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BALANCE PERFORMANCE IN CANCER SURVIVORS WHO HAVE UNDERGONE CHEMOTHERAPY

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CHAPTER 1

INTRODUCTION

In the research literature pertaining to cancer rehabilitation, delineation is often made between “cancer patient” and “cancer survivor”. The term “cancer patient” typically refers to an individual undergoing treatment for active cancer, while “cancer survivor” refers to someone who has been through cancer treatment and is either in remission or is living with a reduced form of their original cancer. In recent years, there has been a concerted effort among cancer rehabilitation specialists to eliminate this delineation. For the purposes of this paper, a cancer survivor will be defined as “any individual that has been diagnosed with cancer, from the time of discovery and for the balance of life”, as suggested by the National Coalition for Cancer Survivorship.

There is both anecdotal and empirical research evidence to indicate that many cancer patients who receive chemotherapy find the variety and unpredictability of chemotherapy-related side-effects difficult to cope with (Cohn, 1982; Tierney, Taylor & Closs 1989). Up to 80% of cancer survivors treated with chemotherapy experience fatigue and this fatigue has a greater negative impact on survivors’ activities of daily living (ADL) and quality of life (QOL) than other cancer-related symptoms, such as pain, depression, and nausea (Hofman et al., 2007). A decreased capacity to perform ADL (walking up and down stairs, getting up from a chair, lifting objects from the floor/overhead, and walking for short distances) is one of the most common side-effects of chemotherapy (Curt et al., 2000; Dimeo, Stieglitz et al., 1997; Given, Given, & Stommel, 1994; Irvine, Vincent, Graydon, & Bubela, 1998; Lehman et al., 1978; Messias, Yeager, Dibble, & Dodd, 1997; Mustian et al. 2008; Schwartz, 1999; Stafford &

Cyr, 1997). Decreases in ADL performance can be a major component of an overall decrement in quality of life for the cancer survivor (Courneya & Friedenreich, 1999; Dimeo, 2001; Ferrell, Grant, Dean, Funk, & Ly, 1996; Lehman et al., 1978).

Participants in the investigation conducted by Irvine et al. (1998) indicated that their ability to complete functional activities was negatively altered by 20.1% over the course of treatment (mean age 60, wide variety of cancers). Another study reported that a majority of their participants (mean age 52, wide variety of cancers) experienced a significant decline in their ability to perform daily activities and noted that many of these individuals reduced their hours of employment or took leave of their position entirely (Messias et al., 1997). Stafford and Cyr (1997) reported that 48% of their cancer subject group (mean age 75, wide variety of cancers) experienced difficulty with at least one ADL during their treatment. A survey of a large cohort of survivors of a wide variety of cancers (4,878 Participants, age range: 18-88 years) determined that individuals with a cancer history were 30% more likely to have at least one functional limitation and 11% more likely to be unable to work because of their health (Hewitt, Rowland, & Yancik, 2003). Similar data were reported by Ness, Wall, Oakes, Robison, and Gurney (2005) with physical performance limitations and participation restrictions reported to be 32 and 18 percent more likely in cancer survivors than in individuals with no cancer history. In another study conducted by Mustian et al. (2008), 553 of 753 of cancer survivors who were receiving chemotherapy treatment reported that cancer related fatigue interfered with their activities of daily living. A similar study reported fatigue and ADL dependence in 81% of older cancer survivors (Luciani et al., 2008).

Chemotherapy drugs are suspected as being among the most neurotoxic of the cytotoxic agents (Wujcik, 1992). The chemotherapeutic agents most often associated with chemotherapy-induced peripheral neuropathy are platinum compounds, taxanes, vinca alkaloids, thalidomide, and bortezomib (Park et al., 2008; Visovsky, Collins, Abbott, Aschenbrenner, & Hart, 2007). These neurotoxic chemotherapy agents inactivate the components required to maintain the metabolic needs of the axon resulting in axonal degeneration. Peripheral neuropathy occurs as the end result of peripheral, motor, sensory, and autonomic neuron damage. There are both motor (muscle weakness and atrophy) and sensory signs of peripheral neuropathy (loss of proprioception, ataxia, loss of balance, and a decrease in vibration sensation) (Visovsky, 2003).

The motor and sensory deficits related to chemotherapy induced peripheral neuropathy contribute to balance loss that can impact functional performance in a negative manner (Park et al., 2008). The ability to sustain balance is heavily involved in the performance of many ADL and is a major factor in the maintenance of independent living (Judge, 2003; Kolbe-Alexander, Lambert, & Charlton, 2006; Powell, Carnegie, & Burke, 2006). Cancer survivors have been reported in the past to frequently have difficulties with dizziness and balance that are the result of their treatments (Dodd, 1987). This data is outdated and relies primarily on anecdotal accounts. Furthermore, these accounts have only be substantiated in studies of cancer survivors with cerebral tumors (Syczewska, Dembowska-Baginska, Perek-Polnik, Kalinowska, & Perek, 2008) or those undergoing treatments that elicit an inordinate loss of muscle mass (Bylow et al., 2008). These studies target specific cancer survivor groups and severely limit the ability to generalize to the entire population of cancer survivors. Other studies have focused on fine

motor movements rather than the gross motor movements involved in the ADL mentioned above. Despite continued evidence of balance issues from anecdotal accounts, little attention has been focused on balance testing in cancer survivors who have undergone chemotherapy) (Visovsky et al., 2007).

Statement of Purpose

The purpose of this research was to assess balance performance, ADL performance, and quality of life in cancer survivors who are undergoing or have undergone chemotherapy treatment within the past two years and to compare this data to the balance performance, ADL performance, and quality of life of age and physical activity level matched apparently healthy controls.

Hypotheses

It was hypothesized that:

a. cancer survivors who have undergone chemotherapy treatment will have significantly poorer balance performance when compared to age-matched apparently healthy controls.

b. balance performance will correlate with ADL performance, particularly in cancer survivors who have undergone treatment.

c. QOL will correlate with balance and ADL performance, particularly in cancer survivors who have undergone treatment.

