The Effect of a Physical Exercise and Education Prehabilitation Program in General Surgery Patients

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This thesis is submitted as partial fulfillment of the requirement of the Masters Degree of Exercise Science (Research) at Murdoch University, Perth, Western Australia.

I declare that this thesis is my own account of my research and contains as its main content the work which has not previously been submitted for a degree at any tertiary institution.

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Deven.
Abstract

Background: Patients undergoing general surgery can often experience complication rates of 30-40% after surgery and can include post-surgical bleeding, pain, nausea, infection, and sepsis which can all significantly delay recovery. Prehabilitation enhances the physical function of patients prior to surgery to improve surgical outcomes and facilitate recovery. Previous research has explored the benefits of aerobic-based prehabilitation in improving recovery after surgery, however research into appropriately prescribed resistance focussed interventions is lacking. Resistance based exercise has the benefit of increasing muscle mass, muscle strength and physical function prior to surgery, enhancing recovery and return to pre-surgery function. This study explored the effects of a resistance-based prehabilitation program on overall patient recovery when compared to usual care. Methods: Seventeen participants (8 males and 9 females) were recruited via inpatient admissions and randomly assigned to an intervention group (n=9) receiving a pre-surgery resistance-based exercise program or usual care group (n=8) receiving standard patient education. The exercise program consisted of 6 resistance exercises targeting large major muscle groups with the focus of building muscle mass. Primary outcomes were length of stay (days) and post-operative complications. Secondary measures included; whole body resistance, isometric muscle strength, physical function, aerobic fitness, self-reported physical function and quality of life (QoL) and limb disability (upper and lower limb) Results: No differences were observed in length of stay between the prehabilitation and control groups (p=0.655). The control displayed a significant within group loss of 8.4kg in grip strength between pre and post-surgery (p=0.001), compared to the intervention group who only lost 0.8kg (p=0.776). Mental health summary score reported a significant difference between groups at six-week post-surgery (p=0.006) displaying increased quality of life as a result of the intervention. Conclusion: The preliminary results of this study indicate that resistance-based exercise training in the peri-operative period are associated with reported increases in patient mental health and isometric muscular strength.
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Chapter 1 – Background

1.0 Introduction

Hospitalisation in patients often leads to declines in physical function and activity. Covinsky et al. (2) indicates that at the time of discharge, 35% of patients report reduced activities of daily living (ADL) and reduced physical function when compared to their preoperative state. This is often due to the homeostatic stress caused by surgical procedures (surgical response) (3). General surgery focuses on the abdominal contents and organs and can consist of surgeries such as organ resections (removal of part or all of an organ), mastectomies and bariatric surgeries to name a few.

Hospitalisation and surgery introduce additional stressors to the body which impact physical function and the mental health of the patient. In general surgery complication rates of 30-40% are reported often due to the severity of the surgery and how the patient is managed during the perioperative and post-operative phase (4). In addition, the effects of extended hospitalisation can both lead to decreased quality of life (QoL) in patients, which potentially increases adverse effects and possible readmission (5).

Length of stay, adverse events and readmission rates are a key focus in the management of surgical patients. Recent literature has provided strong evidence for the use of prehabilitation programs in the treatment of patients requiring surgical intervention. Prehabilitation programs are more commonly referred to as enhanced recovery after surgery (ERAS) programs. These are multi-faceted programs often implemented prior to surgery with the aim of reducing the loss of function and promote the return to normal physical function after surgery (6). Including methods of nutrition, counselling, lifestyle habit management and surgical preparation (i.e. pre-operative fasting), these programs are common practice before a surgical treatment. However, the implementation of a pre-operative exercise program is still not considered as a key component in ERAS programs. While the most current ERAS programs have seen reduced rates of morbidity, decreased length of stay and faster recovery after surgery (7, 8) it is theorised that the addition of exercise prior to surgery will enhance these effects.

Benefits of pre-surgical prehabilitation programs include reducing patient length of stay, risk of adverse events, readmission rates and improving patient quality of life (1, 9, 10). Jack et al. (9) found that pre-surgical exercise programs in patients undergoing major surgery (hip/knee replacement surgery and cardiac/major vascular surgery) are feasible in improving
quality of life and wellbeing in patients undergoing major surgery. This is supported by Pouwels et al. (11), who discussed the feasibility of a prehabilitation exercise program on major abdominal surgery patients. They reported pre-operative physical activity increased physical function prior to surgery but was unclear on how this affected post-operative outcomes, such as length of stay, post-operative complications, and readmission rates after surgery.

Much of the previous research has focused on the physical aspects of prehabilitation while little consideration has been given to the psychological aspects of prehabilitation. Patients report being less concerned with the impact of the surgery on their physiological status and more concerned with the impact of the surgery on their own and their family’s emotional and financial wellness (10). Shaughness et al. (10) discovered a significant correlation between psychological variables such as depression, anxiety and stress and post-operative outcomes with patients reporting these variables prior to surgery experiencing increased recovery times when compared to those who did not report these issues. This is strengthened by Banugo and Amoako (12), who indicated that patients experiencing anxiety and distress after diagnosis and treatment suffered increased recovery time and risk of adverse events such as post-operative pain and impaired wound healing. This provides a strong argument for the use of psychological support in the prehabilitation process.

This review will discuss the current use of prehabilitation in general surgery patients. With the aim of providing a comprehensive overview of all the factors that influence the effectiveness of a prehabilitation program, this review will detail the differing modes of prehabilitation programs, in addition to the physiological and emotional effects of prehabilitation and the potential economic effects of prehabilitation programs on the hospital systems.

2.0 Outcomes of General Surgery

During the post-operative period certain outcomes are monitored to assess the success and impact of the surgery. Outcomes such as length of stay (days) and adverse events are these key outcomes that play a role in the recovery of a patient after surgery. As complication rates (rate of adverse events) of 30-40% are commonly reported after general surgery (4) placing patients at a high risk of increased length of stay and adverse events and therefore an extended recovery period effecting the overall effectiveness of the surgery.
2.1 Length of Stay

Length of stay refers to the time spent as an inpatient after hospitalisation prior to discharge. Length of stay is commonly measured in two forms; prolonged length of stay (PLOS) and prolonged post-operative length of stay (PPOLOS)(13). Prolonged length of stay is referred to when discussing the optimisation of hospital procedures and policy, prolonged post-operative length of stay is more commonly referenced when assessing quality of care of a patient. Chiu et al (13) discovered a correlation between length of stay and adverse events, when a patient suffered from both minor and major adverse events there was a resultant increase in length of stay with minor complications resulting in a 5.5 day increase and major complications increasing length of stay by 10 days. Additionally, while length of stay has a direct impact on overall economic cost to the healthcare system, prolonged length of stay results in a reduction in available beds and increased hospital resource consumption (14).

2.2 Adverse Events

Adverse events are closely linked to increased levels of patient morbidity and mortality (15), generally the greater the severity of the event the more it will impact patient centred outcomes such as recovery, quality of life and patient satisfaction. Pirson et al. (16) reported when adverse events occur in the post-operative period, patient length of stay increases by an average of 19 days. Additionally, Chiu et al. (13) also reported a link between length of stay and adverse event risk showing with the occurrence of adverse events there was a resultant increase in length of stay. However, with the implementation of a prehabilitation program, the rate of adverse events decreases as described by Carli et al. (17). They reported the benefits of a multimodal prehabilitation program consisting of psychological support and nutritional support in addition to physical exercise, allowed for reduced adverse events and as a result reduced length of stay. They also reported adults who were physically active, not overweight or obese and had no reported mental health issues, displayed higher levels of functional health and lower risk of adverse events (17). This is due to the patients having a higher level of physical functioning prior to surgery therefore decreasing the stress response seen as a result of surgery.

2.3 Return to Pre-surgery Function

Return to function is vital to the overall recovery of the patient and is one of the main patient centred outcomes following surgery. An increased return to function, and therefore
discharge has resulted in decreased length of stay and increased patient satisfaction and quality of life (18). Through the use of prescribed exercise, nutritional support, and psychological support an increase in the patient’s physical and psychological function can be seen prior to surgery. Therefore, counteracting the stress response commonly seen after surgery allowing the patient to experience an improved recovery rate (6).

Multimodal prehabilitation programs consist of 2 or more modes of prehabilitation (exercise, diet and nutrition or psychological support) and are used to accelerate a return to function. These programs have been shown to increase a patients physical and psychological function prior to surgery resulting in increased quality of life and reduced adverse events (9, 12, 17, 19). Through the use of exercise, healthy diet and lifestyle habit management prior to surgery patient physical function should be improved and therefore they should experience a less complicated recovery and reduced length of stay allowing them to return to pre-surgical function more efficiently.

2.4 Quality of Life

Quality of life refers to the subjective and personally derived assessment of overall wellbeing that results from the evaluation of satisfaction across personally or clinically important domains (20). Quality of life can be divided into 4 main domains 1) physical (performance or self-care activities), 2) psychological (life satisfaction and sense of control), 3) social (social interactions) and spiritual wellbeing (maintaining hope and meaning) (21). Regular exercise has reported higher levels of quality of life than when exercise isn’t performed on a regular basis (22). As exercise has been shown to improve physical functioning, psychological functioning and social functioning (20), including exercise during the prehabilitation phase is likely to promote a greater quality of life in patients.

Hijazi et al. (23) discovered in their review that 4 randomised control trials (19, 24-26) all performed primarily aerobic exercise and discovered significant improvements in patient quality of life in favour of the prehabilitation intervention group compared to the control group when measuring quality of life in general surgery patients. Burke et al. (20) supported these findings as they reported that patients who underwent a 6-week prehabilitation program with psychological support showed significant improvements in quality of life at the conclusion of the program and during the recovery period when compared to the patients who just undertook the 6 week exercise program. Patients involved in the intervention reported increased vitality, a more positive attitude, greater social connections, and a strong sense of purpose after the
conclusion of the program prior to surgery. This research provides strong evidence to the benefits of prehabilitation programs on patient quality of life.

3.0 General Prehabilitation

Functional reserve is described as the ‘safety margin’ that may be needed to meet increased demands for cardiac output, carbon dioxide excretion, protein synthesis and immune responsiveness. Often functional reserve is decreased post-surgery (17), as a result the implementation of prehabilitation programs has become common practice to increase a patient’s functional reserve and improve recovery. Physical prehabilitation, nutritional support, psychological support and lifestyle habit management all play a vital role in the preparation and recovery of the patient.

3.1 Physical Prehabilitation

Physical pre-operative exercise programs typically consist of a mixture of aerobic, resistance and mobility exercises (12). Each program is designed using the FITT (frequency, intensity, time, and type) principles that describe the standard for programming exercise regimes. Banugo and Amoako (12) report that prehabilitation programs typically consisted of 1 to 5 sessions per week for 30-60 minutes mainly consisting of 30-45 minutes of aerobic exercise (walking, elliptical or stationary bike) and 15 minutes of resistance exercises (mainly body weight or resistance band work focusing on major muscle groups) with additional flexibility exercises. With the addition of both aerobic and resistance based exercise into prehabilitation programs, both aerobic fitness and muscular strength should be improved placing the patient in better physical condition prior to surgery and therefore reducing the effect of the surgical stress response (2).

