UNIVERSITÉ DU QUÉBEC À MONTRÉAL

BODY COMPOSITION OF CANCER SURVIVORS AND RISK OF SHOULDER DYSFUNCTION IN PATIENTS PREPARING FOR BREAST SURGERY

THESIS

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COMPOSITION CORPORELLE DES SURVIVANTES DU CANCER

ET

RISQUE DE DYSFONCTION DE L'ÉPAULE

CHEZ LES PATIENTES QUI SE PRÉPARENT POUR LA CHIRURGIE DU SEIN

THÈSE

PRÉSENTÉE

COMME EXIGENCE PARTIELLE

DU DOCTORAT EN BIOLOGIE

PAR

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FOREWARD

Over the last fifteen years there has been an increased emphasis on taking a preventative approach to reduce the risk of developing different chronic diseases including certain types of cancers. Between 2020 and 2030 it is expected that cancer will overtake cardiovascular disease as the number one cause of death in the world. The literature has shown that some types of cancers and some of the side effects associated with cancer treatment may be diminished by adopting the following recommendations: 1) leading a physically active lifestyle; 2) maintaining a healthy weight throughout one's lifetime; 3) avoiding the use of tobacco; 4) limiting the use of alcohol. These guidelines have been around for the past decade and were endorsed at the Montréal 2012 World Cancer Congress.

In January 2008 a link was established with the Ville-Marie Medical Centre (VM Medical) where these preventative approaches could be implemented. A two-year process was undertaken to create an integrative health and wellness centre at VM Medical. Tasks included carrying out an in-house survey, defining the mission statement for the wellness center, designing the layout of the facility and finally, outlining the services that would be provided to patients. In the Fall of 2009 the VM Medical Integrative Health and Wellness Centre (WC) opened its doors; however, it would take another half-year before protocols would be developed and integrated with the medical team, including how the outcomes measures would be entered in to the electronic database. After 2 ½ years of work, we were ready to begin the initial data collection process. The goal was to standardize the evaluation process in regards to body composition and blood pressure values, implement preventative protocols to address treatment, and advise women on healthy lifestyle choices. The importance of standardizing this intake evaluation and integrating it with the patient's visit to the physician served to minimize the patient's stress during the testing process and delivered

important information to the medical team. The thesis presented here includes a portion of the information that has been collected thus far at the WC.

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RÉSUMÉ

OBJECTIFS

Cette thèse visait trois objectifs. Le premier consistait à créer un ensemble de tests normalisés à intégrer au processus de dépistage courant au Centre médical Ville-Marie (VM Médical), spécialisé dans la prévention, la détection, le diagnostic et le traitement du cancer du sein. Le deuxième objectif était de repérer les femmes risquant de développer diverses maladies cardiovasculaires et chroniques, et certains types de cancer. Le troisième objectif visait à déterminer quelles femmes risquent de souffrir de problèmes d'épaules à la suite d'une chirurgie.

MÉTHODOLOGIE

Les patientes de VM Médical ont été soumises à l'une des deux évaluations. Chez celles évaluées pendant leur bilan de santé annuel, les valeurs de la composition corporelle et de la pression sanguine ont été mesurées, puisqu'elles contribuent à déterminer le risque de maladies cardiovasculaires. Les patientes devant subir une chirurgie ont été soumises à un ensemble de tests sur la mobilité de l'épaule avant et après la chirurgie. Elles ont également reçu de l'information sur la chirurgie mammaire et les mesures à prendre pour minimiser les problèmes à la suite de la chirurgie.

RÉSULTATS

Selon l'analyse préliminaire des résultats de 9 315 patientes, les femmes ayant survécu à un cancer (C), qui ont été traitées contre cette maladie, étaient plus susceptibles de présenter des résultats défavorables concernant la circonférence de la taille, l'indice de masse corporelle (IMC) et la pression sanguine que les patientes régulières (R) qui n'ont reçu aucun traitement. Dans le groupe C, une corrélation faible a été constatée entre la circonférence de la taille et la pression sanguine.

Un sous-ensemble de 1 596 patientes, regroupant 262 patientes C et 1 334 patientes R, a également été évalué. Dans ce sous-ensemble, les valeurs de la pression sanguine, de la masse grasse et de la masse maigre ont été comparées. D'importantes différences entre les patientes C et R ont été relevées dans la plupart des résultats. De plus, une forte corrélation a été établie entre les valeurs de la masse grasse et de la pression sanguine dans le groupe C.

Dans un deuxième ensemble de données recueillies auprès de 4 300 patientes, une analyse a été réalisée pour déterminer les répercussions de la chirurgie et des différentes formes de traitement du cancer sur la composition corporelle et la pression sanguine. Les 747 femmes du groupe C ont été stratifiées selon les interventions chirurgicales mammaires courantes qu'elles ont subies. Les résultats de l'analyse indiquent que plus

les interventions n'étaient invasives, plus les patientes présentaient des résultats défavorables.

Ces données ont aussi été analysées en fonction des interventions thérapeutiques. L'analyse a démontré que les patientes ayant subi le plus de traitements présentaient les facteurs de risque de maladies cardiovasculaires les plus élevés, surtout parmi celles âgées de 40 à 49 ans. Un groupe constituait une anomalie par rapport à cette tendance : les femmes ayant subi une mastectomie, en particulier celles ayant subi une chirurgie seulement, sans aucun autre traitement. Ce groupe présentait aussi un risque accru de maladie cardiovasculaire comparativement aux patientes du groupe R.

Dans une autre analyse, 102 patientes ont été soumises à des tests avant et après la chirurgie. Selon les résultats des tests pré-chirurgicaux, un nombre élevé de femmes présentaient un conflit sous-acromial et un syndrome de la traversée thoracobrachiale. Les résultats des tests post-chirurgicaux ont démontré une diminution de la flexion de l'épaule, dont l'importance dépendait du type de chirurgie. La perte était supérieure chez les patientes ayant subi une mastectomie complète comparativement à celles ayant subi une mastectomie partielle.

CONCLUSION

Les femmes ayant reçu un traitement contre le cancer affichaient des valeurs défavorables par rapport aux autres en ce qui concerne la composition corporelle et la pression sanguine, et courraient donc un risque plus élevé de maladies cardiovasculaires. Il convient de souligner que ce risque accru était peut-être présent avant le traitement ou peut avoir été exacerbé par le traitement.

Le traitement vise principalement à atténuer les conséquences du cancer. Malheureusement, il peut entraîner certains problèmes secondaires, par exemple un risque accru de maladies cardiovasculaires et métaboliques. Comprendre ces risques contribuera à améliorer la qualité de vie des personnes survivant au cancer.

Mots-clés: cancer du sein, pression sanguine, composition corporelle, conflit sous-acromial

ABSTRACT

OBJECTIVES

The objectives of this thesis were three-fold. The first objective was to establish a series of standardized testing procedures to be included in the regular screening process at the Ville-Marie Medical Centre (VM Medical), a centre that specializes in the prevention, detection, diagnosis and treatment of breast cancer. The second objective was to identify women who may be at risk for various cardiovascular and chronic diseases, as well as at risk of developing certain types of cancers. The third objective was to identify women who may be at risk for shoulder problems associated with a surgical intervention.

METHODOLOGY

Patients at VM Medical underwent one of two different evaluations. Patients who were being evaluated as part of their annual medical examination, had body composition and blood pressure values measured to help assess their level of risk for cardiovascular disease. Patients who were scheduled for surgery, underwent a series of pre and post-surgery shoulder mobility tests, and were also provided with information on what to expect with breast surgery and what to do to minimize post-surgical problems.

RESULTS

Preliminary analysis of 9,315 female patients found that cancer survivors (CS), who received cancer treatment, were more likely to have poorer outcome measures related to waist circumference, body mass index (BMI) and blood pressure compared to regular (R) patients who had not received any treatment. A weak correlation was found between waist circumference and blood pressure in the CS group.

A subset group of 1,596 patients made up of 262 CS and 1,334 R patients were also evaluated. In this analysis, blood pressure, body fat and lean muscle mass were compared. Significant differences were observed between CS and R patients in most measurements and a good correlation was seen between body fat and blood pressure values in the CS group.

In a second set of data collected on 4,300 patients, an analysis was conducted to determine how surgery and different forms of cancer treatment affected body composition and blood pressure values. The 747 women in the CS group were stratified according to common surgical interventions for breast surgery. The analysis showed that the more invasive the intervention the women received, the poorer were the outcome measures.

The same data was analyzed based on treatment intervention. The more treatment the patient received, the greater the impact was on cardiovascular risk factors especially,

in the 40-49 age group. The one group that was an anomaly from this trend was the mastectomy group, in particular those who had surgery alone and no other treatment. This group also exhibited increased risk of cardiovascular disease compared to the R patients group.

In another analysis, 102 patients were tested before and after surgery. Pre-surgery testing demonstrated that a significant number of the women had positive tests for shoulder impingement and thoracic outlet problems. Post-surgery testing showed a decrease in shoulder flexion, the significance of which, depended on the type of surgery performed. Patients that underwent a full mastectomy were affected more severely than patients who underwent a partial mastectomy.

CONCLUSION

Women who received cancer treatment displayed poor body composition and blood pressure values, creating a risk for cardiovascular disease. Note that this risk may have been present before treatment and/or exacerbated by treatment.

The primary goal of treatment is to address the underlying problems associated with cancer. Unfortunately, treatment can lead to some secondary problems such as increased risk for cardiovascular disease as well as metabolic diseases. Understanding these risks could help improve the quality of life for cancer survivors.

Keywords: Breast cancer, blood pressure, body composition, shoulder impingement

CHAPTER I

INTRODUCTION - REVIEW OF THE CURRENT LITERATURE

1.1 Breast Cancer

Over the past 15 years there has been a growing body of evidence to indicate that people who are diagnosed with cancer should utilize exercise to diminish the negative effects of cancer therapy (Kruijsen-Jaarsma et al., 2013). The idea of exercise having a positive impact on someone's life has even gone one step further. Major health organizations have started to take the position that people can reduce their risk of developing certain types of illnesses and cancers if they include exercise as part of their daily activities (World Cancer Research Fund, 2007). These same health organizations have also indicated that once someone has had cancer and undergone adjuvant therapy, they should include regular physical activity as a way to reduce their risk of the cancer re-occurring (World Cancer Congress, 2012).

There are over 200 different types of cancers (MacDonald, Ford and Casson, 2004).This research project focused on one type of cancer, that is, breast cancer. Breast cancer is the most common cancer affecting women around the world, accounting for 23% of all cancers worldwide. According to Statistics Canada, it is estimated there will be approximately 22,800 new cases and 5, 000 deaths from this disease in Canadian 2013 (Canadian Cancer Society/Statistics Canada, 2013). Breast cancer in Canada accounts for 26% of all women's cancers. About 1 in 9 women will develop breast cancer in their life time. Due to advances in prevention, early detection and treatment, however, the number of women surviving breast cancer has increased dramatically in recent years.

Epidemiologic studies have linked obesity and low levels of physical activity with an increased risk of breast cancer (Brown et al., 2003; Thune and Furberg, 2001). Clinical and epidemiologic studies have also identified obesity and weight gain as important negative prognostic factors for survival among women with this disease (Chleboski, et al., 2002). Physical activity has been associated with weight loss and weight maintenance among healthy individuals (Irwin et al., 2004; Wing, 1999). Studies have shown a favourable effect of exercise on body weight among breast cancer survivors (Rock and Demark-Wahnefried, 2002; Irvin et al., 2004). Despite the evidence indicating that regular physical activity can protect against weight gain, decrease breast cancer risk, and potentially improve breast cancer prognosis, efforts to encourage physical activity are not a routine part of the cancer treatment or rehabilitation process. Rarely are the topics of exercise and levels of activity addressed or even considered when patients are consulting with their physicians. The evidence is conclusive that physical activity for women before, during and after breast cancer therapy has a positive influence on the women's overall health. Physical activity intervention researchers have been faced with similar challenges when evaluating activity levels and developing effective strategies aimed at physical activity behaviour (Vallance et al., 2007). Unfortunately despite the reported benefits of physical activity, the majority of breast cancer survivors are not meeting public health guidelines (at least 150 min/wk. of moderate-to-vigorous intense physical activity) (Irvin et al., 2004). This difficulty to modify breast cancer survivors' physical activity behaviour seems to extend to the general population.

Several questions need to be asked: 1) Are women interested in finding out about exercise? 2) Are women utilizing the available resources to learn about exercise? 3) Are women actually changing their activity habits? 4) Are these changes in physical activity habits being reflected in women's body compositions and levels of fitness?

The first question was addressed in a preliminary survey that was performed at VM Medical in 2007. The survey was performed to gain a better understanding of the interest

patients of the clinic would have in receiving information and guidance on exercise (Jones et al., 2008). The in-house survey helped to evaluate the interest in establishing an onsite fitness center for the women at VM Medical. Over a one-month period, 606 women at the clinic were asked about their level of activity, their interest in receiving direction on exercise and exercise rehabilitation, and whether they would make use of a local facility to exercise (Jones et al., 2008). The survey indicated that 45.4% (276) of the women considered themselves regular exercisers, 43% (263) of the women would be interested in receiving individual instruction on exercise and 34% (203) of the women would like the service to be available at VM Medical.

The results of the survey led to the opening of a fitness centre at VM Medical in November 2008. This led to the following questions: Has the establishment of a fitness program at VM Medical had an impact on the fitness level and body composition of the clientele? Is there a difference in cardiovascular risk factors between women who have been treated for breast cancer and women who are part of the regular patient clientele?

1.2 Shoulder problems associated with treatment for breast cancer

A number of studies have looked at the impact exercise has on people undergoing cancer therapy (Kruijsen-Jaarsma et al., 2013). Some studies have evaluated women before and after chemotherapy. However, many studies are done in a post-hoc manner, often after the completion of adjuvant therapy. The physical condition of the women before any type of exercise / physical activity interventions has gone relatively unstudied. For example, it is unclear how many women present with underlying shoulder pathology since current fitness levels and physical activity histories are seldom reported. When these measures are obtained, it is often after the initial intervention of cancer treatment; many times the measures are never taken. This is why it has been recommended that screening for pain and range of motion (ROM) restrictions has become an integral part of breast cancer follow-up care (Thomas-Maclean et al., 2008).

Aside from the lack of physical activity, survivors of breast cancer must deal with a host of physical, psychological and sociological problems that can occur with treatment. At this point it is appropriate to review some of the expected challenges women may encounter while undergoing therapy.

Breast cancer therapy may cause unfavourable changes in physical functioning, body composition, psychosocial functioning, and quality of life (QOL) (Courneya et al., 2007). Some of the limitations may include: 1) Weight gain, a commonly reported side effect of adjuvant chemotherapy (Campbell et al., 2007); 2) Breast cancer-related lymphoedema (BCRL) - a chronic swelling that can occur in the ipsilateral hand or arm of women treated for breast cancer (Lane et al., 2005); 3) Pain and ROM (Thomas-Maclean et al., 2008); 4) Overall body fatigue during and after treatment (Dimeo et al., 2008); and 5) Decrease in physical activity level leading to changes in body composition that may have important health implications for survivors (Campbell et al., 2007).

It is clear that the need to regain shoulder mobility exists for this cohort of women, to avoid prolonged shoulder problems. One approach that maybe utilized to address this problem is to control the amount of post-operative pain the women are enduring so that they may begin to move their arm. Research projects by different groups (Kilgour et al., 2007) try to minimize the amount of post-operative shoulder dysfunction that does take place through the use of a home-based exercise program, but there is still much work to be done.

Certainly having a portion of one's body removed is a very traumatic event but in comparison to many types of orthopedic surgery in and around the shoulder, this intervention is considered minor surgery (Leidenius et al., 2003). Oncology physicians are still not certain why so many women run into problems, yet many of the women who do undergo this regime of treatment are at risk for developing chronic arm, shoulder and neck problems (Leidenius et al., 2003).

Delay in, or lack of, immediate post-operative exercise may result in adverse outcomes such as spasm of the musculature surrounding the joint, muscle atrophy, tightening of the shoulder capsule and decreased short-and long-term functional mobility, leading to chronic immobility and pain (Kilgour et al., 2008).

Concerning shoulder function, two comparative studies have described significantly less impaired function after Breast Cancer Therapy (BCT) compared to ROM and moderately impaired shoulder mobility reported after BCT. Other studies have found no significant differences in such impairment between patients treated for BCT or ROM (Enrst et al., 2002; Kuehn et al., 2000).

It is possible that women may be predisposed to developing problems in the upper body. Thus, it may also be important to look at other areas of daily living where women may be at risk for developing pain in the neck, shoulder and arm regions. These predispositions to developing upper body complications are outlined in the following section.

Women who have a pre-existing shoulder problem:

A number of studies have shown that workers, performing the same movements over prolonged periods of time, are prone to be at risk of developing chronic musculoskeletal dysfunction and possibly neurological problems. These workers fall into a number of occupational groups, from manual labourers, workers in jobs that are considered hazardous (e.g. forestry), assembly line workers, professional support staff, and office workers, to name a few. In this project we focused on office workers whose jobs require them to spend a good portion of their workday at computer terminals. Over time this group demonstrated that they were at risk of developing problems in the neck, shoulder and arm regions (Johansson et al., 2003; Luime et al., 2004). These problems may include pain in the neck due to muscle tension, possibly leading to tension headaches. The pain in the shoulder region may be due to tendonitis (Lundberg et al., 1999), possible nerve

entrapment, causing periodic numbness (Pascarelli and Hsu, 2001), thoracic outlet, or brachial plexopathies (Mense and Simons, 2001). The pain in the elbow/forearm region may be related to lateral or medial epicondylitis (Johansson et al., 2003). Finally pain in the wrist, hand and finger may be due to carpal tunnel syndrome and/or Dequarvian syndrome (Rice et al., 1996).

A common thread among workers who experience pain in the neck, upper torso and arm regions, is that they are often asked to perform a task(s) that requires a muscle or group of muscles to maintain a static position for a prolonged period of time (Mense and Simons, 2001). This may be somewhat contrary to what many people may think leads to an increase in the risk of problems. The general population may believe that only workers who perform tasks that involve large muscle groups, like manual labourers, would be at risk. This perception has led to a delay in understanding and appreciating the impact of low intensity and repetitive movement have on the worker's body (Mense and Simons, 2001).

Women seem to be at greater risk for developing pain in the neck, shoulder and arm regions in comparison to men (Chesterton et al., 2003). Women often comprise a significant portion of different occupations (Sorock and Courtney, 1996) that are most at risk to upper body injuries. Men have also been shown to have repetitive injury syndrome, but not to the same extent as women. When evaluating the work of men and women who work on production lines, there is a similarity in the type of chronic injuries that occur (Westgaard and Winkel, 1996), although women seem to be affected to a greater extent. There is growing consensus that musculoskeletal disorders may be related to the occupational activities of the individuals (Punnett and Wegman, 2004) but it is still unclear how much predisposing factors play a role in a worker developing musculoskeletal disorders. A common trend that is seen in many of these studies is the high prevalence of neck–shoulder pain in females (Chesterton et al., 2003).

An evaluation of muscle fiber composition in the trapezius muscle of the neck and shoulder region, showed a significant difference between men and women (Lindman et al; 1990, and 1991). This study led to speculation that women maybe at greater risk for developing neck, shoulder and arm problems. Through the use of muscle biopsies, a significantly greater proportion of type 1 muscle fibers were found in the trapezius muscle of women in comparison to men (Lindman et al., 1990; 1991). Thus, having a greater composition of type 1 (slow twitch fatigue resistant) fibers in the trapezius muscle would perhaps allow a worker not to fatigue as quickly when performing low intensity tasks, in comparison to type 2 fibers. On the other hand, having a greater composition of type 2 fibers (fast twitch non-resistant to fatigue) in the trapezius muscle, a worker would be able to generate greater explosive contractions/force, but would fatigue quicker. This initial investigation led Lindeman et al., (1991) to evaluate the way women and men perform the same activity, specifically data entry. The women involved in the study were shown to use shoulder, arm and wrist motions in a different manner compared to men and were expending significantly more energy. The women were also often found to be much more effective at entering large volumes of data compared to men. Entering more data and expending more energy may also be two factors that have contributed to women experiencing more pain while performing this task in comparison to men, who used less energy as well as entered less data (Lindman, Eriksson and Thornell, 1990).

Karlqvist et al. (2003) believe that workers that are in poor physical condition are at greater risk for developing pain and dysfunction in different regions of the body. Their work has shown that workers, both men and women, but in particular women, are not in good physical condition and that the jobs they perform on a regular basis do not improve their fitness level. If anything, the jobs tend to be deleterious to workers' health (Chesterton et al., 2003).

It has been shown that many women are at risk of developing musculoskeletal pain in the upper body particularly the neck and shoulder regions. Often the jobs that they

perform along with the muscle fiber composition in their neck and shoulder region place them at greater risk of developing pain in these two locations compared to men (Chesterton et al., 2003; Johansson et al., 2003).

It would be expected that any pain a woman experiences in the neck and shoulder regions would have a lower priority once a lump in the breast has been discovered and surgery is recommended. It is unclear how many women who begin adjuvant therapy are dealing with musculoskeletal restrictions in these areas. Thus the above discussion leads to the following question: Does the presence of pre-existing upper body dysfunction prolong the recovery time for women who are undergoing breast sparing surgery?

Research has indicated that women who work outside of the home appear to be at greater risk of developing orthopaedic problems in the neck, shoulder and arms. Furthermore, women in western society also appear to be at greater risk for developing breast cancer compared to their eastern counterparts. The goal of this project is to evaluate the possible link between breast cancer therapy and the risk of developing upper body dysfunction in women who are undergoing adjuvant therapy. We believe that a number of women may already be at risk for developing problems in the upper body and that breast cancer therapy further increases their risk of dysfunction. Understanding the risk and implementing preventative strategies may help these women better tolerate the treatment protocols.

It seems apparent from the above discussion that the need to regain shoulder mobility exists for this cohort of women in order to avoid prolonged shoulder problems. One approach that may be utilized to address this problem is to control the amount of post-operative pain the women are enduring so that they may begin to move the afflicted ipsilateral arm. Exercise is a popular method to address limited shoulder and arm ROM (Kilgour et al., 2007).