CHAPTER 2

METHODS

Participants

Participants in this study were 19 male and female adults between the ages of 35 and 70 years (most prevalent age range for cancer diagnosis). Nine of these participants were individuals diagnosed with cancer who received chemotherapy treatment within the last 2 years (C: 57±6 years; 7 females and 2 males). The average time from last chemotherapy treatment for C was 8.4 months. The remaining 10 participants were age-matched, apparently healthy controls (H: 54±4 years; 6 females and 4 males). All participants were free of any major disease at the time of study participation (including vestibular disease).

Participants in group C were recruited via fliers posted in the oncology offices in Southern Illinois. Participants in group H were recruited via flyers posted on the Southern Illinois University Carbondale (SIUC) campus. Upon initial contact, the researchers evaluated the participants suitability for the study based on the aforementioned medical criteria.

Data Collection Procedures and Instruments

Once participants were deemed suitable for study inclusion, they were mailed a medical history (see appendix C), a cancer treatment history (see appendix D), a quality of life questionnaire (Ferrans and Powers Quality of Life Index – Cancer Version III© , see appendix A) (Ferrans, 1990), a physical activity level questionnaire (Baecke Self-Administered Habitual Physical Activity Questionnaire, see appendix B) (Baecke, Burema, & Frijters, 1982), and were scheduled for testing. The medical and cancer

histories were used to evaluate the participants' readiness for participation. On the testing day, the participants reported to Davies Hall (SIUC campus), returned all completed paperwork, and signed an informed consent approved by the SIUC Human Subjects Committee. Following these initial check-in procedures, participants completed the following tests under the supervision of the researchers. For all of the tests, only one trial was necessary and no familiarization trials were required.

Balance

Balance was tested using the AccuSwayPLUS® platform (AMTI) (Manor & Li, 2009). The Accusway System consists of a portable balance platform. It measures the three forces (Fx, Fy, Fz) and three moments (Mx, My, Mz) involved in balance. For this study, balance trainer software was used for data acquisition and analysis. Each participant was asked to take a barefooted, double-legged stance on the platform with arms at side, heels 5 cm apart and heels abducted 10 degrees. The outlines of both feet were marked with a marker. After leaving the platform, the individual's base of support was entered in the computer using the pointer wand. Participant was then asked to step on the platform again with arms at side. Participants performed 30 seconds of the eyes open closed base protocol. A member of the research team spotted each subject throughout the test to ensure that the chance of an accidental fall was minimized. The center of pressure average velocity (V; cm/s^2) and center of pressure area (i.e., the area of a confidence ellipse enclosing 95% of the center-of-pressure trajectory) (A; cm^2) were analyzed by the balance platform (Manor & Li, 2009).

Stair Climb and Descent

Each subject's ability to climb and descend stairs was evaluated using the stair climb and descent test (Malmberg et al., 2002; Salen, Spangfort, Nygren, & Nordemar, 1994). The subject walked up and down a standard flight of stairs (12 steps, step rise: 7 in., step run: 11 in.) three times at a self-selected pace, using a handrail for support if necessary. A stopwatch was started at the moment the first step was contacted during the initial ascent and stopped at the moment both of the subject's feet were in contact with the "landing" area at the end of the 3rd descent. The ascent/descent performance time served as the primary variable for the evaluation of stair climbing ability. A member of the research team spotted each subject throughout the test to ensure that the chance of an accidental fall was minimized. The stair climb and descent test was found to have reliability rating of at least 0.70 (Salen et al., 1994). In addition the test has been shown to be highly feasible with less than 5% of 1133 subjects excluded from participation in the test (Malmberg et al., 2002).

Sit to Stand

The sit-to-stand test is a test of lower body extremity muscle strength and was used to evaluate each subject's ability to get into and out of a chair (Csuka & McCarty, 1985; Headley et al., 2002; Newcomer, Krag, & Mahowalk, 1993; Painter et al., 1999; Schicht, Camaiene, & Owen, 2001). The subject sat in a standard straight back, padded chair (seat height: 18.5 in.; seat depth: 18.1 in.) with arms folded across the chest (unless arm assistance was needed – "no arms" was encouraged). Following instructions on proper form and 1-2 practice trials, the subject stood up and sat down 10 times as quickly as possible. A stopwatch was started as soon as the subject began the initial "stand" and

was stopped when the subject sat down following the 10th repetition. The time that it took to complete the ten repetitions was used as the primary variable for the evaluation of the subject's ability to get into and out of a chair. In order to ensure that the chance of an accidental fall was minimized, each subject was spotted throughout the test by a member of the research team. The sit-to-stand test has shown a test-retest reliability rating of 0.88 (Newcomer, et al., 1993) and coefficient of variation of 6.8% (Czuka & McCarty, 1985).

Lift and Carry

The ability of each subject to pick up an object from the floor and carry it a short distance was evaluated via a lift and carry task. (Ettinger et al., 1997; Rejeski et al., 1995; Sevick et al., 2000). Using the protocol of Rejeski et al., the subject lifted a 13.5 by 13.5 inch crate containing a 10-pound weight (total weight: 11.5 lb) from the floor to waist level, carried it at waist level for twenty feet (90° angle between upper and lower arm), set it on a shelf 51.5 inches high, picked up the crate again, carried it at waist level for twenty feet (90° angle between upper and lower arm), and safely set it back on the floor at the original starting point. A stopwatch was started on the subject's first movement and was stopped when the weighted crate was set safely on the floor following the fifth repetition. The time required to complete the task was recorded and used as the research variable by which the subject's ability to lift and carry an object was evaluated. Subjects were monitored to insure that proper lifting technique was utilized (bend at the knees, spine in neutral position; feet shoulder width apart, maintenance of balance). Subjects were spotted by a member of the research team throughout the test to ensure that the chance of an accidental injury was minimized. This lift and carry task has earned a reliability rating of 0.92 (Rejeski et al., 1995).

