 3. Prehabilitation Exercise Program

An outline of the exercise program provided to each patient at baseline performed until pre-op assessment.

Focusing on patient education, subjects undergoing prehabilitation were informed that they would be seen in hospital by a kinesiologist and encouraged to perform a tailored exercise program during their stay. The supervised preoperative exercise sessions allowed the patients to become comfortable with the exercises as well as build a rapport with the kinesiologist. This way, neither the program nor the kinesiologist was unfamiliar in hospital, which was also expected to positively influence compliance. Patients were re-assessed using the same tests administered at baseline to account for any change in physical status resulting from the prehabilitation program and were reminded that a kinesiologist would be visiting them the day after their surgery.

In-Hospital Period

Following surgery, patients were seen for three consecutive days during the post-operative in-hospital period for supervised exercise sessions, with the first session occurring on the first post-operative day, within 24-hours of surgery. This time point was chosen for the initiation of the in-hospital program for standardization purposes and to determine feasibility. During these sessions, the kinesiologist viewed the nurse's notes regarding patient status and asked whether or not the patients had been pre-mobilized. The kinesiologist then evaluated each patient based on a set criteria devised by the research team in order to determine which exercise program was best suited for their state. After evaluation, patients were encouraged to partake in either an in bed, seated or standing resistance exercise routine depending on their physical capabilities. The assessment criteria consisted of a number of physiological symptoms contraindicating exercise including: blood pressure, nausea, shortness of breath in addition to a series of physically impairing symptoms such as being unmoved by a nurse, unable to get from lying down to seated position unassisted and feeling weak (*Table 4*). During this time, an interview coupled with the MILES questionnaire (*Appendix 3*)[59] was conducted in order to gain insight on compliance to the program related to pain and discomfort. Once cleared of any detrimental contraindications, the kinesiologist guided the patients through the appropriate exercise program (*Table 5*).

IN BED	SEATED	STANDING/MOBILE
• Unmoved by nurse/ nurses suggestion • Low BP (relative to patient normal) • Dizziness • Constant Nausea/Vomiting • Unable to get from lying down to sitting unassisted • Fatigued • Feeling of weakness • Constant moderate/severe pain • Shortness of breath • Cognitively impaired	• Slightly low BP (relative to patient normal) • Mild dizziness • Occasional nausea • Able to move from bed unassisted • Fatigued • Feeling of weakness • Unstable balance • Mild pain	• Stable BP (relative to patient normal) • Free from dizziness • Mild occasional nausea • Able to move from bed unassisted • Mild fatigue • Minimal pain

Table 4. Contraindications to In-Hospital Exercise

List of contraindications used to determine best suited exercise program during the hospital stay

IN BED	SEATED	STANDING/MOBILE
• Chest • Bicep Flexion • Triceps Extension • Leg Flexion/Extension • Leg extension • Ankle Plantar Flexion/Extension • Alternating leg abduction/adduction	• Chest • Shoulder abductions • Bicep flexion • Triceps extensions • Hip flexions • Knee extensions • Seated Row	• Wall push-ups • Chest • Shoulder abduction • Biceps flexion • Triceps flexion • Knee flexions • Hip flexion • Calf raises • Seated row

Table 5. List of In-Hospital Exercises

List of exercises performed in each stage. Exercises were encouraged to be performed a minimum of 12 repetitions, with the option to continue with willingness and ability of the patient. Compliance and progression of the program was recorded.

Two functional tests were also conducted during the hospital stay: a 2MWT, and an adapted arm curl test. During the in-hospital period, the 6MWT was omitted and solely the 2MWT was administered, for feasibility reasons: A 6MWT is not optimal, as this test must be administered in the often busy hospital corridor with many space limitations. Moreover, post-surgical patients may not be able to complete an entire 6MWT due to fatigue, dizziness or being impeded by their IV stand. The arm curl test was modified as patients are instructed not to lift anything over 5lbs, thus a 4lb weight was used for both sexes. These tests were administered to determine patients' level of ability, as a comparison to prehabilitation strength was not feasible based on the use of Therabands.

Post-Operative Period

Upon discharge, the program became completely home-based while patients continued their exercise and nutrition program for 4-weeks post-operatively. Patients were instructed to engage in the original exercise program (given at baseline) and to gradually increase the intensity of their exercise over the weeks following surgery. During the first post-operative month, patients were discouraged from engaging in abdominal crunches in order not to perturb the healing process and avoid discomfort. The patients were called on a weekly basis to ensure compliance and proper adjustment of the exercise program as well as to answer any questions regarding the program and their recovery. Patients were asked to come in for a final assessment one month following their procedure, where all functional tests were re-administered.

Study Outcomes

Primary Outcome

Feasibility of the in-hospital exercise program was assessed by compliance, willingness and ability to complete the exercise program. In order to quantify feasibility, a higher compliance to exercise than previously tested protocols would qualify the new program as feasible. All reasons for non-compliance were recorded using the set criteria as well as interviews and the MILES questionnaire, logging any contraindication or reason for avoidance of exercise and mobility. The progression of each patient's exercise program (in-bed, seated or standing) was also observed, keeping track of the most frequently used program and any issues with each of the adapted exercises. An average of the number of repetitions performed was also taken into account to assess the intensity of the in-hospital exercises.

Interviews along with the MILES questionnaire were conducted with the goal of gaining insight into patient experience during the hospital stay and whether or not they were able to attain the ERAS recommendations for mobilization. Patients were asked how much time they spent seated outside of bed, as well as time spent walking and how their pain varied throughout their stay. Their progress and perceptions and were logged and quantified using numerical scales. This information was put into tables in order to provide a summary of the typical post-operative patient's experience over the course of their stay and quantify the most frequent occurrences.

Secondary Outcomes

Functional walking capacity was assessed as a secondary outcome, quantified using the 2MWT and 6MWT. Both tests have been validated in the context of surgical recovery[60] and were administered at each assessment point (baseline, pre-operative, in-hospital, 4-weeks post-operative), omitting the 6MWT during the in-hospital assessment. The 6MWT is an assessment of the ability to tolerate moderate physical endurance, therefore an appropriate measure to evaluate functional exercise capacity: the ability to undertake physically demanding activities of daily living[33]. The test was conducted along a 15m stretch of the hospital corridor, where patients were encouraged to walk for 2- and 6-minutes at a comfortable walking pace that would tire them at the end of the test. The 2-minute walking test was administered in order to account for the learning effect and also for feasibility during the hospital stay. The tests were administered as per the American Thoracic Society guidelines[61]. Total distance covered over the duration of the test was recorded in meters, along with post-exercise heart rate and Borg scale perception. Predicted walking distances for males and females were calculated using the following formula: predicted walking distance (m) = 868 – (age x 2.9) – (female x 74.7) with age represented in years and the value '1' assigned for female. These tests were chosen as they are easily administered in a clinical setting and in this population.

Compliance to prehabilitation program was also assessed as a secondary outcome along with post-operative adherence to the home-based program, monitored through weekly phone calls, in addition to being logged in the self-reported exercise journal. Compliance was scored on a scale from 0 to 10 (5 points allocated for exercise and 5 points allocated for nutrition) (*Table 6*).