3.2 Nutritional Support

Nutritional support is another mode of prehabilitation that can assist in reducing length of stay, adverse events (12, 17). Patients with a higher lean preoperative body mass have been shown to have a greater ability to cope with the physiological stress of surgery as the rate of protein synthesis outweighs the rate of protein breakdown (12, 17). The aim of a pre-surgery nutritional intervention is to improve protein synthesis within the body to compensate for the
catabolic response of surgery postoperatively (27). General nutritional prehabilitation interventions include carbohydrate loading to reduce insulin resistance and promote an anabolic state, minimising loss of protein, lean body mass and muscle function (12). Li et al. (19) performed a multimodal prehabilitation program consisting of moderate intensity exercise, nutrition advice and psychological support on function recovery in colorectal cancer surgery and reported nutritional counselling and protein supplementation alongside psychological assistance and an exercise regime produced significant results in post-operative functional walking capacity and improved recovery time. This provides strong evidence for nutritional support to be included in all prehabilitation programs.

3.3 Mental/Psychological Support

Surgery can present risks to patient wellbeing in addition to the effects to physical health as well. However, there may also be some effect to family structure and wellbeing as well, when the primary household earner is scheduled for surgery loss of income, increased workload and levels of stress in the family structure may place excess strain on the patient. In patients undergoing cardiac valve surgery, depression has been demonstrated as a risk factor for mortality in post-operative care with 13.2% mortality rate for depressed patients 6 months post-surgery compared to 7.6% for non-depressed patients (28). Additionally, Mayo et al. (29) has discovered colorectal surgical patients who had high belief in physical exercise they were undertaking as prehabilitation had better recovery rates and improved adverse events when compared to the group who had lesser beliefs of exercise (29). Due to the high level of motivation when completing exercise adherence was positively impacted allowing for improved results before and after surgery (29). Furthermore, Munafo and Stevenson (30) report a strong correlation between high anxiety levels pre-surgery and increased levels of pain post-operatively. While evidence is minor into the effects of psychological states on post-operative recovery and outcomes, there is still strong evidence to suggest psychological support should be included in prehabilitation programs to improve post-operative outcomes.

3.4 Lifestyle Habit Management

Lifestyle habit management has become a key facet of multimodal prehabilitation programs. Issues such as smoking, excessive alcohol consumption and excess body weight can lead to issues such as impaired wound healing, excessive bleeding, myocardial ischemia,
infections and cardiopulmonary complications (31-34). With lifestyle habit management the aim is to manage the habits patients undertake in their everyday life that may inhibit their recovery after surgery.

3.4.1 Smoking Cessation

Smoking for extended periods leads to significant systemic effects within the body that are quite well documented. Decreased lung capacity and reduced oxygen consumption precede an increased risk of developing chronic diseases such as atherosclerosis and chronic obstructive pulmonary disease (COPD)(35). However, the effects of how smoking causes the body to react during surgery are less well known, smoking pre-operatively carries the risk of increased post-operative complications such as myocardial ischemia, infection and pneumonia (31, 32). These effects seen due to the effects of long-term smoking can be lessened with a short-term cessation of smoking prior to surgery greatly lowering the risk of complications arising during recovery (32). However, the long-term effects (e.g. reduced lung capacity, impaired immune function) may take weeks, months or longer to recover. As a result, to ensure the fastest, most efficient, and safest recovery for the patient smoking cessation should be undertaken immediately.

3.4.2 Reduced Alcohol Consumption

Alcohol has been shown to negatively affect post-operative outcomes, long term excessive alcohol consumption (> 3 standard drinks per day or 21 per week) prior to surgery has been linked to increased bleeding time, cardiac arrhythmias and immune dysfunction which places patients at risk of cardiopulmonary complications, infections and bleeding episodes during and after surgery (33). A study performed by Tønnesen reported lower adverse events when alcohol consumption was ceased one month prior to surgery through pharmacological assistance (disulfiram 800mg) when compared to when alcohol consumption was not ceased (p=0.04) (36). With lower rates of adverse events comes improved recovery times and decreased length of stay.

3.4.3 Weight Management

Body mass has been demonstrated to be linked with the risk of adverse events post-surgery. Low body mass (BMI<18.5 kg/m²) has been reported to increased post-operative
complications (12). Obese patients (BMI>29.9 kg/m²) have been shown to have to be at greater risk of wound infection, surgical blood loss and longer surgery times ultimately leading to increased recovery time and length of stay. However, while these patients are at a higher risk of adverse events they do experience an increased long term survival rate; this interaction is referred to as the obesity paradox (34). Tjeertes et al. (34) reported patients who were classed as overweight to mildly obese (25 kg/m² to >30 kg/m²) displayed greater 30 day survival rates when compared all other weight classifications as the excess adipose tissue played a protective role during surgery. Weight management therefore plays a close role with nutritional support as the aim of a prehabilitation program is to reduce the risk of adverse events to improve patient recovery. Keeping the patient in a normal weight range (BMI=18.5-24.9 kg/m²) is the best way to decrease the potential risk of increasing length of stay and developing adverse events.

4.0 Prehabilitation Programs

4.1 Program Modality

There are differing forms of prehabilitation programs, as such there has been much discussion into the what the best pre-surgical program would involve to provide the greatest benefit to the patient. Li et al. (19), West et al. (37) and Dronkers et al. (38) have all performed studies in which patients underwent a prehabilitation program consisting of a primarily aerobic exercise with nutritional and psychological support with the aim of discovering the most effective prehabilitation program modality. All studies discovered that all facets of prehabilitation (physical exercise, nutrition, mental support and lifestyle habit management) have a positive effect in reducing of length of stay and adverse events and they have revealed the benefits of all facets of prehabilitation on post-operative outcomes by themselves and collectively (19, 37-39).

West et al. (37) indicated both tailored exercise and nutrition support showed benefits in morbidity, length of stay and quality of life when compared to only nutritional support. Additionally Li et al. (19) provided strong evidence that a multimodal program consisting of exercise, pre-surgical nutrition and psychological support improved functional walk time and post-operative recovery time when compared to the standard nutritional support received by the control group. This suggests there is evidence for the use of multimodal prehabilitation programs consisting of nutrition, physical exercise, psychological support, and lifestyle habit management.
While Li et al. (18), West et al. (36) and Dronkers et al. (37) report the benefits of including exercise in the prehabilitation period, all prescribe a primarily aerobic exercise program with low load resistance training exercises using a resistance band. With resistance exercise being shown to promote muscular growth and strength and potentially attenuate the effects commonly seen after surgery (2), the inclusion of resistance based exercise seems largely beneficial. However, while these programs have shown some effectiveness with low load exercises prescribed, the likelihood of the appropriate response expected from resistance training being elicited is unlikely. As such the concept of how an appropriately resistance-based training program effects prehabilitation and recovery has formed a subsequent gap in the literature.

4.2 Length of the Prehabilitation Program

Most prehabilitation programs span approximately 2-6 weeks (12, 19, 37, 38). Dronkers et al. (38) investigated the feasibility of a 2-4-week prehabilitation exercise program where patients trained 2 times per week with the aim of increasing pre-operative function prior to surgery. They discovered this type of exercise program was feasible in improving physical function prior to surgery seeing increases in aerobic capacity with no other significant results found. Additionally, Sanchez-Lorente et al. (40) discovered that a period of 2-6 weeks of high intensity interval training was the best alternative to regular endurance training pre-surgery in patients undergoing thoracic surgery. The research described above shows exercise programs in the perioperative period ranging from 2-6 weeks have benefits to the patient increasing post-operative outcomes. However, the challenge surrounding these prehabilitation programs is the time prior to surgery to implement the interventions. Often patients only receive 2-4 weeks’ notice prior to surgery as such to see beneficial outcomes, a prehabilitation program would need to be implemented immediately.

4.3 Method of Delivery

Prehabilitation is often delivered through home-based programs generally consisting of daily walking and light body weight or resistance band exercises (physical exercise) and support through the use of nutritional counselling, dietary supplementation, and psychological support as described in Gillis et. al (25). And secondly, supervised prehabilitation programs consisting of both aerobic and resistance exercises performed in the presence of a qualified
practitioner, support through the use of nutritional counselling, dietary supplementation, and psychological support as described by Li et. al (19).

4.3.1 Home Based (unsupervised) vs. Clinic Based (supervised)

While both supervised and unsupervised programs show have displayed benefits including reduced length of stay, improved physical function (aerobic and muscular) and improved psychological function (25, 38, 41), current literature demonstrates that supervised prehabilitation programs often demonstrate greater benefits to the patient (38, 42). Gillis et. al (25) reported that a 4-week supervised multimodal prehabilitation program with nutritional counselling, dietary supplementation and psychological support showed meaningful changes in improving length of stay, reducing adverse events and returning post-operative function to baseline or above baseline function after 8 weeks when compared with a home based aerobic prehabilitation program which also received nutritional counselling, dietary supplementation and psychological support. Additionally, Awasthi et al. (42) showed patients involved in supervised exercise training consisting of both aerobic and resistance exercise enhanced their aerobic fitness, muscle strength and endurance at both 4 weeks and 8 weeks post-operatively when compared to the home-based program.

5.0 Effects of Prehabilitation

5.1 Physiological Outcomes

Multimodal prehabilitation programs incorporate and target multiple facets of health and

![Figure 1](image)

**Figure 1.** Theoretical benefits of prehabilitation (1)
wellbeing such as physical function, nutrition, psychological support and lifestyle habit management to achieve the overall aim of improved recovery after surgery (12, 17). Prehabilitation and particularly exercise, has been shown to increase cardiovascular fitness, muscular strength and endurance in both cardiovascular patients and musculoskeletal patients through the use of both aerobic and resistance exercises prior to surgery (9). Figure 1 displays the benefits of completing a prehabilitation program including exercise, physical function is comparatively better at all timepoints when compared to a non-prehab patient.

When patients present with greater levels of aerobic fitness, muscle strength and endurance, the hypermetabolic and hypercatabolic state caused by surgery can be minimised and lead to improved and quicker recovery in the post-rehabilitation state (43). The aim of the prehabilitation programs is to decrease length of stay and improve post-operative outcomes such as return to function and risk of post-operative complications by increasing the patient physical, nutritional, and psychological function to reduce the surgical response.

5.2 Psychological outcomes

Depression and anxiety have both been demonstrated to influence patient motivation to carry out basic social functions and functional activities (39). Mavros et. al (44) identified the link between psychological wellbeing and post-operative outcomes, stating increases in stress, depression levels and hostility lead to a more complicated recovery period. Wallace (45) reported patients that underwent psychological support during the prehabilitation stage prior to surgery showed lower levels of stress, post-operative anxiety and pre-operative fear and anxiety. This combined with the research performed by Munafo and Stevenson (30) shows while psychological wellbeing can have a negative effect during the post-operative phase when not addressed prior, the inclusion of management techniques and psychological support during prehabilitation phase is likely to lower the associated risks that increase unwanted post-operative outcomes such as increased recovery time and post-operative complications (44). Therefore, psychological support should play a vital role in the prehabilitation program to adequately prepare the patient for surgery.

5.3 Economic cost

Economic costing plays a vital role in assessing the success of a prehabilitation program. Prolonged bouts of hospitalisation lead to increased treatment costings, hospital resource use and bed costs. Previously studies have investigated the effect of prehabilitation
and the economic value of decreasing length of stay. Raut et al. (46) discovered a 0.5 day reduction in length of stay in the United States saved an estimated $457-$846 per episode of hospitalisation, this reduction was seen in treatment cost, hospital resource use and bed cost. With reduction in length of stay through prehabilitation we would expect to see a reduction in costing for both the patient and the hospital system.