1.3 Summary of Introduction

Consistent with the requirements of a doctoral thesis, this was a multi-staged project made up of the following five stages;

Stage 1

In stage 1 of the project, I began with are view of the patient file database at VM Medical. The initial objective was to determine the cardiovascular risk of the women at the Centre, which led to evaluating the possibility of implementing standardize procedures for obtaining the anthropometric measurements, and blood pressure and resting heart rate values of the women. Also, testing of cancer survivors (CS) and regular (R) patients was done to see whether there were any differences between the two groups. We note a relationship between blood pressure and waist circumference in both of the groups.

Stage 2

In stage 2 of the project, we investigated the use of bioimpedance to measure body composition in CS and R patients. The additional information provided from bioimpedance allowed us the opportunity to evaluate the relationship between body fat and blood pressure.

Stage 3

In stage 3 of the project we utilized the standardized measurements of stage 1 and took into consideration the type of surgery and treatment that the women underwent. We then stratified the women according to the type of surgery and treatment they received.

Stage 4

In stage 4 of the project we looked at the incidence of pre-existing shoulder dysfunction and shoulder range of motion ROM in women preparing for breast surgery.

Stage 5

In stage 5 of the project we implemented the Jones template (Jones et al, 2007) to evaluate women who were about to undergo surgery associated with breast cancer. The template evaluation was included in the regular pre-surgery and post-surgery evaluation process.

At this stage the evaluator used the Jones template along with orthopaedic testing to evaluate if the women presented with upper body problems in addition to a diagnosis of a suspicious breast mass. The expectation was that the women who already had problems in the upper body before surgery were much more likely to continue to have problems after surgery.

1.4 Hypotheses

The working hypothesis was that cardiovascular risk factors were related to deleterious changes in body composition. The specific hypothesis for each stage of the project are as follows;

Stage 1

The hypothesis for this stage was that anthropometric measurements are directly proportional to deleterious cardiovascular risk factors.

Stage 2

For stage 2 the hypothesis was that an increase in resolution of body composition provided by bioimpedance analysis discriminates cardiovascular risk factors between cancer survivors (CS) and regular (R) patients.

Stage 3

The hypothesis for stage 3 was that cancer surgery and treatment type has a negative effect on both body composition and cardiovascular risk factors in CS when compared to R patients.

Stage 4

In this stage the hypothesis was two-fold. First, we expected that a number of women would be at risk for developing shoulder problems before breast surgery. Secondly, we suspected that some of the women were not meeting recommended fitness standards and that there would be a difference between CS and R patients.

Stage 5

We expected that certain locations on the Jones template would be more sensitive than other locations for breast cancer patients.

CHAPTER II

METHODOLOGY

2.1 Primary screening of VM Medical patient database

2.2 Stage 1: Preliminary evaluation

As part of the standard intake evaluation, patients waiting to meet with one of the physicians at the WC underwent a series of tests administered by one of the Centre's kinesiologists. Results from tests, which included vital signs and body composition measurements, were entered into VM Medical's electronic medical records. Each patient that came to VM Medical was asked to review and consider signing a consent form that allowed for their medical information to be entered into the electronic database. The information that was extracted from the electronic database and which was used for this study, was stripped of personal information so that no individual could be identified. The electronic database was used by the medical team to monitor and address patient needs. This study was approved by VM Medical Ethics Board and conformed to the World Medical Association (WMA) Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects.

As part of the preparation for testing, patients were asked to refrain from smoking or drinking caffeine products for at least 4 hours prior to testing. Before testing began, patients were also asked if they needed to use the washroom to void any fluids. Testing of the patient took place in a medical evaluation room, away from the main clinic area. The kinesiologist explained to the patient the purpose for the testing. After approximately 5 minutes the patient was then given the opportunity to relax and ask questions before the testing began.

Resting heart rate and blood pressure values were obtained through the use of an automated sphygmomanometer (Physiologic Auto-memory 90; AMG Medical Inc., Montréal Canada). The patient's left arm was used for testing. If the patient had breast surgery on the left side of their torso with lymph node(s) removed, the right arm was used.

The cuff was wrapped around the upper arm and was supported at the level of the heart. The cuff was aligned with the brachial artery. If measurements obtained on the patient were outside of expected values for the patient's age group, the test was repeated after a 5-minute waiting period.

The patient's height was taken using a stadiometer (equipment used for measuring height, consisting of a vertical ruler with a sliding horizontal rod that is adjusted so that it rests on the top of the head. Also, the patient's weight was taken using a weight scale.

Waist circumference was the last measurement taken. The American College of Sports Medicine (ACSM) 2013, guidelines were followed to measure waist circumference and was measured at the level of the greater trochanter of the hip and the umbilicus using a Gulick anthropometric tape (Mississagua, Ontario Canada). Waist measurements were taken with the patient standing upright, feet together, and arms at their side while maintaining a relaxed breathing pattern. A horizontal measure was taken at the narrowest location between the umbilicus and the sternum. The test was repeated twice and the average was taken. If there was a difference of more than 5 millimeters between measurements, a third measurement was taken.

Patients were classified into two groups; cancer survivors (CS) or regular (R) patients. All of the women classified as CS underwent either a partial or a full mastectomy and may also have received adjuvant therapy such as chemotherapy, radiotherapy and hormonal therapy. Some patients may have received only one adjuvant therapy while others may have received up to three. Patients classified, as R patients may not have had

any of the adjuvant therapies mentioned above. Both the CS and the R patients may also have had other health issues for which they were taking additional medication that may have affected outcome measurements.

2.3 Stage 2: Inclusion of the bioimpedance unit to measure body fat

The recently validated (Karelis et al 2013) body composition measurement by bioimpedance was used to determine body weight, percent body fat, lean muscle mass, and total body water. Before standing on the foot pads of the unit (In-Body 230; Seoul, Korea), the patient was asked to remove her shoes and socks as well as any external metal objects (e.g. watches, rings) that might affect the results. The patient was asked to hold on to the external handles of the unit allowing data to be collected and documented from the display by the kinesiologist.

2.4 Stage 3: Stratifying by surgery and stratifying by treatment

CS were stratified according to one of five common surgical interventions that they underwent: 1) A partial mastectomy; 2) A full mastectomy; 3) Bilateral surgery; 4) Bilateral full mastectomy; and 5) Reconstruction, either a unilateral reconstruction or bilateral reconstruction that may have occurred on the same day as the full mastectomy or on a different day.

CS were also stratified according to the treatment intervention they underwent. The eight different categories included: 1) Surgery only; 2) Surgery and chemotherapy; 3) Surgery and radiotherapy; 4) Surgery and hormone therapy; 5) Surgery, chemotherapy, radiotherapy and hormone therapy; 6) Surgery, radiotherapy and hormone therapy; 7) Surgery, chemotherapy and radiotherapy; and 8) Surgery, chemotherapy and hormone therapy.

2.5 Stage 4: Pre-surgery shoulder assessment

Patients who were scheduled for breast surgery were asked to undergo a preoperative evaluation by the kinesiology team. The preoperative session had five main components that included; 1) Outlining to the patient what she could expect post-operatively; 2) Reiterating the surgeon's preoperative instructions; 3) Outlining the post-operative exercises that needed to be performed; 4) Performing base line testing of patients, including shoulder mobility, arm strength, present activity level, body composition, shoulder impingement, and testing to evaluate neurovascular occlusion; 5) Addressing additional questions that the patient had concerning treatment.

Kinesiologists met with each patient for approximately 90 minutes. Recognizing the amount of stress that the patient was under and given the recent diagnosis of a suspicious lump in their breast, it was left to the discretion of the kinesiologist working in consultation with the patient to determine what information and testing was most important for the patient at that particular stage.

A series of tests were performed to evaluate the patient's shoulder range of motion (ROM), forearm strength, and the presence of shoulder pain or reduced upper extremity circulation before surgery. The breast surgery performed was either a partial or full mastectomy with sentinel node or axillary node sampling.

Before their surgery the women were asked to undergo testing (methodology described below) to evaluate their current level of shoulder ROM and their current level of physical activity. During the testing session, the kinesiologists advised the women on the appropriate exercises to be performed post-operatively. Also, the women were provided an opportunity to clarify any questions they had concerning potential post-operative problems. Again, recognizing the amount of stress that the patient was under with a recent diagnosis of a suspicious lump in their breast, it was left to the discretion of the kinesiologists working in consultation with the patient to determine what information

and testing was most important for the patient at this stage. The following tests were performed;

Shoulder Flexion

Shoulder flexion was assessed with the use of a handheld goniometer, an instrument used to measure range of motion (ROM). The subject was assessed in a standing position, with the axis of the goniometer positioned at the acromion process of the scapula, through the head of the humerus. The stationary arm of the goniometer was placed along the mid axillary line of the trunk, while the moving arm was placed along the midline of the humerus in line with the lateral epicondyle.

Forearm Strength

A Jamar handgrip dynamometer (Lafayette Instruments, Lafayette, IN USA) was used to assess forearm strength. The adjustable handle was fit to the hand size of the patient so that the proximal interphalangeal (PIP) joints of digits 2 through 5 were positioned at a 90 degree angle of finger flexion as a starting position. The subject kept their shoulder in a neutral position and their elbow extended by their side while performing the test. The subject squeezed the dynamometer with maximum isometric effort, and maintained the effort for 5 seconds.

Shoulder Dysfunction

Shoulder impingement was assessed with the use of the Neer test and the Hawkins Kennedy. With the Neer test, the patient's arm was moved into end range of flexion at the same time as the patient's scapula was stabilized. The test was considered positive if it elicited pain, typically at the end of the range of flexion. If the patient had full shoulder flexion with overpressure applied at the end of the range without experiencing pain, then the test was considered negative.

The Hawkins Kennedy test was performed by flexing the elbow to 90 degrees and then elevating the patient's arm to 90 degrees of shoulder flexion and then internally rotating

the shoulder. The patient either experienced pain with this manoeuvre or tried to elevate the ipsilateral shoulder to increase the subacromial space and prevent the impingement.

When pain occurred with either of these tests, it was considered a positive sign for sub-acromial impingement. The goal behind these tests was to transiently aggravate inflamed or impinged structures as they passed under the coracoacromial arch. The inflamed structures may have included the long head of biceps tendon, the supraspinatus tendon and/or sub acromial bursa.

Thoracic outlet test using the Roos test

Testing was performed to assess for the possibility of neurovascular occlusion often associated with thoracic outlet syndrome through the use of a Roos Test (Howard, Lee and Dell 2003).The patients were asked to abduct both shoulders to 90 degrees and then flex both of their elbows to 90 degrees. Patients were then asked to open and close their hands repeatedly for up to 3 minutes. During that time if the patient started to experience numbness and/or a pins and needles sensation in the hands, the test was stopped and a positive sign noted. If there was no presence of numbness and/or a pins and needles sensation, then a negative sign was recorded.

Level of activity

To gain an understanding of the patient's typical level of physical activity, patients were asked to indicate what best represented their current level of activity. The scale was: 1) Active, 1 day per week 2) Active 3-5, days a week, and 3) Active, every day of the week.

Patient's height and weight were recorded and classified according to BMI (Body Mass Index) based on guidelines from the Canadian Physical Activity, Fitness and Lifestyle Approach (CPAFLA, CSEP, 2003). Patients were ranked as follows; Mild Thinness (BMI of less than 17.9), Normal (BMI 18.0-24.9), Overweight (BMI 25.0-29.9), Obese level 1 (BMI 30.0-34.9), Obese level 2 (BMI 35.0-39.9), Obese level 3 - morbidly obese (BMI greater than 40.0).

Data analysis

Statistical analysis was performed using IBM SPSS version 19.0. A one-way nova with Tukey post-hoc analysis was performed on shoulder ROM measures with significance assumed at $P<0.05$. Simple t-tests were performed on handgrip strength measures. Significance was set at $P< 0.05$. Pearson correlation was used to evaluate relationships between outcomes measures. Significance was set at $P< 0.05$.

2.6. Stage 5: Evaluation of the fitness level of patients

An evaluation of the fitness level of patients was performed on both R patients and CS at the WC. A battery of tests, proposed by the Canadian Society of Exercise Physiology, namely the Canadian Physical Activity Fitness & Lifestyle Approach (CPAFLA, CSEP 2003), was utilized to evaluate the patients. The tests are based on age-matched data to determine how each individual ranked in comparison to people in the same age-matched group. The tests included assessment of low back and abdominal strength, handgrip strength, lower body flexibility as well as aerobic testing with the use of a treadmill and the modified Bruce protocol. A screening process was done to identify women that were at risk; either a Physical Activity Readiness Questionnaire (Par-Q) or a medical Par-Q form was completed for each patient that was tested.

2.7 Stage 6: Validation of the Jones template on breast cancer patients

In this stage the subjects underwent primary and secondary measures that are outlined in the following protocol.

Pre and post-surgical measurements in both Stage 4 objective measures and self-reported data were collected. The outcome measures were repeated for both stages.

Primary outcome measures were: 1) The assessment of arm/shoulder mobility using the “arm-shoulder/upper torso grid” developed by Jones et al. (2007) to measure pressure pain threshold (PPT) with a handheld algometer. The upper body grid

evaluates the PPT of eight different locations in the upper arm and torso. The specific locations were selected for the following reasons; 1) Several of the locations such as the trapezius, deltoid and infraspinatus have been used in previous studies. 2) Locations such as the rhomboid and supraspinatus have often been identified in a clinical setting as being problematic. 3) The biceps and triceps were selected because these regions have been found to be frequently painful especially in women who have had breast surgery with an axillary node dissection for the determination of breast cancer. Sensitivity of locations and possible trigger points were noted and recorded. This template is important when considering the fact that many breast cancer patients develop myofascial dysfunction characterized by the presence of palpable nodules ”trigger points” (Cheville 2007). (Evaluation time required, 25 minutes)

Twenty one (21) female subjects were recruited from VM Medical. Demographic information including age, height, weight and mean body mass was collected.

As part of their job, subjects typically spent at least 2 hours a day at a computer terminal. Some subjects experienced shoulder pain or significant musculoskeletal pain at the time but were not receiving any therapeutic treatments to address their existing problems. Subjects were recruited for this study following approval of the l’Université du Québec à Montréal (UQAM) Human Research Ethics Committee. Each subject had all of the risks of participating in this study explained to them and were asked to voluntarily give their written informed consent. (Annexes 1 &2)

The subjects were asked not to undertake any new physical activity in the two days preceding the testing. New physical activities were defined as activities performed routinely for an extended period of time (for example, weight training after a prolonged period of inactivity). The ingestion of caffeine has been found to alter a person’s perception of pain so subjects were asked to avoid ingesting any caffeine products (Galeotti et al., 2002) for at least 4 hours prior to each testing period. Subjects were also asked to avoid any analgesic medication for 12 hours prior to the testing time.

Women participating in this project underwent repeated measures at 3 different intervals during a 2-month period beginning from the time of their breast cancer diagnosis. The objective measures were repeated (Maastricht questionnaires were only completed at the pre-surgery evaluation).

All participants for this project were recruited through VM Medical. The women in the project, aged 25-60, were in relatively good health, and without multiple health related problems with the exception of being diagnosed with a suspicious breast mass. The attending physician/medical team recommended a course of treatment which either began with surgery or neo-adjuvant therapy. The women participating in the project did not have any psychological or emotional factors which would have limited their ability to understand the project. The women were then referred to the VM Medical Integrative Health and Wellness Centre (WC) where baseline measurements were taken.

As with most research we wanted to have a positive impact on the lives of the women dealing with breast cancer. Our goal was not to establish a program that would end when the research project ended. Our goal was to implement changes in the typical protocols for breast cancer patients so as to diminish the negative signs and symptoms associated with treatment. A number of the tests that were used in this protocol could easily be carried over to clinical situations, and utilized as part of the standard protocol/procedure for patients.

Materials

The testing protocol outlined in detail below was initially utilized and validated in the 2008 Masters project by D.H. Jones. For consistency the same calibration of the algometer, subject preparation, testing locations on the subject, and application of the algometer, were utilized for all projects.

Algometer calibration and application:

Calibration: The algometer was calibrated at the onset of each day of testing before being applied to the subject. The algometer (Somedic Algometer Type II; Somedic Production AB, Sollentuna, Sweden) was calibrated using a standard protocol recommended by the manufacturer. The acceptable calibration values ranged from 98 to 102 kilopascals. This meant a potential 4% error in the recorded values. The calibration process was repeated 3 times to make sure that calibration values fell within the expected range. When the values did not fall within the acceptable, ± 2 kilopascal range, the algometer was restarted and the calibration process repeated.

Application: Following the manufacturer's calibration guidelines, the 0.5 cm applicator head was replaced with a 2 cm applicator head to measure PPT's. The 2 cm applicator head reduced the risk of causing excessive pain, and bruising. Using an applicator head smaller than 2 cm on subjects who were post-surgery may have placed them at an increased risk of bruising and localized tissue trauma. This may have heightened their concern about developing lymphedema, a significant problem for this population (McCredie et al., 2001). The 2 cm applicator appears to have been more effective at indicating local pain sensation when compared to smaller applicator heads (Takahashi et al., 2005).

Patient Position

The subject was placed in a supine position on a portable treatment table and then in a prone position on the same table. The two different positions were used so that the algometer could be safely applied and allowed for better stabilization of shoulder and torso compared to a seated position. With the subject in the supine position, the kinesiologist applied the algometer to the anterior aspect of the shoulder and arm for the PPT measurement over the marks located on the anterior deltoid and bicep. With the subject in a prone position, the kinesiologist then applied the algometer to the posterior aspect of the arm (triceps), shoulder (posterior deltoid) and torso (infraspinatus, supraspinatus, rhomboids and the trapezius) for the measurement of PPTs. Pillows and

padding were used to support the subject's shoulder and arm when appropriate. The total time required to collect 3 complete sets of data for each subject (4 trials total) was approximately 25 minutes. This included the time to change the position of the subject (8 times total; supine-prone-supine) as well as the time to set up and stabilize the shoulder. This worked out to approximately a 5-minute rest time between applications of the algometer at each location.

Testing

An initial trial was performed at the outset of each testing session to familiarize the subject with the testing procedure. The data from this trial was discarded. Thereafter, three complete sets of data were collected on the subject. A complete set of data included applying the algometer to each location (1 through 8 in sequence) and recording the values obtained from the location. This order of measurement was done two more times. Each trial (of all 8 locations) were recorded on a single data sheet. Three complete sets of data were collected on each subject and at each testing session. When the data sheet was completed, the sheet was removed from view of the kinesiologist so that subsequent data sets could be collected without bias.

Determination of the PPTs

At the beginning of each testing session, the subject was told that a PPT is defined as "the instant or moment that the pressure on the skin surface changes from the sensation of pressure to the sensation/perception of pain". The kinesiologist explained to each subject that they would feel a gradual increase in pressure on the skin. The pressure would continue to increase until the subject would experience a sensory transition from pressure to pain. The kinesiologist explained to each subject that the trial at a specific location would end if the subject pressed the handheld switch or if the readings went beyond 400 kilopascals. This precautionary measure was installed to avoid any unnecessary pain or damage to the skin and underlying structures. The kinesiologist applied the nozzle of the handheld algometer to each landmark location at an

approximate rate of 30 kilopascals per second. The increase in the force applied to the skin surface was viewed by the experimenter via the digital output display on the algometer. The kinesiologist continued to apply pressure until the subject pressed the button on the handheld switch indicating that they perceived a sensory transition from pressure to pain. The subject never viewed the recorded values.

Reference points - Bony landmarks

The use of bony landmarks as anatomical reference points (McGee, 2002; Kendall et al., 2005) was thought to be the most appropriate method to identify the locations in the upper extremity and torso region. The use of a bony reference point is a common technique used by clinicians to locate anatomical structures due to the tremendous variability in body composition. For this project it would have been impractical to measure a specific distance with a tape measure because of the number of locations in and around the scapula and the variability of the scapula's position relative to the spinal column.

2.8 Statistical analyses performed in projects

Statistical analyses were performed using IBM SPSS version 19.0.

Projects 1 and 2

Simple t-tests were performed between the groups and the significance was established at $P< 0.05$. Regression analysis was performed looking at the relationship between mean arterial pressure and waist circumference, as well as mean arterial pressure and body fat.

Projects 3 and 4

A one-way ANOVA and Dunnett post-hoc analysis with significance set at $P< 0.05$. R patients were used as the control group. CS were stratified according to age, in groups

of 10 years. The same one-way ANOVA with Dunnett post-hoc analysis was performed.

Project 5

A one-way nova with Tukey post-hoc analysis was performed on shoulder ROM with significance established at $P<0.05$. Simple t-tests were performed on handgrip strength measures. Significance was fixed at $P< 0.05$. Pearson correlation test was used to evaluate relationships between outcomes measures. Significance level was set at $P< 0.05$.

Individual and combined effects of the variables on the risk of neck and shoulder pain were examined using regression analysis. The 0.05 significance level was used as a guide to determine the statistical significance of the relationship between the variable time at the computer, previous pathology in the model, and the dependent variable, shoulder dysfunction.

CHAPTER III

MANUSCRIPT NUMBER 1

3.1 Overview of the first manuscript

This manuscript was presented in part as a poster at the annual conference of the National Consortium of Breast Centers 2012.The primary goal of the project was to investigate the potential relationship between cardiovascular risk and body composition in both R patients and CS and to determine if any differences in cardiovascular risk factors existed between both groups.

The main finding of the project was the significant differences across a number of outcome measures when comparing CS to R patients. Also evident was that waist circumference changes do not reflect changes in mean arterial pressure in CS. After this initial study it was proposed that additional information on body composition, specifically, body fat, and muscle mass be gathered to allow for a potentially more robust evaluation of cardiovascular risk factors.

3.2 Manuscript 1: Increased cardiovascular risk factors in breast cancer survivors identified by routine measurements of body composition, resting heart rate and arterial blood pressure

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Abstract

Fundamental body composition measurements is important information that can be utilized to determine the risk for various diseases. At the Ville-Marie Medical Centre (VM Medical), kinesiologists worked side by side with the medical/oncology team to collect a number of base-line measurements on body composition, resting heart rate, and blood pressure, as part of the standard intake evaluation when female patients visited their physician for their annual checkup. A total of 9,315 patients were evaluated: 476 cancer survivors (CS) and 8,839 regular (R) patients. CS were more likely to have a higher BMI ($P = 0.001$) and a larger waist circumference ($P = 0.001$) than R patients. CS were also shown to have higher blood pressure values: diastolic pressure of 76.9 mmHg ± 10.5 vs 75.5 mmHg ± 9.9, ($P = 0.01$) and systolic pressure of 129.8 mmHg ± 17.2 vs 126.7 mmHg ±17.4 ($P = 0.001$) compared to R patients, respectively.