Data analysis procedures

Means and standard deviations were calculated for all variables for both groups. The investigation utilized independent t-tests in order to determine if statistically significant differences exist between the study group mean values on all variables. Pearson correlation was done to determine the correlation of balance performance with ADL performance and quality of life. Alpha level was set at .05.

CHAPTER 3

RESULTS

As stated earlier, C and H were well-matched for age, C (M = 57, SD = 6) and H (M = 54, SD = 4), p = .321. Both groups were also well-matched at physical activity level, C (M = 36.2, SD = 2) and H (M = 38.1, SD = 4). p = .456. C demonstrated statistically significantly greater center of pressure area (A; cm^2), C (M = 1.2, SD = .4) vs. H (M=.8, SD = .2), p = .046. While not statistically significant, C demonstrated greater center of pressure average velocity (V; cm/s^2), C (M = .93, SD = .3) vs. H (M= .72, SD = .1), p = .078. H showed significantly higher quality of life than C, H (M = 5.3, SD = 0.32) vs. C (M = 4.8, SD = .55), p = .01). C showed reduced activities of daily living performance (varying level of significance) as indicated by 1) Slower timed stair climb and descent test performance as compared to H, C (M = 43.2, SD = 3.3 vs. H (M = 32.9, SD = 4.5), p = .025. 2) Slower timed sit to stand test performance in C as compared to H, C (M = 32.7, SD = 8.1) vs. H (M = 25.3, SD = 2.2), p = .048. 3) Slower timed lift and carry performance as compared to H, C (M = 76.4, SD = 16.5) vs. H (M = 72.9, SD = 11.3), p = .153. A strong correlation (Rubin, 2009; Sheskin, 2004) existed between A and stair climb/descent (r = .79), while moderate correlations (Rubin, 2009; Sheskin, 2004) existed between: A and sit to stand time (r = .59); V and stair/climb descent time (r = .52). Moderate correlations existed between A and QOL (r = .42), as well as lift and carry and QOL (.39). See Table 1 and Table 2 for a visual depiction of the results.

Table 1

Tests' Results With p-values

TESTS	C	H	p-value
STANDING BALANCE **(Accusway Balance Platform®)**			
Eyes open closed base - V; cm/s^2	.93±.3	.72±.1	**.** 078
Eyes open closed base -A; cm^2	1.2±.4	.8±.2	.046
QUALITY OF LIFE (Ferrans and Powers – Likert Scale)	4.8 ± .55	5.3 ± 0.32	.01
ACTIVITIES OF DAILY LIVING			
Sit to stand (Seconds to complete 10 cycles)	32.7±8.1	25.3±2.2	**.** 048
Stair climb/descent (Seconds to complete 3 cycles)	43.2±3.3	32.9±4.5	.025
Lift and carry (Seconds to complete 5 cycles)	76.4±16.5	72.9±11.3	**.** 153

Table 2

Cross-tabulation of Pearson Correlation Coefficients of A, V, ADL, and QOL

	Sit to stand	**Stair climb/descent**	**Lift and carry**
A	.59	.79	--
V	--	.52	--
QOL	--	--	.39

CHAPTER 4

DISCUSSION

The ability to sustain balance is involved in the performance of most ADL (Judge, 2003; Kolbe-Alexander, Lambert, & Charlton, 2006; Powell, Carnegie, & Burke, 2006) and decreases in ADL performance can be a major component of an overall decrement in quality of life for the cancer survivor (Courneya & Friedenreich, 1999; Dimeo, 2001; Ferrell, Grant, Dean, Funk, & Ly, 1996; Lehman et al., 1978). The results of this study show that QOL was reduced along with ADL and balance performance in participants who had undergone chemotherapy. Although the results for center of pressure average velocity and the lift and carry test did not have statistically significant p- values, the results still indicate a trend toward better balance and activities of daily living performance in the healthy group based on group means. This study suggests a link between cancer treatment, balance, activities of daily living performance, and overall quality of life. The results are consistent with the hypotheses, cancer survivors showed significantly poorer balance performance when compared to age-matched apparently healthy controls. In addition, Balance performance correlated with ADL performance and QOL correlated with balance and ADL performance in cancer survivors.

There were some potential limitations in this study. First, the mean age of group C was slightly higher than the mean age of Group H and this might have affected the results. A recent study suggests that aging affects the balance performance year by year (Aslan, Cavlak, Yagci, & Akdag, 2008). Another study has shown that balance, strength, gait and activity performance measures declined significantly with increasing age (Haber, Erbas, Hill, & Wark, 2008). With aging, a lower capacity for neuromuscular response in

controlling postural sway leads to impaired balance with a decrease in speed of postural adjustments and event detection (Izquierdo, Aguado, Gonzalez, Lopez, Hakkinen, 1999). The slight age difference may have exacerbated the group differences beyond the effect of chemotherapy.

Second, the male female ratio was different in both groups, with more female participants in group C as compared to group H. Studies have shown that women experience greater disability than men of the same age across a wide range of functional measures, including both basic ADL such as bathing and dressing, and instrumental ADL, such as housework and shopping (Newman, & Brach, 2001; Leveille, Resnick, & Balfour, 2000). Another study confirms gender differences in functional limitation onset and that males have better balance performance in comparison to females (Aslan, Cavlak, Yagci, & Akdag, 2007). A study conducted by Lee, Simmonds, Wang, & Novy (2003) showed that men outperformed women on all the activities measured in the study (i.e., repeated reach-ups, forward reach, 50-ft walk, and distance walked in 6 minutes). The reasons for these differences are not fully understood; however, the fact that group C contained a slightly higher percentage of females may have contributed to the fact that group C performance was diminished compared to group H.