6.0 Conclusion

This review provides support for the use of prehabilitation programs prior to surgery to improve patient recovery. By increasing patient physical function prior to surgery, the hypercatabolic and metabolic stage that leads to increased muscle loss, reduced immune function and increased likelihood of developing complications will be managed effectively allowing the patient to experience a faster recovery (3). While most of the literature surrounds the effect of a mainly aerobic exercise based multimodal program, the effect resistance training may have on the human body before, during and after surgery provides a direction for future research to follow to find the best possible mode of exercise to perform. Currently, most hospitals are implementing aerobic based prehabilitation programs to improve physical functioning prior to surgery. Due to the constraints of a resistance-based program such as requiring a gym and supervision for patient safety it is difficult to implement a more advanced resistance program. However, with the literature displaying the large benefits seen when a multimodal prehabilitation programs are implemented, a strong argument can be made for multimodal prehabilitation programs including both aerobic and resistance based exercises to become gold standard of practice to ensure fast and efficient recovery after surgery (19, 37)
Chapter 2 – Study Purpose, Hypothesis and Aims

1.0 Statement of the Problem

Enhanced recovery after surgery (ERAS) programs are now increasingly used to reduce length of stay, post-operative complication rates and improve patient quality of life after surgery (6). Primarily, these ERAS programs consist of nutrition, psychological and lifestyle habit management, and more recently the introduction of exercise (6). Studies investigating the effects of exercise to enhance recovery after surgery report promising results with increases seen in patient quality of life, reduced length of stay and post-operative complications (9-11, 17, 26). However, these studies have typically focused on aerobic training (19, 37, 38). Research into the effects of a resistance focused training program in general surgery patients is lacking. It is possible that using an exercise program consisting of primarily resistance exercises as its main form of pre-surgery exercise, patients can increase muscle mass, muscular strength, physical function and quality of life and as such improve their recovery after surgery. The introduction of an exercise program prior to surgery could provide a new standard of care for patients waiting to undergo elective surgery and improve hospital efficiency and patient management.

2.0 Research Aims

1. Examine the effect of a resistance-based prehabilitation program on length of stay and readmission rates after surgery.
2. Examine the relationship between prehabilitation programs and adverse events, physical function, and quality of life.

3.0 Hypothesis

1. A prehabilitation program will decrease length of stay and readmission rates after surgery when compared to routine care.
2. Prehabilitation will be associated with decreased adverse events, increased strength and function and increased quality of life after surgery when compared to routine care.
4.0 Significance of Study

Examining the relationship between resistance exercise and recovery after surgery will further our understanding of the effects of resistance exercise on patient recovery. Currently, there is a gap in the literature surrounding the use and effectiveness of a resistance-based prehabilitation program. The ability to potentially increase patient physical function via increasing their muscle mass and strength in addition to their functional ability will reduce the effects commonly seen during surgical stress response (3). We believe that the implementation of resistance exercise may be beneficial prior to surgery in improving post-surgical outcomes and improving patient recovery. In 2017/2018 in Western Australia alone there were 14,390 admissions for general surgery (47), equating to 277 admissions per week across all hospitals in Western Australia alone. Recent census data reported mean (SD) length of stay for general surgery patients 4.3 (5.4) days. Previous studies have reported that with increased length of stay comes increased health care cost (48-50). In Western Australia it is estimated that reducing length of stay by one day will reduce costs by approximately $8352 per day on the intensive care ward and $1128 per day on the general surgery ward (51). This reduction in costing combined with the ability to potentially increase patient physical function in addition to increasing their wellbeing leading to decreased recovery time will significantly benefit not only the patient but the wider health care system.

A priori analysis was conducted using G*Power 3 (52) to test the difference between two groups, a small effect size (d =0.125) and an alpha of 0.05 showed that a total sample of 50 participants with two equal sized groups (n=25) was required to achieve a power of 0.8. As such during this study we aimed to recruit 50 patients who are scheduled for general surgery, with this sample size we will examine the effects of resistance exercise on patient length of stay, readmission rates and post-operative complications after surgery. Additionally, this study will aim to provide grounds for future research to be conducted to help pave the way for resistance-based prehabilitation exercise programs to be considered as standard care for surgery in the health care system.
Chapter 3 – Manuscript

The following chapter has been formatted for submission to the ANZ Journal of Surgery. As such, all sections have been prepared in accordance with the journal’s author guidelines.
The Effect of a Physical Exercise and Education Prehabilitation Program in General Surgery Patients

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1.0 Abstract

**Background:** Patients undergoing general surgery can often experience complication rates of 30-40% after surgery, which delay recovery. Prehabilitation enhances the physical function of patients prior to surgery to improve surgical outcomes and facilitate recovery. Previous research has explored the benefits of aerobic-based prehabilitation in improving recovery after surgery, however research into appropriately prescribed resistance exercise interventions is lacking. This study explored the effects of a resistance-based prehabilitation program on overall patient recovery when compared to usual care. **Methods:** Seventeen participants (8 male and 9 females) were recruited via inpatient admissions and were randomly assigned to either an intervention group (n=9) receiving a pre-surgery resistance-based exercise program or usual care group (n=8) receiving standard patient education. The exercise program consisted of 6 moderate intensity exercises targeting the large major muscle groups with the focus of building muscle mass. Primary outcomes were length of stay (days) and post-operative complications. Secondary measures included whole body resistance, isometric muscle strength, physical function, aerobic fitness, self-reported physical function and quality of life and limb disability (upper and lower limb) **Results:** No differences were observed in length of stay between the prehabilitation control groups (p=0.655). The control displayed a significant within group loss of 8.4 kg in grip strength between pre and post-surgery (p=0.001), compared to the intervention group who only lost 0.8kg (p=0.776), there was no within group significance. Mental health summary score reported a significant difference between groups at six-week post-surgery (p=0.006) displaying increased quality of life as a result of the intervention. **Conclusion:** The preliminary results of this study indicate that resistance-based exercise training in the peri-operative period are associated with reported increases in patient mental health and attenuation of isometric muscular strength.
2.0 Introduction

General surgery refers to surgery involving the torso region of the body and the subsequent organs and is a primary treatment for a variety of conditions. Surgery can lead to homeostatic disturbance within the body, which is known as the surgical stress response (3). This response manifests in the processes of hypermetabolism and hypercatabolism and a period of increased oxygen demand which can lead to complications such as muscle wastage, reduced immune function and slower wound healing (3, 43). These cumulative factors can increase the number of days a patient spends hospitalised and lead to a longer recovery period.

Length of stay is a quasi-measure of patient recovery after surgery and an indicator of increased bed rest in hospital. As such, loss of muscle mass and strength, as well as decreases in cardiovascular fitness are often observed due to disuse atrophy and detraining effects (2, 53). Additionally, these delays to discharge are often extended by post-operative complications. Complication rates for general surgery are reported as high as 30-40%, placing the patients at a higher likelihood of an extended recovery period after surgery (4, 29, 54). Complications can include issues such as sepsis, wound infection, pain and haemorrhage (25). In 2018 alone, Western Australian hospitals admitted 14,390 patients for general surgery (47), identifying opportunities to reduce length of stay in general surgery patients can potentially provide benefits to the patient as well as the health care system.

Contemporary enhanced recovery after surgery (ERAS) programs consist of multimodal programs involving an exercise component in addition to a nutrition and psychological component. The main aim of these programs is reducing the loss of physical function and accelerating the return to normal function after surgery (6, 12). Patient education in the form of nutrition, counselling, lifestyle habit management and surgical preparation (i.e. pre-operative fasting) is the most common method of prehabilitation used. However recently, the inclusion of exercise has become a promising concept leading to the discussion around the benefits of implementing exercise prior to surgery (19, 26). Previous research has provided promising results in increasing aerobic and physical function with the implementation of aerobic exercise prior to surgery (1, 9, 11).

Despite this emerging body of evidence, pre-operative exercise programs are not considered a key component of ERAS programs. When combined with other components of ERAS programs, exercise should further enhance physical function and mental wellbeing by increasing muscular strength and cardiorespiratory fitness to accelerate recovery from surgery.
The inclusion of aerobic exercise into ERAS programs has reported reduced rates of morbidity, mortality and decreased length of stay and faster recovery after surgery (7, 8). While the benefits of aerobic exercise are documented, little is known of the effects of implementing resistance exercise prior to surgery. It is thought the addition of an adequately prescribed progressive resistance program will further enhance recovery through muscular adaptations such as increased muscle strength and muscle mass enhancing physical function.

Along with the physical benefits of undertaking exercise prior to surgery, incorporating physical activity into ERAS programs has been shown to improve wellbeing, mood, stress and coping mechanisms and therefore, patient quality of life (10, 30, 55). These effects can be linked with a decrease risk of post-operative complications and therefore decreased levels of pain and mortality rates (10, 55). With depression being linked to an increased mortality rate of 13.2% post-surgery in patients undergoing cardiac valve surgery (28) the inclusion of exercise, can decrease levels of anxiety, stress and depressive symptoms prior to surgery can decrease post-operative complication risk and improve patient quality of life and therefore patient recovery (10, 30, 55).

Modern exercise-based prehabilitation programs have traditionally consisted of largely aerobic exercise or a mixture of aerobic exercise and low intensity resistance band exercises. While resistance based exercise has been prescribed in some studies (19, 37, 38), the load prescribed was low and unlikely to elicit the appropriate response seen with resistance training. Little is known regarding the effect of primarily resistance based exercise training in a prehabilitation program for improving muscular strength, muscle mass and physical function following surgery, creating a gap in the literature. By improving these markers of muscular fitness and physical function is protective against the detrimental effects of surgery; it is likely that resistance-based exercise in prehabilitation programs could improve patient recovery. Therefore, the aim of this study was to examine the effectiveness of a resistance training prehabilitation program patient’s physical function, post-surgery length of stay, and mental health, compared with a no training control group.
3.0 Methods

Seventeen participants (8 male and 9 females) were recruited for this study over a 6-month period from October 2018 - March 2019 through outpatient admission for general surgery. Participants were recruited through the use of the hospital surgery waitlist as well as consultation with the surgeons. All patients were informed of the risks and benefits of participation of the study prior to gaining consent. Inclusion criteria included; a predicted minimum of 2 weeks pre-surgery wait time, attendance to a pre-surgical clinic (pre-admission clinic), discharge to a community dwelling and willing to attend a training location 3 times per week. Exclusion criteria included; patients out of the catchment area for the hospital (i.e. rural patients), inability to commit to attending three gym sessions per week, inadequate time to surgery (<10 days) and significant orthopaedic issues that prevent participation in an exercise program. All Participants were randomly allocated via random number generator into either the intervention or control group before baseline assessment.

This study received ethics approval from the South Metropolitan Health Service (PRN1049RGS000001049) and the Murdoch University Human Research Ethics Committee (Project Number: 2018/157) prior to commencement of recruitment. All participants were provided with the participant information sheet and required to sign an informed consent document.

3.1 Outcome Measures

This was an unblinded study where participants were randomised to either the rehabilitation group consisting of exercise and pre-surgery education or the usual care group which received pre-surgery education only. Participants were assessed at baseline, pre-operative (one to three days pre-surgery), post-operative (one to three days post-surgery), hospital discharge, and six weeks post-operatively. Participant descriptive data including age, sex, height and weight were collected at baseline.

Length of stay (days) was measured at inpatient discharge through the hospital patient database commencing at date of admission and was collected as full days hospitalised. Post-operative complications that altered the patient’s recovery process (i.e. pain, wound infection and nausea) were extracted after discharge through the hospital patient database. Post-operative complications were analysed using the Clavien-dindo classification grading post-operative
complications severity from grade I to grade V (56). While both length of stay and post-operative complications may be used individually to measure patient recovery, they are not interactive, and complications have a compounding effect on length of stay. When post-operative complications occur during the recovery period, length of stay can be double that expected (16, 48, 57). Patient readmission rate was collected six weeks post-operatively through the hospital patient database.