Data was also stratified according to ten-year age segments. The same trends were seen in many of the age groups. Regression analysis looking at the relationship between mean arterial pressure and waist circumference did not show any difference between the two groups that is CS vs R. Patients who had a higher BMI, a larger waist circumference, and higher blood pressure levels, were also shown to be at greater risk for developing cardiovascular disease, diabetes and various musculoskeletal problems as well as an increased risk for various forms of cancers including reoccurrence of previously treated cancer.

Changes in body composition should be considered by the medical team when planning preventative healthcare strategies for their patients.

Introduction

It has been well established that as body composition changes with an increase in waist circumference and an overall increase in body mass index (BMI), there is a greater risk for individuals to develop various metabolic diseases such as diabetes, heart disease, as well as an increased risk of developing cancer or having a reoccurrence of a previously treated cancer (Han et al 2006). Major health organizations, such as the World Health Organization (WHO), have recognized the importance of physical activity, maintaining ideal body size, improving dietary habits and ceasing smoking to reduce the risk of developing various metabolic diseases (Harvie et al 2005). Unfortunately even with these guidelines, many people still present with increases in total body fat, increases in BMI, as well as reduced fitness levels (Flegal et al 2010).

A number of studies have looked at the relationship between changes in body composition and vital sign measures and the increase in risk for developing various diseases. Many studies have had to rely on patients self-reporting these measures or have had to rely on data extraction from records kept at multiple locations, which tend to result in underestimated patient body composition values (Battaglini et al 2011, Blair et al 2011).

Some researchers have used meta-analysis to evaluate the impact that body composition has on one's health. (Carmichael and Bates 2004).

In our study we hypothesized that by measuring a woman's body composition and vital signs as part of their regular follow-up care and compared the CS to the R patients that we would obtain a better understanding of the potential health risks that cancer patients face after undergoing cancer therapy. Thus, the main objective of this prospective study

was to obtain a better understanding of the body composition and vital sign measures of CS compared to R patients.

Methodology

Participants were recruited at VM Medical. Patients waiting to meet a physician as part of their routine checkup or *de novo* consult were invited to go to the adjacent VM Medical Integrative Health and Wellness Centre (WC) to undergo a series of tests administered by one of the resident kinesiologists. Results from tests, which included vital signs and body composition measurements, were entered into VM Medical's electronic medical records. The information that was extracted from the electronic database and that was used for this study had personal information removed so that no individual could be identified. Each patient that came to VM Medical was asked to review and sign a consent form that allowed for their medical information to be entered into the electronic database. The electronic database was used by the medical team to monitor and address patient needs. This study was approved by VM Medical's Ethics Board and conformed to the World Medical Association (WMA) Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects.

Testing of the patient took place in a medical evaluation room, away from the main clinic area. The kinesiologist explained to the patient the purpose of the testing. After approximately 5 minutes the patient was given the opportunity to relax and ask questions before the testing began.

Resting heart rate and blood pressure values were obtained with the use of an automatic blood pressure monitor (Physiologic Auto-memory 90; AMG Medical Inc., Montréal Canada). This monitor contains a technology called Fuzzy Logic that enables personalized inflation levels resulting in accurate and more comfortable readings. The patient's left arm was used for testing. If the patient had breast surgery on the left side of their torso with lymph node(s) removed, the right arm would be used. The cuff was wrapped around the upper arm and the arm was supported at the level of the heart. The

cuff was aligned with the brachial artery. Following Canadian guidelines, if measurements obtained on the patient were outside of expected values for the patient's age group, the test was repeated after a 5-minute waiting period (REF, Canadian Heart and Stroke Foundation Guidelines). The patient was then asked to stand in front of a stadiometer, a piece of equipment used for measuring height. Briefly, a stadiometer consists of a vertical ruler with a sliding horizontal rod that is adjusted so that it rests on the top of the head. The participant was asked to take in a full breath and hold it for several seconds while the height was recorded. Total body weight was taken using a floor scale.

Waist and hip circumferences were measured following the ACSM (American College of Sports Medicine 2009) guidelines. Briefly, waist and hip circumferences were obtained at the level of the greater trochanter of the hip and the umbilicus using a Gulick anthropometric tape (Mississagua, Ontario Canada), respectively. Waist measurements were performed with the patient standing upright, feet together, and arms at their side while maintaining a relaxed breathing pattern. A horizontal measure was taken at the narrowest location between the umbilicus and the sternum. The test was repeated two times and the average was taken. If there was a difference of more than 5 millimeters between measurements, a third measurement was taken. Hip measurements were performed with the patient standing upright and feet approximately 10 centimeters apart. A horizontal measure was taken at the location where the buttock had the widest circumference. The test was repeated two times and the average was taken. If there was a difference of more than 5 millimeters between measurements a third measurement was taken.

For this study, patients were classified into two groups; cancer survivors (CS) or regular patients (R). All of the women classified as CS underwent either a partial or a full mastectomy, and may also have received adjuvant therapy such as chemotherapy, radiotherapy and hormonal therapy. Some patients may have received only one adjuvant

therapy while other patients may have received up to three. Patients classified, as R may not have had any of the adjuvant therapies mentioned above. Both the CS and the R patients may also have had other health issues for which they were taking additional medication that may have affected outcome measurements.

Data analysis

Statistical analyses were performed using IBM SPSS version 19.0**.** Simple unpaired t-tests were performed between groups and the significance was calculated at $P< 0.05$. Pearson correlation was used to evaluate relationships between outcomes measures. Regression analysis was performed using Sigma plot version 12.

Results

A total of 9,315 female patients were evaluated: 476 CS and 8,839 R patients. The mean age of each group was as follows; CS= 59.71 ±9.93 yrs. and R= 55.81 ±9.90 yrs. (N.S., p>.05).

Significant differences between CS and R patients in the following outcome measures are shown in Table 3.1: Diastolic pressure: CS= 76.9 ±10.53 vs R=75.5 ±9.91 mmHg (p= .01), Systolic pressure: CS= 129.8 ±17.18 vs R= 126.7 ±17.42 mmHg (p= .001). BMI: CS= 26.99 ±5.14 vs R= 25.97 ±5.61 kg/m^2 (p= .001) and Waist circumference: CS= 88.44 ±11.83 vs R= 86.29 ±11.98 cm (P=.001). Resting heart rate was not significantly different between the two groups: CS= 73.25 ±12.82 vs R= 72.32 ±11.91 bpm (p= .10).

As shown in Tables 3.2 and 3.3, patients were stratified according to 10-year age segments from 20-29 years to 80-89 years. At each end of the stratification there were only a few patients in the CS group: 1 patient in the 20-29 year segment, 7 patients in the 30-39 year segment and 5 patients in the 80-89 year segment.

Significant differences were seen in the diastolic blood pressure in the 40-49 and the 50-59 age groups. Also, significant differences were seen in weight, BMI and waist circumference in the 50-59 age group.

In the 80-89 age group, CS had significantly lower measures in terms of diastolic and systolic blood pressure and waist circumference.

All CS showed a clear trend for higher body weight, BMI and waist circumference measures when compared to the R patients, except for the patients in the 80-89 age range.

Regression analysis of mean arterial pressure (MAP) and waist circumference was performed (Figure 3.1). Significant correlations in the CS and R patients groups were observed between MAP values and waist circumference values ($r= 0.16$, $p= .001$ and $r= 0.29$, $p= .001$, respectively).

Discussion

The CS patients' measures were shown to be significantly different from the R patients, with CS having higher levels of total body fat, higher BMIs and greater waist circumferences. The CS diastolic and systolic blood pressure values were also significantly greater in comparison to the R patients.

Cancer survivors face many challenges as they undergo adjuvant therapy as part of cancer treatment strategies. One of the deleterious effects of adjuvant therapy may potentially be significant changes in body composition and elevated blood pressure. In fact, in the present study, systolic blood pressure (SBP) for all CS, except for the 30-39 age group (Table 3. 2) was higher than 120 mmHg, which, according to the ACSM, is outside the normal range. The normal range for SBP recommended by ACSM is under 120 mmHg. This is similar to other studies that show a similar trend in all types of confounded cancer patients. Also, with aging, the systolic pressure increases to mild hypertensive levels. Nonetheless, in the present study, controlling for age did show that

both systolic and diastolic blood pressure values in CS were consistently higher than the R patients with the greater risk being in the 60-69 age range (Table 3.3).

Another confounding variable is that the elevated blood pressure of CS might have been related to the medication the women were taking at the time or had previously taken (e.g. hormone therapy). The elevated blood pressure may also have been related to adjuvant therapy the women received. Our results on blood pressure are similar to those recently reported by other investigators that have shown that both medication, including chemotherapy, and other adjuvant therapies (e.g. radiotherapy) had an effect on blood pressure. In their study, however, they did not report on body composition as we did. The study may not have accounted for any kind of medication either group may have been taking when blood pressure was recorded (Hojan et al 2012).

Waist circumference

It has been shown that as women age and move through menopause, the levels of estrogen in their bodies drop. The drop in estrogen has been shown to be linked with an increase in visceral fat (Feigelson et al 2006). We were able to see this increase in waist circumference in our study in both the CS and R patients. The R patients' mean waist circumferences increased from 81.8 cm at 30-40 years of age to 89.5 cm at 70-80 years of age while the CS mean waist circumferences increased from 85.4 cm at 30-40 years of age to 90.00 cm at 70-80 years of age. Waist circumferences were consistently greater for the CS group compared to R patients except at age 80-89. Many of the patients were already considered to be overweight.

The BMI values obtained on the patients in this study showed that many of the women were not meeting the recommended guidelines put forward by the ACSM. Normative data out of the Cooper clinic make recommendations on waist circumference and BMI and stratifies people according to age group (20-29 yrs., etc.). In our study, we observed that both the R patients and CS values exceeded the recommended guidelines. As well,

for CS, there appeared to be only a small effect on mean arterial pressure with an increase in waist circumference (Fig. 3.1). By contrast, the increase in waist circumference in R patients appears to have a marked effect on mean arterial pressure. A plausible explanation is that in the lower waist circumference range the mean arterial pressure difference between CS and R patients was larger with the difference becoming smaller as waist circumference increased.

It is not known if the women would continue to maintain these elevated weights, BMI values and waist circumferences levels as they aged. It would appear that the levels could increase over time unless some intervention was implemented.

Strength of study

We believed that by having someone on site to collect the data for the study instead of relying on self-reporting by the patient (weight, height and waist circumference) gave a clearer picture of the patient's actual body composition. Based on the scientific literature, it is noted that patients tend to underestimate their weight. We also knew that relying on the data extraction approach did not increase risk of error for measurements. We recognized that there would be a certain level of error with our data collection method but we believed that it would be consistent across all patients. We also recognized the importance of an electronic database so that the medical team was able to track the body composition values of the different patients and identify which women were at greater risk.

It would be interesting to see the effects of an intervention, such as counseling, while tracking these two groups over time to see if the patients' body composition and blood pressure would improve. Without any intervention it would be expected that both body composition and blood pressure values would continue to move in a negative direction as both the CS and R patients aged, with the CS potentially being more affected.

Limitations of the study

One factor that may have affected the vital sign measurements of the CS might have been the stress of going to the doctor's office. We speculated that it may have been more stressful for the CS because they were also seeing their surgical oncologist as part of an ongoing follow up. The CS fear of hearing about a possible reoccurrence may have elevated their BP values. By contrast, the R patients were typically visiting the clinic for an appointment with their general practitioner (GP) or their obstetrician and gynecologist (OBGYN) as part of their routine yearly evaluation. A second limitation in the study may have been the lack of diversity in the patient population that was being evaluated.

Future Direction

It would be important to evaluate the total amount of body fat, the lean muscle mass, and the fitness level of the cancer survivors (CS) and compare the results to that of regular (R) patients.

Conclusion

The baseline risk assessment protocol established at VM Medical and administered by kinesiologists is critical in helping to understand some of the fundamental risks faced by patients. The protocol used by VM Medical kinesiologists, who were working in conjunction with the medical team at the centre, gave the patients a clear starting point as to some of behavior changes to be adopted by the patient to help reduce their risk of developing different forms of cancer, cardiovascular issues and metabolic diseases.

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Table 3.1: Summary table comparing all regular (R) patients to all cancer survivors (CS)

Outcome Measures	**R n=8839**	**CS n= 476**	**F- value**	**Sig. (2-tailed)**
BP Diastolic	75.52	76.85	4.339	0.01
SD	9.912	10.53		
BP Systolic	126.70	129.83	0.009	0.00
SD	17.42	17.18		
Heart Rate(BPM)	72.32	73.25	2.103	0.10
SD	11.91	12.82		
Mean Arterial Pressure(mmHg)	92.14	93.72	1.33	0.01
SD	12.85	14.27		
Weight (kg)	67.49	68.97	0.001	0.02
SD	13.71	13.54		
Height (cm)	161.18	159.64	0.883	0.00
SD	6.76	6.41		
BMI	25.97	26.99	0.002	0.00
SD	5.61	5.14		
Waist circumference (cm)	86.29	88.44	0.873	0.00
SD	11.98	11.83		

P <0.05, type CS= cancer survivors, type R = regular patients, Standard deviation= SD

Table 3.2: Anthropometric and vital signs measures stratified by 10-yr age groups (20 to 59 years) for regular (R) patients and cancer survivors (CS)

Outcome Measures	R 20-29 n=10	CS 20-29 n=1	R 30-39 n=255	CS 30-39 n=7	R 40-49 n=2311	CS 40-49 n=78	R 50-59 n=3224	CS 50-59 n=140
Mean weight (kg)	57.69	57.00	65.14	67.08	67.00	67.23	67.73	70.91*
SD	11.32	0.00	13.25	7.26	14.30	14.22	13.86	14.87
Mean BP Diastolic (mmHg)	69.70	76.00	71.92	78.14	74.68	78.17*	76.14	78.27*
SD	5.68	0.00	8.80	9.75	9.89	10.76	9.79	9.92
Mean BP Systolic (mmHg)	113.00	129.00	115.65	119.14	119.94	121.33	125.36	127.57
SD	10.51	0.00	11.48	7.86	14.72	16.51	15.77	15.07
Mean Arterial Pressure (mmHg)	76.48	93.76	86.50	91.81	89.34	92.56*	92.68	93.35
SD	26.15	0.00	8.94	8.94	12.32	11.76	12.61	15.43
Mean heart rate (BPM)	78.50	79.00	73.46	71.86	72.22	72.37	72.17	74.06
SD	12.64	0.00	11.34	12.08	11.83	13.63	11.96	12.29
Mean BMI	21.28	21.20	24.28	25.79	25.19	25.48	25.96	27.01
SD	3.47	0.00	5.28	3.68	5.52	5.32	5.60	5.57
Waist circumference (cm)	74.40	76.00	81.82	85.39	83.79	86.02	86.12	88.14*
SD	6.07	0.00	10.42	6.96	11.79	11.55	11.85	7.48

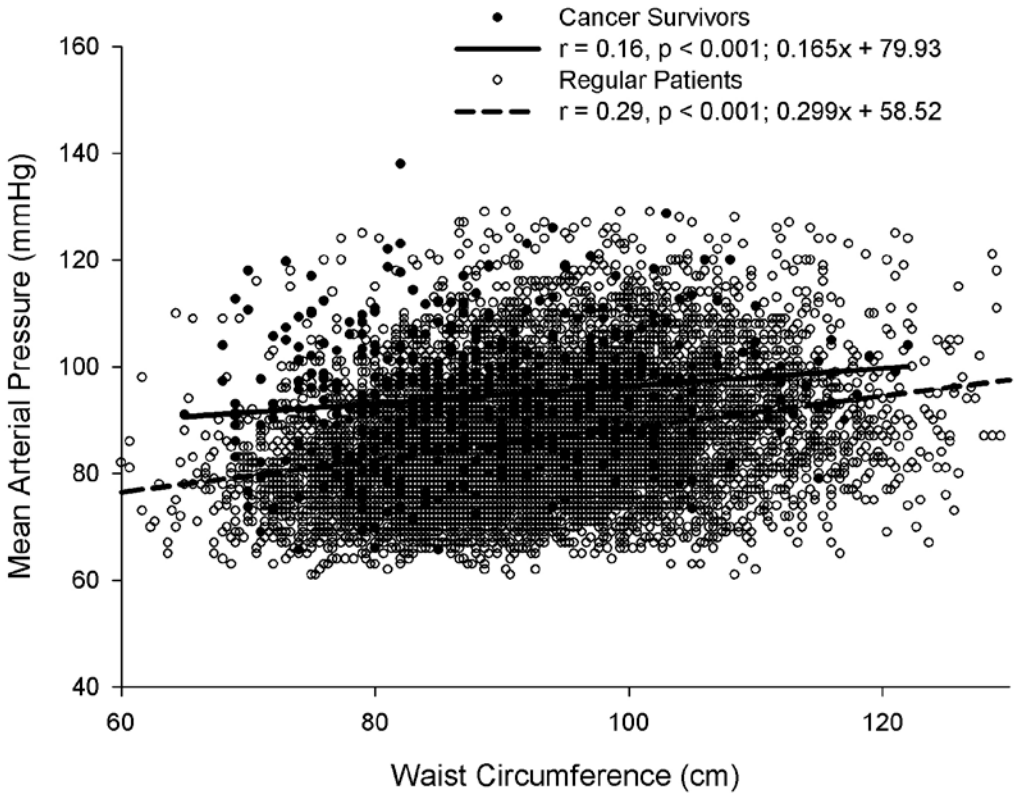
Significance set P<0.05, Standard deviation= SD, * Significant difference between CS and R with CS values being significantly greater than R values

Table 3.3: Anthropometric and vital signs measures stratified by 10-yr age groups (60 to 89 years) for regular (R) patients and cancer survivors (CS)

Outcome Measure	R 60-69 n=2184	CS 60-69 n=162	R 70-79 n=753	CS 70-79 n=82	R 80-89 n=102	CS 80-89 n=5
Mean weight (kg)	68.36	68.83	66.97	68.29	62.71	63.44
SD	13.16	12.48	12.83	11.98	12.24	6.81
Mean BP Diastolic (mmHg)	76.23	76.24	74.85	75.16	74.42	62.60**
SD	9.79	10.95	10.09	9.90	10.58	9.84
Mean BP Systolic (mmHg)	132.41	133.54	138.24	135.56	143.73	126.00**
SD	18.36	17.16	17.67	17.95	16.43	16.93
Mean Arterial pressure (mmHg)	94.53	94.76	95.47	94.14	97.52	83.73**
SD	13.15	14.11	13.05	15.24	10.75	11.76
Mean heart rate (BPM)	72.79	73.21	71.42	72.74	72.37	74.80
SD	11.88	13.65	12.07	11.50	12.15	13.55
Mean BMI	26.66	27.46	26.95	27.81	26.64	24.48
SD	5.37	4.90	5.99	4.81	7.12	2.13
Waist circumference (cm)	88.47	89.39	89.53	90.00	90.41	84.86**
SD	11.70	12.85	12.27	9.53	11.72	4.25

*Significance set P<0.05, Standard deviation = SD, **Significant difference between CS and R with CS values being significantly less than R values*

Figure 3.1: Relationship between mean arterial pressure and waist circumference in regular (R) patients and cancer survivors (CS)



CHAPTER IV

MANUSCRIPT NUMBER 2

4.1 Overview of the second manuscript

This manuscript was presented in part as a poster at the 2012 Annual Meeting of the American College of Sports Medicine. The primary goal of the second study was to include a more detailed analysis of body composition including body fat, and muscle mass in breast cancer survivors, while the secondary goal was to evaluate more closely the relationship between body fat and blood pressure.

The main findings of the study were the significant differences observed in outcome measures of body fat, muscle mass and total water between cancer survivors (CS) and regular (R) patients. Also, percent body fat seems to be a better indicator of changes in mean arterial pressure (MAP) for CS. Nonetheless, additional information about different treatment protocols that cancer patients may undergo would be required to gain a better understanding of body composition changes in CS.

4.2 Manuscript 2: Fundamental measurements of body composition and resting heart rate as indicators for providing women with healthy life style choices

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Abstract

The goal of this study was to standardize the anthropometric and blood pressure measurements performed as part of the intake evaluation of the patients at the Ville-Marie Medical Integrative Health and Wellness Centre (WC).

The investigators believed that these measurements could help identify women who are at greater risk for developing cardiovascular disease.

The women were divided into two groups. The first group, cancer survivors (CS) received some form of treatment associated with breast cancer while the second group, regular patients (R) did not receive any kind of cancer treatment.

CS and R patients were evaluated collectively as a group and then stratified according to age. Outcome measures showed significant differences between CS and R patients with regards to blood pressure, body fat and lean muscle mass values.

Regression analysis of mean arterial pressure and percent body fat showed a similar relationship between CS and R patients. CS patients, however, appeared to be at greater risk for developing cardiovascular disease and diabetes compared to R patients.

Introduction

The percentage of the general population affected by obesity in North America has increased substantially since the 1960s (De Schutter et al 2013) with levels now reaching 34% among adults and 17% among children and adolescents (Flegal et al 2010, Röbl et al 2013). This increase in obesity has been linked to changes in lifestyle and changes in work and living environments resulting in a decrease in physical activity (Röbl et al

2013). This has not necessarily meant that people have more or less time in their daily lives to participate in recreational activities, but rather that they have become significantly busier and more focused on performing less metabolically demanding activities, such as spending more time performing more mentally challenging activities Oftentimes, this has resulted in increased levels of stress (Claire Wang et al 2013).