	Exercise Score	Nutrition Score
(5/5)	Complete all exercises as prescribed	Whey protein taken as prescribed
(4/5)	Aerobic exercise daily, at least 2 days of resistance exercises	Patient did not take whey protein for 1 day out of the week
(3/5)	Aerobic exercise 3 days of the week, 1 days of resistance exercises	Patient did not take whey protein for 2 days out of the week
(2/5)	Aerobic exercise 3 days of the week, no resistance exercises	Patient did not take whey protein for 3 or 4 days out of the week
(1/5)	Aerobic exercise 1 day of the week, no resistance exercise	Patient did not take whey protein for 5 days out of the week
(0/5)	No Exercise performed	Patient did not consume any whey protein during the week

Table 6. Compliance Scoring

Breakdown of compliance scores for exercise and nutrition for both the pre-operative and post-operative period. Standard for prehabilitation studies conducted in our lab.

Sample Size

The sample size for this study was established to be comparable to previous work conducted in our lab[56], thus 30 patients were desired for the final analysis. Anticipating approximately 20% withdrawal and loss to follow up, experienced in past studies conducted in our lab, 40 patients were recruited in order to meet the target sample.

Statistical Analysis

Statistical analysis was performed using IBM SPSS for MacIntosh (IBM SPSS Statistics for MacIntosh, Version #23.0 Armonk, NY: IBM Corp.). All data parameters were tested for normality using the Shapiro-Wilk test. Results are expressed as mean (SD) and number of patients (percentage). Continuous variables were tested using a Student's T-test or a Mann-Whitney test. All tests were two side, using $P<0.05$ to denote significance.

II

Manuscript

Title: Strategies for Minimizing Bed Rest in Post-Operative Colorectal Cancer Patients: Exercising to ERAS

Abstract

Purpose: Perioperative care is under constant evolution to ensure optimization of post-operative recovery. This is needed as the incidence of complications associated with major abdominal surgery remains high, with many patients experiencing a decline in physical function following the intervention. The objective of this study was to assess the feasibility of initiating a progressive in-hospital resistance exercise program within 24-hours of surgery in colorectal cancer patients. It was hypothesized that this would minimize time spent in bed over the hospital stay, supporting patients in attaining the Enhanced Recovery After Surgery (ERAS) guidelines specific to mobilization.

Methods: Subjects who participated in an evidence-based prehabilitation program before surgery (~4 weeks) were guided through a progressive in-hospital resistance exercise intervention within the first 24-hours after surgery based on their ability to exercise. Feasibility was assessed as the primary outcome using compliance as a measure, accounting for all contraindications to exercise and mobility. Secondary outcomes included reducing sedentary time and ability to conform to ERAS mobilization guidelines quantified by time spent out of bed over the hospital stay.

Results: Patient adherence to in-hospital exercise was high, confirming feasibility. All reasons for non-compliance to in-hospital exercise were recorded, yielding an average compliance to the program of 90% on post-operative day one (POD1). Patients were also able to attain the ERAS early mobilization guidelines on POD2 and POD3 with over 70% success rate. At 4-weeks after surgery, 58.6% of patients surpassed their baseline 6-minute walking test result, while 13.8% came within 10 meters.

Conclusion: In-patient exercise initiated within 24-hours of surgery is feasible, minimizes time spent in bed and is effective in helping patients achieve ERAS goals. Based on the small sample size, long term effects can only be postulated, though a return to baseline functional capacity was observed at 4-weeks after surgery, as previously seen in our lab.

Keywords: Prehabilitation, In-patient Exercise, Abdominal Surgery, Colorectal Cancer, Recovery

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Introduction

Colorectal cancer patients are often sedentary and deconditioned, as the onset of this disease occurs in later life, with most cases occurring in those over the age of 70[1]. Currently, the only curative treatment is surgical resection of the tumor, which can be difficult for the elderly to tolerate given age-related comorbidities and health status[2,3]. Despite a shift toward laparoscopic technology, this intervention is associated with many complications such as bleeding, wound infection and anastomotic leakage, regardless of patient status[2]. Complication rates are as high as 60%[4–6], occurring more frequently in older deconditioned patients[7]. In addition, some patients never return to baseline level of functioning after surgery, engaging in less physical activity following treatment than prior to diagnosis[8]. As this population is inherently sedentary, the optimization of post-operative care supporting a favorable recovery process is thus of critical importance.

In an effort to reduce the complication rates associated with surgery, clinicians have developed the enhanced recovery after surgery (ERAS) pathway[9,10]. The goal of this pathway is to mitigate the surgical stress response through physiological regulation, beginning in the pre-operative period[11]. ERAS encompasses a multimodal approach to perioperative care including preadmission counseling, no prolonged fasting, short acting anesthetic agents and early post-operative mobilization[9]. After surgery, ERAS guidelines suggest up to 6 hours of ambulation on each day during the post-operative hospital stay[9]. Notably, successful outcomes of ERAS are dependent on proper compliance to the mobilization component of the protocol[12]. Unfortunately, it is difficult for patients to successfully attain these goals[13]. Historically, patients in prehabilitation do not achieve the daily recommended mobilization guidelines. In a previous study conducted at the Montreal General Hospital (MGH), less than 50% of patients met the mobilization guidelines over their hospital stay[13]. This may be due, in part, to a lack of patient support, lack in structure of the ERAS mobilization guidelines, or lack of active focus on accumulating mobilization time[12].

The post-operative in-hospital time frame is associated with pain, decreased oral food intake and bed rest[14]. Often patients have a tendency to remain sedentary due to poorly managed pain[15], or simply under false pretense that ‘rest is best’. Additionally, surgical stress leads to an increased protein demand resulting from the hypermetabolic catabolic state[16]. Over the course of their stay, patients may never meet the early mobilization guidelines suggested in the ERAS protocol, resulting in a further deconditioned state and increased chance of developing post-operative complications. These patients are subject to detraining and consequently, some patients do not regain their baseline level of functioning. This can prolong recovery along with subsequent treatment and considerably effect their quality of life[17].

Recently, more patients are being supported through the surgical process by participating in prehabilitation prior to surgery[18–20]. This multimodal intervention focuses on exercise, nutrition and anxiety-reducing strategies in order to increase functional capacity in anticipation of an upcoming physiological stressor[21]. The basis for this intervention is that patients with higher functional capacity are better able to cope with the stress of surgery[7]. Following surgery, patients are also offered rehabilitation programs to help with their recovery. Though greater success has been found when prehabilitation precedes rehabilitation, the positive effects of rehabilitation alone are well-documented[22,23]. Patients are thus supported in both the pre- and post-operative period, though there seems to be a lack of focus on physical activity and exercise over the in-hospital period[24]. After having patients participate in prehabilitation emphasizing the improvement of functional capacity, it seems counterintuitive to promote bed rest after surgery. Patients are currently not supported to enable in-hospital exercise, which can favor sedentary behavior and deconditioning during this catabolic period (approximately 3-4 days)[14].

Addressing this gap in the surgical care system is thus of critical importance. By supporting patients during the in-hospital stay, they may be more likely to meet the ERAS guidelines and thus lower the incidence of post-operative complications. Currently, there is no mention of resistance based-exercise in the ERAS protocol, and there has been minimal research on the benefits of this kind of intervention in surgical patients outside of the intensive care unit[24–26]. Incorporating structured exercise over the length of stay may prevent further decline of functional status, aiding in the smooth transition into the recovery period after surgery, by avoiding detraining. This can enhance surgical recovery, enabling patients to return to their normal activities of daily living sooner and prepare for any subsequent treatment following the procedure[17]. An in-hospital exercise program has been tested in our lab, though compliance was low (43% on the first post-operative day), and patients did not succeed in conforming to the ERAS mobilization guidelines[27]. It should be noted, this program was only feasible for those able to exercise in a standing position. With the varying symptoms experienced by patients as a result of surgery, a modifiable program should be more appropriate for the heterogeneous patient population, encouraging a higher participation.