Post-operative complications were assessed using the Clavien-dindo classification system which grades the severity of the complication from grade one to grade five with a higher grading indicating a higher severity of complication. More detailed descriptions of the grading are shown in Appendix O.

Body composition was assessed using whole body resistance (Ω) using bioimpedance spectroscopy equipment (Model SFB7, Impedimed, Queensland, Australia). Using the resistance parameter of $R_{\text{infinity}}$ ($R_i$), we are able to collect a measure of whole body resistance that is indicative of lean muscle mass minus body water (58). As muscle resistivity (10Ω) has been shown to be less than that of bone (100Ω) and fat (15-50Ω), lower whole body resistance measurement is indicative of greater lean muscle mass (58).

Isometric grip strength was used as a surrogate marker of overall muscular strength and was assessed via an analogue handheld isometric dynamometer (hydraulic hand grip dynamometer, Jamar, United States). Each patient was seated with their elbow flexed at 90 degrees and were required to squeeze the dynamometer as hard as possible for three seconds to achieve the highest force possible. This was completed three times on both the dominant and non-dominant side with the best grip strength from each side reported. This outcome was collected at baseline, pre-surgery, post-surgery, discharge, and six weeks post-surgery.

Functional capacity was assessed using the timed up-and-go (TUG) assessment. The patient was timed as they stood from a seated position and walk three metres around a cone and returned back to the seated position as fast as possible this was timed using a handheld stopwatch (100 LAP digital stopwatch, Pursun, Guangdong, China). Patients were instructed and guided through a familiarisation trial prior to completing the assessment. This outcome was measured at baseline, pre-surgery, discharge, and six weeks post-surgery timepoints.

Cardiorespiratory fitness was assessed via the Modified Chester Step Test (59). Participants were required to step up onto a 30 cm step at an initial rate of 15 steps per minute (timed via a metronome), increasing at a rate of five steps per minute for every minute of the
assessment. This test has been shown to be a valid submaximal test of oxygen consumption (VO$_2$ max) (60). During testing, the participant’s heart rate (Nellcor Oximax n-65, Minneapolis, MN, USA) and rating of perceived exertion (RPE) (Borg CR-10 scale) were measured every minute. Testing was stopped at participant withdrawal or when the participant reached 80% of their age predicted maximum heart rate. This test was conducted at baseline and six weeks post-surgery.

Self-reported quality of life was measured using the 36-item short form health survey (SF-36, version 2) (61). The SF-36 measures quality of life through eight scales; four scales measuring physical functioning (role-physical, bodily pain, general health, and physical functioning) and four scales mental and emotional wellbeing (vitality, social functioning, role-emotional and mental health). The summary scores were collated at baseline and six weeks post-surgery.

Self-reported functional capacity was assessed via the Quick Disability of Arm, Shoulder and Hand (QuickDASH) questionnaire to assesses functional ability of the upper limbs (62). This 11-item questionnaire relates to activities of daily living and how competent the patient is at completing these activities. The Lower Limb Functional Index (LLFI-10) questionnaire consists of 10 questions relating to competency completing activities of daily living (63). Both questionnaires were collected at baseline and six-weeks post-surgery.

Patient assessed recovery was assessed via the Quality of Recovery (short form) (QoR-15) questionnaire. This 15-item questionnaire assesses patient based health status outcomes including; physical comfort, physical independence, psychological support, and emotional state. 11-point rating scale rates recover on a scale of 0 (poor recovery) to 150 (excellent recovery) (64). QoR-15 was measured after surgery.

**Figure 2.** Outcome assessment timeline
3.2 Prehabilitation Program

The prehabilitation group completed a supervised gym-based resistance exercise program, performed three times per week alongside a walking diary encouraging them to walk daily. All patients in the prehabilitation group commenced the exercise program with a minimum of two weeks pre-surgery wait time and consisted of six exercises targeting the large muscle groups of the upper body (chest press, seated row, and shoulder press) and lower body (leg press, leg extension and hamstring curl). All exercises were completed in the hospital gym and were completed under supervision of an Accredited Exercise Physiologist or physiotherapist.

The control group for this study received the same standardised education program as the intervention group, in addition to a cardiovascular exercise information in the form of a walking diary with participants encouraged to walk daily (see appendix E). Participants did not receive any resistance training advice prior to surgery.

Weight for the exercises was set through a RPE of 7/10 (Borg CR-10 scale) as this is listed as "heavy" when referring to exertion on the CR-10 Borg RPE scale, patients competed one set and were asked to rate the difficulty of the set; scores higher than 7/10 resulted in the weight being decreased, while scores lower than 5/10 resulted in the weight being increased. This was completed during the patient’s first gym session, as one repetition maximum was not deemed to be feasible in the population. Weight progression was completed on a session by session basis with the RPE limit being maintained at seven, when the participant rated the exercise below a five on the modified Borg RPE scale on any exercise in the previous session, weight was then increased between 2-10% in accordance with the American College of Sports Medicine guidelines (65).

The sessions were progressively structured to increase training volume over several sessions as high volume, multiple set programs facilitate gains in muscular hypertrophy (66, 67). Sets and repetitions were progressed as detailed in Table 1.

<table>
<thead>
<tr>
<th>Session Number</th>
<th>Sets</th>
<th>Repetitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>4-9</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>10-15</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>16-21</td>
<td>4</td>
<td>8</td>
</tr>
</tbody>
</table>
Table 1. Per session set and repetition progression

3.3 Education Program

All participants (intervention and control) received the same standardised education program in the form of flyers providing short- and long-term goal setting advice (Appendix B), healthy lifestyle information (focused on diet and exercise; Appendix C), drug and alcohol information (Appendix D) this information was provided individually during a 30 minute face to face interview at the attendance of each patients’ first assessment session. This education program is considered standard care for patients undergoing surgery at the hospital.

3.4 Statistical Analyses

Standard descriptive statistics were calculated and are presented as mean ± standard deviation. Student’s t-tests were used to determine differences in length of stay and post-operative complications between the control and intervention groups. Repeated measures analysis of variance was used for all measures with reoccurring collection points (modified Chester step test, SF-36, LLFI-10, QuickDASH, QoR-15, bioimpedance, grip strength, timed up and go) to determine differences in between group factors and time factors. Where a significant main effect was observed, the Bonferroni post-hoc procedure for multiple comparisons was used to adjust for multiple differences between groups. Intention-to-treat principle was used to adjust for patient attrition by carrying forward the last completed data set. All tests were two-tailed and an alpha (α) level of <0.05 was required to determine significance. Due to small sample size, the magnitude of the effect size was calculated using Hedge’s g (0.2 = small effect, 0.5 = moderate effect and 0.8 = large effect) (68). Data were analysed using IBM® SPSS Statistics (v 26, IBM corp., Somers, NY, USA).
4.0 Results

4.1 Participant Characteristics

A total of 135 patients were screened during the recruitment process. Seventeen patients (8 male and 9 female) awaiting general surgery were recruited through outpatient admissions at the hospital general surgery ward (Figure 3). The baseline physical characteristics are presented in Table 2. No differences were observed in these characteristics between groups at baseline.

Figure 3. CONSORT flow diagram for the study design
Table 2. Patient baseline physical characteristics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Intervention</th>
<th>Control</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>9</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>64.4 (5.3)</td>
<td>63.5 (13.5)</td>
<td>0.848</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>167.6 (7.9)</td>
<td>160.6 (9.9)</td>
<td>0.129</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>71.2 (18.3)</td>
<td>72.9 (15.6)</td>
<td>0.837</td>
</tr>
<tr>
<td>BMI (kg·m²)</td>
<td>25.3 (6.2)</td>
<td>26.2 (4.1)</td>
<td>0.748</td>
</tr>
</tbody>
</table>

Data presented as mean (SD); BMI = Body Mass Index

Specific surgeries undertaken by the participants are reported in Table 3. The most common procedures performed included oesophagectomy and gastrectomy both with 4 patients undergoing each.

Table 3. Surgical procedures performed during the study

<table>
<thead>
<tr>
<th>Surgery Type</th>
<th>Intervention</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oesophagectomy</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Whipples Procedure</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hemihepatectomy (Liver Resection)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Gastrectomy (partial or full)</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Colectomy/ileocolic Resection</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Pancreaticoduodenectomy</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Abdominoperineal resection</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

4.2 Post-Operative Complications

The descriptive information regarding post-operative complications observed during the study are described in Table 4. Prevalence of complications showed little variation between groups (4 cases in intervention, 3 in control). However, the intervention group was observed to have suffered from objectively more severe complications (as per the Clavien-Dindo classification) when compared to the control group.
Table 4. Post-operative complication grading (Clavien-Dindo classification system)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Prevalence</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Grade I</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Grade II</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Grade III</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Grade IIIa</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>- Grade IIIb</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Grade IV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Grade IVa</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>- Grade IVb</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Grade V</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

4.3 Length of Stay and Patient Re-admission

Mean length of stay in the intervention and control groups was 10.9 ± 12.4 and 7.5 ± 4.4 days, respectively. There was no significant difference (p=0.475) for length of stay between groups.

Readmission rate for all participants was 17.6%. In the intervention group, two patients were readmitted and one patient from the control group was readmitted. However due to the low event rate and sample size, no differences were observed between the groups.

4.4 Bioimpedance

4.4.1 Whole Body Resistance

The results of the ANOVA show no significant time*group interaction for whole body resistance (F(1,15)=1.654 p=0.255). While there was no main effect for group (p=0.576), a main effect for time was observed for whole body resistance (p=0.007). The line trend displayed in Figure 4 shows a decrease in whole body resistance from baseline to discharge.
A significant interaction was observed for time*group ($F(1,15)=4.223$, $p=0.001$) in right handed grip strength (Figure 5). Post hoc analysis indicated a significant decrease of 8.4kg in the control group between pre- and post-surgery timepoints ($p=0.001$, $g=0.96$), vs a non-significant decrease of 0.8kg in the intervention group ($p=0.776$, $g=0.04$). Additionally, there was a difference between groups of 10.3kg at the post-surgery timepoint ($p=0.23$, $g=0.81$) The change seen in the control group from pre- to post-surgery displays the loss in muscle strength seen as a result of surgery. No other significant between-group differences were found at any other time points.
Left handed grip strength did not display a significant interaction (F(1,15)=1.167, p=0.346). Main effects showed no significant difference in time (p=0.412) or group (p=0.467).

Figure 5. Change in right-hand and left-hand grip strength with pre-surgery, post-surgery, discharge and six-weeks post-surgery from baseline.

*denotes significance between pre- to post-surgery
4.6 Timed Up and Go (TUG)

There was no significant interaction for time*group (F(1,15)= 0.283, p=0.843) for the timed up-and-go test (Table 5). A significant main effect for time was observed (p=0.003) and no effect was observed for group (p=0.504). We observed a time effect improvement from baseline to pre-surgery. As expected, post-surgery scores decreased during the recovery period.

4.7 Modified Chester Step Test (mCST)

There was no significant interaction for time*group (F(1,15)=32.8, p=0.447), or main effect for time (p=0.403) and group (p=0.846).

4.8 SF-36

4.8.1 Physical Function Summary Score

There was no significant interaction in time*group (F(1,15)= 1.544, p=0.119). Main effects also showed no significant effect for time (p=0.635) or group (p=0.356) shown in figure 6.

4.8.2 Mental Health Summary Score

There was significant interaction for time*group (F(1,15)= 7.510, p=0.039). At six weeks post-surgery there was a significant difference between the groups (p=0.006, g=1.32) as shown in figure 6 with the intervention group displaying a 10.1% increase in mental health component summary score when compared to a 13.1% decrease in mental health component summary score in the control group. With a large effect size (g=1.32) there is a trend favouring improved mental health summary scores in the exercise group as a result of the intervention.
Figure 6. Change in physical component and mental component summary scores for six-weeks post-surgery from baseline.

