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Cognitive and Psychological Factors Associated with Early Post-Treatment Functional Outcomes in Breast Cancer Survivors

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Abstract

Breast cancer survivors experience cognitive difficulties following chemotherapy, yet the effects of these deficits on functional outcomes have not been systematically evaluated. This study assessed the relationships between post-chemotherapy cognitive difficulties and functional outcomes. Forty-six women with breast cancer were seen at 1-month post-chemotherapy; data were collected on cognitive functioning, psychological variables, and physical symptoms. Wilcoxon Signed Rank analyses revealed cognitive deficits in executive functioning and verbal fluency. Subsequent regression analyses demonstrated that poorer executive functioning was associated with decreased productivity, community involvement, and social role functioning. Poorer quality of life was predicted by depression and reluctance to seek social support, but not cognitive functioning. These findings indicate that executive functioning deficits are associated with important functional outcomes among breast cancer survivors 1-month post-chemotherapy. Thus, treatment efforts should focus on addressing cognitive, as well as psychological and physical, issues among cancer survivors.

Keywords

Breast cancer; Cognitive; Quality of life; Social support; Community integration

INTRODUCTION

Breast cancer is currently the most prevalent malignancy affecting women. Treatments have improved over time, such that the current survival rate across stages is approximately 88% (American Cancer Society, 2006). Coinciding with these improvements in mortality rates,

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medical and behavioral health care providers alike are increasingly attuned to the experiences women have following treatment completion. Research on quality of life after treatment for cancer abounds (e.g., Carver, Smith, Petronis & Antoni, 2006; Helgeson & Tomich, 2005; Mols, Vingerhoets, Coebergh & van de Poll-Franse, 2005), with efforts underway to identify factors that improve the quality of life experienced by cancer survivors, so that treatments to enhance these factors can be developed.

Cognitive Deficits Following Cancer Treatment

Within the field of cancer survivorship research, one issue receiving increased attention in the past 10 years is the impact of chemotherapy on cognitive functioning. A growing literature suggests that chemotherapy is associated with a decline in cognitive functioning among a subset of women treated for breast cancer (for reviews, see Rugo & Ahles, 2003; Tannock, Ahles, Ganz, & Van Dam, 2004), with prevalence estimates ranging from 17-35% (Ahles & Saykin, 2001). Deficits have specifically been noted in memory (e.g., Ahles et al., 2002; Brezden, Phillips, Abdolell, Bunston, & Tannock, 2000; Meyers, Byrne, & Komaki, 1995; Wienke & Dienst, 1995), attention/concentration (Schagen et al., 1999; van Dam et al., 1998; Van Oosterhout et al., 1996; Wienke & Dienst, 1995), psychomotor speed (Ahles et al., 2002; Meyers et al., 1995; van Dam et al., 1998), and cognitive processing speed (Silberfarb, Philibert, & Levine, 1980; van Dam et al., 1998; Van Oosterhout et al., 1996). Several meta-analyses have revealed small to medium effect sizes across each of these cognitive domains (Falleti, Sanfilippo, Maruff, Weih, & Phillips, 2005; Stewart, Bielajew, Collins, Parkinson, & Tomiak, 2006), with the largest effects for executive functioning and verbal memory (Anderson-Hanley, Sherman, Riggs, Agocha, & Compas, 2003). The etiology of these deficits remains unclear, with several possibilities currently under consideration including: fatigue, hormonal changes, direct neurotoxic effects, and genetic predispositions (for reviews, see Reid-Arndt, 2006; Saykin, Ahles & McDonald, 2003).

While research documents cognitive changes post-chemotherapy, the duration of these observed changes has not been clearly delineated. Some studies suggest these deficits may be long-term, as continued reports of a decline in cognitive functioning (e.g., forgetfulness, increased distractibility, problems concentrating) have been noted among breast cancer survivors at 5-10 years after initial diagnosis (Ahles et al., 2002; Ganz et al., 2002). However, other results from longitudinal and cross-sectional studies reveal that, for some women, cognitive impairments may diminish over time. For example, one series of studies indicated that initial cognitive impairments noted at 2 years post-treatment (Schagen et al., 1999; Van Dam et al., 1998) were no longer present at 4 years post-treatment (Schagen et al., 2002). Another study followed 18 women treated for breast cancer, collecting data pre-chemotherapy, at 6-months post-chemotherapy, and at one year post-chemotherapy (Wefel, Lenzi, Theriault, Davis, & Meyers, 2004). Deficits were documented in attention, processing speed and verbal memory, particularly at 6-months post-chemotherapy; approximately 45% evidenced improvements over time. Finally, one cross-sectional study compared individuals currently undergoing chemotherapy with a group who had completed chemotherapy a median of 2 years prior and a group of healthy controls (Brezden et al., 2000). A general cognitive screen revealed deficits among all women with a history of chemotherapy; importantly, women with a prior history of chemotherapy performed better than those currently undergoing chemotherapy, while the healthy controls performed better than both chemotherapy groups. Together, these data suggest that the decline in cognitive functioning post-chemotherapy may resolve over time among a portion of affected individuals, while some will continue to demonstrate cognitive deficits.