Though relatively short, the in-hospital period can be a pivotal point in the recovery process, encouraging immediate engagement in the rehabilitation phase and providing confidence to start exercising in a supportive environment. The objective of this study was to investigate the feasibility of implementing a progressive resistance-based exercise program in post-operative colorectal cancer patients, within 24-hours of surgery. The goal of the program was to reduce sedentary time over the length of stay, while helping patients achieve the early mobilization guidelines outlined in the ERAS protocol, in an effort to optimize patient care.

Materials and Methods

Subjects

This study was approved by the Research Ethics Board of the McGill University Health Centre, Montreal, Quebec, Canada (NCT 02586701). Patients scheduled for curative colorectal resection were recruited from the pre-operative clinic at the Montreal General Hospital (*Figure 1*). Enrollment began in June 2015 and was completed in October 2016. Those with known metastases, contraindications to exercise and the inability to speak English or French were excluded. Baseline patient characteristics and measures are reported in *Table 1*.

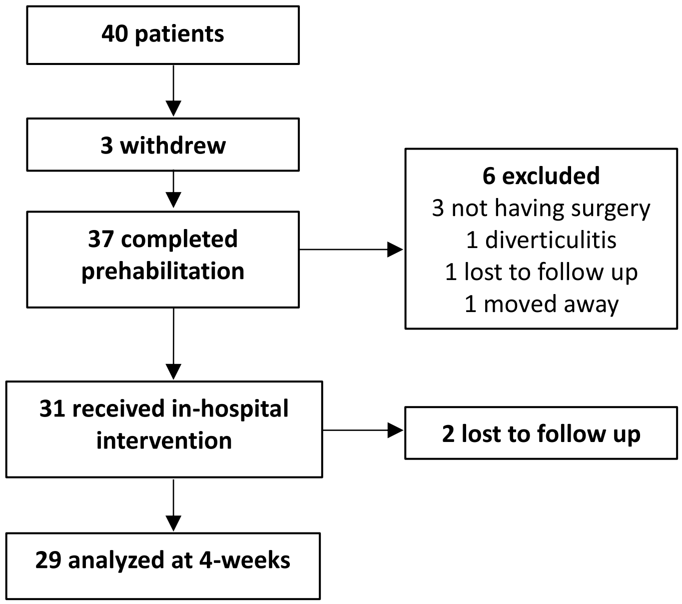

Figure 1. Consort of the trial

Pre-operative period

This research project was designed in order to investigate the feasibility of implementing a progressive resistance-based exercise program over post-operative hospitalization of colorectal cancer patients (*Figure 2*). Upon consent, subjects were assessed by a kinesiologist, dietician and psychologist trained in relaxation techniques. After assessment, all subjects were instructed to begin an evidence-based trimodal prehabilitation intervention immediately. The initial (baseline) assessment consisted of a medical examination, biochemical, functional and anthropometric measurements. This intervention did not influence the schedule of surgery.

Age (y)	64 (12.2)
Age over 75	6 (19.4%)
Male (n)	16 (67.7%)
Body Mass Index (kg/m^2)	26.5 (5.96%)
Current smoker	1 (3.2%)
Previous abdominal surgery	21 (67.7%)
ASA physical status	
I	4 (12.9%)
II	21 (67.7%)
III+	6 (19.4%)
Comorbidities	
Hypertension	8 (25.8%)
Diabetes	6 (19.4%)
Anemia	12 (39.7%)
Cardiovascular Disease	3 (9.7%)
Asthma	2 (6.5%)
Arthritis	8 (25.8%)
Hypothyroidism	5 (16.1%)
Charlson Comorbidity Score	5.3 [9.58]
TNM Cancer Stage	
0-1	9 (32.2%)
2	12 (38.7%)
3	6 (19.4%)
4	3 (9.67%)
Laparoscopic Procedure	29 (93.5%)
Type of Resection	
Colon	23 (74.2%)
Rectum	8 (25.8%)
New Stoma	2 (6.45%)
Baseline 6MWD (m)	488.5 (87.7)
6MWD (% predicted)	76.59 (12.1)
Patients with 6MWD <400m (n)	6 (19.3%)
Lean Body Mass (kg)	47.9 (9.8)
Fat percentage (% of weight)	31.4 (11.5)
Albumin (g/l)	41.1 (4.2)

Table 1. Baseline Patient Characteristics and Measurements (n=31)

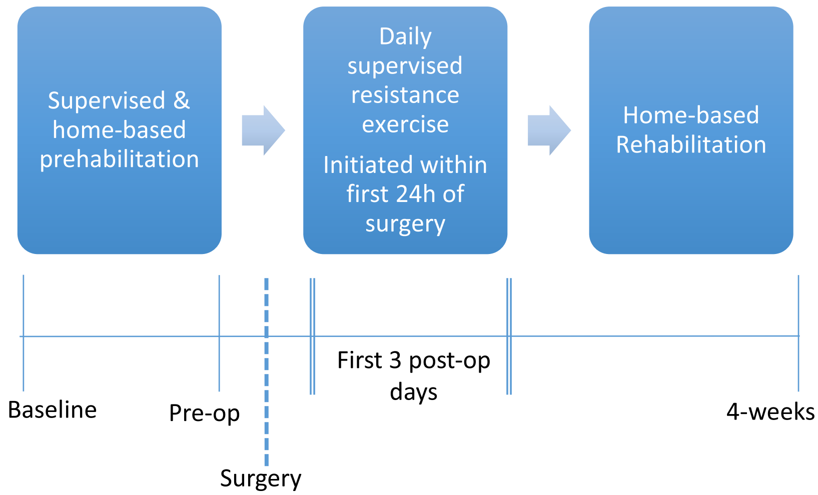

Figure 2. Study Design

To optimize compliance and physical results, the prehabilitation period of the intervention was supervised, consisting of weekly hour-long exercise sessions with a kinesiologist until the date of surgery. Within 48-hours prior to surgery (pre-op), all patients were required to return to the lab for reassessment to account for any change resulting from the prehabilitation. The prehabilitation program has been described elsewhere[21].

Intra-Operative Period

Patients were visited by a kinesiologist within the first 24-hours post-surgery, in order to assess symptoms and ability to engage in resistance exercise based on a set of criteria developed by the research team (*Table 2*). During this time, patients also completed the MILES questionnaire, measuring patient independence and quality of life. The questionnaire used was on an 18-point scale and is used to evaluate post-operative quality of recovery[28]. Once cleared of any contraindications, subjects were encouraged to take part in either an in-bed, seated or standing resistance exercise routine depending on their ability, symptoms and willingness to participate

(*Table 3*). All patients were encouraged to get out of bed if they showed no contraindicating symptoms and were pre-mobilized by the nurse.