Third, all the participants in group C were involved on at least a limited basis in an aerobic and strength training exercise program either during or after the treatment and therefore, does not likely represent the typical cancer survivor who is more sedentary. Previous studies have shown that participating in exercise program can improve balance in older people (Barnett, Smith, Lord, Williams, & Baumand, 2003; Liu-Ambrose, Khan, Eng, Lord, & McKay, 2004). Despite the fact that there were no significant differences in

measured physical activity level between the groups, the fact that group C was likely more active than the typically cancer survivor may have diminished the potential for differences between the groups.

Finally, the small sample size in the study limits the ability to generalize the results to the entire population of cancer survivors. The larger the sample size, the more a sample will represent the entire population. Future studies that examine this topic should target greater participant numbers.

This study underscores the need for exercise programs that target the functional needs of cancer survivors. Oncologists are often unsure of the appropriate recommendations for exercise when their patients inquire. Although future investigations are needed to further evaluate the effect of exercise on balance performance in individuals receiving chemotherapy, the findings of this research can improve the knowledge base of oncologists in this area and increases the frequency and urgency of recommendations to their patients to participate in regular exercise before, during, and after treatment. Involving cancer survivors in structured exercise prior to, during, and after their treatment can help them maintain a higher level of quality of life throughout their cancer experience. This could translate not only to an improvement in balance and ADL performance, but may also translate to higher levels of self esteem and self efficacy, reductions in depression and anxiety, and reduction in physician visits, home-nurse support, and overall health-care costs.

REFERENCES

Aslan, U.B., Cavlak, U., Yagci, N., & Akdag B. (2008). Balance performance, aging and falling: A comparative study based on a Turkish sample. *Archives of Gerontology and Geriatrics, 46,* 283-292. doi:10.1016/j.archger.2007.05.003

Barnett, A., Smith, B., Lord, S.R., Williams, M., & Baumand, A. (2003). Community-based group exercise improves balance and reduces falls in at-risk older people: a randomized controlled trial. *Age Ageing, 32,* 407-414. doi:10.1093/ageing/32.4.407

Baecke, J.A., Burema, J., & Frijters, J.E. (1982). A short questionnaire for the measurement of habitual physical activity in epidemiological studies. *The American journal of clinical nutrition, 36,* 936-42. Retrieved from http://www.ajcn.org/

Manor, B., & Li, L. (2009). Characteristics of functional gait among people with and without peripheral Neuropathy. *Gait & Posture*, *30,* 253–256. doi:10.1016/j.gaitpost.2009.04.011

Bylow, K., Dale, W., Mustian, K., Stadler, W.M., Rodin, M., Hall, W., …Mohile, S.G. (2008). Falls and physical performance deficits in older patients with prostate cancer undergoing androgen deprivation therapy. *Urology, 72*, 422-427. doi:10.1016/j.urology.2008.03.032

Cohn, K.H. (1982). Chemotherapy from an insider's perspective. *Lancet, 319*, 1006–1009. doi:10.1300/J077v07n04_11

Courneya, K.S., & Friedenreich, C.M. (1999). Physical exercise and quality of life following cancer diagnosis: a literature review. *Annals of Behavioral Medicine, 21*, 171-179. doi:10.1007/BF02908298

Curt, G. A., Breitbart, W., Cella, D., Groopman, J. E., Horning, S. J., Itri, L. M., ...Vogelzang, N.J. (2000). Impact of cancer-related fatigue on the lives of patients: new findings from the fatigue coalition. *The Oncologist, 5*, 353-360. Retrieved from http://theoncologist.alphamedpress.org/

Czuka, M., & McCarty, D. J. (1985). Simple method for measurement of lower extremity muscle strength. *The American Journal of Medicine, 78*, 77-81. doi:10.1016/0002-9343(85)90465-6

Dimeo, F. C. (2001). Effects of exercise on cancer related fatigue. *Cancer Supplement, 92*, 1689-1693. doi:10.1002/1097-0142(20010915)92:6+<1689::AID-CNCR1498>3.0.CO;2-H

Dimeo, F. C., Stieglitz, R. D., Novelli-Fischer, U., Fetscher, S., Mertelsmann, R., & Keul, J. (1997). Correlation between physical performance and fatigue in cancer patients. *Annals of Oncology, 8,* 1251-1255. doi:10.1002/cncr.20777

Dodd, M. J. (1987). *Managing the side effects of chemotherapy and radiation*. New York, NY: Prentice Hall Press.

Ettinger, W. H. J., Burns, R., Messier, S. P., Applegate, W., Rejeski, W. J., Morgan, T., …Craven, T. (1997). A randomized trial comparing aerobic exercise and resistance exercise with a health education program in older adults with knee osteoarthritis. *Journal of the American Medical Association, 277*, 25-31. Retrieved from http://jama.ama-assn.org/

Ferrans, C. (1990). Development of a quality of life index for patients with cancer. *Oncology Nursing Forum, 17,* 15-19. doi:10.1111/j.1365-2702.2006.01274.x

Ferrell, B. R., Grant, M., Dean, G. E., Funk, B., & Ly, J. (1996). "Bone tired": the experience of fatigue and its impact on quality of life. *Oncology Nursing Forum, 23*, 1539-1547. Retrieved from http://ons.metapress.com/content/0190-535X/

Given, C. W., Given, B. A., & Stommel, M. (1994). The impact of age, treatment, and symptoms on the physical and mental health of cancer patients: a longitudinal perspective. *Cancer, 74*, 2128-2138. doi:10.1002/1097-0142(19941001)74:7+<2128::AID-CNCR2820741721>3.0.CO;2-J

Haber, N.E., Erbas, B., Hill, K.D., & Wark, J.D. (2008). Relationship between age and measures of balance, strength and gait: linear and non-linear analyses. *Clinical Science, 114,* 719-727. doi:10.1042/CS20070301