Evidence exists indicating a probable protective effect physical activity has on reducing breast (Sheean PM, Hoskins and Stolley, 2012) and endometrial cancers (Carmichael and Bates, 2004, Calle and Kaaks, 2004) with risk reductions ranging from 20 to 30%. Major health organizations such as the World Health Organization have recognized the importance of physical activity (Franceschi and Wild, 2013), maintaining ideal body size, improving dietary habits, and ceasing smoking and their effect on reducing the risk of developing metabolic disease (Li Yuquig, 2012). Unfortunately, even with these guidelines many people are still presenting with increases in total body fat, decreases in lean muscle mass, and reduced levels of fitness.

Adipose tissue is considered a dynamic endocrine organ. It stores triglycerides, which provides energy to the body (Guyton and Hall, 2000) and insulation to protect against cold. However, excessive amounts of adipose tissue has been shown to significantly alter hormone metabolism which has been linked to different kinds of cancer. (Grossmann et al, 2010). The 2012 World Cancer Congress held in Montreal, Canada noted the importance of reducing body weight and working towards ideal body size, increasing levels of physical activity, improving overall diet and eliminating tobacco usage as preventative means to decrease the risk of cancer occurrence and reoccurrence (Jarde et al, 2011). This is consistent with a number of studies that have looked at adiposity and the risk factor that is associated with developing colorectal, breast (post-menopausal), endometrial, esophageal (adenocarcinoma), pancreatic, and kidney cancers (Parekh, Chandran and Bandera, 2012).

We believe that although many people know the benefits of maintaining lower body weight and lower body fat, they are still not achieving the recommended targeted levels. We believe those oncology patients who are at risk for reoccurrence of cancer are also increasing their risk for cardiovascular and metabolic diseases such as diabetes.

Methodology

As part of the standard intake evaluation, patients waiting to meet with one of the physicians at VM Medical underwent a series of tests administered by one of the kinesiologists working at the WC. Results from tests, which included vital signs and body composition measurements, were entered into VM Medical's electronic medical records. The information that was extracted from the electronic database and that was used for this study had personal information removed so that no individual could be identified. Each patient who came to VM Medical was asked to review and sign a consent form that allowed for their medical information to be entered into the electronic database. The medical team used the electronic database to monitor and address patient needs. This study was approved by the VM Medical Ethics Board and conformed to the World Medical Association (WMA) Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects.

As part of the preparation for testing, patients were asked to refrain from smoking or drinking caffeine products for 4 hours prior to testing. Before testing began, patients were asked if they needed to go to the washroom to void any fluids. Testing of the patient took place in a medical evaluation room, away from the main clinic area. The kinesiologist explained to the patient the purpose of the testing. After approximately 5 minutes the patient was given the opportunity to relax and ask questions before the testing began.

Resting heart rate and blood pressure values were obtained with the use of a Physiologic Auto-memory 90 instrument (AMG Medical Inc., Montréal Canada) (Figure 4.1). The patient's left arm was used for testing. If the patient had breast surgery on the left side of

their torso with lymph node(s) removed, the right arm was used. The cuff was wrapped around the upper arm and was supported at the level of the heart. The cuff was aligned with the brachial artery. If measurements obtained on the patient were outside of expected values for the patient's age group, the test was repeated after a 5-minute waiting period. The patient's height and weight were measured using a stadiometer and weight scale respectively.

The In-Body 230 (Seoul, Korea) (Figure 4.2) impedance unit was used to determine body weight, percent body fat, lean muscle mass, and total body water. The patient was asked to remove their shoes and socks and any external metal objects (e.g. watches, rings) that might affect the results. The patient then stood on the foot pads of the unit while holding onto the external handles so that data could be collected. The kinesiologist collected the information from the display monitor (Karelis et al 2013).

Waist circumference was taken using a Gulick anthropometric tape (Mississagua, Ontario Canada) and the ACSM (American College of Sports Medicine2013) recommended methodology. Waist measurements were performed with the patient standing upright, feet together, and arms at their side while maintaining a relaxed breathing pattern. A horizontal measure was taken at the narrowest location between the umbilicus and the sternum. This location was typically 2.5 cm above the umbilicus. The test was repeated twice and the average was taken. If there was a difference of more than 5 millimeters between measurements, a third measurement was taken.

For this study, patients were classified as either being cancer survivors (CS) or regular (R) patients. All of the women classified as CS underwent either a partial or a full mastectomy, and may have had additional forms of adjuvant therapy, for example, chemotherapy, radiotherapy, and/or hormonal therapy. Some patients may have had only one additional therapy while other patients may have had as many as three forms of adjuvant therapy. Patients classified as R would not have had any of the adjuvant therapies listed above. Both the CS and the R patients may also have had other health

issues and may have been taking additional medication, which may have affected outcome measurements.

Data analysis

Statistical analyses were performed using IBM SPSS version 19.0. Simple t-tests were performed between the groups and the significance was calculated at $P< 0.05$. Regression analysis was performed looking at the relationship between mean arterial pressure and body fat.

Results

A total of 1,596 patients were evaluated: 262 cancer survivors (CS) and 1,334 regular (R) patients. The ages of the patients were CS (μ= 59.86 yrs., SD 9.83) and R (μ= 54.27 yrs., SD 9.10).

Analysis showed a significant difference between CS and R patients as can be seen in the following outcome measures (also see Table 4.1), $P <0.05$.

Diastolic blood pressure: CS (μ= 76.69 mmHg, SD 9.98) vs R (μ=74.46, SD 9.30), Systolic blood pressure: CS (μ= 130.52 mmHg, SD 16.04) vs R (μ=124.87, SD 16.04), Arterial pressure: CS (μ= 93.93 mmHg, SD 13.51) vs R (μ= 90.99, SD 11.66), Resting heart rate: CS (μ= 72.78 bpm, SD 12.44) vs R (μ= 71.21 bpm, SD 11.62), BMI: CS (μ=26.74, SD 5.14) vs R (μ=25.81, SD 4.94), Muscle mass: CS (μ=10.94 kg, SD 1.67) vs R (μ=11.22 kg, SD 1.48), Percent body fat: CS (μ= 37.71, SD 7.39) vs R (μ=34.88, SD 8.31), and Waist circumference: CS (μ= 87.84 cm, SD 10.86) vs R (μ=84.90, SD 11.24). Total body water was not significantly different between the two groups: CS (μ= 30.02 kg, SD 3.91) vs R (μ= 30.79 kg, SD 3.70). (Table 4.1)

Patients were then stratified according to age in 10-year segments, starting with 20-29 years of age up to 80-89 years of age. At each end of the stratification there were only a few patients in the CS group: 1 patient in the 20-29 year range, 7 patients in the 30-39 year range, and 5 patients in the 80-89 year range.

Significant differences were seen in diastolic blood pressures in the 30-39, 40-49 and 50-59 age ranges while mean arterial pressure was significantly different for the 30-39 and 40-49 age groups Percentage body fat was notably different between CS and R patients in the 40-49, 50-59, 60-69 and 70-79 age groups. Mean muscle mass was lower in CS in the 40-49 and 60-69 age groups (Tables 4.2 and 4.3).

Regression analysis showed that the relationship between MAP values and body fat was very similar for both groups: CS: $r^2= 0.04$, $p< 0.001$; $0.34x +81.38$ (Figure 4.3) and R $r^2= 0.05$, $p< 0.000$; $0.32x + 79.78$ (Figure 4.4).

Discussion

We know that basic anthropometric and cardiovascular measures are taken at many medical facilities on a regular basis and often entered into patient charts. By having the same individuals obtain all the measurements via a standardized process and entering them into a central electronic database we believe that we have a better understanding of some of the challenges faced by the women at the WC and will ultimately provide us with more specific information on healthy lifestyle habits.

Through the use of the body impedance tool, detailed information was obtained on how body composition differed between the two groups. We were aware that bioimpedance measurements have been shown to overestimate (American College of Sports Medicine 2013) the total amount of body fat by 3-4 % for an individual in comparison to a DEXA measurement (American College of Sports Medicine 2013). One of the goals of this project was to implement a protocol that would make it easy for many facilities to utilize and implement the patient screening process. We were also aware that a number of the cancer survivors had already received a significant amount of radiation associated with their adjuvant therapy. Thus, it was important to utilize a measuring tool that would carry minimum to no risk for the patient, whether actual or perceived.

The data obtained in this study was similar to that obtained in our previous work (Jones et al 2013, Manuscript 1). The CS were shown to have higher blood pressure values and poorer body composition traits in comparison to the R patients. The literature clearly shows the potential for elevated risk of developing different and recurring forms of cancer, i.e., an increased risk of developing type two diabetes as well as developing cardiovascular issues related to an increase in blood pressure values and increase in levels of body fat (Blair et al 2012, Brown and Simpson 2010).

The data shows that many of the patients' outcome measures are not within the recommended guidelines put forward by the ACSM (American College of Sports Medicine). The ACSM provides normative data as well as recommendations for percent body fat, waist circumference and BMI.

CS were shown to have significantly lower levels of lean muscle mass compared to the R patients. We would expect that this group might be at greater risk for developing sarcopenia, which is the age-related loss of muscle and function (Di Sebastiano and Mourtzakis 2012). It is likely that losses in strength may occur prior to any detectable changes in lean mass. Muscle quality, a ratio of strength to lean mass, may account for changes in both variables for early detection of sarcopenia.

With the increase of total body fat in cancer survivors, it is not unreasonable to assume that this group is also at risk for developing metabolic problems such as cardiovascular disease and diabetes.

It is not readily apparent why there was a significant difference between the two groups. The cancer survivors were challenged to undergo treatment to reduce or try to eliminate the spread of the cancer tumor and cells from their bodies. Different treatment protocols might have affected outcome measures. We expected different types of surgery, as well as the use of chemotherapy, radiotherapy and/or hormone therapy might have had

adverse effects on outcome measures. This information was not available to the research team at that stage.

Other factors that might also have accounted for this difference include: 1) Lack of direction from the medical team as to what should be done to address changes in body composition; 2) A fear by the patient to undertake any type of program which might aggravate their condition; 3) Lack of encouragement or possible discouragement from undertaking an exercise program other than walking; 4) The patient might not have been an habitually active individual; 5) Perhaps the patient attempted to become active but became discouraged and stopped like many people often do. Though exercise during cancer therapy has been encouraged in recent years, there is still some reservation about undertaking an exercise program.

Some of the limitations for this project included not knowing the type of medication that the patients were ingesting prior to and during the testing. In both instances, this would be cause for confounding variables in the study's outcome measures. Medications that could have impacted our findings may have included patients taking beta blockers and diuretics (Boxall and Clark 2012). It is not unreasonable to expect that as patients age they may begin taking these medications as part of a preventative treatment protocol. This would influence the measures for both CS and R patients.

As individuals age they tend to show an increase in body fat, a decrease in lean muscle mass, and an elevation in blood pressure. It was expected that patients in both groups might be utilizing medication such as beta blockers and statins to address elevated blood pressure and cholesterol values. The possibility that they might be taking additional medications to control other medical issues were also considered, for example, some of the cancer survivors might have been taking hormones such as Tamoxifen and Arimedex (Hojan et al 2012). This would affect body composition and vital sign values, such as blood pressure.

One other factor, which might have influenced heart and blood pressure values, in particular for the cancer survivor group, was the anticipation (anxiety) of going to the doctor's office. For some patients this is a stressful visit, e.g., white coat syndrome. This may have been particularly relevant for the cancer survivors who are often concerned about a potential reoccurrence of their cancer.

The next step in our project is to continue to collect the anthropometric and cardiovascular measurements to see how all treatments (therapies and medications) may be influencing the measures collected for both CS and R patients. We would also like to know what would happen to both groups as they age i.e. Do their values continue to change significantly over time? We believe that the CS need to be followed much more closely than what was previously thought.

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Table 4.1: Group Statistics for all patients

Outcome Measure	R n=1334	CS n=262	F Value	Significance P< 0.05
Age	54.27	59.86	3.08	0.00
SD	9.10	9.83		
Mean weight (kg)	67.12	68.65	0.31	0.08
SD	13.16	13.25		
Mean height (cm)	161.21	158.23	7.30	0.00
SD	6.25	14.07		
Mean BP Diastolic (mmHg)	74.46	76.69	2.06	0.00
SD	9.30	9.98		
Mean BP Systolic (mmHg)	124.87	130.52	0.24	0.01
SD	16.04	16.04		
Mean Arterial Pressure (mmHg)	90.99	93.93	0.84	0.00
SD	11.66	13.51		
Mean heart rate (BPM)	71.21	72.78	1.26	0.05
SD	11.62	12.44		
Mean BMI	25.81	26.74	0.59	0.01
SD	4.94	5.14		
Mean Muscle Mass (kg)	11.22	10.94	0.04	0.01
SD	1.48	1.67		
Mean % body fat	34.88	37.71	3.80	0.00
SD	8.31	7.39		
Mean total body water (kg)	30.79	30.02	0.11	0.00
SD	3.70	3.91		
Waist circumference (cm)	84.90	87.84	0.53	0.00
SD	11.24	10.86		

Figure 4.1: Physiologic Auto-memory 90 (Measures resting heart rate and blood pressure)

Figure 4.2: In-Body 230 (Body Composition Analyzer)

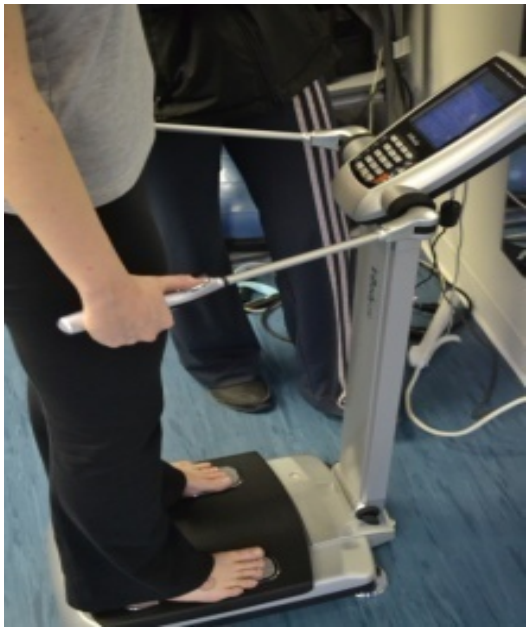


Table 4.2: Outcome measures for regular (R) patients and cancer survivors (CS) (Ages 20 to 59)

Outcome Measure	R 20-29 n=10	CS 20-29 n=1	R 30-39 n=255	CS 30-39 n=7	R 40-49 n=2311	CS 40-49 n=78	R 50-59 n=3224	CS 50-59 n=140
Mean weight (kg)	57.15	57.00	65.04	67.23	66.59	66.95	67.29	70.83
SD	9.69	0.00	13.51	7.94	13.85	13.10	13.13	15.13
Mean BP Diastolic (mmHg)	68.50	76.00	70.10	**80.33***	73.72	**78.45***	75.20	**78.16***
SD	0.71	0.00	6.55	**6.81**	9.21	**10.01**	9.43	**9.98**
Mean BP Systolic (mmHg)	114.50	129.00	114.51	122.00	118.65	122.81	125.05	127.91
SD	2.12	0.00	8.77	8.89	13.43	16.91	15.27	14.37
Mean Arterial Pressure(mmHg)	83.84	93.67	84.90	**94.22***	88.22	**93.24***	91.64	93.59
SD	0.23	0.00	6.67	**7.50**	11.88	**11.54**	11.34	14.75
Mean heart rate (BPM)	71.50	79.00	71.51	70.33	71.44	72.83	71.27	73.69
SD	12.64	0.00	11.34	12.08	11.83	13.63	11.96	12.29
Mean BMI	21.05	21.20	24.35	26.10	25.05	25.48	25.99	26.94
SD	2.33	0.00	4.70	3.73	4.97	4.87)	4.96	5.68
Mean Muscle Mass (kg)	10.56	10.96	11.83	10.94	11.65	**11.51**	11.18	11.31
SD	1.06	0.00	2.00	0.96	1.61	**2.78**	1.39	1.39
Mean % body fat	28.75	26.20	31.40	37.23	32.19	**35.67***	35.42	**36.51***
SD	5.73	0.00	7.08	8.50	8.29	**7.25**	8.48	**7.54**
Mean total body water (kg)	28.93	30.12	31.30	29.93	30.61	31.87	30.74	31.16
SD	2.45	0.00	4.02	2.28	3.77	4.15	3.80	3.85
Waist circumference (cm)	71.50	76.00	79.77	83.67	82.82	85.16	85.02	87.52
SD	2.12	0.00	10.81	4.73	11.21	10.45	11.05	12.52

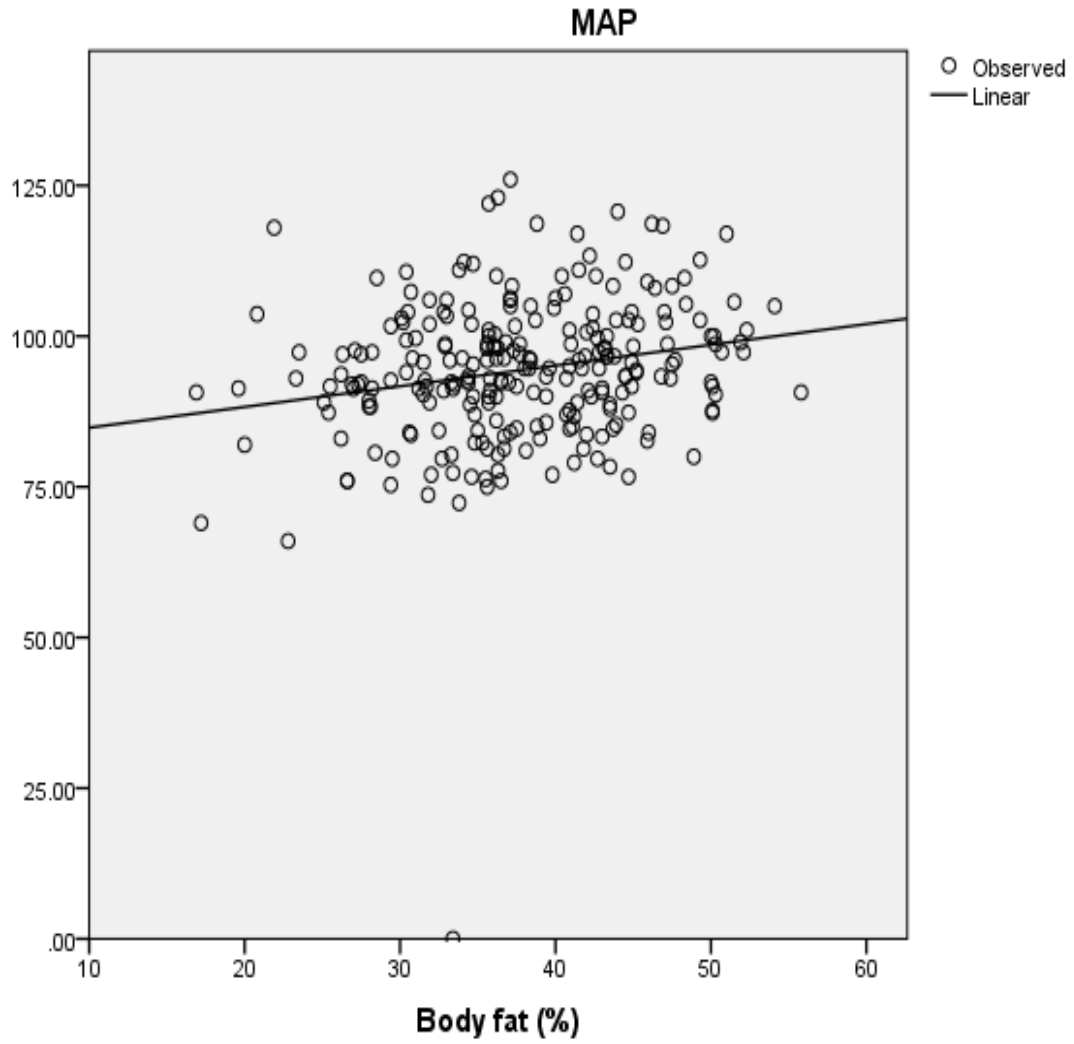
**Significant difference between CS and R, Significance set P<0.05, Standard deviation= SD,*

Table 4.3: Outcome measures for regular (R) patients and cancer survivors (CS) (Ages 60-89)

Outcome Measure	R 60-69 n=2184	CS 60-69 n=162	R 70-79 n=753	CS 70-79 n=82	R 80-89 n=102	CS 80-89 n=5
Mean weight (kg)	68.28	68.29	65.05	68.52	58.60	64.53
SD	12.17	12.18	11.57	13.20	4.55	6.89
Mean BP Diastolic (mmHg)	75.10	75.83	73.20	74.74	78.00	66.30
SD	9.39	10.34	9.16	9.03	9.90	11.85
Mean BP Systolic (mmHg)	130.88	133.59	137.75	136.26	145.00	132.67
SD	16.98	16.29	15.67	17.78	15.56	17.50
Mean Arterial pressure (mmHg)	93.39	94.07	94.72	95.25	100.34	88.44
SD	11.97	14.95	9.84	10.36	11.78	13.32
Mean heart rate (BPM)	71.21	72.37	69.25	71.87	70.50	74.67
SD	12.10	11.44	12.88	11.41	6.89	13.44
Mean BMI	26.69	27.30	25.95	**28.02***	24.90	25.07
SD	4.84	4.91	4.61	**4.88**	0.42	2.22
Mean Muscle Mass (kg)	10.94	**10.61**	10.23	10.35	10.56	10.88
SD	1.25	**1.34**	1.20	1.06	0.44	1.17
Mean % body fat	37.31	**39.07***	37.59	**39.87***	34.55	34.77
SD	7.26	**7.04**	7.53	**7.33**	2.48	1.66
Mean total body water (kg)	30.12	29.31	28.12	28.74	29.15	29.15
SD	3.35	3.65	3.37	2.93	0.82	3.43
Waist circumference (cm)	87.71	88.75	86.77	89.64	92.00	85.33
SD	10.97	10.19	11.01	9.68	7.07	5.03