*denotes significance at six weeks post-surgery
Table 5. Timed up and go and Modified Chester step test at assessed time points.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Timed Up and Go</th>
<th>Modified Chester step test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Timed Up and Go</td>
<td>Mean change from baseline, (%)</td>
</tr>
<tr>
<td></td>
<td>(sec)</td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>7.6 (1.0)</td>
<td>-</td>
</tr>
<tr>
<td>Control</td>
<td>7.9 (1.9)</td>
<td>-</td>
</tr>
<tr>
<td>Pre-surgery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>6.6 (1.5)</td>
<td>-1 (13.2%)</td>
</tr>
<tr>
<td>Control</td>
<td>6.8 (1.3)</td>
<td>-1.1 (-13.9%)</td>
</tr>
<tr>
<td>Discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>8.8 (2.7)</td>
<td>1.2 (15.8%)</td>
</tr>
<tr>
<td>Control</td>
<td>10.6 (4.3)</td>
<td>2.7 (34.2%)</td>
</tr>
<tr>
<td>Six weeks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention</td>
<td>8.1 (2.8)</td>
<td>8.7 (2.8)</td>
</tr>
<tr>
<td>Control</td>
<td>8.7 (2.8)</td>
<td>0.8 (10.1%)</td>
</tr>
</tbody>
</table>

Data presented as mean (SD- standard deviation)
4.9 QuickDASH

There was a no interaction was seen in time*group (F(1,15)=1.544, p=0.354) (Table 6). Analysis of main effects also showed no effect due to time (p=0.356) or group (p=0.691). While no significant differences were found there was a 31.7% decrease in self-reported disability in the intervention group compared to no change in the control group from baseline to six weeks post-surgery (g=0.40). While not significant, this 31.7% improvement in self-reported upper limb disability may potentially fall within a range that is the minimal clinical important difference (MCID) to patients based on the guidelines provided by Jaeschke, Singer and Guyatt.(1989) that state an improvement in 0.5 per item (69, 70).

4.10 Lower Limb Functional Index (LLFI-10)

There was no interaction seen in time*group (F(1,15)=0.552, p=0.866) (Table 6). Analysis of the main effects also displayed no significant effect for time (p=0.094) or group (p=0.691). However, there was a difference of 39.1% in the intervention group (g=0.45) vs 24.1% in the control group (g=0.23) from baseline to six weeks post-surgery. While not significant this 15% difference with a the small effect size seen in the intervention group may potentially fall within a range that is the minimal clinical important difference (MCID) to patients based on the guidelines provided by Jaeschke, Singer and Guyatt.(1989) that state an improvement in 0.5 per item (69, 70).

4.11 Quality of Recovery 15

There was no difference observed in quality of recovery between the intervention and control group (F(1,15)=0.86, p=0.773). There was no difference between the intervention group and the control group after surgery respectively (p=0.80).
Table 6. QuickDASH and Lower Limb Functional Index 10 mean scores for baseline and six-weeks post-surgery

| Assessment | QuickDASH |                  | LLFI-10 |                  |
|------------|-----------|----------------|---------|----------------|----------------|
|            | Disability Score | Mean change from baseline, (%) | Disability Score | Mean change from baseline, (%) |
| Baseline   | Intervention    | 12.6 (12.5) | - | 2.3 (2.0) | - |
|            | Control          | 15.1 (26.7) | - | 2.9 (2.9) | - |
| Six weeks  | Intervention    | 8.6 (8.2) | -4 (-31.7%) | 1.4 (2.0) | -0.9 (-39.1%) |
|            | Control          | 15.1 (23.3) | 0 (0%) | 2.2 (3.1) | -0.7 (-24.1) |

Data presented as mean (SD- standard deviation)
5.0 Discussion

This study assessed the effects of a resistance-based prehabilitation exercise program on length of stay and post-operative complications in patients undergoing elective general surgery. The main findings from this study were: 1) the intervention was successful in increasing isometric muscular strength in the right hand prior to surgery, and muscle strength was maintained after surgery in the intervention group, and 2) self-reported mental health and wellbeing was improved after surgery in the intervention group. Length of stay and post-operative complications were not different between the intervention and control group and, no additional benefits were observed in the intervention group for muscle mass and limb disability, cardiorespiratory fitness, measured physical function and self-reported physical function.

Length of stay has been reported to be closely related with post-operative complications (16, 48). Our study observed no differences in both length of stay and post-operative complications between the intervention and control group. However, commonly when post-operative complications occur, patient length of stay increases (13, 15, 48), our results show though there is no difference between the number of complications observed between the groups, however the severity of the complications had played some role. The intervention group was hospitalised for an additional 11.9 days following multiple grade IIIb and one grade IV complication and the control for 6.1 days following multiple grade IIIa complications (Table 4). While our study observed no statistical differences in both length of stay and post-operative complications due to the intervention, prehabilitation programs have been found to reduce the likelihood of post-operative complications often due to the increased physical function seen as a result of the intervention (16, 48, 57). While no differences were observed, multiple patients in the intervention group experienced post-operative complications all graded higher than 3 on the clavian-dindo classification system. There is a possibility that without the intervention protocol they undertook these classifications could have been more severe A low sample size likely accounts for the lack of differences in this study, as there was a large variance in the number of days spent hospitalised with and without post-operative complications between groups.

While there was no evidence of a significant improvement in muscle mass related to the prehabilitation program. The trend observed indicated a decrease of resistance levels from baseline to discharge (Figure 3). Normally from a 2-week resistance-based program no large
hypertrophic effects would be seen. Current literature states that 10-12 weeks of regular (3 times per week) resistance training is required to see large hypertrophic effects (71), and in elderly patient this can be slightly longer. Hagerman et al. (2000) reported a 16 week training protocol is required to experience these hypertrophic effects in elderly (60-75 year old) men (72). However, muscular strength increases have been discovered in early periods of resistance based training, these changes have been reported to be the result of neural adaptation that develops more efficient pathways along the route to the muscle (73) in addition to increased muscle fibre recruitment (74). This being the case no significant increases in muscle mass were seen as a result of the intervention. However, while not significant we did observe a slight decrease in resistance indicating a slight increase in muscle mass in both groups from baseline to pre-surgery, this decrease in resistance is indicative of increases in muscle mass prior to surgery. This increase places the patients at an increased level of physical condition potentially leading to the attenuation of the hypercatabolic and hyper metabolic state that causes multiple post-operative complications in the period following surgery (3, 43).

Isometric muscular strength was improved in the right hand following the prehabilitation program. Following surgery, the control group saw a 29.4% reduction in right-handed muscular strength in the control (p=0.001, g=0.96). This significant decrease from pre-surgery to post-surgery is more than likely indicative of the surgical stress response seen after surgery. However, no significant differences were observed in left-handed grip strength. Grip strength has been demonstrated to be a reliable predictor of the risk of post-operative complications, length of stay and skeletal muscle mass (75, 76). Kerr et al (75) reported grip strength >31kg in men and >18kg in women pre-operatively was associated with a 25% increase in the likelihood of an early return home. As grip strength is a reliable predictor of muscle mass, grip strength higher that the benchmarks provided by Kerr et al. (75) would indicate an increased likelihood of an early recovery. Our results displayed the effect of the hypercatabolic period following surgery, if this can be attenuated the likelihood of an accelerated recovery is much higher.

No statistically significant improvements in physical function were identified, in conjunction with small effect sizes. Ideally maintenance of muscle mass would enable the body to attenuate any loss in muscular strength that would be expected following surgery, and as a result physical function would also be maintained. Previous literature also has reported
increases in aerobic capacity resulted in accelerated recovery back to baseline levels. Patients who deteriorated during these studies were also found to be at greater risk of post-operative complications (19, 29). With poor physical function being risk factors for poor recovery (77) these results highlight the importance of exercise prior to surgery to maintain base level of physical function during the post-operative recovery period promoting an accelerated recovery.

QoL following surgery is a crucial post-operative outcome, as many patients that undergo surgery experience some impairment of their quality of life. Changes to quality of life often are used to determine the success of the subsequent surgery (78). A 10.1% improvement in mental health component summary score in the intervention compared to a 13% decrease in the control group at six weeks post-surgery demonstrates the ability of a physical exercise program to improve patient QoL in the recovery period. Burke et al. (20) reported increased patient quality of life in patients who underwent an interval aerobic based exercise program displayed improved QoL when compared to the control. Although this study specifically looked at the effect of interval training, similar improvements in patient QoL are seen in our resistance training focussed intervention.

While there was no evidence of statistical significance, the improvements seen in self-reported physical function and upper limb disability at six weeks post-surgery, may affect patient centred outcomes and prove to be significant to the patient. The minimal clinical important change score (MCID) indicates that a threshold of 15.91 points is enough to be effective for the patient themselves as has been validated as the MCID cut-off (70). A 11.6% improvement in self-reported physical function was at six weeks post-surgery is encouraging considering no change was found in the control group while a 31.7% increase was found in the intervention group from baseline. A decrease in patient upper limb disability while not only providing benefit to physical function, may also provide benefits to patient quality of life through decreased levels of pain, disability and increased ability to perform regular activities (10, 32, 55). While the results may not have reached significance, Cook et.al (70) did describe a level to which a patient might expect to see improvement. Therefore, when discussing the improvement in self-reported limb disability while there may not have been the significant difference expected, this may suggest that it is possible there was some benefit observed from a patient centred standpoint.
Whilst resistance based prehabilitation programs have shown potential benefits in improving muscle strength, physical function, upper limb disability and self-reported physical function we discovered no significant differences. There were a number of limitations present in this study; a small sample size as a result of patients not meeting the eligibility criteria, withdrawal or refusal to participate at recruitment resulted in 17 patients participating in the study, substantially less than the 50 patients anticipated, issues surrounding patients being unable to complete certain assessments due to issues such as pain, nausea and fatigue meant intention-to-treat analysis was used to account for any missing data. To avoid issues such as this, assessments that would not be influenced by any external factors should be avoided (i.e. six-minute walk test as opposed to Modified Chester step test for an older population). When discussing protocols, the potential for a cardiac patient on heart rate controlling medication such as beta blockers skewing the data of heart rate dependent tests such as the modified Chester step test was not considered throughout this study. The time constraint of a 2 week resistance based program may cause some limitation to the effectiveness of the program, as typically large changes in muscle mass and physical function often occur over larger time periods as uncovered in previous research (12, 19, 37, 38). Blinding of the participants and researchers was not used during this study primarily due to the type of intervention undertaken during the study.

Our research has demonstrated a resistance-based training program can improve quality of life and muscular strength in general surgery. These improvements promote the increase in patient function prior to surgery in an attempt to reduce the impact of the surgical stress response and promote an accelerated recovery (3, 43). While there were no differences in length of stay or post-operative complications, multiple small effect sizes do not indicate favourable trends for improved physical function, cardiorespiratory fitness, self-reported physical function, and upper limb disability. This study has deemed resistance training to be a feasible form of prehabilitation for this population and future direction for this research requires a larger randomised control trial to understand the benefits of resistance training and its effects on recovery when applied during the pre-operative phase. While improvements may not have been observed in length of stay and post-operative complications, the improvements in patient function prior to surgery provide encouraging support for resistance focused prehabilitation programs.
6.0 References


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Appendix A - Patient Information and Informed consent

PARTICIPANT INFORMATION SHEET

**Short Title:** Preoperative Exercise and Education for Recovery after Surgery (FEERS) Project

**Title:** In general surgery patients, does an individualized prehabilitation exercise program with targeted education, improve patient recovery time and outcomes, compared to usual practice?