Headley, S., Germain, M., Mailloux, P., Mulhem, J., Ashworth, B., Burris, …Jones, M. (2002). Resistance training improves strength and functional measures in patients with end-stage renal disease. *American Journal of Kidney Diseases, 40*, 355-364. doi:10.1159/000087184

Hewitt, M., Rowland, J.H., & Yancik, R. (2003). Cancer Survivors in the United States: Age, Health, and Disability. *Journals of Gerontology Series A: Biological Sciences & Medical Sciences, 58*, 82-91. doi: 10.1093/gerona/58.1.M82

Hofman, M., Ryan, J.L., Figueroa-Moseley, C.D., Jean-Pierre, P., & Morrow, G.R. (2007). Cancer-related fatigue: the scale of the problem. *The oncologist, 12,* 4-10. doi:10.1634/theoncologist.12-S1-4

Irvine, D., Vincent, L., Graydon, J.E., & Bubela, N. (1998). Fatigue in women with breast cancer receiving radiation therapy. *Cancer Nursing, 21*, 127-135. Retrieved from http://www.ovid.com/site/catalog/Journal/374.jsp

Izquierdo, M., Aguado, X., Gonzalez, R., López, J.L., & Hakkinen, K. (1999). Maximal and explosive force production capacity and balance performance in men of different ages. *European Journal of Applied Physiology and Occupational Physiology, 79,* 260-267. doi:10.1007/s004210050504

Judge, J.O. (2003). Balance training to maintain mobility and prevent disability. *American Journal of Preventative Medicine, 25*, 150-156. doi:10.1016/S0749-3797(03)00178-8

Kolbe-Alexander, T.L., Lambert, E.V., & Charlton, K.E. (2006). Effectiveness of a community based low intensity exercise program for older adults. *Journal of Nutrition, Health, and Aging. 10*, 21-29. doi:10.3109/09638280903095916

Lee, J.Q., Simmonds, M. J., Wang, X. S., & Novy, D. M. (2003). Differences in Physical Performance Between Men and Women With and Without Lymphoma. *Arch Phys Med Rehabil, 84,* 1747-52. doi:10.1016/S0003-9993(03)00437-4

Lehman, J.F., Delisa, J. A., Warren, G., deLateur, B.J., Sand-Bryant, P.L., & Nicholson, C. G. (1978). Cancer rehabilitation: assessment of need, development, and evaluation of a model of care. *Archives of Physical Medicine and Rehabilitation, 59*, 410-419. Retrieved from http://www.archives-pmr.org/

Leveille, S.G., Resnick, H.E., & Balfour, J. (2002). Gender differences in disability: evidence and underlying reasons. *Aging Clinical, 12,* 106–112. Retrieved from http://journalseek.net/cgi-bin/journalseek/journalsearch.cgi?field=issn&query=1594-0667

Liu-Ambrose, T., Khan, K.M., Donaldson, M.G., Eng, J.J., Lord, S.R., & Mckay, H.A. (2006). Falls-Related Self-Efficacy Is Independently Associated With Balance and Mobility in Older Women With Low Bone Mass. *J Gerontol A Biol Sci Med Sci*, *61*, 832-838. Retrieved from http://biomedgerontology.oxfordjournals.org/

Luciani, A., Jacobsen, P.B., Extermann, M., Foa, P., Marussi, D., Overcash, J.A., & Balducci, L. (2008). Fatigue and functional dependence in older cancer patients. *American journal of clinical oncology. 2008, 5,* 424-30. doi:10.1097/COC.0b013e31816d915f

Malmberg, J.J., Miilunpalo, S.I., Vuori, I.M., Pasanen, M.E., Oja, P., & Haapanen-Niemi, N.A. (2002). A health related fitness and functional performance test battery for middle- aged and older adults: feasibility and health-related content validity. *Archives of Physical Medicine and Rehabilitation, 83*, 666-677. doi:10.1053/apmr.2002.32304

Messias, D. K. H., Yeager, K. A., Dibble, S. L., & Dodd, M. J. (1997). Patient's perspectives of fatigue while undergoing chemotherapy. *Oncology Nursing Forum, 24*, 43-48. Retrieved from http://ons.metapress.com/content/0190-535X/

Mustian, K. M. , Palesh, O., Heckler, C. E., Roscoe, J. A., Morrow, G. R., Jacobs, A., **…**Schwartzenberger, P. O. (2008). Cancer-Related fatigue interferes with activities of daily living among 753 patients receiving chemotherapy: A URCC CCOP study. *Journal of Clinical Oncology, 26,* 9500-. Retrieved from http://jco.ascopubs.org/

Ness, K. K., Wall, M. M., Oakes, J. M., Robison, L. L., & Gurney, J. G. (2006). Physical performance limitations and participation restrictions among cancer survivors: A population-based study. *Annals of Epidemiology, 16,* 197-205. doi:10.1016/j.annepidem.2005.01.009

Newcomer, K. L., Krag, H. E., & Mahowalk, M. L. (1993). Validity and reliability of the timed sit-to-stand test for patients with rheumatoid arthritis and other chronic diseases. *Journal of Rheumatology, 20,* 21-27. doi:10.1093/gerona/57.8.M539

Newman, A.B., & Brach, J.S. (2001). Gender gap in longevity and disability in older persons. *Epidemiol Rev, 23,* 343–350. Retrieved from http://epirev.oxfordjournals.org/content/current

Painter, P., Stewart, A. L., & Carey, S. (1999). Physical functioning: definitions, measurement, and expectations. *Advancements in Renal Replacement Therapies, 6*, 110-123. doi:10.1093/geront/43.suppl_2.28

Park, S.B., Krishnan, S.V., Lin, C.S-Y., Goldstein, D., Friedlander, M., & Kiernan, M.C. (2008). Mechanisms Underlying Chemotherapy-Induced Neurotoxicity and the Potential for Neuroprotective Strategies. *Current medicinal chemistry, 15,* 3081-3094. doi:10.2174/092986708786848569

Powell, M.W., Carnegie, D.H., & Burke, T.J. (2005). Reversal of diabetic peripheral neuropathy with phototherapy (MIRE) decreases falls and the fear of falling and improved activities of daily living in seniors. *Age and Aging, 35*, 11-16 doi:10.1093/ageing/afi215

Rejeski, W. J., Ettinger, W. H. J., Schumaker, S., James, P., Burns, R., & Elam, J. T. (1995). Assessing performance-related disability in patients with knee osteoarthritis. *Osteoarthritis and Cartilage, 3*, 157-167. doi:10.1016/S1063-4584(05)80050-0

Rubin, A. (2009). *Statistics for Evidence-Based Practice and Evaluation.* California: Brooks/Cole.