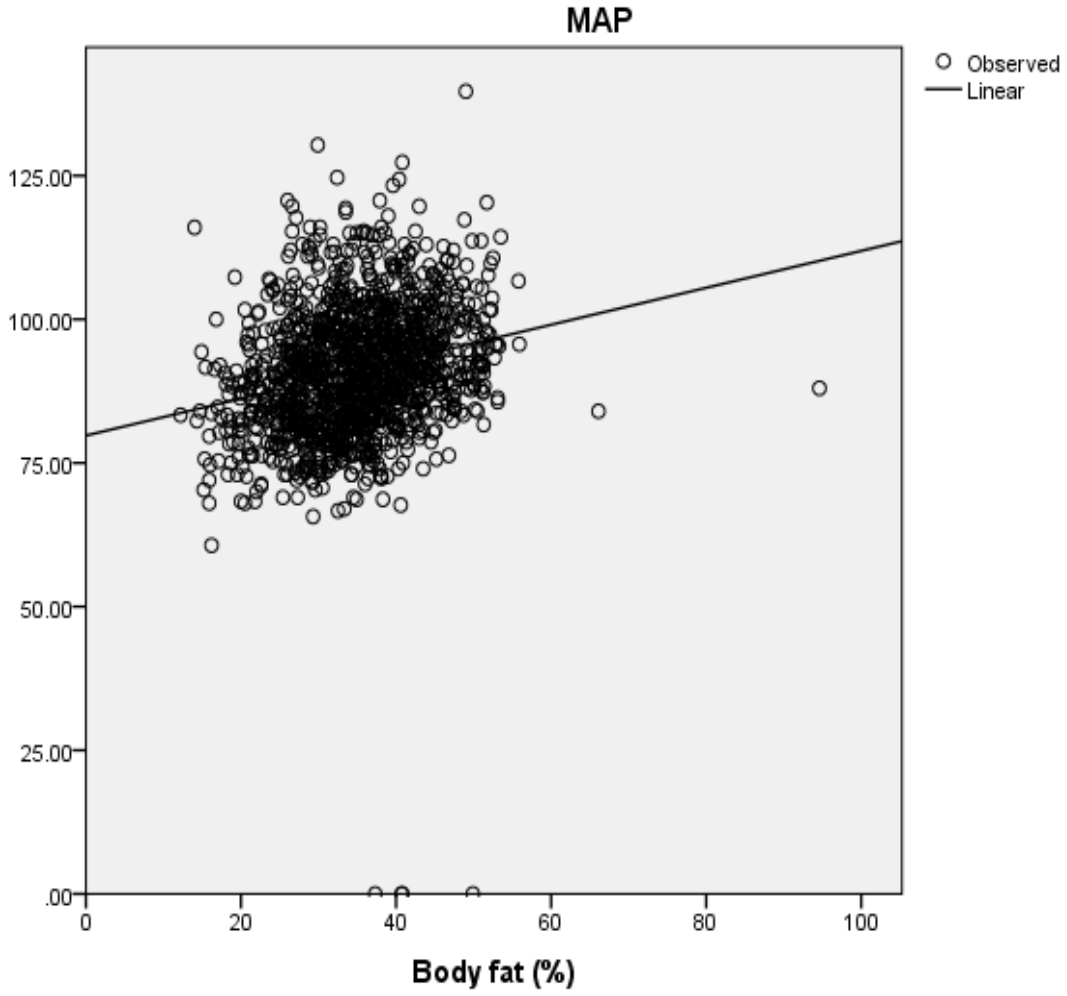
**Significant difference between CS and R, Significance set P<0.05, Standard deviation= SD*

Figure 4.3: Regression analysis of mean arterial pressure and body fat in cancer survivors (CS)



Cancer Survivors (CS) r= 0.21, r^2= 0.04, p< 0.001; 0.34x +81.38

Figure 4.4: Regression analysis of mean arterial pressure and body fat in regular (R) patients



Regular (R) patients r= 0.23, r^2= 0.05, p< 0.000; 0.32x + 79.78

CHAPTER V

MANUSCRIPT NUMBER 3

5.1 Overview of the third manuscript

This manuscript, along with manuscript number 1, was presented as part of the research poster presentations at the annual conference of the National Consortium of Breast Cancer Centers 2013.

Patients in this manuscript were stratified based on the type of surgical intervention they had undergone. The surgical interventions were partial mastectomy, full mastectomy, bilateral surgery, unilateral reconstruction and bilateral reconstruction.

The main finding was that the more significant the surgical intervention, the more likely the patient would have an elevated risk for cardiovascular disease.

5.2 Manuscript 3: Impact of different surgical interventions on anthropometric and vital sign measurements in breast cancer survivors

Abstract

The Ville-Marie Medical Integrative Health and Wellness Center (WC) monitors body composition, physical activity and vital signs of both regular (R) patients and cancer survivors (CS) as part of their patients' annual mammography screening.

Objective

The objective of the study was to determine whether or not body composition and baseline cardiovascular function of R patients is in contrast with CS who have undergone surgical interventions.

Methods

Baseline measurements were taken on 3,694 female R patients and 712 CS (for a total of 4,406 screened patients) at VM Medical. These measurements included Body Mass Index (BMI), resting heart rate, blood pressure, percent body fat, muscle mass, total body water, and waist circumference. CS were stratified into 5 groups (see Table 5.1) according to surgery type (ST). ST groups were compared to R patients. A one-way ANOVA was performed followed by a Dunnett's post-hoc analysis. Significance was set at $p < .05$.

Results

Significant differences were seen between ST groups and the R patients ($p= 0.001$) for eight key variables.

Conclusion

Surgical intervention for breast cancer is vital, however, certain surgical protocols appear to be associated with an increase in negative body composition and blood pressure outcomes. Thus, it seems important that follow-up medical teams encourage CS patients to engage in healthy lifestyle habits to help modify these negative outcomes before they become even more critical.

Introduction

When a suspicious mass is found in the breast, surgery to remove the tumor is an important tool used to minimize its potential impact on the body. However, surgery and all of the interventions associated with surgery, do have an impact on the body as a whole. Complications after surgery have been shown to have a significant impact on the recovery of the individuals. Complications have been grouped into three categories: major surgical complications, wound complications, and medical complications (Fischer et al 2013). Work has also been done regarding complications that occur with breast reconstruction in particular looking at the use of expanders and implants or the patient's own soft tissue (TRAM - transverse rectus abdominus musculocutaneus) and the post-surgical complications that may follow (Christensen et al. 2013). The short

term impact of these complications is often brought to the immediate attention of the medical team. The same attention is not always present with some of the long term challenges for the patients post-surgery. We have observed that as women undergo cancer treatment their blood pressure and body composition may change. The changes in body composition and blood pressure may place these women at risk for other underlying problems such as cardiovascular and metabolic disease. There is a strong association between negative changes to both body composition and cardiovascular risk factors and the impact this has on a person's mobility (Flegal et al. 2010). As an individual's mobility diminishes they tend to become more dependent on family, friends and social services to fulfill some of their daily functions.

It is not clear to us how different types of surgery affect these women in the long term. We would expect that as the women have more invasive surgery or repeated surgeries that this would have a negative effect on the outcome measures for cardiovascular and metabolic disease. The goal of this investigation was to perform basic body composition measurements on patients who have undergone breast surgery to determine if there were changes in blood pressure and body composition values.

Methodology

As part of the standard intake evaluation, patients waiting to meet with one of the physicians at VM Medical underwent a series of tests administered by one of the kinesiologists working at the VM Medical Integrative Health and Wellness Centre (WC). Test results, which included vital signs and body composition measurements, were entered into VM Medical's electronic medical records. Each patient who came to VM Medical was invited to review and sign a consent form that allowed for their medical information to be entered into the database. The medical team uses the database to monitor and address patient needs.

The information that was extracted from the database, and that was used for this study, was stripped of personal information so that no individual could be identified. The

study was approved by the VM Medical Ethics Board and conformed to the World Medical Association (WMA) Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects.

As part of the preparation for testing, the patients were asked to refrain from smoking or drinking caffeine products for 4 hours prior to testing. Before testing began, patients were given the opportunity to use the washroom to void any fluids. Testing took place in a medical evaluation room, away from the main clinic area. The kinesiologist explained to the patients the purpose of the testing. After approximately 5 minutes, patients were given the opportunity to relax and ask questions before the testing began.

Resting heart rate and blood pressure values were obtained through the use of a Physiologic Auto-memory 90 instrument (AMG Medical Inc., Montréal Canada). The patient's left arm was used for testing. If the patient had breast surgery on the left side of their torso with lymph node(s) removed, the right arm was used. The cuff was wrapped around the upper arm and the arm was supported at the level of the heart. The cuff was aligned with the brachial artery. If measurements obtained on the patient were outside of expected values for the patient's age group, the test was repeated after a 5-minute waiting period.

The patient's height and weight were measured using a stadiometer and weight scale respectively. The In-Body 230 (Seoul, Korea) impedance unit (Karelis et al 2013) was used to determine body weight, percent body fat, lean muscle mass and total body water. The patient was asked to remove her shoes and socks as well as to remove any external metal objects (e.g. watches, rings) which might affect the results. The patient then stood on the foot pads of the unit while holding onto the external handles so that data could be collected. The kinesiologist then documented the information from the display monitor.

Waist circumference was taken using a Gulick anthropometric tape (Mississagua, Ontario Canada) and followed ACSM (American College of Sports Medicine 2008) methodology. Waist measurements were taken with the patient standing upright, feet together, and arms at their side while maintaining a relaxed breathing pattern. A horizontal measure was taken at the narrowest location between the umbilicus and the sternum. This location was typically 2.5 cm above the umbilicus. The test was repeated twice and an average was taken. If there was a difference of more than 5 millimeters between measurements, a third measurement was obtained.

For this study patients were classified into two groups; cancer survivors (CS) or regular (R) patients. All of the women who were classified as CS underwent either a partial or a full mastectomy, and may have received adjuvant therapy, such as chemotherapy, radiotherapy and hormonal therapy. Some patients may have received only one adjuvant therapy while other patients may have received up to three. Patients classified as regular (R) patients may not have had any of the adjuvant therapies mentioned above. Both the CS and the R patients may also have had other health issues and may have been taking additional medication that may have affected outcome measurements.

CS were stratified according to one of five common surgical interventions 1) a partial mastectomy; 2) a full mastectomy; 3) bilateral surgery; 4) bilateral full mastectomy; and 5) a unilateral reconstruction (which may have occurred on the same day as the full mastectomy or on a different day) or, bilateral reconstruction (which may have occurred on the same day as the bilateral full mastectomy or on a different day).

Data analysis

Statistical analyses were performed using IBM SPSS version 19.0, a one-way ANOVA and Dunnett post-hoc analysis; significance calculated at $P< 0.05$. The R patients were used as the control group. Patients were also stratified according to age, in groups of 10 years. The same one-way ANOVA with Dunnett post-hoc analysis was performed.

Results

The mean age of CS varied from 56-63 years of age compared to the mean age of the R patients which was 55 years of age. The patients in the unilateral reconstruction category had a mean age close to the R patients at 56 years of age. (As per Methods)

BMI

Body composition values followed the same pattern as the blood pressure values. Body mass index (BMI) values were highest in the full mastectomy group (27.12 SD 5.81) and were the lowest in the R patients group (26.07 SD 5.16). There was not as marked a difference between the groups as with other measurements (Table 5.1).

Resting Heart Rate

Resting heart rate values were highest in the full mastectomy group (78.02 bpm SD 13.72) and were the lowest in the bilateral reconstruction group (64.20 bpm SD 9.39) (Table 5.1).

Blood Pressure

Blood pressure values were shown to increase with the type of surgery. Diastolic blood pressure values were highest in the unilateral reconstruction group (79.14 mmHg SD 10.68) and were lowest in the bilateral reconstruction group (73.60 mmHg SD 8.44). Systolic blood pressure values were highest in the full mastectomy (132.58 mmHg SD 17.39) and the bilateral surgery (132.93 mmHg SD 15.72) groups. The lowest systolic blood pressure values were in the bilateral reconstruction group (120.80 mmHg SD 22.13). Mean arterial pressure values were highest in the unilateral reconstruction group (95.49 mmHg SD 11.06) and were the lowest in the bilateral reconstruction group (89.33 mmHg SD 12.07) (Table 5.1).

Body Fat

Percent body fat values were highest in the full mastectomy group (38.09% SD 7.15) and were the lowest in the bilateral reconstruction group (30.03% SD 8.24) (Table 5.1).

Mean Muscle Mass

Mean muscle mass values were highest in the unilateral reconstruction group (11.87 kg SD 1.35) and were the lowest in the bilateral reconstruction group (10.57 kg SD 2.29). Total body water values were highest in the unilateral reconstruction group (32.64 kg SD 3.66) and were the lowest in the bilateral reconstruction group (29.26 kg SD 5.49) (Table 5.1).

Waist Circumference

Waist circumference values were highest in the bilateral surgery group (87.79 cm SD 8.83) and were the lowest in the bilateral reconstruction group (82.20 cm SD 11.82) (Table 5.1).

Patients were also stratified by age and type of surgery. The 40-49 years age group, Table 5.2, and the 50-59 years age group, Table 5.3, showed significant differences between their outcome values when compared to the R patients. Age groups 60-69 years (Table 5.4) and 70-79 years (Table 5.5) showed the same trend but there was not a significant difference in the outcome measures between these groups.

Discussion

In general, patients who underwent surgery i.e. CS had significantly poorer results compared to the regular (R) patients. Three different categories of the CS group were shown to have significantly different outcome measures in comparison to the R patients control group. The CS categories included patients who underwent a partial mastectomy, a full mastectomy or a unilateral reconstruction. Generally, the more invasive the surgical intervention was for the women, the greater the impact was on the outcome measures. The patients who underwent a full mastectomy had poorer measures compared to the women who underwent a partial mastectomy. Patients who underwent unilateral reconstruction had the poorest diastolic and mean arterial pressure values than all other CS categories. Body composition values were affected in this group but not as severely as in other groups. Some of the patients in the unilateral

reconstruction group may have had only one surgery, where both the surgical oncologist and the plastic surgeon would have been present. The patients in this category may also have had two more surgeries. The first surgery would have been with the surgical oncologist, to remove the tumor and sample the lymph node(s). The second surgery and possibly subsequent surgeries would have been with the plastic surgeon. This may account for some of the elevated values that were measured.

With the limited number of patients in the bilateral full mastectomy category and bilateral reconstruction category, it was difficult to draw substantive conclusions. One notable observation from the data in the bilateral reconstruction category, was that their body fat and waist circumference values were smaller compared to the R patients. This may have been attributable to the type of surgical intervention that some of the patients may have undergone as part of their reconstruction surgery. They may have had a surgical technique known as a TRAM, where part of the adipose tissue in the abdominal region, along with a small portion of the rectus abdominus muscle is transplanted into the chest wall to replace the breast, which may have accounted for the lower body fat and waist circumference values seen this category (Christensen et al 2013). We did not know what type of reconstruction the patients underwent.

Why are women who undergo a full mastectomy more likely to have negative outcome measures compared to those undergoing a partial mastectomy? One explanation for the difference in body composition and blood pressure values for the partial mastectomy category may be related to the women's ability to exercise at a higher intensity for change in their body's metabolism (Demark-Wahnefried et al 2001). It was expected that patients undergoing a full mastectomy would experience more restrictions in the upper body such as tightness in the chest wall and upper arm region. With the removal of the breast, the fascia which envelopes the muscles in the region, become adherent to the torso. This adherence, if not addressed, will restrict shoulder mobility. When someone has a shoulder problem, dynamic movement of the upper and lower body may

be altered. This change in movement pattern may make it uncomfortable for the patient to run, to walk briskly or exercise (Hojan et al 2012). Although patients are encouraged to exercise after surgery, many may not be receiving sufficient direction or encouragement to address some of these restrictions. It is not unreasonable to assume that the patients may become discouraged when they do not see sufficient progress from their efforts and ultimately stop exercising (Ronco et al 2012). We do not know what the activity or fitness levels were of the patients that were tested.

Patients were stratified into four age groups and type of surgery (Tables 5.2 to 5.4). The same pattern that was seen in all patients (Table 5.1) was also seen in the 40-49 age group (Table 5.2) and the 50-59 age group (Table 5.3) for cancer survivors (CS) who underwent a partial mastectomy or full mastectomy. The women in the older age groups, 60-69 years and 70-79 years (Tables 5.4 and 5.5), showed the same trends but the differences were not statistically significant between surgery categories and the regular (R) patient group. In some instances there was little difference between the women in the full mastectomy category and the unilateral reconstruction category. There seems to be no difference in blood pressure, heart rate, lean muscle mass or total body water values for women in the over 60 age groups compared to the R patients. Percent body fat and waist circumferences remained higher for CS than for the R patients.

There were only 6 patients in total in the age groups below 40 years of age. Their blood pressure and body composition values were poorer when compared to the R patients, but with the small number in these groups it was difficult to draw substantive conclusions. It was not apparent why the most significant impact of the different surgeries on women was in the 40-59 and 50-59 age groups. It would appear that the older patients seemed better able to adapt to the intervention.

One of the limitations of this study is that we did not know when the women underwent surgery though we did know that all of the women were at least one year post-surgery.

It is possible that the women in the older age groups may have had surgery a number of years previous and that their bodies gradually returned to what would be considered normal state.

One observation that did stand out when we reviewed the BMI data for the 40-49, 50-59 and 60-69 age groups, is that there was little difference between the groups i.e. CS & R patients. If physicians were using BMI and body weight to help evaluate their patient's health they may have been misled into thinking that their CS did not differ significantly from their R patients. Our data clearly shows that this was not the case. In a number of instances, BMI and body weight was very similar.

We evaluated effect size for all groups collectively and then grouped them by age. Effect size for all patients grouped by surgery ranged from small to medium (0.29-0.60) effect. The effect size was more apparent when the surgery groups were stratified by age with the effect size varying from medium to large (0.37, 0.55, 0.61, and 0.82) for diastolic blood pressure (age 40-49) for patients who had undergone partial mastectomy, full mastectomy, full bilateral mastectomy and unilateral reconstruction. With regard to body fat, the effect size stayed in the medium range (0.30, 0.51, and 0.51) for the age 40-49 patients who had undergone partial mastectomy, full mastectomy and unilateral reconstruction.

It is generally recognized that being physically fit is more important than being overweight (Blair et al 2012). We noted that the women studied were not only overweight but also had elevated blood pressure values. As well, these patients tended to have larger waist circumferences leading to the belief that the elevated body fat was more visceral fat. We would expect that these factors would place this group at a greater risk for cardiovascular disease.

Some of the limitations of this study were the lack of information regarding fitness and activity levels, and health issue traits such as diet and tobacco use. As the Centre

evolves we hope to be able to obtain this information, which will help us to better advise these women. Ideally we should have pre-surgery measures for this group, which would allow us to track and evaluate these individuals before and after each intervention with subsequent follow up.

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Table 5.1: All patients stratified by type of surgery

Outcome Measure	Regular Patient n=3694	Partial Mastectomy n=534	Full Mastectomy n=89	Bilateral Surgery n=14	Unilateral Reconstruction n=70	Bilateral Reconstruction n=5	F-Value
Age (years)	54.61	60.16	59.15	62.57	56.00	57.00	39.71
SD	9.41	8.85	9.22	8.9	7.68	13.1	
Weight (kg)	67.98	68.96	69.74	68.44	70.93	67.68	1.29
SD	13.87	12.74	16.28	9.13	11.19	17.01	
BP Diastolic (mmHg)	74.18	75.87*	77.52*	75.21	79.14*	73.60	7.82
SD	9.66	9.85	10.67	9.23	10.68	8.44	
BP Systolic (mmHg)	123.48	128.06*	132.58*	132.93	128.17	120.80	14.21
SD	15.83	16.91	17.39	15.72	14.87	22.13	
MAP (mmHg)	90.10	92.92*	94.90*	94.45	95.49*	89.33	9.14
SD	12.59	12.35	15.16	10.69	11.06	12.07	
Heart Rate (BPM)	73.04	75.15*	78.02*	74.00	75.36	64.20	6.29
SD	12.02	12.80	13.72	12.31	14.55	9.39	
BMI	26.07	27.05*	27.12	26.67	26.75	26.82	4.11
SD	5.16	4.93	5.81	3.72	4.81	6.91	
Muscle Mass (kg)	11.63	11.26*	11.09*	11.28	11.87	10.57	7.32
SD	1.59	1.40	1.50	0.87	1.35	2.29	
Total Body Water (kg)	31.90	31.01*	30.50*	31.32	32.64	29.26	6.22
SD	4.23	4.01	3.92	2.44	3.66	5.49	
Body Fat (%)	34.45	37.13*	38.09*	37.01	36.91	30.03	13.07
SD	8.28	7.78	7.15	6.38	7.31	8.24	
Waist Circumf. (cm)	84.91	87.61*	87.66*	87.79	87.06	82.20	6.06
SD	11.79	12.28	13.03	8.83	10.77	11.82	

**Significant at P<0.05; SD, Standard deviation*

Table 5.2: Patients aged 40-49 stratified by type of surgery

Outcome Measure	Regular Patient n=985	Partial Mastectomy n=62	Full Mastectomy n=18	Bilateral Surgery n=2	Unilateral Reconstruction n=14	Bilateral Reconstruction n=2	F-Value
Weight (kg)	67.48	67.88	69.31	67.55	71.32	59.00	0.40
SD	14.72	13.47	12.92	10.25	13.98	5.37	
BP Diastolic (mmHg)	73.28	76.85*	78.56	67.50	81.07*	71.50	4.47*
SD	9.52	9.16	10.61	6.36	15.09	3.54	
BP Systolic (mmHg)	118.45	121.00	126.22	114.50	126.43	104.01	2.75*
SD	13.70	15.95	15.62	13.44	20.17	0.71	
MAP (mmHg)	87.80	91.57*	94.44	83.17	96.19*	85.50	3.51*
SD	12.14	10.68	11.63	8.72	16.33	2.12	
Heart Rate (BPM)	73.55	77.08	80.17	83.00	76.21	59.00	2.74*
SD	12.22	12.98	16.73	32.53	19.67	9.90	
BMI	25.33	25.71	26.42	24.45	26.84	21.80	0.66
SD	5.10	4.99	4.31	2.19	5.83	2.69	
Muscle Mass (kg)	12.04	11.67	11.55	11.93	12.24	11.61	0.89
SD	1.69	1.43	1.40	1.09	1.43	1.99	
Total Body Water (kg)	32.95	31.99	31.74	32.82	33.48	32.18	0.83
SD	4.43	3.88	3.78	2.40	3.91	5.36	
Body Fat (%)	31.73	34.16	35.95	33.20	35.95	25.85	2.63*
SD	8.20	8.42	5.73	4.95	8.96	5.73	
Waist Circumf. (cm)	82.85	85.14	84.19	83.00	84.71	73.00	0.87
SD	11.44	12.48	10.68	8.49	10.66	2.83	