**Protocol #:** PEERS V2.2

**Project Sponsor:** Prof David Fletcher, Head of Department, General Surgery, Fiona Stanley Hospital.

**Coordinating Principal Investigator:** Associate Professor Dale Edgar

**Associate Investigators:**
- **FSH Clinicians:** Ms Alix Barrett-Lennard; Prof. Marina Wallace; Mrs Claire Cloney; Dr. Kris Owen.
- **Murdoch University Exercise Researchers:** Dr Brad Wall and Research Assistant (TBC)
- **Curtin University Researcher:** Associate Professor Anne-Marie Hill.
- **The University of Notre Dame Australia Researchers:** Dr Dana Hince (Senior Biostatistician); and, Dr. Jacqueline Francis-Coad.

**Location for Recruitment:** Fiona Stanley Hospital

**Location for Exercise Interventions:** Fiona Stanley Hospital Allied Health Department and Murdoch University Exercise Sport Science Rehabilitation Gym

**What is the project about?**

You are being invited to participate in this project because you are about to undergo surgery at Fiona Stanley Hospital. The aim of the project is to work out if participating in an exercise and education program before surgery leads to better outcomes after your surgery. The research is testing two exercise programs that happen before surgery. The exercise program will be combined with various targeted education. To measure which program is better, you will be asked to complete measures of muscle strength, fitness (step test) and lower limb function, as well as several questionnaires. This research aims to improve our pre-surgery program and outcomes as well as streamline care for patients in the future.

**Who is undertaking the project?**

This project is being conducted by staff, clinicians and researchers from Fiona Stanley Hospital, The University of Notre Dame Australia and Murdoch University. The study is led by Associate Professor Dale Edgar. The project is funded by the Spinnaker Health Research Foundation to promote patient recovery time and outcomes after surgery.
What will I be asked to do?
If you agree to take part in the study before your surgery, you will take part in a weekly exercise routine and keep an exercise diary. Depending on which group you are randomly assigned to will depend what type of exercise you will be asked to do.

Resistance group: If randomly assigned to the resistance exercise group, you will be asked to complete a walking program and up to three (3) gym sessions per week before your surgery at Fiona Stanley Hospital (Physiotherapy Department) and, or Murdoch University Exercise Gym, whichever is most convenient. The gym schedule across both sites is designed to provide flexible access to the supervised exercise sessions.

Walking group: Alternatively, if you are randomly assigned to the walking exercise group, you will be asked to complete a walking program at your own convenience. Targeted education and information resources will be provided to all participants at recruitment or first scheduled (baseline) assessment.

You will also be asked to complete several physical tests which will take around 20-25 minutes. You will also be asked to complete some surveys (to assess the research outcomes which will take about 20-30 minutes. These measurements will be collected prior to your operation, immediately after, at discharge and at six and twelve weeks after operation. Please feel free to ask any questions you may have, and ensure that all your questions have been answered before you agree to participate.

Are there any risks associated with participating in this project?
We do not anticipate any significant risks associated with the exercise program. The exercise routine will be tailored to your current physical level and supervised by experienced clinicians and sports scientists. However, if you feel any symptoms such as light-headedness, persistent chest or shoulder deep aches or nagging pain heart palpitations, suspected strained muscles or ligaments and significant discomfort during the exercises, you do not have to continue the exercise routine. If you experience any of these symptoms, please seek assistance from the staff supervising the gym. If you experience symptoms while walking, you should seek medical assistance from your GP or attend hospital ED, as soon as possible.

What are the benefits of the research project?
While not guaranteed, we hope that by completing exercise and receiving education prior to surgery, you may achieve some direct benefits from this project. Depending on how many weeks prior to your surgery, the programs have the potential to improve, your grip strength, fitness and mobility, confidence during admission and recovery and general physical and mental well-being. Future surgical patients at the hospital may also benefit from your contribution and recommendations to the testing of the program.

What if I change my mind?
Fiona Stanley Hospital Participant Information Sheet & Consent Form
[PEERS study V2.3] [July 13 2018]
Participation in this study is completely voluntary. Even if you agree to participate, you can withdraw from the study at any time without change to your treatment, discrimination or prejudice. If you withdraw, measurements collected and information you have provided can be deleted, if you desire. **Non-participation or withdrawal will in no way whatsoever effect your ongoing treatment at the hospital.**

**Will anyone else know the results of the project?**
Your information will be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law. Computer based information will be stored on the researcher’s laptop only until backed up on a hospital server and protected on the device by 1) Password access to log onto the device; and, 2) Password access to protect the spreadsheet. Once safely backed up on the password protected health server, all identifiable information will be erased from the recording device and, or laptop. Where data is to be shared for analysis, information will be de-identified and then be further protected via encryption on a password protected device.

Once the study is completed, the hard copy questionnaires answers and signed consent forms will be stored securely in a locked filing cabinet on Level 4, Burns Outpatients area at Fiona Stanley Hospital for at least a period of seven years. The digital files containing physiological data collected from you will be de-identified and stored for the same period prior to being disposed of as per the WA Department of Health standards. The data may be used in future research approved by the FSH HREC, should you consent to that, but you will not be able to be re-identified. An example of a future project includes the use of your data as a historical comparison to determine if changes made to the exercise training has improved outcomes. It is anticipated the results of the study will be published or presented as summarised data in a professional scientific journal and, or presented at a health care conference. All data will remain deidentified.

**Will I be able to find out the results of the project?**
Once we have analysed the information from this study we can email you if you provide your address, or mail you a summary of our findings. You can expect to receive this feedback in 2019.

**Who do I contact if I have questions about the project?**
If you have any questions about this project please feel free to contact Associate Professor Dale Edgar, on Ph: 0413070364. We are happy to discuss with you any concerns you may have about this study.

**What if I have a concern or complaint?**
The study has been approved by the South Metropolitan Health Service Human Research Ethics Committee (Approval number PRN1049). If you have a concern or complaint regarding the ethical conduct of this research project and would like to speak to an independent person, please contact the Research Ethics and Governance Unit at (08) 6152 2064 or SMHS.HREC@health.wa.gov.au quoting.
reference number: PRN 1049. Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

How do I sign up to participate?
If you are happy to participate, please sign both copies of the consent form, keep one for yourself and give the other one to the person talking to you about this research. This information sheet is for you to keep. Thank you for your time and consideration. We appreciate your contribution to this study to help improve the outcomes for future surgery patients.

Yours sincerely,

Dale Edgar
Senior Physiotherapist
State Adult Burn Unit
Fiona Stanley Hospital
Assessment of short-term, functional and quality of life outcomes of general surgery patients undergoing the Preoperative Exercise and Education for Recovery after Surgery (PEERS) program

CONSENT FORM
Preoperative Exercise and Education for Recovery after Surgery
(strike out points for which you do not wish to provide your consent)

- I agree to take part in this research project. I have read the Information Sheet provided and been given a full explanation of the purpose of this research project and what is involved in the PEERS program.
- I understand that I will be asked to complete exercise sessions up to three times each week prior to my surgery.
- If assigned to the resistance training group, I understand that I will complete my exercise onsite at either Fiona Stanley Hospital or Murdoch University.
- I understand that I will have physical and survey assessments at the start, before and after my operation, including at six and twelve weeks after surgery.
- I understand that it is expected for me to complete a home walking program and maintain an exercise diary.
- The researcher has answered all my questions and has explained possible risks that may arise as a result of the PEERS program and how these risks will be managed.
- I understand that I may withdraw from participating in the project at any time without prejudice or change to my treatment.
- I understand that all information provided by me is treated as confidential and will not be released by the researcher to a third party unless required to do so by law.
- I agree that any research data gathered for the study may be published provided I remain completely anonymous.
- I understand that research data gathered may be used for future research projects but my name and other identifying information will be removed prior to storage.

<table>
<thead>
<tr>
<th>Name of participant</th>
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<table>
<thead>
<tr>
<th>Signature of participant</th>
<th>Date</th>
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- I confirm that I have provided the Information Sheet concerning this research project to the above participant, explained what participating involves and have answered all questions asked of me.

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<thead>
<tr>
<th>Signature of Researcher</th>
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Appendix B – Education Information: Goal Setting

My Goals

Think of some goals that you may want to achieve prior to and following the surgery. It is beneficial to make these goals specific and have a time frame included so that you can track your progress. Some examples may relate to smoking cessation, exercise or nutrition goals, socialisation and return to work or hobbies.

Before Surgery (short term)

After Surgery (Long Term)
Appendix C – Education Information: Health, Diet and Exercise

Staying active
BEFORE YOUR SURGERY

Keeping fit and strong before your surgery will help your recovery. More active people also have less risk of problems during surgery. If you need to stay in hospital until your surgery ask to see a physiotherapist for help.

You will need advice about what exercises is best for you. This depends on the type of surgery you are having and how soon it is. It can be beneficial to see an exercise physiotherapist or physiotherapist before starting exercises. Ask your local doctor or surgeon about what is most carefull with. It is important to be comfortable with the type of exercise you do. If something feels uncomfortable you should stop doing it.

AUSTRALIAN PHYSICAL ACTIVITY GUIDELINES

Everyone is different, but we should all aim to do some regular exercise.
It helps to improve your fitness, control weight and keep your muscles and joints healthy before surgery. Staying active before your surgery will help you to avoid putting on weight.

Being at a healthy weight before surgery lowers your risk of problems. It also helps you to have a faster recovery.

TRY TO:
- Be active on most days. Doing any physical activity is better than doing none.
- Build up to 30 minutes or more of moderate-intensity physical activity each day.
- Do muscle strengthening activities on at least 2 days each week.

FOR JOINT SURGERY:
Exercising before joint surgery keeps your muscles strong and your joints lubricated, moving and more stable.

Reducing weight will also put less stress on your joints.
Do activities that put less pressure on your joints like:
- Swimming or exercising in water
- Stretching and general strengthening fitness
- Balance exercises
- Cycling

Exercise when your pain medications are having their biggest effect.

FOR HERNIA, BOWEL OR STOMACH SURGERY:
Walking or swimming at a comfortable effort is helpful and safe for most people.

DO NOT DO:
- Heavy lifting or pushing that may result in strain or hold your breath.
- Stomach muscle exercises like sit-ups or push-ups.

FOR MORE INFORMATION GO TO:
- Active and Healthy
- Exercise and Sports Balance Australia
- Australian Physiotherapy Association
- Exercise Right

www.activeandhealthy.nsw.gov.au
www.eosa.org.au
www.physiotherapyasa.org.au
www.exerciseright.com.au

Staying active before your surgery will help to avoid putting on weight.

TO FIND OUT MORE SCAN QR CODE

Surgery Journey
Good nutrition is important for health. It is very important in the time leading up to your surgery. Your body is in its best state to deal with the stress of surgery when you eat a healthy, balanced diet.

It may also help with a faster recovery process.

Poor nutrition can lead to poor outcomes after surgery. Patients who do not eat well are more likely to have problems after surgery. Your wounds may take longer to heal you may get infections and have a longer stay in hospital.

What Does a Healthy Diet Look Like?

Eating from the 6 food groups is important to ensure your body gets all the nutrients it needs. This includes protein, vitamins and minerals.

It is best to be eating a wide variety of healthy foods. It is also important to drink plenty of water and avoid drinking too much alcohol. More than 2 alcoholic drinks a day can increase your risks.

Cider people should eat nutritious foods and keep physically active to help maintain muscle strength.