IN BED	SEATED	STANDING
• Unmoved by nurse/ nurses suggestion • Low BP • Dizziness • Constant Nausea/Vomiting • Unable to get from lying down to sitting unassisted • Fatigued • Feeling of weakness • Constant moderate/severe pain • Shortness of breath • Cognitively impaired	• Slightly low BP (relative to patient normal) • Mild dizziness • Occasional nausea • Able to move from bed unassisted • Fatigued • Feeling of weakness • Unstable balance • Mild pain	• Stable BP (relative to patient normal) • Free from dizziness • Mild occasional nausea • Able to move from bed unassisted • Mild fatigue • Minimal pain

Table 2. List of contraindications used to qualify patients into appropriate exercise program

IN BED	SEATED	STANDING
• Chest • Bicep Flexion • Triceps Extension • Leg Flexion/Extension • Leg extension (towel) • Ankle Plantar Flexion/Extension (Theraband) • Alternating leg abduction/adduction	• Chest • Shoulder abductions • Bicep flexion • Triceps extensions • Hip flexions • Knee extensions • Seated Row	• Wall push-ups • Chest • Shoulder abduction • Biceps flexion • Triceps flexion • Knee flexions • Hip flexion • Calf raises • Seated row

Table 3. List of exercises preformed in each program (minimum 12 repetitions)

The kinesiologist guided each patient through the appropriate exercise routine encouraging at least one set of 12 repetitions of each exercise dependent on ability to continue. The resistance exercise program consisted of a whole body work out targeting all major muscle groups of the body. Exercises were conducted at a light to moderate intensity (Borg <11/20) and were aimed at better mobilizing the patients in order to reduce sedentary time while promoting adherence to early mobilization outlined in the ERAS protocol.

Patients were seen for three consecutive days starting on post-operative day one (POD1), in the first 24-hours after surgery, and were encouraged to progress their program to the next stage on each day, should they not have attained a standing position in the previous day. All patients received standard ERAS care, including early mobilization, which specifies dangling their legs on the day of surgery, ambulating between four and six hours per day after surgery and eating all meals in their chair during their hospital stay. Additional information collected over the in-hospital period was logged, in order to monitor patient symptoms not accounted for in the set criteria.

Post-Operative Period

Upon discharge, patients were instructed to continue their exercise program at home. In order to monitor compliance, a standardized set of questions pertaining to the program were asked through weekly phone calls. The questions addressed adherence to the exercise program with proper frequency, intensity and duration. Patients were also asked about their protein intake and whether or not they were facing any difficulties following the program. At four weeks after surgery, patients were asked to return to the lab for a final assessment to identify any changes in functional capacity over the course of the program. Performing abdominal crunches was discouraged in the post-operative period, in order not to affect the surgical incision sites during this time.

Outcomes and Measures

Patient assessments were completed over four separate time points: At the initial appointment (baseline), within 48 hours prior to surgery (pre-op), for three consecutive days during the post-operative in-hospital stay (intra-op) and 4-weeks after surgery (4-weeks). These included both primary and secondary outcome parameters.

Primary Outcome

The primary outcome for this intervention was feasibility, as measured by compliance to the in-hospital exercise program. In addition to a set criteria qualifying subjects to the appropriate resistance routine, all contraindications to exercise and reasons for non-compliance during the in-hospital period were recorded.

Interviews were also conducted to gain insight into patient experience and use of their time during the hospital stay. Subjects were asked how much time they spent outside of bed and how many hours they spent walking using the MILES questionnaire.

Secondary Outcomes

Secondary outcomes included ability to meet the ERAS early mobilization guidelines and functional walking capacity, measured using the 6-minute walking test (6MWT). Ability to meet ERAS guidelines was established by comparing the average time spent out of bed over the length of stay to the current recommended amount of time suggested for surgical patients in the ERAS protocol. The total number of patients able to achieve the recommended guidelines was also calculated as a measure of feasibility and ability of our patients to attain the ERAS guidelines.

Change in functional walking capacity was monitored throughout the duration of the program to account for potential effects of prehabilitation. The 6MWT has been validated in the context of surgical recovery in colorectal cancer patients and evaluate one's level of moderate physical endurance[29]. The test was administered as per the American Thoracic Society guidelines, conducted along a 15-meter corridor[30], with a 20-meter change considered clinically meaningful in this population, correlated with the estimated error measurement[31,32]. Age- and sex-specific predicted walking distances were calculated using the following equation: 6-minute walking distance = 868 – (age x 2.9) – (female x 74.7); age calculated in years while '1' being assigned for females and '0' to males.

Post-operative complications occurring within 30-days of surgery were also graded, using the Dindo-Clavien classification[33].

Results

Forty patients were consented to undergo the research protocol at baseline and received the prehabilitation program. The average duration of the prehabilitation period was 39 days (SD: 36.17). Three participants withdrew before completing the prehabilitation period due to lack of interest, while six were excluded prior to surgery for various reasons such as moving out of the country or electing to not have surgery. Thus a total of 31 were seen for the in-hospital intervention. Mean length of hospital stay was 3 days. Following discharge, 2 patients were lost to follow up and a total of 29 were analyzed at 4-weeks after surgery.

Compliance to the in-hospital program within the first 24-hours of surgery was 90.3% (*Table 4*). The majority of subjects participated in a standing resistance program (58%), though 9.7% and 22.6% participated in seated or in-bed routines respectively. Three patients (9.7%) refused to take part in any exercise on the first post-operative day. Reasons for refusal on POD 1 included: fatigue, nausea/vomiting, dizziness and uncomfortable IV placement. Those who engaged in a modified exercise program were either unmoved by the nurse, or had mild sensations of nausea and/or dizziness. More patients who participated in the in-bed exercise program on POD1 experienced a longer length of stay (*Table 5*). A complete list of patient symptoms and contraindications to exercise experienced over the length of stay is reported in Table 5.

Exercise Program n(%)	**In-bed**	**Seated**	**Standing**	**Refused**	**Not seen by Kinesiologist**
Post-operative day (POD)					
POD1 (n=31)	7 (22.6)	3 (9.7)	18 (58)	3 (9.7)	0 (0)
POD2 (n=28)	0 (0)	3 (10.7)	21 (75)	3 (10.7)	1 (3.6)
POD3 (n=15)	0 (0)	3 (20)	8 (53.3)	3 (20)	1 (6.7)

Table 4. List of patients participating in each program over the length of stay. The decrease in number of patients over each POD can be attributed to patients discharged from hospital.

Most frequent symptoms deterring exercise			
	POD1 (n=31)	**POD2** (n=28)	**POD3** (n=15)
Unmoved by nurse	5 (16.1)	0 (0)	0 (0)
Fatigue	10 (32.3)	3 (10.7)	4 (26.7)
Nausea/Vomiting	3 (9.7)	4 (14.3)	2 (13.3)
Dizziness	4 (12.9)	2 (7.1)	0 (0)
Pain	5 (16.1)	2 (7.1)	2 (13.3)

Table 5. List of patient symptoms deterring exercise over the length of stay. The decrease in number of patients over each POD can be attributed to patients discharged from hospital.

Compliance remained high over the rest of the length of stay, with all patients able to progress to the next stage of exercise on the second post-operative day. All patients were also able to increase the number of repetitions preformed from 12 to 15 from the first to second post-operative day, regardless of exercise routine they were complying with. Interviews and the MILES questionnaire revealed that on average, more patients were able to attain the ERAS mobilization guidelines on POD2 and POD3 (*Table 6*).