**Significant at P<0.05; SD, Standard deviation*

Table 5.3: Patients aged 50-59 stratified by type of surgery

Outcome Measure	Regular Patient n=1447	Partial Mastectomy n=178	Full Mastectomy n=24	Bilateral Surgery n=2	Unilateral Reconstruction n=35	F-Value
Weight (kg)	68.44	68.97	74.07	72.05	71.59	1.41
SD	14.18	11.60	22.79	0.78	11.19	
BP Diastolic (mmHg)	75.02	76.69	80.50*	73.50	79.94*	4.93*
SD	9.64	10.05	9.99	2.12	10.16	
BP Systolic (mmHg)	122.96	124.79	132.54*	144.50	128.00	4.31*
SD	15.72	15.81	17.70	4.95	14.60	
MAP (mmHg)	90.44	92.20	97.85*	97.17	95.96*	4.21*
SD	12.81	13.06	11.10	3.06	10.75	
Heart Rate (BPM)	73.20	76.02*	78.42	65.50	76.11	3.60*
SD	12.09	13.51	13.12	7.78	14.44	
BMI	26.18	26.67	27.70	28.50	26.48	0.96
SD	5.17	4.32	8.18	0.71	4.57	
Muscle Mass (kg)	11.68	11.49	11.54	11.39	12.00	1.06
SD	1.55	1.36	1.74	0.38	1.32	
Total Body Water (kg)	31.99	31.47	32.00	31.71	33.02	1.13
SD	4.26	4.28	5.16	0.71	3.59	
Body Fat (%)	34.81	36.12	38.92	40.15	36.22	2.70*
SD	8.28	7.37	8.74	1.06	6.97	
Waist Circumf. (cm)	85.12	86.70	89.38	95.00	87.84	2.11¥
SD	11.95	10.64	16.38	5.66	11.00	

**Significant at P<0.05; SD, Standard deviation*

Table 5.4: Patients aged 60-69 stratified by type of surgery

Outcome Measure	Regular Patient n=879	Partial Mastectomy n=207	Full Mastectomy n=30	Bilateral Surgery n=6	Unilateral Reconstruction n=17	Bilateral Reconstruction n=3	F-Value
Weight (kg)	68.87	68.60	69.68	66.42	67.82	73.47	0.18
SD	12.97	13.18	14.40	12.97	8.63	20.94	
BP Diastolic (mmHg)	74.66	71.11	77.28	77.00	77.29	75.00	1.35
SD	9.55	9.49	10.59	10.51	8.11	11.36	
BP Systolic (mmHg)	128.81	131.36	132.48	134.83	128.82	131.67	1.25
SD	15.89	15.72	17.87	17.34	10.81	23.16	
MAP (mmHg)	92.19	94.53	92.49	96.28	94.47	93.89	1.35
SD	12.68	10.53	20.82	11.91	7.60	14.54	
Heart Rate (BPM)	72.65	75.07*	77.72	74.33	74.65	67.67	2.41*
SD	11.75	12.86	12.72	9.35	10.52	9.07	
BMI	27.00	27.17	27.62	25.57	25.91	30.17	0.62
SD	5.07	4.97	5.30	4.88	3.35	7.05	
Muscle Mass (kg)	11.27	11.02	10.96	11.23	11.30	8.48	1.97
SD	1.39	1.39	1.40	.99	1.29	0.00€	
Total Body Water (kg)	31.07	30.47	29.77	31.24	31.21	23.41	2.17*
SD	3.72	3.83	2.32	2.96	3.58	0.00€	
Body Fat (%)	37.06	38.00	38.40	35.05	38.02	38.40	0.77
SD	7.41	7.42	6.50	5.55	5.71	0.00€	
Waist Circumf. (cm)	87.30	87.33	89.37	82.42	84.76	88.33	0..62
SD	11.50	13.80	12.73	8.65	7.85	11.59	

**Significant at P<0.05; SD, Standard deviation*

Table 5.5: Patients aged 70-79 stratified by type of surgery

Outcome Measure	Regular Patient n=223	Partial Mastectomy n=78	Full Mastectomy n=17	Bilateral Surgery n=4	Unilateral Reconstruction n=3	F-Value
Weight (kg)	66.37	70.31	64.21	70.10	77.43	2.233
SD	12.55	13.26	9.91	4.98	12.75	
BP Diastolic (mmHg)	72.47	72.82	72.65	77.25	71.00	.239
SD	10.16	10.65	10.94	11.00	2.65	
BP Systolic (mmHg)	132.93	132.67	139.53	133.50	138.33	.680
SD	15.89	15.72	17.87	17.34	10.81	
MAP (mmHg)	92.21	91.60	94.94	96.00	93.45	.312
SD	12.30	15.97	11.60	11.44	5.40	
Heart Rate (BPM)	70.90	71.87	75.71	73.25	62.33	1.181
SD	12.16	10.67	11.54	5.91	3.06	
BMI	26.56	28.51*	26.22	28.53	33.53	3.262*
SD	5.27	5.60	4.24	2.43	7.25	
Muscle Mass (kg)	10.67	10.91	10.13	10.95	10.39€	1.459
SD	1.22	1.25	.91	.87	0.00	
Total Body Water (kg)	29.52	30.32	28.07	30.49	29.30€	1.717
SD	3.34	3.49	2.57	2.56	0.00	
Body Fat (%)	37.23	39.84	38.54	40.30	51.10€	2.220
SD	7.90	8.01	7.16	8.83	0.00	
Waist Circumf. (cm)	87.10	90.86*	85.88	94.63	103.00	3.225*
SD	11.36	12.85	9.21	2.93	15.39	

**Significant at P<0.05; SD, Standard deviation*

CHAPTER VI

MANUSCRIPT NUMBER 4

This abstract was submitted to the 2013 Canadian Society of Exercise Physiologist (CSEP) Conference held in Toronto, Canada, October 16 - 19 2013.

6.1 Overview of the fourth manuscript

Key points

We believe that a significant number of women preparing for breast surgery already have some underlying shoulder problems. These underlying problems make it difficult for the patient to differentiate between what was present before surgery and what signs and symptoms are present after surgery.

Main findings

Almost one third of all patients tested had positive impingement and/or thoracic outlet type problems. No matter what type of breast surgery these patients had, their shoulder mobility was further comprised.

6.2 Manuscript 4: Risk of shoulder dysfunction in women waiting for breast surgery

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Abstract

Women waiting to undergo breast surgery to remove a tumor often experience transient shoulder limitations after surgery. These limitations can be further aggravated if the women have a pre-existing shoulder problem. The purpose of this study was to determine how many of the women waiting for surgery had positive shoulder impingement signs and positive thoracic outlet signs, both of which may prolong rehabilitation.

As part of a pre-surgery education process for the women at VM Medical, a number of objective outcome measures were performed to identify women who might be at risk for developing shoulder problems post-surgery. Of the 102 women who were evaluated before surgery, 42 out of 82 women had a positive Neer test, 33 out of 87 had a positive Hawkins Kennedy test, and 31 out of 85 had a positive Roos test. A significant correlation ($p= 0.01$) was found between positive impingement tests and positive thoracic outlet tests. As expected shoulder range of motion was decreased after surgery especially in those women who underwent a full mastectomy. Women with higher Body Mass Index (BMI) scores were also more likely to have positive tests. This information should be taken into consideration when advising women about what to expect post-surgery and to differentiate between previous shoulder problems and potential shoulder problems related to their impending surgery.

Introduction

After surgery to remove a suspicious lump in the breast, it is not uncommon for women to experience an initial loss in their shoulder mobility, a reduction in forearm strength, and adherence of the subcutaneous fascia to muscle, restricting arm mobility (Levy et

al 2012). With appropriate direction many of these women are able to regain their shoulder mobility and strength with few problems (Levy et al 2012). Delay in or lack of immediate post-operative exercise may result in adverse outcomes such as spasm of the musculature surrounding the joint, muscle atrophy, tightening of the shoulder capsule, and decreased short- and long-term functional mobility, increasing the risk of chronic immobility and pain (Hauglann et al 2012).

If a patient currently has a shoulder/arm problem that is painful or is predisposed to shoulder dysfunction, it is not unreasonable to expect that this patient may have difficulty distinguishing between what was there before breast surgery and what the limitations are as a result of their surgery. Understanding the difference between the two problems should make it easier to outline realistic goals for the patient so that the patient does not become discouraged (Herrera and Stubblefield, 2004).

It is unclear how many women who begin adjuvant therapy associated with breast cancer are dealing with musculoskeletal restrictions in the upper body. We do know that many women are at risk of developing musculoskeletal pain in the upper body, particularly in the neck and shoulder regions (Lindegård et al 2012). It would be expected that any pain a woman was experiencing in the neck and shoulder regions prior to surgery would have a lower priority once a lump in the breast has been discovered and surgery is recommended.

Women in general seem to be at greater risk for developing pain in the neck, shoulder and arm regions in comparison to men because they engage in more occupations that expose them to upper body injuries (Sorock GS and Courtney 1996). The increased risk may be associated with work environments that require the women to perform repetitive movements over prolonged periods of time, such as working at a computer. This environment places them at greater risk of developing chronic musculoskeletal dysfunction and possible neurological problems (Howard M, Lee and Dellon 2003).

The goal of this study was to evaluate how many women were already at risk of developing upper body dysfunction before undergoing breast surgery. Our team believed that a number of women were at risk of developing problems in the upper body and that the start of breast cancer treatment increased their risk of dysfunction taking place. Understanding this risk and incorporating preventative strategies could help these women better tolerate the treatment protocols.

Methods

As part of the standard intake evaluation, patients waiting for their annual mammogram met with one of the physicians at VM Medical and underwent a series of tests administered by one of the kinesiologists working at the Centre. Each patient who visited VM Medical was asked to review and consider signing a consent form that allowed for their medical information to be entered into VM Med's medical records database. These medical records are used by the medical team to help monitor and assess patient needs.

Test results were entered into the database. The information that was extracted from the database and that was used for this study, had personal information removed so that no individual could be identified. The study was approved by the VM Medical Ethics Board and conformed to the World Medical Association (WMA) Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects.

Patients who were scheduled for breast surgery were asked to undergo a preoperative evaluation by the Kinesiology team. The preoperative session had five main components which included; 1) Outlining to the patient what she could expect post-operatively; 2) Reiterating the surgeon's preoperative instructions; 3) Outlining the post-operative exercises that needed to be performed; 4) Performing base line testing of patients, including shoulder mobility, arm strength, present activity level, body composition, shoulder impingement, as well as, testing to evaluate neurovascular

occlusion; and 5) Addressing additional questions that the patient had concerning treatment.

Kinesiologists met with each patient for approximately 90 minutes. Recognizing the amount of stress that the patient was under, given the recent diagnosis of a suspicious lump in their breast, it was left to the discretion of the kinesiologist working in consultation with the patient to determine what information and testing was most important for the patient at that particular stage.

A series of tests were performed before surgery, to evaluate the patient's shoulder range of motion, forearm strength, and the presence of shoulder pain or upper extremity circulation issues. The breast surgery was either a partial or full mastectomy with either sentinel node or axillary node sampling.

Before surgery, the women were asked to undergo testing to evaluate their current level of shoulder function and their current level of physical activity. The testing session was also used by the kinesiologists to advise the women on the appropriate exercises to be performed post-operatively. The testing session also provided an opportunity for women to ask any questions they had concerning potential post-operative problems. Again, recognizing the amount of stress that the patient was under with a recent diagnosis of a suspicious lump in their breast, it was left to the discretion of the kinesiologists working in consultation with the patient to determine what information and testing was most important for the patient at this stage. The following tests were performed;

Shoulder flexion

Shoulder flexion was assessed with the use of a handheld goniometer. The subject was assessed in a standing position, with the axis of the goniometer positioned at the acromion process of the scapula, through the head of the humerus. The stationary arm

of the goniometer was placed along the mid axillary line of the trunk, while the moving arm was placed along the midline of the humerus in line with the lateral epicondyle.

Forearm strength

A Jamar handgrip dynamometer (Lafayette Instruments, Lafayette, IN USA) was used to assess forearm strength. The adjustable handle was fit to the hand size of the patient so that the proximal interphalangeal (PIP) joints of digits 2 through 5 were positioned at a 90 degree angle of finger flexion as a starting position. The subject kept their shoulder in a neutral position and their elbow extended by their side while performing the test. The subject squeezed the dynamometer with maximum isometric effort, and maintained the effort for 5 seconds.

Shoulder dysfunction

Shoulder impingement was assessed with the use of the Neer test and the Hawkins Kennedy test. With the Neer test (Palmer and Epler 1998), the patient's arm was moved into end range of flexion at the same time as the patient's scapula was stabilized. The test was considered positive if it elicited pain, typically at the end of the range of flexion. If the patient had full shoulder flexion with overpressure applied at the end of the range, without experiencing pain, then the test was considered negative.

The Hawkins Kennedy test (Palmer and Epler 1998) was performed by flexing the elbow to 90 degrees and then elevating the patient's arm to 90 degrees of shoulder flexion and then internally rotating the shoulder. The patient either experienced pain with this manoeuvre or tried to elevate the ipsilateral shoulder to increase the subacromial space and prevent the impingement.

When pain occurred with either of these tests, it was considered a positive sign for sub-acromial impingement. The goal behind these tests was to transiently aggravate inflamed or impinged structures as they passed under the coracoacromial arch. The

inflamed structures may have included the long head of biceps tendon, the supraspinatus tendon and/or sub acromial bursa.

Thoracic outlet test-Roos test

Testing was performed to assess for the possibility of neurovascular occlusion often associated with thoracic outlet syndrome through the use of the Roos Test (Howard, Lee and Dell 2003). The patients were asked to abduct both shoulders to 90 degrees and then flex both of their elbows to 90 degrees. They were then asked to open and close their hands repeatedly for up to 3 minutes. During that time if the patient started to experience numbness and/or a pins and needles sensation in their hands, the test was stopped and a positive sign noted. If there was no presence of numbness and/or a pins and needles sensation, then a negative sign was recorded.

Level of activity

To gain an understanding of the patient's typical level of physical activity, patients were asked to indicate what best represented their current level of activity. The scale was: 1) Active 1 day per week; 2) Active 3-5 days a week; and 3) Active every day of the week.

BMI (Body Mass Index)

Patient's height and weight were recorded and were classified according to BMI based on the Canadian Physical Activity, Fitness and Lifestyle Approach (CPAFLA- CSEP). Patients were ranked as follows; Mild thinness (BMI 17.0 -18.49), Normal (BMI 18.0- 24.9), Pre-obese (BMI 25.0- 29.9), Obese level I (BMI 30.0- 34.9), Obese level II (BMI 35.0- 39.9), Obese level III (BMI greater than 40.0).

Data analysis

Statistical analysis was performed using IBM SPSS version 19.0. A one-way nova with Tukey post-hoc analysis was performed on shoulder ROM (range of motion) measures with significance assumed at $P<0.05$.

Simple t-tests were performed on handgrip strength measures. Significance was assumed at $P< 0.05$. Pearson correlation was used to evaluate relationships between outcomes measures. Significance was assumed at $P< 0.05$.

Results

From a total of 224 VM Medical patient visits, 156 were seen in the WC. Of these 156 patients, 84 patients were evaluated preoperatively only, 41 patients were evaluated post-operatively only, and 31 patients were evaluated preoperatively and post-operatively. A total of 94 patients had a partial mastectomy, 45 had a full mastectomy, and 10 had bilateral full mastectomies. The type of surgery was not recorded for 7 of the patients.

Hand dominance

A total of 146 patients were right-handed and 8 patients were left-handed. Two of the patients' hand dominance was not recorded. For 81 patients, the primary surgery was performed on the right side; 75 of the patients had surgery on their left side.

Preoperative shoulder impingement

The Neer test was administered to 82 patients, 42 of whom had positive findings, while 40 had negative findings, provoking pain. The Hawkins-Kennedy test was performed on 87 patients, 33 of whom had positive findings while 54 had negative findings, provoking pain (Table 6.1).

Preoperative potential thoracic outlet problems

The Roos test was performed on 85 patients; 31 tests were positive and 54 tests were negative for signs of numbness or a tingling, pins and needles sensation (Table 6.1).

Shoulder flexion (ROM - Range of Motion)

Pre-surgery shoulder flexion tests showed little variation between groups (partial mastectomy; full mastectomy) for either the left or right arm, with values ranging from 173-176 degrees. Post-operatively, there was a significant difference between groups

with patients who underwent a full mastectomy having poorer shoulder flexion with values varying from 115-119 degrees. Patients who underwent a partial mastectomy had the greatest shoulder flexion with values varying from 139-146 degrees (Table 6.2).

Grip strength

Grip strength tests were only performed pre-surgery and not post-surgery. The mean grip strength on the left side was 23.05 with SD of 4.85 while mean grip strength on the right side was 24.69 with SD of 5.30, total grip strength 46.91 with a SD of 9.76. A simple test showed a significant difference ($p<0.001$) between left and right hand (Table 6.2).

Pearson correlation (with significance set at 0.05, 2 tailed) showed a significant correlation with a positive Neer's test and a positive Hawkins-Kennedy test ($P<0.05$, $r^2= 0.59$) and positive thoracic outlet test ($p<0.05$, $r^2= 0.71$).

Correlation between shoulder ROM, grip strength and positive tests

A significant correlation was found between the Hawkins-Kennedy impingement test and the post-operative shoulder flexion on the left side ($p=0.28$, $r=0.31$). Correlations were also seen between handgrip strength on the left and pre-surgery shoulder flexion on the left ($P<0.05$, $r^2= 0.12$) and on the right ($P<0.05$, $r^2= 0.09$) (Tables 6.1 and 6.2). No differences between groups, however, were observed (Tables 6.3 and 6.4).

BMI (Body Mass Index)

The weight and height of 77 patients were taken and recorded. The BMI for 41 of these patients was within the normal range, while 15 patients were considered pre-obese/overweight and 19 were considered obese. Only 2 patients fell within the "mild thinness" category. (Table 6.6)

Fitness level

Patients were asked to identify their typical activity level during a regular week: There were 28 patients who did light exercise on a regular basis, one time per week (Level 1). There were 37 patients who did light exercise on a regular basis, three times per week (Level 2). There were 49 patients who did regular, moderate-intensity exercise three to five times per week (Level 3). There were 10 patients who did regular exercise every day of the week (Level 4). Finally, there were 10 patients who did not exercise on a regular basis (List of tables6.5). A total of 97 patients were not asked or did not identify their level of activity

Discussion

The purpose of this study was to implement a preoperative protocol for women waiting to undergo breast surgery. This protocol would provide information such as the functional capacity and activity level of the women before their surgery. This information in turn could be used to advise the women on what they should do to minimize the potential negative effects associated with surgery and also help to identify patients who may be at greater risk for post-operative problems.

It was expected, based on a literature review, that 15-20% of the women would have positive impingement tests; however, it was surprising to see that 38% of the patients had positive tests. There was a correlation between a positive Hawkins-Kennedy test and reduced shoulder range of motion on the left side after surgery (Kappe et al 2013). Both the Hawkins Kennedy and the Neer tests assessed the presence of impingement in the anterior aspect of the shoulder. This was not the only type of shoulder problem that a patient would have experienced, but it was one of the more common pathologies.

The expectation was that the women who did have positive tests before surgery would continue to have positive tests after surgery. We also expected that certain regions would show greater sensitivity before and after surgery in patients with positive tests.

Previous studies have recognized that dysfunction can occur after breast surgery (Dahl et al 2011, McNeely et al 2010). These studies evaluated patients post-operatively using impingement tests. Studies that evaluated patients preoperatively focused on range of motion testing and in some instances did so repeatedly; however, they did not include preoperative impingement testing.

At the WC the time frame between diagnosis of a lump in the breast, repeated imaging, and follow up consultation leading to surgery was approximately 10 days. Due to the small window of time from diagnosis to scheduling of surgery, it was often difficult to obtain preoperative information on all patients. The preoperative evaluation combined with the surgery and the surgical findings are important pieces of information which help to direct the patient as to the appropriate type of treatment and the recommended follow-up.

Patients who had a higher BMI score were shown to be more likely to have positive impingement tests and positive thoracic outlet tests. This is consistent with a study by Nilsen et al. 2011 who showed that women who had higher BMI scores were more likely to have shoulder/neck and lower back problems compared to women with lower BMI scores (Table 6.6).

There was a significant correlation between higher total handgrip values and higher fitness level scores. There was also a significant correlation between higher handgrip scores and pre-operative shoulder range of motion values. Post-operative handgrip values were not collected because of concerns the Centre's physicians had about the effects of maximal exertion of the forearm muscles two weeks after surgery.

By far the vast majority of the patients were right-hand dominant, which would account for the difference in grip strength between the left (23.05 ±4.85) and right hands (24.69 ±5.30). When looking at handgrip strength both groups would be ranked below average when compared to the normative values for handgrip strength.

There was a trend between the type of surgery that was performed and the likelihood of reduced shoulder range of motion after surgery. Patients that had a bilateral mastectomy or a full mastectomy had reduced post-operative range of motion compared to patients who had a partial mastectomy.

Factors have come to light that may help identify patients at risk of developing post-operative problems. Certainly a risk of pre-existing problems may be considered a factor as well as the patient's body composition and the type of breast surgery. A patient at lower risk would be a patient that has negative impingement or thoracic outlet tests, a lower BMI, and undergoing a partial mastectomy. A patient at greater risk would be a patient with positive impingement or thoracic outlet tests, a high BMI score, possibly less physically active, and undergoing a full mastectomy. Previous studies have also shown that the removal of multiple lymph nodes may also be a factor in the patient's recovery.

One of the limiting aspects of this study was the post-operative follow up of all the patients. Patients that were doing well after surgery did not feel the need to come in for post-operative follow up at the WC. They wanted to get themselves ready in anticipation for the recommended adjuvant therapy. This is a step that has been done in other studies often without the inclusion of the pre-surgery measures (Stan et al 2012, Chan, Lui and So 2010).