Staying in a healthy weight range is also important. Speak with your local doctor about seeing a dietitian if you are concerned about your weight. Older people should eat nutritious foods and keep physically active to help maintain muscle strength.

Being overweight increases the chance of diabetes. Diabetes can cause difficulties before, during and after surgery. Have you talked to your local doctor about your risk?

What if I’m having trouble eating?

Poor food intake can lead to problems after surgery. Your wounds may take longer to heal you may get infections and have a longer stay in hospital.

If you are having difficulty eating due to a poor appetite, or have recently lost weight without trying, please let your local doctor or nurse know. A visit with a dietitian might help you. If you are underweight, increasing both protein and total energy (kilocalories or calories) may help you gain weight.

Protein and Energy in food:

Protein is used for growth and repair of body tissues and muscles. To increase protein and energy and help your recovery, try the following:

- Include protein foods as part of every meal and snack.
- Eat three (3) meals and three (3) nourishing snacks each day.
- If your appetite is poor, serve meals on small plates.
- Eat with family & friends or in pleasant surroundings.
- If you are not hungry at meal times try to have a nourishing milk drink or dairy dessert. Not eating may make you feel sick in the stomach.
- Avoid filling up on low calorie foods such as tea, coffee, water, vegetable juices, diet drinks and clear soups.

It is important to keep up healthy food and drinks after surgery to help your wound to heal.

FOR MORE INFORMATION GO TO:
- Australian Dietary Guidelines
- Dietitians Association of Australia
  - www.eatforhealth.gov.au
  - www.das.asn.au
WHAT SHOULD I BE EATING?

<table>
<thead>
<tr>
<th>Category</th>
<th>Serves per day</th>
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<tbody>
<tr>
<td>Vegetables and legumes/beans</td>
<td></td>
</tr>
<tr>
<td>18–59 years</td>
<td>Men 6</td>
</tr>
<tr>
<td></td>
<td>Women 5</td>
</tr>
<tr>
<td>51–70 years</td>
<td>Men 5½</td>
</tr>
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<td></td>
<td>Women 5</td>
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<tr>
<td>70+ years</td>
<td>Men 5</td>
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<td></td>
<td>Women 5</td>
</tr>
<tr>
<td>Fruit</td>
<td></td>
</tr>
<tr>
<td>18–59 years</td>
<td>Men 2</td>
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<tr>
<td></td>
<td>Women 2</td>
</tr>
<tr>
<td>51–70 years</td>
<td>Men 2</td>
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<td></td>
<td>Women 2</td>
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<tr>
<td>70+ years</td>
<td>Men 2</td>
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<td></td>
<td>Women 2</td>
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<tr>
<td>Grain (cereal) foods, mostly wholegrain and/or high cereal fibre varieties</td>
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<tr>
<td>18–59 years</td>
<td>Men 6</td>
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<td></td>
<td>Women 6</td>
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<tr>
<td>51–70 years</td>
<td>Men 4</td>
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<td></td>
<td>Women 3</td>
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<tr>
<td>70+ years</td>
<td>Men 4</td>
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<td></td>
<td>Women 3</td>
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<tr>
<td>Lean meat and poultry, fish, eggs, tofu, nuts and seeds, and legumes/beans</td>
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</tr>
<tr>
<td>18–59 years</td>
<td>Men 3</td>
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<tr>
<td></td>
<td>Women 2½</td>
</tr>
<tr>
<td>51–70 years</td>
<td>Men 2½</td>
</tr>
<tr>
<td></td>
<td>Women 2</td>
</tr>
<tr>
<td>70+ years</td>
<td>Men 2</td>
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<td>Women 2</td>
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<tr>
<td>Milk, yoghurt, cheese and/or alternatives, mostly reduced fat</td>
<td></td>
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<tr>
<td>18–59 years</td>
<td>Men 2½</td>
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<td>51–70 years</td>
<td>Men 2½</td>
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<td>Women 2</td>
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<tr>
<td>70+ years</td>
<td>Men 3½</td>
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<td>Women 4</td>
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My weight in kilograms (kg) with no shoes on: ____________________________  
(for example 60 kg)

My height in centimetres (cm) with no shoes on: ____________________________  
(for example 160 cm tall)

WHAT IS MY BMI?
Body mass index, or BMI, is used to work out if you are in a healthy weight range for your height. Your BMI is important to know before you have anaesthetic medicine.

Google a “BMI calculator” and work out your BMI ____________________________

Tell the hospital your BMI ____________________________

It is best to be eating a wide variety of healthy foods, drink plenty of water and avoid drinking too much alcohol.

Image used with permission from National Health and Medical Research Council.

MY SURGERY JOURNEY 9
Appendix D – Education Information: Drugs and Alcohol

SMOKING, ALCOHOL & ILICIT DRUGS

If you are a smoker, for the sake of your own health, you are encouraged to think about quitting.

Please talk to your local doctor about the choices that are available to support your decision to quit.

To avoid complications you should avoid smoking. Think about quitting at least 60 days before any surgery.

There are many ways to make stopping smoking easier and less stressful. Some are medicines that are available only by prescription, so talk to your local doctor. Over the counter treatments such as nicotine patches, gums, lozenges and sprays work well. They need to be used correctly to get the best from them. Nicotine replacement patches are cheaper if you get a script from your doctor. You can combine them with some nicotine gum, lozenges or spray for the best effect. Ask your doctor or nurse to arrange these for you if you feel the urge to smoke during your stay in hospital.

The Quitline (Call 137 848) can answer any questions you may have. It is confidential and free.

You should not smoke before and after surgery as cigarette smoke can increase your risk of lung and wound infections. Smoking can slow down wound healing. Most patients tell us that even the smell of cigarette smoke can make them feel sick after an anaesthetic, so you should also ask your family and friends not to smoke before visiting you.

Our hospitals are Smoke Free for your health and the health of others. There is no smoking allowed inside any of the buildings or on hospital grounds by patients, visitors or staff. This includes the hospital stairwells, toilets or outside the front of our buildings.

If you drink alcohol regularly, talk with your medical team. It can affect your recovery from surgery.

Heavy alcohol use can cause bleeding during surgery and affect healing afterwards. More than 2 alcoholic drinks each day increases your risk.

If you use illicit drugs, please tell your medical team. This can affect your anaesthetic during surgery and your recovery afterwards. Drugs can change the way your body responds to pain medicines after surgery. We have specialist teams to help people who use drugs.

WE NEED TO KNOW. WE WANT YOU TO TELL US.
Appendix E – Baseline Assessment Sheet

Date of Assessment:

Pt UMRN:

TUG (secs): _________________________

Grip strength (kgs):

<table>
<thead>
<tr>
<th>Grip</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
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<tbody>
<tr>
<td>Left</td>
<td></td>
<td></td>
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<tr>
<td>Right</td>
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Bioimpedance file numbers:
(Rf: forearm sentinel measure of muscle mass – drive humerus and distal 3rd MC: sense – volar wrist crease (ulna styloid) + cubital fossa crease)

Whole body:

Arm:

Leg:
Appendix F – Pre-Surgery Assessment Sheet

Date of Assessment:

Pt UMRN:

Number of PEERS sessions:

TUG (secs):

Grip strength (kgs):

<table>
<thead>
<tr>
<th>Grip</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bioimpedance file numbers:
(R forearm sentinel measure of muscle mass – drive humerus and distal 3rd MC; sense – volar wrist crease (ulna styloid) + cubital fossa crease)

Whole body:

Arm:

Leg:
Appendix G – Post-Surgery Assessment Sheet

**Immediate postop**  Grip strength  QoR15

**Date of Assessment:**
**Pt UMRN:**

**Grip strength (kgs):**

<table>
<thead>
<tr>
<th></th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Quality of Recovery Score (QoR-15)**

**PART A - How have you been feeling in the past 24 hours?**
0 to 10 where 0 = none of the time (poor) and 10 = all of the time (excellent). Circle relevant options.

1. Able to breathe easily
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

2. Been able to enjoy food
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

3. Feeling rested
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

4. Have had a good sleep
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

5. Able to look after personal toilet and hygiene unaided
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

6. Able to communicate with family or friends
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

7. Getting support from hospital doctors and nurses
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

8. Able to return to work or usual home activities
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

9. Feeling comfortable and in control
   - None of the time
   - 0 1 2 3 4 5 6 7 8 9 10
   - All of the time

10. Having a feeling of general well being
    - None of the time
    - 0 1 2 3 4 5 6 7 8 9 10
    - All of the time

**PART B - Have you had any of the following in the last 24 hours?**
10 to 0, where 10 = none of the time (excellent) and 0 = all of the time (poor). Circle relevant options.

11. Moderate pain
    - None of the time
    - 0 1 2 3 4 5 6 7 8 9 10
    - All of the time

12. Severe pain
    - None of the time
    - 0 1 2 3 4 5 6 7 8 9 10
    - All of the time

13. Nausea or vomiting
    - None of the time
    - 0 1 2 3 4 5 6 7 8 9 10
    - All of the time

14. Feeling worried or anxious
    - None of the time
    - 0 1 2 3 4 5 6 7 8 9 10
    - All of the time

15. Feeling sad or depressed
    - None of the time
    - 0 1 2 3 4 5 6 7 8 9 10
    - All of the time
Appendix H – Discharge Assessment Sheet

<table>
<thead>
<tr>
<th>At inpatient discharge</th>
<th>Grip strength, TUG, mCSTE, BIS (forearm)</th>
<th>LOS coded post-op complications</th>
</tr>
</thead>
</table>

**Date of Assessment:**

**Pt UMRN:**

**TUG (secs):** ____________________________

**Grip strength (kgs):**

<table>
<thead>
<tr>
<th>Grip</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bioimpedance file numbers:**

**Whole body:**

**Arm:**

**Leg:**

**LOS:**

**Post op coded complications**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix I – Six-Weeks Post-surgery Assessment Sheet

Date of Assessment:

Pt UMRN:

28 day readmission: yes/no

TUG (secs): __________________________

Grip strength (kgs):

<table>
<thead>
<tr>
<th>Grip</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bioimpedance file numbers:
(R forearm sentinel measure of muscle mass – drive humerus and distal 3rd MC, sense – volar wrist crease (ulna styloid) + cubital fossa crease)

Whole body:

Arm:

Leg:
Appendix J – Twelve-Weeks Post-surgery Assessment Sheet

Twelve (12) weeks postop  Above if attending follow-up at FSH  SF36, QuickDASHes; LLFes
Grip strength; TUG; mCSTes; BIS (forsarm)

Date of Assessment:

Pt UMRN:

TUG (secs):

Grip strength (kgs):

<table>
<thead>
<tr>
<th>Grip</th>
<th>Trial 1</th>
<th>Trial 2</th>
<th>Trial 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bioimpedance file numbers:
(R forearm sentinel measure of muscle mass – drive humerus and distal 3rd MC; sense – volar wrist crease (ulna styloid) + cubital fossa crease)

Whole body:

Arm:

Leg:
Appendix K – SF-36 Questionnaire

SF-36v2 Acute

Your Health and Well-Being

This questionnaire asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Thank you for completing this survey!

For each of the following questions, please mark an x in the one box that best describes your answer.

1. In general, would you say your health is:

<table>
<thead>
<tr>
<th>Excellent</th>
<th>Very good</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Compared to one week ago, how would you rate your health in general now?