Average time out of bed hrs (SD)	
POD1	2.28 (2.86)
POD2	6.27 (4.04)
POD3	7.63 (5.84)
Patients meeting ERAS mobilization guidelines (between 4-6 hours daily) n (%)	
POD1	6 (19.4)
POD2	20 (71.4)
POD3	11 (73.3)
Patient MILES scoring (/18)	
POD1	14.2 (2.78)
POD2	16.4 (1.98)
POD3	16.2 (2.08)

Table 6. Self-reported time spent out of bed over the length of stay and corresponding MILES

Complications including bleeding and other gastrointestinal complications occurred in 16.1% of patients, with most occurring in those who did not get out of bed on POD1. Eight patients experienced in hospital complications (25.8%) such as urinary retention, vomiting and primary ileus all of which were in hospital for at least five days (*Table 7*).

Impact on 4-week Recovery

Four-week post-surgical assessment indicated a return to normal functional walking capacity for most patients (58.6%), while and additional 13.8% returned to 10m of baseline indicating no clinically meaningful decrease from baseline (Table 8). This trend is similar to other cohorts tested in our lab.

Discharge	**<2 days** (n=14)	**3-4 days** (n=10)	**>5 days** (n=7)
Avg Baseline 6MWD (m)	491.4	455.8	509.4
Avg Pre-op 6MWD (m)	516.6	510.7	434.6
POD1 Exercise Program	Standing: 13 Seated: 0 In-bed: 1 Refusal: 0	Standing: 4 Seated: 3 In-bed: 2 Refusal: 1	Standing: 1 Seated: 0 In-bed: 4 Refusal: 2
Charlson Score	2 patients: 8.7	2 patients: 20.9	1 patient: 8.7 2 patients: 12.2 2 patients: 20.9 1 patient: 33.7
In-hospital complications	0	0	5 (71.4)
30-day complications	2 (14.3)	1 (10)	4 (57.1)

Table 7. Patient characteristics by of length of stay

6MWD over study duration	
Baseline (n=31)	484 ± 90
Pre-op (n=31)	519.5 ± 97.2 *
4-weeks (n=29)	484.7 ± 87.1

Table 8. Change in 6MWD over duration of program
(*) denotes significance $p<0.05$

Compliance to Program After Surgery

Patient compliance to the post-operative home-based exercise program was high, with an overall 92.3% between discharge and 4-weeks compared to 74% in a historical cohort tested in our lab. Additionally, 70% of patients returned to regular exercise within the first week of discharge, while the remaining 30% started within the following week.

Discussion

Minimizing long periods of bed rest by introducing a progressive post-operative in-hospital resistance exercise program is feasible and leads to greater achievement of the ERAS guidelines for early mobilization. With an aim of this project to break up sedentary time and support patients in achieving the ERAS early mobilization guidelines, participation in the resistance exercise program over the length of stay was high confirming feasibility and the anticipated outcomes. Historically, patients seen in our lab have not been able to attain the early mobilization goals outlined by ERAS, and as such were arguably more at risk of post-operative complications, in addition to the potential for muscle loss and diminishing functional capacity over the LOS[14,34]. The results of this study show that surgical patients are capable of engaging in a whole body resistance exercise within the first 24 post-operative hours, regardless of ability to leave their beds, through means of an adapted program suitable for their condition.

In recent years, patients seen in our lab have been offered in-hospital resistance exercise, though compliance was low[27]. The previously used program was not specific to patient symptoms over the length of stay, feasible only for those able to get out of bed. In the current investigation, we used an inclusive approach to enable participation as much as possible. Offering an in-bed and seated program allowed patients who would have previously been incapable of participating in exercise, in addition to being unable to attain the ERAS mobilization guidelines, to ambulate regardless of patient status.

Proper adherence to early mobilization guidelines after surgery is often associated with better post-operative recovery[12,35,36]. A main goal of our intervention was to support patients in eventually attaining these goals, including those having more difficulty on the first post-operative day. We aimed to provide alternative to upright walking to those confined to their beds. A recent study has demonstrated however, that even with supported mobilization over the length of stay yielding high compliance to the guidelines, does not lead to improved post-operative recovery[13]. Incorporating resistance exercise may enhance the results seen in the supported mobilization study by supporting the preservation of muscle mass after surgery and by helping patients attain the strength needed to stand upright[37]. In this way, there is a need for more structured and adaptable guidelines for early mobilization within ERAS in order to target the varying physical status of surgical patients. ERAS guidelines demonstrate a lack of structure in tailoring to those who are unable to initially get out of bed following surgery[36]. In identifying these patients in-hospital, appropriate instruction can be provided to them in order to prevent additional physical decline, which can exacerbate the recovery process[14]. As far as we know, the prognosis of patient outcome has not been assessed through means of in-patient exercise, despite physical function being drastically deteriorated with the impact of surgery[38]. Regaining physical function is especially important in this population, as their independence and quality of life are contingent of proper surgical recovery and physical function[38]. Traditionally being a sedentary population, patients who do not regain baseline functional capacity are subject to increased dependence on caregivers and possibly the need to be placed in a rehabilitation centre[6]. Furthermore, treatment in the post-operative period, such as chemo- and radiotherapy are largely dependent on the functional status of the patient, those with poor physical function at risk of not receiving further treatment and subsequently exacerbating their health status[39]. It is therefore crucial to optimize patients' return to baseline functional capacity. Albeit noticeable benefits over the length of stay, long term effects of the program can only be postulated, based on the small sample sized used in this study. The findings of the 4-week post-operative assessment are consistent with previous work conducted in our lab in that patients were able to return to baseline functional walking capacity along with other functional strength measures. With the similarity of the findings at 4-weeks after surgery compared with the historical cohort, a more rigorous might be more beneficial in this patient population[13]. Initiating the rehabilitation process by means of in-patient exercise may be critical in the recovery process, as it is the first instance structured exercise is introduced after surgery.

Limitations

Some limitations were encountered in this investigation. There was also a lack of hospital questions regarding anxiety, self-efficacy and state of mind, which may have provided more insight into reasons for refusal of exercise or willingness to comply. It would also have been beneficial to include perception of one's functional abilities in order to determine whether the program was able to influence patients' perception of fitness and capability in relation to re-engagement to exercise after discharge. Future studies should focus on the psychological implications of initiating structured exercise within the first 24-hours following surgery, as the effects of self-efficacy and reassurance are not known.

With the sample including only a small group of colorectal cancer patients, the results are not generalizable to all surgical patients and may underestimate the true impact of the progressive in-hospital exercise routine. A larger sample size followed for a longer period of time is thus suggested for future research. As this was a feasibility study, the lack of a control group made it difficult to assess the true impact the proposed in-hospital program. Conducting a randomized controlled trial would address the unanswered question of long term benefits in this patient population related to enhanced recovery and improved functional capacity after surgery. Furthermore, the preservation of muscle mass was not measured and may be an influential factor contributing to strength and the ability to walk after surgery.

Conclusion

Engaging in structured resistance-based exercise over the LOS can assist patients in attaining the ERAS early mobilization guidelines, while reducing sedentary time. While these results are preliminary, they may provide insight into the optimization of post-operative care using structured in-patient resistance exercise. Using the results of this study as a guide, future research will be aimed at determining an appropriate inclusive protocol for post-operative patients during hospitalization.