It was important to implement the pre-operative protocol with an understanding of the amount of stress the patients are under while waiting for surgery combined with the possibility adjuvant therapy after surgery. The next step in this preoperative assessment protocol would be to evaluate pain objectively before and after surgery. On a number of occasions pain has been evaluated subjectively via questionnaires, often in conjunction with shoulder mobility testing.

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Table 6.1: Impingement and thoracic outlet testing

N	Neer test	%	HK	%	Roos- test	%
Total	**82**		**87**		**85**	
Positive	42	51.22	33	37.93	31	36.47
Negative	40	48.78	54	62.07	54	63.53

Hawkins - Kennedy Impingement test (HK)

Table 6.2: Patients stratified according to surgical intervention

	N	Partial Mastectomy	N	Full Mastectomy	N	Bilateral Mastectomy
Grip Strength Left	63	23.48	21	22.79	5	20.40
SD		4.84		4.90		4.34
Grip Strength Right	64	25.50	21	22.95	5	22.60
SD		5.34		5.21		4.10
Grip Strength Total	63	47.95	21	45.26	5	43.00
SD		9.94		9.71		7.48
Presurgery Left ROM	73	174.41	22	175.95	6	173.33
SD		11.49		7.69		7.53
Presurgery Right ROM	72	174.29	23	173.13	5	173.40
SD		11.77		15.78		7.60
Post-surgery Left ROM	27	145.52	16	119.00	6	129.33
SD		33.19		34.18		25.19
Post-surgery Right ROM	28	138.68	14	114.86	6	126.17
SD		40.33		39.61		21.91

Table 6.3: Analysis of variance (ANOVA) of pre-surgery and post-surgery measures

		df	Mean Square	F	Sig.
Pre-surgery Left ROM	Between Groups	3	26.631	.237	.871
	Within Groups	98	112.591		
	Total	101			
Pre-surgery Right ROM	Between Groups	3	8.426	.053	.984
	Within Groups	98	159.313		
	Total	101			
Post-surgery1 Left ROM	Between Groups	3	2499.769	2.330	.087
	Within Groups	46	1072.784		
	Total	49			
Post-surgery1 Right ROM	Between Groups	3	2320.108	1.565	.211
	Within Groups	45	1482.548		
	Total	48			

P<0.05

Table 6.4: Post-hoc analysis of shoulder flexion after surgery

Type of Surgery	n	1	2
Full Mastectomy	10	102.00	
Bilateral Mastectomy	19	136.68	136.68
Partial Mastectomy	2		150.00
Sig.		0.192	0.773

Tukey post-hoc test P < 0.05

Table 6.5: Perceived activity level of patients

		Frequency
Valid	Level 1 (Occasional exercise, once a week)	28
	Level 2 (Regular light exercise, 3 days/week)	37
	Level 3 (Regular moderate exercise, 3-5 days a week)	49
	Level 4 (Very active regular exercise, every day)	10
	Sedentary (No regular exercise)	10
	Total	**134**

Table 6.6: Body Mass Index (BMI) of patients

		Frequency
Valid	Mild Thinness (17.0 - 18.49)	2
	Normal Range (18.50 - 24.99)	41
	Pre-Obese / Overweight (25.0 - 29.99)	15
	Obese Class I (30.0 - 34.99)	12
	Obese Class II (35.0 - 39.99)	4
	Obese Class III (≥ 40.0)	3
	Total	**77**

CHAPTER VII

RESULTS PERTAINING TO ADDITIONAL QUESTIONS

7.1 Question 1: Relationship between hormone therapy and body composition

The following information concerning the relationship between hormone therapy and cardiovascular risk factors was presented at the 2013 Groupe de Recherche en Activité Physique Adaptée (GRAPA) International Conference held in Montréal, Canada. It was presented in the poster section of the conference and is titled: *Impact of different estrogen inhibitor therapy on body composition and vital sign measurements in breast cancer survivors.* Below is the abstract of the poster presentation, followed by Table 7.1 outlining the data that is presented.

Abstract

Purpose

The purpose of the study was to determine if body composition and basic cardiovascular function of cancer survivors varies depending on the type of hormone therapy being given to women as part of adjuvant therapy.

Methods

Kinesiologists performed base line measurements on 3,673 regular (R) patients and 716 cancer survivors. The cancer survivors were stratified into 5 different groups according to type of hormone therapy as follows; Arimedex (A) = 97 patients, Aromasin (Ar) = 14 patients, Tamoxifen (T) = 143 patients, no hormone therapy (N) = 191 patients and those who had completed hormone therapy (C) = 271 patients. These groups were then compared to the R patients. A one way ANOVA was performed followed by Dunnett's post-hoc analysis with significance set at $p < 0.05$.

Results

Across all groups mean age (± SD) was 55.4 yrs. ±9.29; height was 160.9 cm ±7.60; and weight was 68.19 kg ±13.75. Significant differences were seen between the cancer survivors in all groups and the regular patients with $p<0.001$ in 6 key variables as follows; diastolic blood pressure: ($F= 7.10$) $\mu= 74.2$ mmHg (R) vs $\mu= 78.3$ mmHg (Ar), systolic blood pressure: ($F= 13.27$) $\mu= 123.5$ mmHg (R) vs $\mu= 129.9$ mmHg (A), muscle mass: ($F= 5.88$) $\mu= 11.6$ kg (R) vs $\mu= 11.2$ kg (C and N), total body water: ($F=4.64$) $\mu= 31.9$ kg (R) vs $\mu= 30.9$ kg (C), % body fat: ($F=13.64$) $\mu= 34.5$ % (R) vs $\mu= 38.3$ %. (A), and waist circumference: ($F= 9.04$) $\mu= 84.9$ cm (R) vs $\mu= 93.8$ cm (Ar).

Conclusion

Different hormone therapy protocols for cancer survivors appear to increase cardiovascular risk factors associated to negative changes in body composition and blood pressure.

Table 7.1: Treatment of patient stratified according to type of hormone therapy

	Regular Patients	Arimedex	Aromasin	Tamoxifen	No hormone therapy	Completed hormone therapy	F value (Between groups)
	N=3673	N=97	N=14	N=143	N=191	N=271	
Age (years)	54.61	60.29	65.5	54.84	59.11	62.06	51.1
SD	9.14	7.81	7.89	9.1	8.59	8.31	
Mean weight (kg)	67.98	70.85	71.86	68.58	69.7	68.55	1.61
SD	13.87	12.26	9.77	13.39	14.54	12.02	
BP Diastolic (mmHg)	74.18	78.34 €	78.34 €	77.11	75.66	76.17	7.13
SD	9.66	8.85	16.67	10.17	9.92	10.08	
BP Systolic (mmHg)	123.48	129.87 €	126.79	127.61	127.9	129.55	13.31
SD	15.83	15.87	34.92	17.73	16.42	15.65	
MAP (mmHg)	90.1	94.88 €	94.50 €	93.94	92.27	93.79	9.1
SD	12.59	9.93	22.34	11.78	13.2	13.2	
Heart rate (BPM)	73.04	77.11 €	74.04	77.09	75.83	73.8	6.62
SD	12.02	12.06	9.87	13.21	13.95	12.56	
BMI	26.07	27.78	28.49 €	26.32	27.22	26.91	5.34
SD	5.16	4.75	4.83	4.86	5.4	4.83	
Muscle mass (kg)	11.38	11.15	10.95	11.18	11.07*	10.92*	5.91
SD	1.55	1.24	1.14	1.38	1.54	1.31	
Total body water (kg)	31.2	30.74	30.3	30.8	30.34*	30.16*	4.65
SD	4.14	3.39	2.99	3.83	4.6	3.59	
Body fat (%)	34.45	38.34 €	37.84 €	35.88	37.28 €	37.39 €	13.63
SD	8.28	6.51	8.4	7.97	7.87	9.85	
Waist Circumf. (cm)	84.91	90.12 €	93.75 €	85.08	88.14	87.22	9.06
SD	11.79	11.12	11.21	11.01	11.77	13.01	

** Indicates that post-hoc analysis using the Dunnett's test showed significant difference P<0.05 between regular patients (control) and patients that had treatment for breast cancer and were in a medication group. € Indicates that measure for this group would be in the 62-69 percentile when compared to the control group and would be considered a medium effect size.*

7.2 Question 2: Fitness levels of the patients at VM Medical

The establishment of standard testing protocols by VM Medical's Integrative Health and Wellness Centre (WC) and the sharing of the information with the medical staff has led to the WC being recognized as an important contribution to addressing the health needs of both cancer survivors (CS) and the regular (R) patients. Building on the standardized intake evaluation enabled the WC to offer fitness evaluations to its patient population. To conduct fitness evaluations, the WC utilizes the protocol put forward by the Canadian Society for Exercise Physiology (CSEP). This protocol uses aged matched data to identify the level of fitness of the patient. The information obtained provides ready feedback to the patients.

The data presented in Tables 7.2 and 7.3 below, show the results of CSEP fitness tests performed on regular **(**R**)** patients. Since November 2012, the testing protocol has been expanded to include CS as well. It is expected that by the Fall of 2013, sufficient cancer survivors will have been tested so that aged matched analysis maybe performed. We believe that there will be a significant difference in body composition and blood pressure values between our 2 major groups of patients. Our expectation is that the CS are less likely to score as high on the fitness tests compared to the R patients.

Table 7.2: Fitness levels of women at the VM Medical Integrative Health and Wellness Centre (WC)

Fitness Level	Back Extension	Partial Curl Up	Handgrip Strength	Partial Push Up	Trunk Forward flexion	Aerobic Fitness Treadmill
Excellent	46	59	13	40	16	6
Very good	31	27	28	50	19	3
Good	27	37	22	26	21	29
Fair	19	6	29	10	32	19
Need improvement	7	28	51	3	43	58
Not done	27	0	14	28	26	42

Table 7.3: Mean values from the Canadian Physical Activity, Fitness and Lifestyle Approach (CPAFLA/CSEP) testing

	Mean	**Median**
Back Ext. Modified Total Sec.	105.86	101
Back Ext. Total Sec.	87.75	74
Grip Strength **Left** (kg/m)	22.8	22
Grip Strength **Righ**t (kg/m)	24.84	25
Grip Strength Total (kg/m)	**47.64**	**47**
Partial Curl-Ups Total Modified	18.9	20
Partial Curl-Ups Total Standard	21.38	25
Push-Ups Total Modified	17.62	19
Push-Ups Total Standard	14.73	13
Trunk Forward Flex. Standard Reach	26.89	27.25

Many of the women fall into **"**need improvement**"** category. When looking at forearm strength**,** 51 were identified as in need of improvement for handgrip strength and 58 need improvement in cardiovascular fitness (Bruce protocol). Many of the women scored from good to excellent in abdominal strength.

7.3 Question 3: Use of the hand-held algometer and the Jones template

The protocol to measure the pressure pain thresholds (PPT) of breast cancer patients utilizing the Jones template is only just beginning at the VM Medical Integrative Health and Wellness Centre (WC). A handheld algometer is applied to eight different locations in the upper body before and after surgery. The location where the algometer is applied follows the Jones template that was validated in D.H. Jones' master's thesis. It is expected that over the next two years we will reach the 21 patients required to give the study sufficient power to detect statistical significance. When patients are seen preoperatively and post-operatively it is not uncommon for many of them to have pain in their upper back and neck region. This includes the appearance of trigger point nodules in the upper trapezius and the rhomboid muscles. We expect the Jones template will yield some interesting results and will be a useful tool for clinicians, researchers and patients.

Utilizing the algometer on one patient pre-surgery and post-surgery showed that the pre-surgery values at the eight different locations were similar to the values obtained in previous work by Jones, Kilgour and Comtois, 2008. The post-surgery measures showed site specific sensitivity in the supraspinatus and trapezius locations with lower PPT values.

CHAPTER VIII

SUMMARY AND FUTURE DIRECTION

8.1 Summary of manuscripts

In manuscripts 1 and 2, we found significant differences across a number of outcome measures between the cancer survivors (CS) and the regular (R) patients. We also noted that for cancer survivors, body fat is a better indicator of change in MAP values compared to a person's waist circumference.

In manuscript 3 and the manuscript that has been included in Annex 3, we observed that patients undergoing more extensive surgery and multiple forms of cancer treatment are at greater risk for developing cardiovascular problems, though it is not clear whether the women were already at greater risk before having any form of treatment. It is also unclear to what extent surgery and cancer treatments are contributory factors to the increase in risk of cardiovascular disease.

In manuscript 4, we noted that a significant number of women were at risk for shoulder problems before undergoing breast surgery and depending on the type surgery these women could also expect to have a transient reduction in shoulder mobility after surgery.

8.2 Future Direction

The information presented in the five different manuscripts and the additional questions is only a very small portion of the activities performed at VM Medical. One of the most valuable tools of the Centre is the pre-surgery evaluation in which the women receive information as to what to expect with breast surgery and what they need to do after surgery to minimize complications. This also includes the post-surgery follow up where

the women are able to make use of the WC exercise facility under the supervision of the staff. These initiatives have reduced the number of women who need to seek additional treatment for post-surgical complications, which in turn has reduced some of the women's stress and also provided them tools they can utilize as they go through treatment.

There is a lot of work still too done for cancer survivors. We expect to continue our work with VM Medical patients in the hope that we can contribute to improving their quality of life as well as help reduce their risk for cancer re-occurrence, cardiovascular disease, and other chronic diseases.

ANNEX A

FORMULAIRE DE CONSENTEMENT POUR PARTICIPER DANS UN PROJET DE RECHERCHE

Titre du projet: "Niveau de forme physique et historique du dysfonctionnement de l'épaule chez des patients en attente d'une chirurgie du sein

Vous êtes invité à participer à un projet de recherche qui sera menée par l'Université du Québec à Montréal et le Centre de bien-être de Ville Marie. Le chercheur principal est Alain-Steve Comtois Ph.D., professeure agrégée, département de kinésiologie, l'Université du Québec à Montréal. L'équipe de recherche est composée de David H. Jones, étudiant au doctorat en biologie, l'Université du Québec à Montréal, Melisa Nestore, kinésiologue, Ville Marie Wellness Centre (VMWC) et Sara Henophy, kinésiologue, VMWC.

S'il vous plaît lire les informations ci-dessous et sentez vous entièrement libre de poser toutes les questions sur quoi que ce soit que vous ne comprenez pas avant de décider de participer ou non. Notez que la participation à l'étude est entièrement volontaire.

BUT

Je comprends que le projet de recherche vise à examiner la douleur de l'impact et des restrictions musculo-squelettiques, qui peuvent être présentes avant l'intervention chirurgicale, sur l'habilité à retrouver la mobilité de l'épaule après la chirurgie.

PROCÉDURES

Toutes les épreuves pour le projet se dérouleront au Centre de bien-être Ville Marie. Les tests se feront à deux reprises : avant la chirurgie et environ trois 3 semaines après la chirurgie.

<u>Résumé du protocole d'essai</u>

1. Je comprends que l'amplitude de mouvement, souplesse et force au niveau de mon épaule sera évaluée par un kinésiologue qui est membre de l'équipe de recherche. Des mouvements actifs seront effectués au meilleur de ma capacité sans aggraver une affection sous-jacente. Ma composition corporelle sera également évaluée en mesurant la circonférence au niveau de la hanche et de la taille.

2. Mon niveau de forme physique sera évalué en marchant sur un tapis roulant. Je devrai porter un moniteur de fréquence cardiaque pendant la marche à une vitesse prédéterminée sur le tapis roulant, jusqu'à ce que mon rythme cardiaque atteigne un seuil spécifié correspondant à mon âge. Cette fréquence cardiaque sera d'environ 80 % de la fréquence cardiaque maximale prévue pour mon groupe d'âge. Ce test bien établi, connu comme le protocole de Bruce détermine mon niveau de conditionnement physique sous-maximal. Je comprends que le test prendra environ 20 minutes à compléter.
   Aussi, il vous sera demandé ne pas de discuter de l'information recueillie durant ce test ou toute autre session de test afin de créer un biais chez les autres participantes durant le processus de collecte de données.
3. L'étudiant de cycle supérieur mesurera mes seuils de pression/douleur à l'aide d'un algomètre. L'algomètre servira à mesurer la pression / au seuil de ma douleur. Un algomètre est un dispositif électronique servant à mesurer les variations de pression à la surface de la peau. L'algomètre a approximativement la même forme qu'un scanner à barre mobile utilisé pour lire les codes à barres sur les items retrouvés dans les magasins.
   La sensation ressentie lorsqu'un algomètre est appliqué à la surface de la peau est semblable à une personne poussant son doigt dans son avant-bras. Au moment où la sensation sur la peau change de pression à la douleur, le test est arrêté au site de la mesure et les résultats sont enregistrés. Cette mesure est connue comme la pression / seuil de douleur.
   On mesurera à l'aide de l'algomètre huit sites différents au niveau de votre cou, épaules et bras. Je comprends que les tests d'algomètre seront répétés 4 fois durant ma visite et cela dure environ 30 minutes pour compléter tous les 4 tests.
4. Je comprends que les séances d'examen préopératoire devraient prendre environ 1 ½ heures au total et que les tests post-chirurgie comprendront seulement la mobilité de l'épaule et les mesures avec l'algomètre, ce qui prendra environ 1 heure à compléter.

ADMISSIBILITÉ

Les participants sont les femmes âgées de 30 à 70 ans. Femmes ayant des antécédents d'hypersensibilité (fibromyalgie) ou hyposensibilité (manque de sensibilité) à la douleur seraient exclus de participer au projet. Toute les participantes sont prévues pour une chirurgie mammaire. La chirurgie inclut une mastectomie partielle ou une mastectomie totale avec un échantillonnage de ganglion lymphatique.

LES RISQUES POTENTIELS ET LES MALAISES

Il est possible que je ressente une légère douleur à un ou plusieurs des points de repère/site après l'application de l'algomètre. Il est également possible que l'application de l'algomètre cause quelques ecchymoses locales. Pendant les essais physiques, il vous sera demandé d'effectuer la tâche jusqu'à ce que le niveau d'inconfort ne soit plus tolérable.

Après le test d'aptitude physique sur le tapis roulant, il se peut que je ressente de la fatigue et que je sois un peu plus fatigué que normalement. Cette fatigue devrait disparaître 15 – 20 minutes après avoir complété le test.

AVANTAGES POTENTIELS

De nombreux patients ont des limitations musculo-squelettiques après la chirurgie. Ces mêmes patients bénéficient souvent d'un programme de réadaptation structuré pour surmonter certaines de ces limitations. Votre participation à ce projet aidera à identifier vos limitations musculo-squelettiques, le cas échéant et faciliter l'élaboration et la mise en œuvre d'un programme de réadaptation post-chirurgicale personnalisé.

COMPENSATION POUR VOTRE PARTICIPATION

Les participants qui terminent toutes les phases d'évaluation préopératoire et post-opératoire pour ce projet recevront 2 séances de rééducation sans frais après leur chirurgie. La valeur totale de ces sessions est environ $150.00-$ 200.00.

Les séances de rééducation seront effectuées par le thérapeute du sport qui est membre de l'équipe de recherche, mais aussi un clinicien avec le Centre de bien-être de Ville Marie.

CONFIDENTIALITÉ

L'information utilisée provient du dossier électronique et les données recueillies avec l'algomètre sont confidentielles. Seulement les membres du Comité d'éthique et de l'équipe de recherche auront accès aux données.

Toutes les informations obtenues au cours de cette étude sont strictement confidentielles et ne seront pas révélées à quiconque sans le consentement de votre part. Toutefois, les renseignements recueillis peuvent être utilisés pour faire progresser l'ensemble des connaissances scientifiques et peuvent, donc, être publiés dans des revues scientifiques où l'anonymat de votre participation sera entièrement préservé.

Certains des renseignements obtenus dans l'étude seront stockées dans la base de données électronique de Ville Marie. Ces informations incluent l'amplitude de mouvement au niveau de l'épaule, de la remise en forme du mouvement, votre poids et votre grandeur. Les renseignements obtenus par l'utilisation de l'agomètre seront stockés dans classeur sécurisée et ordinateur dont l'accès est protégé par un mot de passe au département de kinésiologie de l'UQAM et ne seront pas stockées dans la base de données électronique à Ville-Marie.

PARTICIPATION ET RETRAIT

Ma participation à ce projet de recherche est strictement volontaire et je suis libre de me retirer à tout moment avant ou pendant les sessions expérimentales. Mon retrait de ce projet n'aura absolument aucun effet sur la qualité des soins que je recevrai au Centre médical Ville Marie.

APPROBATION DU PROJET DE RECHERCHE

Ce projet de recherche a été approuvé par les comités d'éthique du Centre médical Ville Marie et le l'Université du Québec à Montréal (UQAM). Les coordonnées des comités éthiques sont indiquées à la fin du présent formulaire de consentement.

QUESTIONS

Vous êtes invité et entièrement libre de poser toutes questions que vous croyez pertinentes. Toute question concernant le projet, plaintes ou observations peut-être être adressée à l'un des chercheurs impliqués dans ce projet de recherche. En outre, les sujets sont invités à demander des explications supplémentaires s'ils ont des doutes quant à la participation au projet de recherche. Les chercheurs responsables du projet de recherche sont Alain-Steve Comtois, Chercheur Principal et David Jones, étudiant au doctorat en biologie. On trouvera leurs coordonnées à la fin du présent formulaire de consentement.

Toutes questions concernant la responsabilité des chercheurs, ou dans l'éventualité d'une plainte ne peut pas être adressée directement aux enquêteurs, vous pouvez communiquer avec le représentant du Patient au Comité d'éthique de la Ville Marie Centre médical ou le sous-comité de l'éthique de l'UQAM (*Sous-comité du Comité Institutionnel d'Éthique de la Recherche chez l'Humain de l'UQAM)* directement. Vous trouverez les coordonnées des Comités à la fin du présent formulaire de consentement.

CONSENTEMENT

Je suis satisfaite des explications que j'ai reçues et je conviens avoir entièrement lu et compris les procédures. Je suis consciente des risques encourus en participant à ce projet et qui sont décrits dans le présent formulaire de consentement.