Salen, B. A., Spangfort, E. V., Nygren, A. L., & Nordemar, R. (1994). The Disability Rating Index: An instrument for the assessment of disability in clinical settings. *Journal of Clinical Epidemiology, 47*, 1423-1434. doi:10.1016/0895-4356(94)90086-8

Schicht, J., Camaiene, D. N., & Owen, S. V. (2001). Effect of intense strength training on standing balance, walking speed, and sit-to-stand performance in older adults. *Journal of Gerontology and Medical Science, 56,* 281-286. doi:10.1093/gerona/56.5.M281

Schwartz, A. L. (1999). Fatigue mediates the effects of exercise on quality of life. *Quality of Life Research, 8*, 529-538. doi:10.1023/A:1008978611274

Sevick, M. A., Bradham, D. D., Muender, M., Chen, G. J., Enarson, C., Dailey, M., & Ettinger, W.H. J. (2000). Cost-effectiveness of aerobic and resistance exercise in seniors with knee osteoarthritis. *Medicine and Science in Sports and Exercise, 32*(9), 1534-1540. Retrieved from http://journals.lww.com/acsm-msse/pages/default.aspx

Sheskin, D. (2004). *Handbook of parametric and nonparametric statistical procedures*. Florida: Chapman & Hall/CRC

Stafford, R. S., & Cyr, P. L. (1997). The impact of cancer on the physical function of the elderly and their utilization of health care. *Cancer, 80,* 1973-1980. doi:10.1002/(SICI)1097-0142(19971115)80:10<1973::AID-CNCR15>3.0.CO;2-V

Syczewska, M., Dembowska-Baginska, B., Perek-Polnik, M., Kalinowska, M., & Perek, D. (2008). Postural sway in children and young adults, survivors of CNS tumours. *Advanced Medicine and Science, 1*, 1-7. doi: 10.2478/v10039-008-0031-y

Tierney A.J., Taylor J. & Closs S.J. (1989). *A study to inform nursing support of patients coping with chemotherapy for breast cancer*. University of Edinburgh Department of Nursing Studies, Edinburgh.

Visovsky, C., Collins, M., Abbott, L., Aschenbrenner, J., & Hart, C. (2007). Putting evidence into practice: evidence-based interventions for chemotherapy-induced peripheral neuropathy. *Clinical Journal of Oncology Nursing*, *11*, 901-909. Retrieved from CINAHL with Full Text database

Visovsky, C. (2003). Chemotherapy-Induced Peripheral Neuropathy. *Cancer Investigation, 21,* 439–451. doi:10.1081/CNV-120018236

Wujcik, D. (1992). Current research in side-effects of high-dose chemotherapy. *Seminars in Oncology Nursing, 8,* 102–112. doi:10.1016/0749-2081(92)90026-Y

APPENDICES

APPENDIX A

Date: _____ Subject #: _____

Ferrans and Powers
QUALITY OF LIFE INDEX©
CANCER VERSION – III

Part 1. For each of the following, please choose the answer that best describes how **satisfied** you are with that area of your life. Please mark your answer by circling the number. There are no right or wrong answers.

How satisfied are you with:	Very Dissatisfied	Moderately Dissatisfied	Slightly Dissatisfied	Slightly Satisfied	Moderately Satisfied	Very Satisfied
1. Your health?	1	2	3	4	5	6
2. Your health care?	1	2	3	4	5	6
3. The amount of pain that you have?	1	2	3	4	5	6
4. The amount of energy you have for everyday activities?	1	2	3	4	5	6
5. Your ability to take care of yourself without help?	1	2	3	4	5	6
6. The amount of control you have over your life?	1	2	3	4	5	6
7. Your chances of living as long as you would like?	1	2	3	4	5	6
8. Your family's health?	1	2	3	4	5	6
9. Your children?	1	2	3	4	5	6
10. Your family's happiness?	1	2	3	4	5	6
11. Your sex life?	1	2	3	4	5	6
12. Your spouse, lover, or partner?	1	2	3	4	5	6
13. Your friends?	1	2	3	4	5	6
14. The emotional support you get from your family?	1	2	3	4	5	6
15. The emotional support you get from people other family?	1	2	3	4	5	6
16. Your ability to take care of family responsibilities?	1	2	3	4	5	6
17. How useful are you to others?	1	2	3	4	5	6
18. The amount of worries in your life?	1	2	3	4	5	6
19. Your neighborhood?	1	2	3	4	5	6
20. Your home, apartment, or place where you live?	1	2	3	4	5	6
21. Your job (if employed)?	1	2	3	4	5	6
22. Not having a job (If unemployed, retired, or disabled)?	1	2	3	4	5	6
23. Your education?	1	2	3	4	5	6
24. How well you can take care of your financial needs?	1	2	3	4	5	6
25. The things you do for fun?	1	2	3	4	5	6
26. Your chances for a happy future?	1	2	3	4	5	6
27. Your peace of mind?	1	2	3	4	5	6
28. Your faith in your religion?	1	2	3	4	5	6
29. Your achievement of personal goals?	1	2	3	4	5	6
30. Your happiness in general?	1	2	3	4	5	6
31. Your life in general?	1	2	3	4	5	6
32. Your personal appearance?	1	2	3	4	5	6
33. Yourself in general?	1	2	3	4	5	6

(Please Flip Over To Back)

Part 2. For each of the following, please choose the answer that best describes how **important** that area of your life is to you. Please mark your answer by circling the number. There are no right or wrong answers.