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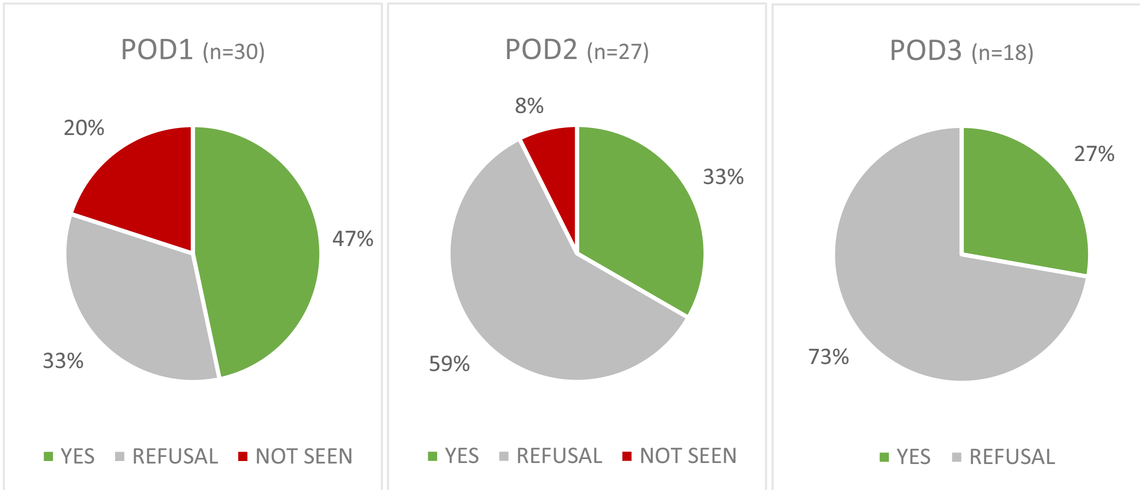
III

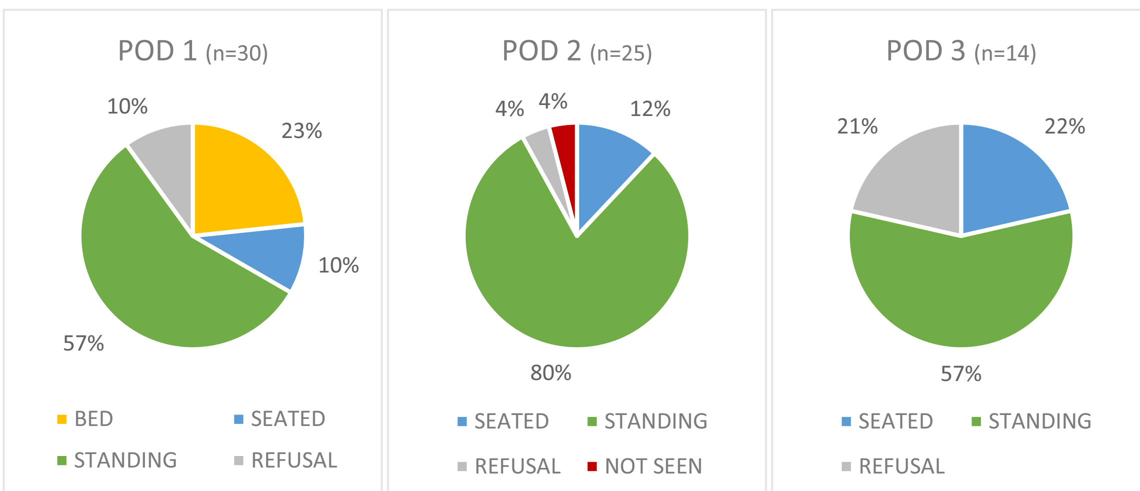
Discussion of Results

The aim of this thesis was to assess the feasibility of a progressive in-hospital exercise program for post-operative colorectal resection patients. With a major point of interest being the attenuation of time spend in bed during the in hospital period, the results demonstrate that enabling the patient to exercise can in fact address this issue. Furthermore, patients tested in our lab have previously been unable to attain the ERAS guidelines to early mobilization over their hospital stay, which has now been established through the incorporation of an individualized resistance exercise program.

This study shows that patients were able to engage in structured exercise within twenty-four hours of major abdominal surgery. The progressive program allowed for significantly higher compliance, compared to previous studies conducted in our lab. Compliance to the in-hospital program on POD1 was 90% in the current group, compared to a mere 47% to a previous group tested in 2014 (*Figure 6*). This significant increase can be associated with the adaptive program, able to include more patients who were previously unable to engage in any sort of exercise based on confinement to their beds. The goal of this project was attained, in that virtually all patients were able to engage in a resistance based exercise program upon volition, regardless of physical status on POD1. This is important because in previous years we have trained them in the pre-operative period through prehabilitation, leaving many to detrain, unable to get out of bed in the days following surgery.



Historical Control



Current Study Population

Figure 6. Comparison: Compliance to In-Hospital Exercise

Graphs illustrate patient participation in exercise protocols in this study (bottom row) versus a historical control group tested by our group in 2014 (top row). The historical group was subject to a significantly higher refusal rate based on the inadaptability of the exercise program (standing only). The new exercise protocol tested in this study was more inclusive and thus a higher compliance to the program was achieved.

While the main symptoms experienced in hospital deterring patients to exercise included fatigue, nausea and vomiting in the current study group, we were able to tailor resistance exercise to virtually all patients successfully. Another major contraindication to exercise on POD1 was having been unmoved by the nurse in the first 24-hours. Due to hospital standards, the kinesiologist was not authorized to be the first person to move patients out of their beds. Evidently, these patients were not able to engage in a seated or standing exercise program on POD1. In previous years, these patients would not have been able to engage in any sort of resistance exercise because of this contraindication. With the adapted program, patients unmoved by the nurse were able to participate in a program while remaining in bed. These patients were however able to progress their exercise programs over their stay, with no patients left preforming an in-bed exercise program on POD2 or POD3. Patients were also able to progress the number of repetitions performed over each day, regardless of a change in program; starting with a minimum of 12 repetitions and increasing up to 18 before discharge depending on LOS.

Physical evaluation of the patients during their hospital stay revealed an improvement over the three post-operative days, as seen by the results of the 2MWT. Patients were able to improve their walking distance over their stay, attributed to the increase in walking on their own time. A major limiting factor to conducting the walking test, even after opting for a 2MWT instead of a 6MWT, was the patient IV placement in their arms/hands as well as the stand they were provided with during their stay. The quality and functioning of the stands was a large contributing factor to the success of the walking test, with some patients unable to steer their stands in a straight line, while others simply did not roll smoothly, slowing down their pace. The IV placement and stand also had in impact on some patients' exercise, with a select amount of exercises having to be adapted in order to accommodate the IV placement. This however did not act as a deciding factor regarding which exercise program they were encouraged to participate in.

Patients reported spending on average 1.71 hours sitting outside of their beds on POD1, indicating a substantial time allocated to bed rest over the remaining hours of the day. Having these patients engage in exercise within 24-hours of surgery split up sedentary time while decreasing overall time spent in bed. Patients reported spending 0.59 hours walking on POD1, which is significantly lower than current ERAS guidelines for early mobilization (between 4 and 6 hours on each POD). This highlights the need for an adapted program for this population, as many do not meet the recommended mobilization guidelines. It was observed that coupled with the resistance program, over 70% of patients were in fact able to attain the recommended ambulation time over the second and third post-operative day. This trend was not previously seen in patients undergoing prehabilitation in preparation for colorectal surgery at the Montreal General Hospital (MGH). Attaining this goal was a notable success of this project, with engaging in early mobilization regarded as a key element in the successful outcome associated with ERAS[16].