Je consens à être un sujet dans le projet de recherche intitulé **" *Niveau de forme physique et historique du dysfonctionnement de l'épaule chez des patients en attente d'une chirurgie du sein***

Date: _____

Name: _____ Signature: _____

(En lettres moulées)

Témoin: _____ Signature: _____

(En lettres moulées)

COORDONNÉES

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ANNEX B

CONSENT FORM TO PARTICIPATE IN A RESEARCH PROJECT

Project title: "Fitness level and history of shoulder dysfunction in patients preparing for breast sparing surgery"

You are being asked to participate in a joint research project to be conducted by Université du Québec à Montréal and the Ville Marie Wellness Centre. The principal investigator is Alain-Steve Comtois Ph.D., Associate Professor, Department of Kinesiology, l'Université du Québec à Montréal. The research team is comprised of David H. Jones, Doctoral Student in Biology, l'Université du Québec à Montréal, Melisa Nestore, Kinesiologist, Ville Marie Wellness Centre (VMWC), and Sara Henophy, Kinesiologist, VMWC.

Please read the information below and ask questions about anything you do not understand before deciding whether or not to participate. Note that participation in the study is entirely voluntary.

PURPOSE

I understand that the purpose of the research project is to examine the impact pain and musculoskeletal restrictions, which may be present before surgery, have on the participant regaining shoulder mobility after surgery.

PROCEDURES

All testing related to the project will be conducted at the Ville Marie Wellness Centre. Testing will be done on two different occasions: before surgery, and approximately three (3) weeks after surgery.

Summary of Testing Protocol

1. I understand that my range of motion, flexibility and strength will be assessed by a kinesiologist who is a member of the research team. Active movements will be performed to the best of my ability without aggravating any underlying condition. My body composition will also be evaluated through hip to waist circumference measurements.

2. My fitness level will be assessed by walking on a treadmill. I will wear a heart rate monitor and will be required to walk at a predetermined speed until my heart rate reaches a specified level that corresponds to my age. This heart rate will be approximately 80% of the maximum capacity expected for my age group. This well-established test known

as the Bruce Protocol will determine my sub-maximal fitness level. I understand that the testing will take approximately 20 minutes to complete.

I will be asked not to discuss any of the information that was collected at the fitness level testing session or any other session in order to avoid creating any bias with the data collection process.

3. The graduate student will measure my pressure/pain thresholds using an algometer. An algometer will be used to measure my pressure/ pain threshold. An algometer is a hand-held electronic device used to measure changes in pressure on the skin's surface. The algometer is approximately the same shape as a mobile bar scanner used to read the bar codes on items in a department store.

   The sensation one feels when an algometer is applied to skin is similar to someone pushing their finger into one's forearm. The moment that the sensation on the skin changes from pressure to pain, the test is stopped at that testing site and the results recorded. This measurement is known as the pressure/ pain threshold.

   Eight different landmarks around my neck, shoulder and arm will be measured with the algometer. I understand that the algometer tests will be conducted 4 times and will take approximately 30 minutes to complete all 4 tests.

4. I understand that the pre-surgery testing sessions are expected to take approximately 1 ½ hours in total and that the post-surgery testing, which will include only shoulder mobility testing and testing with the algometer, will take approximately 1 hour to complete.

ELIGIBILITY

Participants are females between the ages of 30 and 70 years of age. Women with a history of hypersensitivity (fibromyalgia) or hyposensitivity (lack of sensitivity) to pain would be excluded from participating in the project. All participants are scheduled for breast surgery. The surgery includes either a partial mastectomy or a full mastectomy with lymph node sampling.

POTENTIAL RISKS AND DISCOMFORTS

I *may* experience mild pain at one or more of the landmarks following the application of the algometer. It is also possible that the application of the algometer may cause some local bruising. During the physical tests, I will be asked to conduct the task until the level of discomfort is no longer tolerable.

After the fitness test on the treadmill I may feel tired and a bit more fatigued than I am normally. This tiredness and fatigue should disappear within 15 – 20 minutes after completing the test.

POTENTIAL BENEFITS

Many patients have musculoskeletal limitations after surgery. These same patients often benefit from a structured rehabilitation program to overcome some of these limitations. Participating in this project will help to identify the participant's musculoskeletal limitations, if any, and facilitate the development and implementation of a personalized post-surgical rehabilitation program.

COMPENSATION FOR PARTICIPATION

Participants who complete all phases of the pre-surgery testing and post-surgery testing for this project will receive 2 rehabilitation sessions free of charge following their surgery. The total value of these sessions is approximately $150.00-$200.00.

The rehabilitation sessions will be conducted by the Athletic Therapist who is a member of the research team as well as a clinician with the Ville Marie Wellness Centre.

CONFIDENTIALITY

The information used from the electronic chart and the data obtained from the algometer is confidential except to the members of the ethics committee and Primary Investigator.
All the information obtained during the course of this study is strictly confidential and will not be released to anyone without the subject's written consent. However, the information collected may be used to advance the body of scientific knowledge and may, therefore, be published in scientific journals where the subject's anonymity will be entirely preserved.

Some of the information obtained in the study will be stored in the Ville Marie electronic database. This information includes a participant's height, weight, fitness level, and shoulder range of motion. Information obtained through the use of the algometer will be stored in a secure facility at UQAM and will not be stored in the electronic database at Ville Marie.

PARTICIPATION AND WITHDRAWAL

My participation in this research project is strictly voluntary and I am free to withdraw at any time prior to or during the experimental sessions. Withdrawal from this project will have absolutely no effect on the quality of care I will receive while at the Ville Marie Medical Centre.

RESEARCH PROJECT APPROVAL

This research project has been approved by the ethics committees of the Ville Marie Medical Centre and the l'Université du Québec à Montréal (UQAM). The ethics committees' coordinates may be found at the end of this consent form.

QUESTIONS

Participants are entirely free to ask any questions that they believe are relevant. Any question about the project, complaints, or comments may be addressed to any of the investigators involved in this research project. In addition, subjects are invited to ask for additional explanations if they have any doubts about participating in the research project. The investigators responsible for the research project are Alain-Steve Comtois, Principal Investigator and David Jones, M.Sc., CAT(C), CSCS. Their coordinates may be found at the end of this consent form.

Questions regarding the responsibility of the investigators, or in the event that a complaint cannot be addressed directly to investigators, you may contact the Patient Representative at the Ville

Marie Medical Centre ethics committee or the UQAM Ethics sub-committee (*Sous-comité du Comité Institutionnel d'Éthique de la Recherche chez l'Humain de l'UQAM)* directly. The Committee's coordinates may be found at the end of this consent form.

CONSENT

I am satisfied with the explanations that I have received and have fully read and understand the procedures. I am aware of the risks involved in participating in this project, which have been outlined in this consent form.

I consent to be a subject in the research project entitled "Fitness level and history of shoulder dysfunction in patients preparing for breast sparing surgery".

Date: _____

Name: _____ Signature: _____
(Please print)

Witness: _____ Signature: _____
(Please print)

COORDINATES

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ANNEX C

MANUSCRIPT: ANTHROPOMETRIC AND VITAL SIGN MEASUREMENTS OF CANCER SURVIVORS STRATIFIED ACCORDING TO TREATMENT

This manuscript was presented as part of the research poster presentations at the 2013 Annual American College of Sports Medicine (ACSM) Conference.

Abstract

The Integrative Health and Wellness Center (WC) at the Ville-Marie Medical Centre (VM Medical) was established to monitor the body composition, physical activity level, and vital signs of regular patients (R) and cancer survivors (CS) as part of their annual mammography screening.

Objective

The objective of this study was to determine if body composition and basic cardiovascular function of CS vary depending on the type of adjuvant therapy received.

Methods

Kinesiologists performed baseline measurements on 4,414 female patients at VM Medical. Measurements were obtained on 3,674 R patients and 740 CS. The data included Body Mass Index (BMI), resting heart rate, blood pressure, total body fat, lean muscle and waist circumference. The CS were stratified into eight different groups (G1-G8) according to the surgery type (ST) they underwent and were compared with the R patients. A one-way ANOVA was performed with Dunnet's post-hoc analysis. Significance was set at $p < .05$. The two largest CS groups were, Group 5 (G5) consisting of 243 women who underwent surgery, chemotherapy, radiotherapy and hormone therapy as part of their treatment and Group 6 (G6) consisting of 207 women who underwent surgery, radiotherapy and hormone therapy as part of their treatment. The remaining 290 CS were classified into 6 treatment groups.

Results

Significant differences were seen between the CS and R patients in all groups with p= 0.00 in 7 key variables. BMI: R (F=4.30) μ= 26.08 vs G6 μ= 27.10 , Resting heart rate: R (F= 6.24) μ= 73.04 bpm vs G5 μ= 76.45 bpm , Diastolic blood pressure: R (F= 4.65) μ= 74.18 mmHg vs G5 μ= 77.00 mmHg, Systolic blood pressure: R (F= 8.75) μ= 123.04 mmHg vs G6 μ= 130.14 mmHg, Lean muscle: R (F= 3.48) μ= 10.09 kg vs G6 μ= 9.74 kg, Total body fat: R (F=9.02) μ= 34.45% vs G6 μ= 37.49 %, and Waist circumference: R (F= 4.44) μ= 84.91 cm vs G5 μ= 87.68 cm.

Conclusion

It would appear that different treatment protocols are associated with an increase in negative body composition and blood pressure measurements in cancer survivors (CS). This information is important for the medical team to consider when directing the CS on healthy lifestyle choices post-treatment.

Introduction

Undergoing treatment for breast cancer is a very challenging event for many women as well as their families and friends. Treatment, although necessary, may lead to unexpected changes in body composition (Carmichael and Bates, 2004) It is unclear how cancer therapy affects body composition and blood pressure of breast cancer survivors. Some studies have shown significant changes taking place while other studies indicate no significant changes taking place (Calle and Kaaks 2004).

Women receive a significant amount of information regarding the appropriate treatment options available, which are dependent upon the recommendations made by the Tumor Board that evaluates and provides the stage category for the tumor that was removed.
The women are advised about some of the temporary side effects that may take place as they undergo treatment as well as the less apparent long-term side effects. The layperson's perception of the effects of cancer treatment may be different to what actually occurs. Physicians may only focus on body weight to provide a glimpse as to

what is happening with their patient (Franceschi and Wild 2013). Patients, with no previous experience with cancer treatment, may anticipate that they will lose weight and become emaciated whereas professionals working with patients throughout treatment often see patients' body weight increase over time.

The goal of this study was to observe how different cancer treatment protocols affect body composition measures. Our researchers believe that as patients go through therapy there is an increased likelihood they would see changes in cardiovascular risk factors. This would include increase in blood pressure, resting heart rate values, increase in body fat, BMI, and waist circumference as well as a decrease in lean muscle mass.

Methodology

As part of the standard intake evaluation, patients waiting to meet with one of the physicians at VM Med underwent a series of tests administered by one of the kinesiologists working at the WC. Results from tests, which included vital signs and body composition measurements, were entered into the VM Med's electronic medical records. The information that was extracted from the electronic database and that was used for this study had personal information removed so that no individual could be identified. Each patient that came to VM Med was asked to review and sign a consent form that allowed for their medical information to be entered into the database. The database was used by the medical team to monitor and address patient needs. This study was approved by the VM Medical Ethics Board and conformed to the World Medical Association (WMA) Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects.

As part of the preparation for testing, patients were asked to refrain from smoking or drinking caffeine products for 4 hours before testing. Before testing began, patients were also asked if they needed to use the washroom to void any fluids. Patient testing took place in a medical evaluation room, away from the main clinic area. The kinesiologist

explained to the patient the purpose for the testing. After approximately 5 minutes the patient was given the opportunity to relax and ask questions before the testing began.

Resting heart rate and blood pressure values were obtained through the use of a Physiologic Auto-memory 90 instrument (AMG Medical Inc., Montréal Canada).The patient's left arm was used for testing. If the patient had breast surgery on the left side of their torso with lymph node(s) removed, the right arm was used. The cuff was wrapped around the upper arm and was supported at the level of the heart. The cuff was aligned with the brachial artery. If measurements obtained on the patient were outside of expected values for the patient's age group, the test was repeated after a 5-minute waiting period. The patient's height and weight were measured using a stadiometer and weight scale respectively.

The In-Body 230 (Seoul, Korea) impedance unit (Karelis et al 2013) was used to determine body weight, percent body fat, lean muscle mass, and total body water. The patient was asked to remove shoes and socks as well any external metal objects (e.g. watches, rings) which might affect the results. The patients then stood on the foot pads of the unit and held on to the external handles so that data could be recorded. The kinesiologist documented the data, which was displayed on the screen.

Waist circumferences were the final measurements taken. Utilizing the ACSM (American College of Sports Medicine 2013) measurements methodology were obtained at the level of the greater trochanter of the hip and the umbilicus using a Gulick anthropometric tape (Mississagua, Ontario Canada). Waist measurements were performed with the patient standing upright, feet together, and arms at their side while maintaining a relaxed breathing pattern. A horizontal measure was taken at the narrowest location between the umbilicus and the sternum. The test was repeated two times and the average was taken. If there was a difference of more than 5 millimeters between measurements, a third measurement was taken.

For this study, patients were classified into two groups; cancer survivors (CS) or regular (R) patients. All of the women classified as CS underwent either a partial or a full mastectomy, and may have received adjuvant therapy such as chemotherapy, radiotherapy and hormonal therapy. Some patients may have received only one adjuvant therapy while other patients may have received up to three. Patients classified, as R patients may not have had any of the adjuvant therapies mentioned above. Both the CS and R patients may also have had other health issues for which they were taking additional medication that may have affected outcome measurements.

CS were stratified according to the type of treatment intervention they underwent. The eight different groups included: 1) Surgery only; 2) Surgery and chemotherapy; 3) Surgery and radiotherapy; 4) Surgery and hormone therapy; 5) Surgery, chemotherapy, radiotherapy and hormone therapy; 6) Surgery, radiotherapy and hormone therapy; 7) Surgery, chemotherapy and radiotherapy; and 8) Surgery, chemotherapy and hormone therapy.

Data Analysis

Statistical analyses were performed using IBM SPSS version 19.0. A one-way ANOVA was performed with Dunnett post-hoc analysis. Significance was calculated at $P< 0.05$. The R patients were used as the control group. Patients were also stratified according to age, in groups of 10 years. The same one-way ANOVA with Dunnett post-hoc analysis was performed.

Results

The mean age of the CS of the 8 different age categories (G1-G8) varied from 56-63 years of age compared to a mean age of 55 years for the R patients The unilateral reconstruction category had a mean age of 56 years, which was closest to the R patients.

Diastolic blood pressure: values were highest in G4 (Surgery and hormone therapy) - 77.00 mmHg, SD 10.42 and lowest in G2 (Surgery and chemotherapy) - 73.85 mmHg, SD 9.35.

Systolic blood pressure: values were highest in G4 (Surgery and hormone therapy) - 130.42 mmHg, SD 13.55 and G7 (Surgery, radiotherapy and hormone therapy) - 130.20 mmHg, SD 16.20 and lowest in the R patients - 123.48 mmHg, SD 15.83.

Mean arterial pressure (MAP): values were highest in G6 (Surgery, radiotherapy and hormone therapy) - 94.03 mmHg, SD 10.55 and the lowest in the R patients - 90.10 mmHg, SD 12.59.

Resting heart rate: values were highest in G7 (Surgery, chemotherapy and radiotherapy) - 79.10 bpm, SD 14.44 and lowest in G2 (Surgery and chemotherapy) - 70.23 bpm, SD 9.39.

Body mass index (BMI): values were highest in G1 (Surgery only) - 28.89, SD 6.60 and lowest in G3 (Surgery and radiotherapy) - 26.02, SD 3.76 and the R patients - 26.08, SD 5.16.

Mean muscle mass: values were highest in the R patients - 10.09 kg, SD 1.38 and lowest in G3 (Surgery and radiotherapy) - 9.74 kg, SD 1.04.

Total body water: values were highest in the R patients - 27.69 kg, SD 3.68 and lowest in G3 (Surgery and radiotherapy) - 26.35 kg, SD 4.48.

Percent body fat: values were highest in G1 (Surgery only) - 39.12%, SD 7.49 and lowest in the R patients - 34.45%, SD 8.27.

Waist circumference: values were highest in G1 (Surgery) - 90.37 cm, SD 13.16 and the lowest in the R patients - 84.91 cm, SD 11.79.

Patients were also stratified by age. The 40-49 age groups and the 50-59 age group showed significant differences between their outcomes values compared with the R patients.

Patients in groups G1, G5, G6 and G7 were also stratified according to the surgery they underwent. The surgeries included partial mastectomy, full mastectomy, bilateral mastectomy, unilateral reconstruction and bilateral reconstruction. There was one woman in the 20-29 age group, 5 women in the 30-39 age group and 2 women in the 80-89 age group.

Discussion

Our analysis shows that the body composition and blood pressure values in women undergoing treatment for breast cancer are affected by the type of treatment they receive. Patients who underwent only surgery and radiotherapy (G3) and surgery and chemotherapy (G2) appeared to have been affected the least, while patients who received multiple types of surgeries combined with two forms of adjuvant therapy (whether chemotherapy, radiotherapy or hormone therapy) seemed to be the most affected. Women who underwent surgery without any adjuvant therapy also had some of the poorest outcome measures.

Surgery and hormone therapy appeared to affect blood pressure values and resting heart rate the most, while having minimal effect on body composition. Diastolic, systolic and MAP (mean arterial pressure) blood pressure values were the most elevated in groups G1, G4, G5, G6, G7 and G8. With the exception of G1, these groups had received hormone therapy or multiple forms of adjuvant therapy.

Body fats and waist circumference values were the highest in groups G1, G5, G6 and G7. It was expected that the women who had the most aggressive treatments would have the most significant differences in body composition in comparison to the R patients, who received no treatment.

Previous work by Botteri et al 2012 looked at the incidence of morbidity related to patients that did or did not have radiotherapy. There was speculation that radiotherapy, a necessary treatment for some patients depending on lymph node involvement and tumor size, may increase the risk of cardiomyopathy. We expected that the women who underwent surgery and radiotherapy would have poorer blood pressure and resting heart rate values than other groups. Only when radiotherapy was combined with other treatments were the measures poorer, which was seen in groups G5, G6 and G7. The G3 group had blood pressure and resting heart values that were similar to the R patients. We did not know which breast the women underwent treatment for. There was speculation that treatment on the left side would have a more adverse effect on the cardiovascular markers. It is also possible that with improvement in radiotherapy techniques the negative effects on the heart have been diminished. Our analysis of this data may have been different if we had had access to more detailed information on the patient such as tumor size and node involvement and how far removed the patients were from treatment.

Age-matched analysis was done for the different treatment groups. Looking at age groups 40-49, 50-59 and 60-69, the same trends were seen with body fat and waist circumference as well as blood pressure values, with G1, G5 and G6 having some of the poorest outcome measures.

The 40-49 age group seemed to have been affected the most by treatment. Even though we see the same trends in the 50-59 and 60-69 age groups, it would appear that treatment had a greater impact on the younger group. Previous work by Sheean and colleagues noted that there was an increase in psychological and social stress associated with this group (Sheean, Hoskins and Stolley 2012) and it would also appear that physiological stress could be added to this list. The increase in stress was believed to be related to the increased demands of family and work for this age group.

It is unclear why patients who only underwent surgery seemed to have had some of the poorest outcome measures. It was expected that this group would have the outcome

measures closest to the R patients, since they would have had the least amount of treatment. It is possible that for patients in this group surgery was the only recommendation that was made by the Tumor Board. Often at least one form of additional treatment is recommended to the patients. It is also possible that some of the women in the study decided not to take any other additional adjuvant treatment. The women may not have received any additional information/direction regarding the possibility of reoccurrence of their breast cancer nor about the possibility of cardiovascular risk. Furthermore perhaps these women based their decisions on treatment that did not include some of the standard medical approaches. With the surgery alone group (G1), it would be important to gain a better understanding of why they had such poor outcome measures. They may not have received direction from the medical team as to the type of activity they could have undertaken to reduce their risk factors. It is also possible that they were afraid to precipitate a reoccurrence and decided not to pursue any further treatment.

The surgery alone group (G1) was stratified according to the type of surgery that was performed to see if there was any relationship between the type of surgery and the poorer outcome measures. Blood pressure values and resting heart values were elevated for women receiving a partial mastectomy and unilateral reconstruction. Body composition across all surgical groups, in particular body fat and waist circumference, were significantly different when compared to R patients.

Over the past two decades we have seen significant changes in our society with regular physical activity becoming a smaller part of people's lifestyle (Blair et al 2012, Flegal et al 2010). A number of women enjoy participating in programs such as yoga to improve flexibility and reduce levels of stress. Undergoing cancer treatment can be very stressful. Unfortunately, yoga has limited effects on body composition and cardiovascular conditioning. This would be another area which should be further evaluated (Hojan et al 2012).

It would have been useful to know what the pre-intervention body composition and blood pressure values of the women when we were conducting our analyses; however, this information was not available to us. With long term monitoring of the women at the WC perhaps this information could be made available in the future. It would important to know how long it would take for the women's outcome measures to return to the same levels as the women in the R patient group.

Some of the limitations of this study include not knowing the dates of the surgery or the treatment, the tumor size or its location, how many lymph nodes, if any, were removed and whether or not any of the nodes tested positive. Also, it would have been useful to know the estrogen receptor status of the patient at the onset of treatment as well as the type of treatment the patient underwent pertaining to chemotherapy or hormonal therapy. All of the above factors would be confounding variables to the data that has been collected.

Patients undergoing cancer treatment can expect to undergo significant changes in body composition and blood pressure values in comparison to patients of the same age not undergoing treatment. It is unclear from our data when these changes take place in the women. Is it when they are undergoing the different treatment protocols or is it after they have completed their treatment? It is also unclear whether or not the changes in blood pressure and body composition values occur over an extended period of time or if they are short term in nature. A review of the literature appears to indicate that these changes occur during treatment (Demark-Wahnefried et al 2001, Nissen, Shapiro and Swenson 2011). Once the women gain the additional weight it would appear that the added weight stays with them over time. As people age, blood pressure values tend to go up and body composition values tend to become larger (American College of Sports Medicine (ACSM) 2008). It is possible that the R patients eventually catch up to the CS as our collected data shows acceleration in values with aging.

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