How important to you is:	Very Unimportant	Moderately Unimportant	Slightly Unimportant	Slightly Important	Moderately Important	Very Important
1. Your health?	1	2	3	4	5	6
2. Your health care?	1	2	3	4	5	6
3. Having no pain?	1	2	3	4	5	6
4. Having enough energy for everyday activities?	1	2	3	4	5	6
5. Taking care of yourself without help?	1	2	3	4	5	6
6. Having control over your life?	1	2	3	4	5	6
7. Living as long as you would like?	1	2	3	4	5	6
8. Your family's health?	1	2	3	4	5	6
9. Your children?	1	2	3	4	5	6
10. Your friends's health?	1	2	3	4	5	6
11. Your sex life?	1	2	3	4	5	6
12. Your spouse, lover, or partner?	1	2	3	4	5	6
13. Your friends?	1	2	3	4	5	6
14. The emotional support you get from your family?	1	2	3	4	5	6
15. The emotional support you get from people other than family?	1	2	3	4	5	6
16. Taking care of family responsibilities?	1	2	3	4	5	6
17. Being useful to others?	1	2	3	4	5	6
18. Having no worries?	1	2	3	4	5	6
19. Your neighborhood?	1	2	3	4	5	6
20. Your home, apartment, or place where you live?	1	2	3	4	5	6
21. Your job (if employed)?	1	2	3	4	5	6
22. Having a job (if unemployed, retired, or disabled)?	1	2	3	4	5	6
23. Your education?	1	2	3	4	5	6
24. Being able to take care of your financial needs?	1	2	3	4	5	6
25. Doing things for fun?	1	2	3	4	5	6
26. Having a happy future?	1	2	3	4	5	6
27. Peace of mind?	1	2	3	4	5	6
28. Your faith in your religion?	1	2	3	4	5	6
29. Achieving your personal goals?	1	2	3	4	5	6
30. Your happiness in general?	1	2	3	4	5	6
31. Being satisfied with life?	1	2	3	4	5	6
32. Your personal appearance?	1	2	3	4	5	6
33. Yourself as a member of society?	1	2	3	4	5	6

APPENDIX B

Date: _____ Subject #: _____

Baecke Self-Administered Habitual Physical Activity Questionnaire:

For each item, circle the response that best pertains to your physical activity level over the course of the past few weeks. If you are retired, answer the "work-related" questions based on any time in your daily routine that you would not consider "leisure time" (yardwork, gardening, housework, volunteer work, babysitting, etc.)

A) At work, I sit

1) Always 2) Often 3) Sometimes 4) Seldom 5) Never

B) At work, I stand

1) Never 2) Seldom 3) Sometimes 4) Often 5) Always

C) At work, I walk

1) Never 2) Seldom 3) Sometimes 4) Often 5) Always

D) At work, I lift heavy loads

1) Never 2) Seldom 3) Sometimes 4) Often 5) Always

E) After working, I am tired

1) Never 2) Seldom 3) Sometimes 4) Often 5) Always

F) At work, I sweat

1) Never 2) Seldom 3) Sometimes 4) Often 5) Always

G) In comparison with others my own age, I think that my work is physically

1) Much lighter 2) Lighter 3) As heavy 4) Heavier 5) Much heavier

H) How many hours per week do you participate in any sports?

1) Less than 1 2) 1-2 3) 2-3 4) 3-4 5) Greater than 4

I) In comparison to others my own age, I think that the amount of time I spend doing physical activity is

1) Much less 2) Less 3) The same 4) More 5) Much more

J) During my leisure time, I sweat

1) Never 2) Seldom 3) Sometimes 4) Often 5) Always

K) During my leisure time, I watch television

1) Always 2) Often 3) Sometimes 4) Seldom 5) Never

L) During my leisure time, I walk

1) Never 2) Seldom 3) Sometimes 4) Often 5) Always

M) During my leisure time, I cycle

1) Never 2) Seldom 3) Sometimes 4) Often 5) Always

N) How many minutes per day do you walk and/or cycle?

1) < 5 2) 5-15 3) 15-30 4) 30-45 5) > 45

APPENDIX C

Medical History Questionnaire

Navitas Cancer Rehabilitation Centers, LLC

Please complete each section of this medical history questionnaire as thoroughly as possible. If you are unsure of the answer to any question, please consult your physician.

Name: _____ ID#:_____ Date: ___/___/____

I. Present Medical History

Check all spaces that apply to you. Include an explanation and the date of occurrence for checked items.

Problem List	Explanation/Date
☐ Abnormal EKG	_____
☐ Anemia	_____
☐ Arthritis	_____
☐ Asthma	_____
☐ Back/Neck pain/injury	_____
☐ Chest discomfort	_____
☐ Chronic/Recurring cough	_____
☐ Connective tissue disease	_____
☐ Coughing up blood	_____
☐ Dementia	_____
☐ Depression	_____
☐ Diabetes	_____
☐ Disease of arteries	_____
☐ Dizziness/Fainting	_____
☐ Epilepsy	_____
☐ Foot/Ankle problems	_____
☐ Heart problems	_____
☐ High cholesterol	_____
☐ High blood pressure	_____
☐ HIV/AIDS	_____
☐ Increased anxiety	_____
☐ Knee/Hip problems	_____
☐ Leg pain after walking	_____
☐ Liver disease (mild,mod.,severe)	_____
☐ Lung disease	_____
☐ Lymphedema	_____
☐ Migraine/recurrent headaches	_____
☐ Moderate or severe renal disease	_____
☐ Recurrent fatigue	_____
☐ Respiratory problems	_____
☐ Rheumatic fever	_____
☐ Sleeping problems	_____