Albeit the success in increasing ambulation time seen in the results, time spent walking over the hospital stay remains rather low for most patients, with the maximum average time exclusively spent walking achieved on POD3 at (1.53 hrs). In order to further improve this value and enhance adherence to ERAS, it may be helpful to visit patients daily and encourage them to walk in the hallway under supervision[62]. A study conducted at the MGH investigated the effects of daily supervised walking on each POD in order to increase time spent walking over the LOS[62]. The intervention was successful in enhancing the time spent walking, helping patients achieve the ERAS guidelines, though better patient outcome at 4-weeks after surgery was not attained in comparison to the control group (regular care). The results of the study demonstrate that early mobilization may not be sufficient enough to change patient outcomes and suggest resistance training for future research. In this respect, this thesis is the basis for future research in the domain of post-operative care optimization. Offering patients alternatives to walking, and supporting in-patient exercise may enhance surgical recovery[26,41]. There is insufficient space in hospital corridors to properly implement walking, whereas resistance exercise requires little space to be effective. Patients may also feel unsettled about walking in the public hallway of the hospital being in a hospital gown, sometimes having a catheter or nasogastric tube, and thus may be less inclined to walk. In order to cater to these patients, it may be beneficial to enable them to engage in aerobic exercise in the privacy of their rooms. Providing patients with modifiable cycle ergometers for example, may be an alternative (*Figure 7*). These products can be used lying down or seated and can be used as an alternative to walking. The device is also adaptable for arm use instead of leg. As an aerobic component is something that was lacking in this research project, this is something to consider for future studies.

Figure 7. Cycle Ergometer

Example of a cycle ergometer than can be adapted for patient needs depending on ability and willingness to leave their bed or their hospital room.

Upon discharge, feedback form the weekly phones calls revealed that patients did return to exercise within the first week of returning home (70%), with the remaining 30% starting in the second week. Patients also progressed the intensity of their exercises as they felt comfortable, depending on pain and discomfort experienced. The early return to exercise implies the possible long term benefits of engaging in exercise prior to discharge. With a quick return to exercise and subsequent activities of daily living, physical deterioration in the weeks following surgery was reduced. At 4-weeks after surgery, patients had made a full functional recovery as outlined by the 6MWT results (*Figure 8*). Most patients were able to return to baseline walking distances, indicating a virtually complete attenuation of the drop in physical functional. This trend was also seen in previous groups tested in our lab, thus a longer follow up period and deeper analysis of post-operative complications should be assessed in order to establish the long term benefits of the new exercise program.

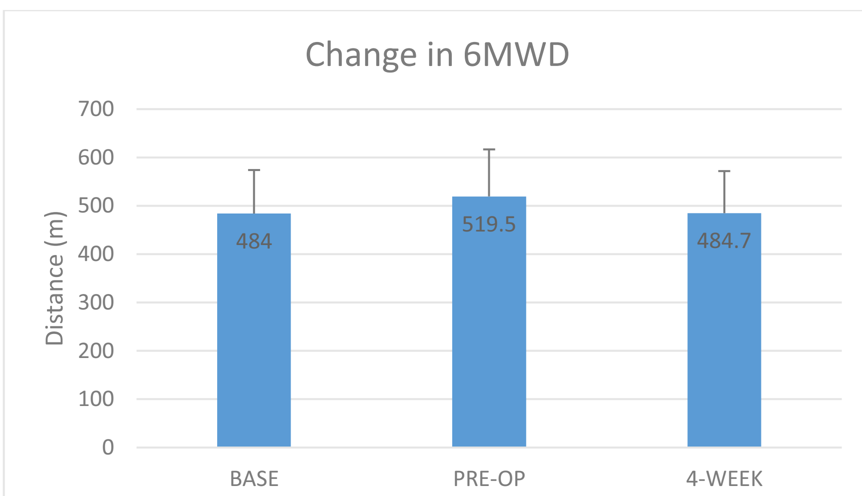


Figure 8. Change in 6MWD

Patients benefited from the prehabilitation program (35.5m increase) and were able to return to baseline functional walking capacity at 4-weeks after surgery.

In completing this thesis, it became clear that little attention has been devoted to exercise in the immediate post-operative context, though enhanced recovery has been a focus in clinical research for many years. With the adoption of prehabilitation, ensuring adherence to exercise in the post-operative period to aid in proper recovery seemed like a natural progression in this field. Furthermore, with the successful outcome of ERAS associated with attainment of early mobilization guidelines, finding minimal research investigating ways of supporting patients in achieving these goals was surprising. Previous work conducted in our lab indicated fixed guidelines pertaining to early mobilization were not feasible for all patients to adhere to, especially on the first post-operative day. A primary motive of this thesis was to develop an adaptable exercise program in order to address this issue. Though patients were able to engage in resistance exercise on POD1, it is not realistic to imply a direct influence on long term functional recovery resulting from one session of supervised exercise. Retrospectively, it would have been beneficial to investigate the psychological implications of engaging in structured exercise prior to discharge from hospital. It is more likely that supervised post-operative exercise may have an effect on confidence, anxiety levels and motivation, which could influence adherence to rehabilitation. Disregarding the psychological effects of the program was a major limitation of this project and should be tested in future research.

The post-operative period is associated with many negative side-effects for the patient in addition to the risk of complications[63–65]. In breaking up sedentary time, there is a potential for the reduction in the incidence of post-operative complications by decreasing symptoms of bed rest and increasing compliance to ERAS guidelines. In previous years, we were unable to accommodate a large portion of patients due to their inability to move out of bed. This new adapted program proposes a solution to this problem, being more inclusive and easily adapted to a wide range of patients of varying physical state. In doing so, we were able to account for some of the gap between surgery and rehabilitation in more patients than previously possible. With the small sample size analyzed for this project, these conclusions cannot be definitively determined, though future analysis through means of a randomized controlled trial would be telling for future research. The post-operative period is a crucial time during the perioperative time frame, which has the potential to greatly influence recovery.