<table>
<thead>
<tr>
<th>Much better now than one week ago</th>
<th>Somewhat better now than one week ago</th>
<th>About the same as one week ago</th>
<th>Somewhat worse now than one week ago</th>
<th>Much worse now than one week ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

   |                            |                                        |                               |                                      |                               |

   |                            |                                        |                               |                                      |                               |

   |                            |                                        |                               |                                      |                               |

   |                            |                                        |                               |                                      |                               |

   |                            |                                        |                               |                                      |                               |
3. The following questions are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Yes, limited a lot</th>
<th>Yes, limited a little</th>
<th>No, not limited at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Lifting or carrying groceries</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Climbing several flights of stairs</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Climbing one flight of stairs</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Bending, kneeling, or stooping</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Walking more than a kilometre</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Walking several hundred metres</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Walking one hundred metres</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Bathing or dressing yourself</td>
<td>□ 1                □ 2                      □ 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. During the past week, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

<table>
<thead>
<tr>
<th>Problem Description</th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cut down on the amount of time you spent on work or other activities</td>
<td>□ 1             □ 2                          □ 3                      □ 4                      □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Accomplished less than you would like</td>
<td>□ 1             □ 2                          □ 3                      □ 4                      □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Were limited in the kind of work or other activities</td>
<td>□ 1             □ 2                          □ 3                      □ 4                      □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Had difficulty performing the work or other activities (for example, it took extra effort)</td>
<td>□ 1             □ 2                          □ 3                      □ 4                      □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. During the past week, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a Cut down on the amount of time you spend on work or other activities</td>
<td>□ 1 □ 2 □ 3 □ 4 □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b Accomplished less than you would like</td>
<td>□ 1 □ 2 □ 3 □ 4 □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c Did work or other activities less carefully than usual</td>
<td>□ 1 □ 2 □ 3 □ 4 □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. During the past week, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>Slightly</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ 1 □ 2 □ 3 □ 4 □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. How much bodily pain have you had during the past week?

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Very mild</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Very severe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ 1</td>
<td>□ 2 □ 3 □ 4 □ 5 □ 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. During the past week, how much did pain interfere with your normal work (including both work outside the home and housework)?

<table>
<thead>
<tr>
<th></th>
<th>Not at all</th>
<th>A little bit</th>
<th>Moderately</th>
<th>Quite a bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ 1 □ 2 □ 3 □ 4 □ 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. These questions are about how you feel and how things have been with you during the past week. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past week...

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Did you feel full of life?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>b. Have you been very nervous?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>c. Have you felt so down in the dumbs that nothing could cheer you up?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>d. Have you felt calm and peaceful?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>e. Did you have a lot of energy?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>f. Have you felt downhearted and depressed?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>g. Did you feel worn out?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>h. Have you been happy?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>i. Did you feel tired?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>All of the time</th>
<th>Most of the time</th>
<th>Some of the time</th>
<th>A little of the time</th>
<th>None of the time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th></th>
<th>Definitely true</th>
<th>Mostly true</th>
<th>Don't know</th>
<th>Mostly false</th>
<th>Definitely false</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. I seem to get sick a little easier than other people</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>b. I am as healthy as anybody I know</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>c. I expect my health to get worse</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>d. My health is excellent</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

THANK YOU FOR COMPLETING THESE QUESTIONS
Appendix L – QuickDASH Questionnaire

INSTRUCTIONS

This questionnaire asks about your symptoms as well as your ability to perform certain activities.

Please answer every question, based on your condition in the last week, by circling the appropriate number.

If you did not have the opportunity to perform an activity in the past week, please give your best estimate on which responses would be the most accurate.

It doesn’t matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.

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Australian English translation developed by Oxford Outcomes Ltd, Oxford, UK under contract by GlaxoSmithKline, UK
Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

<table>
<thead>
<tr>
<th>Activity</th>
<th>No Difficulty</th>
<th>Mild Difficulty</th>
<th>Moderate Difficulty</th>
<th>Severe Difficulty</th>
<th>Unable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Open a tight or new jar.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Do heavy household tasks (e.g., wash walls, wash floors).</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Carry a shopping bag or briefcase.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Wash your back.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Use a knife to cut food.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>Not at All</th>
<th>Slightly</th>
<th>Moderately</th>
<th>Quite a Bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>Not Limited at All</th>
<th>Slightly Limited</th>
<th>Moderately Limited</th>
<th>Very Limited</th>
<th>Unable</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Please rate the severity of the following symptoms in the last week. (Circle number)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Not at All</th>
<th>Slightly</th>
<th>Moderately</th>
<th>Quite a Bit</th>
<th>Extremely</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Arm, shoulder or hand pain at all.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Tingling (pins and needles) in your arm, shoulder or hand.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>No Difficulty</th>
<th>Mild Difficulty</th>
<th>Moderate Difficulty</th>
<th>Severe Difficulty</th>
<th>So Much Difficulty That I Can't Sleep at All</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? (Circle number)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

QuickDASH Disability/Symptom Score = \((\frac{1}{5} \times \text{Symptom Score}) - 1\) x 25,
where n is equal to the number of completed responses.

A QuickDASH score may not be calculated if there is greater than 1 missing item.
**QuickDASH**

**WORK MODULE (OPTIONAL)**

The following questions ask about the impact of your arm, shoulder or hand problem on your ability to work (including homemaking if that is your main work role).

Please indicate what your job/work is: 

- [ ] I do not work. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week.

<table>
<thead>
<tr>
<th>Did you have any difficulty:</th>
<th>NO DIFFICULTY</th>
<th>MILD DIFFICULTY</th>
<th>MODERATE DIFFICULTY</th>
<th>SEVERE DIFFICULTY</th>
<th>UNABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. doing your work in your usual way?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. doing your normal duties at work because of arm, shoulder or hand pain?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. doing your work as well as you would like?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. spending your usual amount of time doing your work?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**SPORTS/PERFORMING ARTS MODULE (OPTIONAL)**

The following questions relate to the impact of your arm, shoulder or hand problem on playing your *musical instrument* or *sport or both*. If you play more than one sport or instrument (or play both), please answer with respect to that activity which is most important to you.

Please indicate the sport or instrument which is most important to you: 

- [ ] I do not play a sport or an instrument. (You may skip this section.)

Please circle the number that best describes your physical ability in the past week.

<table>
<thead>
<tr>
<th>Did you have any difficulty:</th>
<th>NO DIFFICULTY</th>
<th>MILD DIFFICULTY</th>
<th>MODERATE DIFFICULTY</th>
<th>SEVERE DIFFICULTY</th>
<th>UNABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. using your usual technique for playing your instrument or sport?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. playing your musical instrument or sport because of arm, shoulder or hand pain?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. playing your musical instrument or sport as well as you would like?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. spending your usual amount of time practising or playing your instrument or sport?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**SCORING THE OPTIONAL MODULES:** Add up assigned values for each response; divide by 4 (number of items); subtract 1; multiply by 25.

An optional module score may not be calculated if there are any missing items.
Appendix M – Lower Limb Functional Index Questionnaire

LOWER LIMB FUNCTIONAL INDEX-10

NAME: ___________________ INJURY ___________________

DATE: ___________ □ LEFT LEG □ RIGHT LEG

PLEASE COMPLETE ALL 4 PARTS - Each part has a separate score.

Your lower limb (leg) may make it difficult to do some things you normally do. This list contains sentences people use to describe themselves when they have such problems. Think of yourself now or over the last few days. If an item describes you, mark the box ‘Partly’ or ‘Yes’. If an item does not describe you, mark the box ‘NO’.

DUE TO MY LEG:

☐ ☐ ☐ 1. I avoid heavy jobs e.g. cleaning, lifting more than 5kg or 10lbs, gardening etc.
☐ ☐ ☐ 2. I have the pain / problem almost all the time.
☐ ☐ ☐ 3. I have difficulty with normal home or family duties and chores.
☐ ☐ ☐ 4. I sleep less well.
☐ ☐ ☐ 5. I need assistance with personal care e.g. washing and hygiene.
☐ ☐ ☐ 6. My regular daily activities (work, social contact) are affected.
☐ ☐ ☐ 7. I am unable to move as fast as I would wish.
☐ ☐ ☐ 8. I have difficulty with prolonged or extended standing.
☐ ☐ ☐ 9. I have difficulty bending, squatting and / or reaching down.
☐ ☐ ☐ 10. I have problems with my balance on uneven surfaces and/or with unaccustomed footwear.

LLFI SCORE: To score the Upper Part - Add the Marked Boxes:

TOTAL (LLFI Points) 100 Scale (± 1) 100 - Total = ___________ Δ 96

MDC (95% Confidence): 0.07% or 1.47 LLFI points. Change less than this may be due to error.

Numerical Rating Scale (NRS)

In the last few days, on a whole person due to my leg, rate the severity of your Overall Status compared to before the injury?
Total: ___________ 0 1 2 3 4 5 6 7 8 9 10

Worst Possible Half Way Normal / No Problem
Appendix N – Quality of Recovery Questionnaire

### Quality of Recovery Score (QoR-15)

**PART A - How have you been feeling in the past 24 hours?**

0 to 10 where 0 = none of the time (poor) and 10 = all of the time (excellent). Circle relevant options.

<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Able to breathe easily</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Been able to enjoy food</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Feeling rested</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>Have had a good sleep</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Able to look after personal toilet and hygiene unaided</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Able to communicate with family or friends</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Getting support from hospital doctors and nurses</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>Able to return to work or usual home activities</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>Feeling comfortable and in control</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>10</td>
<td>Having a feeling of general well being</td>
<td>None of the time</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

**PART B - Have you had any of the following in the last 24 hours?**

10 to 0, where 10 = none of the time (excellent) and 0 = all of the time (poor). Circle relevant options.

<p>| | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Moderate pain</td>
<td>None of the time</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>Severe pain</td>
<td>None of the time</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>Nausea or vomiting</td>
<td>None of the time</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>Feeling worried or anxious</td>
<td>None of the time</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>Feeling sad or depressed</td>
<td>None of the time</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix O – Modified Chester Step Test Collection Sheet

**PRE-HABILITATION GYM**

<table>
<thead>
<tr>
<th>Chester Step Test</th>
<th>Entered?</th>
<th>Pred. HR Max</th>
<th>80% HR Max</th>
<th>Rest HR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mins</td>
<td>Heart Rate</td>
<td>BORG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
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<td>6</td>
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<td>8</td>
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<td></td>
<td>9</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>10 – Weight 2kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 – Weight 4kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>14 – Weight 6kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>16 – Weight 8kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>18 – Weight 10kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total Test Time (Sec):</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>RPE:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix P – Clavian-Dindo Grading Classification

<table>
<thead>
<tr>
<th>Grade</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deviation from the normal post-operative course without the need for pharmacological treatment or surgical, endoscopic and radiological intervention. Acceptable therapeutic regimens are: drugs as antiemetics, antipyretics, analgesics, diuretics and electrolytes and physiotherapy. This grade also included wound infections opened at the bedside.</td>
</tr>
<tr>
<td>2</td>
<td>Requiring pharmacological treatment with drugs other than such allowed for grade 1 complications. Blood transfusions, antibiotics and total parenteral nutrition are also included.</td>
</tr>
<tr>
<td>3</td>
<td>Requiring surgical, endoscopic or radiological intervention</td>
</tr>
<tr>
<td>3a</td>
<td>Intervention under regional/local anaesthesia</td>
</tr>
<tr>
<td>3b</td>
<td>Intervention under general anaesthesia</td>
</tr>
<tr>
<td>4</td>
<td>Life-threatening complication requiring intensive care/intensive care unit management</td>
</tr>
<tr>
<td>4a</td>
<td>Single organ dysfunction</td>
</tr>
<tr>
<td>4b</td>
<td>Multi-organ dysfunction</td>
</tr>
<tr>
<td>5</td>
<td>Patient demise</td>
</tr>
</tbody>
</table>