☐ Stroke _____
☐ Stomach/Intestinal problems _____
☐ Swollen/stiff/painful joints _____
☐ Thyroid problems _____
☐ Ulcer disease _____
☐ Varicose veins _____
☐ Deep Vein Thrombitis _____
☐ Vision/hearing problems _____

Females Only
Current Menstrual Status: ❍ In menarche ❍ Menopausal
❍ Pre-menopausal ❍ Post-menopausal
☐ Currently pregnant _____
☐ Menstrual irregularities _____

Surgeries
Date:_____ Type:_____
Date:_____ Type:_____
Date:_____ Type:_____
Date:_____ Type:_____

II. Family Medical History
Please check the boxes that apply to family members that are genetically related to you (grandparents, mother, father, brothers, and sisters)

Problem List
☐ Diabetes _____
☐ Early death _____
☐ Heart disease _____
☐ High blood pressure _____
☐ High cholesterol _____
☐ Obesity _____
☐ Stroke _____
☐ Cancer(s)
Type: _____ Family Member(s): _____
Type: _____ Family Member(s): _____
Type: _____ Family Member(s): _____

III. Medications List

Please list ALL medications that you presently take. Medications include prescription drugs, non-prescription drugs, vitamins, herbal supplements and hormone replacement therapy drugs. (If you need more space, bring in a written or typed list on a separate page)

Medication: _____ Dosage/Frequency: _____
Medication: _____ Dosage/Frequency: _____
Medication: _____ Dosage/Frequency: _____
Medication: _____ Dosage/Frequency: _____
Medication: _____ Dosage/Frequency: _____

IV. Drug/Food/Environmental Allergies

Please list any known substances that may cause you to have an allergic reaction.

_____
_____
_____
_____
_____

V. Other Medical Concerns

If you know of any other medical concerns that we should be made aware prior to your participation in this research study, please identify them below.

_____
_____
_____
_____
_____

APPENDIX D

Cancer Treatment History Questionnaire
Navitas Cancer Rehabilitation Centers, LLC

Name: _____ ID#: _____ Date: ___/___/____

I. Cancer Information

Cancer Type/Location: _____
Date of Diagnosis: _____ Stage/Grade at Diagnosis:_____

Cancer Type/Location: _____
Date of Diagnosis: _____ Stage/Grade at Diagnosis:_____

II. Treatment Information

Surgery: ☐ Yes Date: _____ Type: _____
☐ No Date: _____ Type: _____
Date: _____ Type: _____

***Chemotherapy*:**

- Are you currently receiving chemotherapy?
  ☐ YES
  Do you have a chemotherapy port in place presently? ▫ Yes ▫ No

What chemotherapy drug(s) are you receiving?

_____
_____

Start date: _____ Next treatment: _____
How many more treatments will you have? _____
List any complications from treatment you are experiencing.
_____

☐ NO

Did you receive chemotherapy in the past? ▫ Yes ▫ No
Did you have a chemotherapy port? ▫ Yes ▫ No
What chemotherapy drug(s) did you receive?
_____
_____

Start date: _____Final treatment: _____
How many treatments did you have? _____
List any complications from treatment you have experienced.
_____
Will you be receiving chemo in the next 6 months? ▫ Yes ▫ No

Radiation:

- Are you currently receiving radiation?
  ☐ YES
  Start date: _____Next treatment: _____
  How many more treatments will you have? _____
  List any complications from treatment you are experiencing.
  _____

☐ NO

Did you receive radiation in the past? ▫ Yes ▫ No
Start date: _____ Final treatment: _____
How many treatments did you have? _____
List any complications from treatment you have experienced.
_____

Will you be receiving radiation in the next 6 months? ▫ Yes ▫ No

Biotherapy(BT): (Stem cell or bone marrow transplant, gene therapy, etc.)
Are you preparing/ have you begun to undergo any BT treatments?

☐ YES
What type? _____
Start date: _____ Next treatment: _____
How many more treatments will you have? _____
List any complications from treatment you are experiencing.
_____

☐ NO
Did you receive BTin the past? ▫ Yes ▫ No
What type? _____
Start date: _____ Final treatment: _____
What type did you receive? _____
List any complications from treatment you experienced.
_____
Will you be receiving BT in the next 6 months? ▫ Yes ▫ No

Hormone Therapy(HT):
Are you currently receiving HT?

☐ YES
What type? _____
Start date: _____ Next treatment: _____
How many more treatments will you have? _____
List any complications from treatment you are experiencing.
_____

☐ NO
Did you receive HT in the past? ▫ Yes ▫ No
Start date: _____ Final treatment: _____
What type did you receive? _____
List any complications from treatment you have experienced.
_____
Will you be receiving HT in the next 6 months? ▫ Yes ▫ No

Alternative/Complimentary Therapy (ATC):
Are you currently using any ATC? (Vitamins, herbs, supplements, etc.)

☐ YES
Start date: _____ Final treatment: _____
What type are you receiving? _____
List any complications from treatment you have experienced.
_____

☐ NO
Did you use ATC in the past? ▫ Yes ▫ No
Start date: _____ Final treatment: _____
What type did you receive? _____
List any complications from treatment you experienced.
_____
Will you be receiving ATC in the next 6 months? ▫ Yes ▫ No

Currently…
Do you have any medical concerns due to your cancer/ cancer treatment(s)?
▫ Yes ▫ No
If yes explain: _____

Do you have any physical limitations due to your cancer/ cancer treatment(s)?
▫ Yes ▫ No
If yes explain: _____
Do you use medications/ therapies to manage symptoms related to your cancer/treatment(s)?
▫ Yes ▫ No
If yes explain: _____

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