IV

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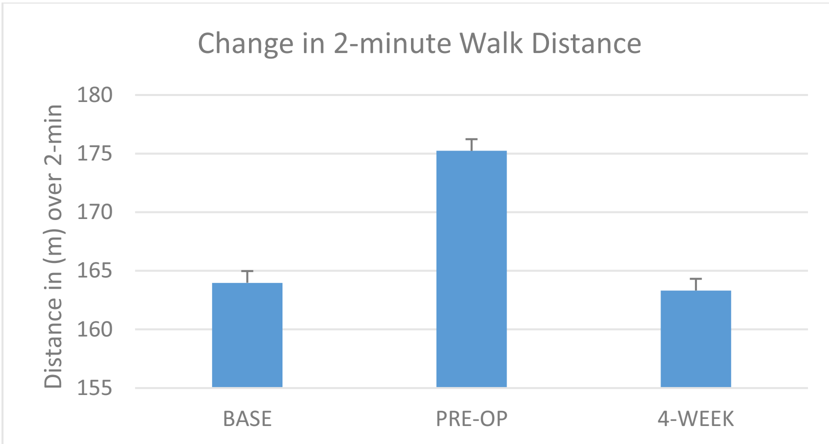
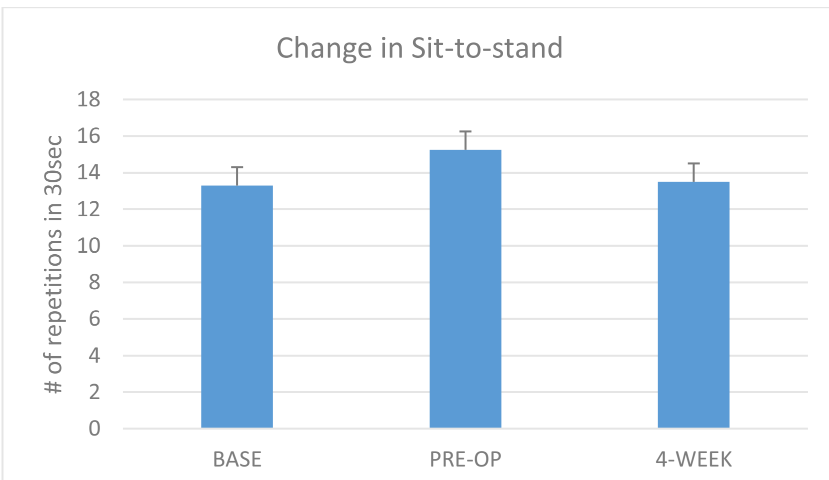
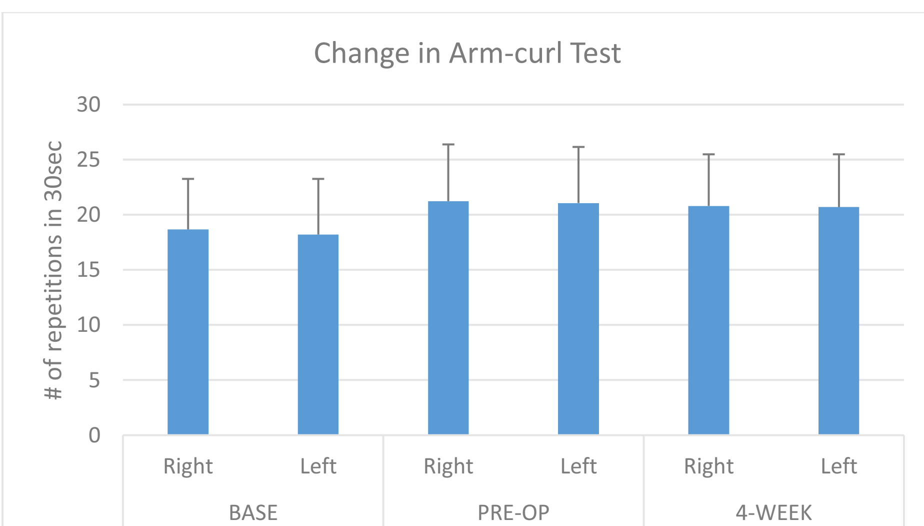
V

Appendix 1: Functional results from prehabilitation intervention

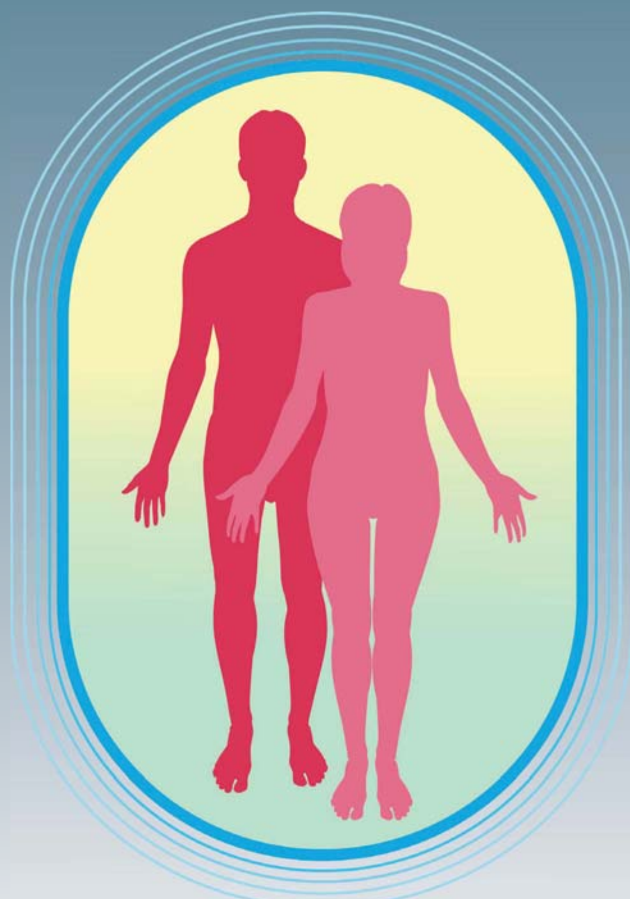






Appendix 2: Sample of Exercise Journal

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
PÉRI-OPÉRATOIRE

MMI
Projet d'informatique médicale Molson de McGill
McGill Molson Medical Informatics

The Borg Scale

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

Borg Scale

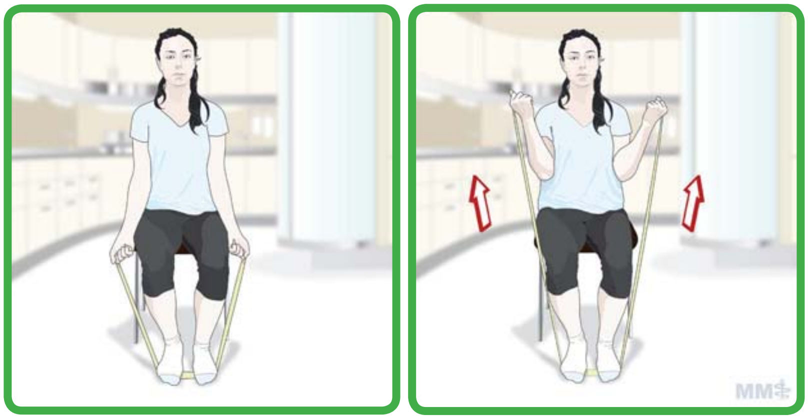
Perceived Exertion

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.

☐ 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.

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)

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

	SUN	MON	TUES	WED	THURS	FRI	SAT
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).

Appendix 3: MILES questionnaire

MILES @ 24 hr POD________

We would like to know how well you feel when you have recovered from your anesthesia and operation
Please circle the most appropriate responses and fill in these
Over the last 24 hours have you

	Not at all	Some of the time	Most of the time
1. Had a feeling of general well-being	0	1	2
2. Had support from others (especially doctor and nurses)	0	1	2
3. Been able to understand instruction and advice. Not being confused	0	1	2
4. Been able to look after personnel to let and hygiene unaided	0	1	2
5. Been able to pass urine and having no problem with bowel function	0	1	2
6. Been able to breath easily	0	1	2
7. Been free from headache, backache or muscle pain	0	1	2
8. Been free from nausea or vomiting	0	1	2
9. Been free from experiencing severe pain or constant moderate pain	0	1	2

Over the last 24 hours:

Please specify the time when you pass first gas________________________________

Please specify the time when you have first bowel movement____________________

Please specify the time when you have first drink______________________________

Please specify the time when you eat first full meal____________________________

Please specify how many hours have you sat out of bed______________hr__________min

Please specify how many hours have you walked out of bed___________hr__________min

What is your pain when you rest min 0------1------2------3-----4-----5-----6-----7-----8-----9-----10 max

What is your pain when you walk min 0------1------2------3-----4-----5-----6-----7-----8-----9-----10 max

What is your pain when you cough min 0------1------2------3-----4-----5-----6-----7-----8-----9-----10 max