Factors Influencing Functional Outcomes among Breast Cancer Survivors

Although progress has been made in identifying and understanding cognitive deficits following cancer treatment, what has yet to be considered is the functional significance of these deficits. Specifically, while studies provide evidence of statistically significant cognitive weaknesses, there is limited information regarding potential clinical significance (Reid-Arndt, 2006). For example, although relative intra-individual cognitive weaknesses have been found, in general women are performing in the normal range compared to age and education matched peers. Additionally, to these authors' knowledge, there is a lack of research documenting the relationship between cognitive functioning and measures of functional outcomes, despite calls for this type of analysis (e.g., Ahles & Saykin, 2001).

While there is a dearth of information regarding the functional impact of cognitive deficits among BCS, there exists a relatively extensive literature documenting the effects of other variables on functional outcomes such as quality of life, vocational functioning, and social functioning. For example, prior research has identified several psychological and interpersonal factors that are associated with better quality of life, including greater degree of optimism (Carver et al., 2005), strong social support (Friedman et al., 2006), and use of stress management interventions (Antoni et al., 2006). Age also plays a part in predicting quality of life after treatment, with younger survivors reporting poorer mental health outcome than older patients (Wenzel et al., 1999).

Returning to work is both an indicator of recovery and an important contributor to quality of life. In a qualitative study of cancer survivors, many individuals reported that “work brought an added sense of meaning, challenge and accomplishment at a time when their cancer made such meaning particularly important” (Main, Nowels, Cavender, Etschmaier, & Steiner, 2005, p. 1002). Unfortunately, some women experience changes in vocational functioning associated with their diagnosis and treatment of cancer. For example, one study found that approximately one-third of the cancer survivors who were employed prior to diagnosis were no longer working 6 months after their diagnosis, and those who returned worked fewer hours per week on average compared to before their diagnosis (Bradley, Neumark, Bednarek, & Schenk, 2005). Moreover, individuals needed to accommodate treatment plans into their vocational obligations in a variety of ways, including quitting their job or changing employers.

Social functioning is an important part of the multidimensional conceptualization of quality of life, and women undergoing treatment for breast cancer express concerns about the impact of their diagnosis and treatment on social and role functioning (Osoba et al., 2006). In a longitudinal study, breast cancer survivors consistently reported lower social and role functioning compared to a control group of healthy individuals both at the time of diagnosis and up to one year after surgery (Schou, Ekeberg, Sandvik, Hjermstad, & Ruland, 2005). While other domains of quality of life showed signs of improvement over time, social and cognitive functioning were the slowest to recover. Several individual and situation factors have been associated with poorer social role functioning outcomes, such as pessimism (Carver et al., 2005), passive approach to decision-making about treatment plans (Hack, Degner, Watson, & Sinha, 2006), and failure to disclose concerns (Figueiredo, Fries, & Ingram, 2004).

Together, these findings demonstrate the evident impact of cancer treatment on quality of life, vocational functioning, and social functioning, as well as how individual factors may moderator this effect. Interestingly, although there is evidence from other populations (e.g., TBI, multiple sclerosis) that cognitive functioning is another individual variable that can impact functioning in each of these domains (e.g., Girard et al., 1996; Hanks, Rapport,

Millis, & Deshpande, 1999; Rao et al., 1991), the link between functional outcomes and cognitive deficits among cancer survivors has yet to be clearly explicated.

The present study represents an initial effort to fill this knowledge gap. Women with Stages 1-3 breast cancer who completed adjuvant chemotherapy were seen at 1-month following chemotherapy, at which time data were collected regarding cognitive, emotional, social, and vocational functioning. The goal of this project was to demonstrate what effects changes in cognitive functioning following chemotherapy for breast cancer may be having on quality of life and functional outcomes in the early stages of survivorship. We predicted that cognitive weaknesses, and particularly executive functioning deficits, would be associated with poorer quality of life and social role functioning among women breast cancer patients one month following completion of chemotherapy.

METHODS

Participants

Forty-six women receiving treatment for Stages I - III primary breast cancer participated in this study. Demographic information for study participants is provided in Table 1. Almost one-half of participants were diagnosed with Stage II breast cancer (47.4%), while 23.7% were diagnosed with Stage I and 28.9% were diagnosed with Stage III. Participants underwent mastectomy or lumpectomy and received adriamycincyclophosphamide with or without paclitaxel or taxotere or a variant of that program; the average number of chemotherapy cycles across all stages was 5.77 (SD = 1.93). Exclusion criteria were identified through a study-specific intake screening questionnaire completed at the first appointment and included: prior history of adjuvant chemotherapy for cancer, past or current neurological illness, and significant psychopathology (e.g., psychosis).

Measures

Demographic data were obtained via a questionnaire created specifically for this study. Information regarding medical variables (e.g., cancer stage, number of chemotherapy cycles, and exposure to other adjuvant therapies including radiation and Tamoxifen) was obtained from the participants' medical records, with their informed consent.

Neuropsychological measures were used to evaluate skills in five cognitive domains: Immediate Memory, Delayed Memory, Attention, Executive Functioning, and Verbal Fluency. Specific tests comprising each of 5 cognitive domains are listed in Table 2. Of note, while verbal fluency is often considered a component of executive functioning because it can be associated with frontal lobe lesions (e.g., Miceli, Caltagirone, Gainotti, Masullo, & Silveri, 1981;Stuss et al., 1998), an a priori decision was made to separate this from other executive functioning measures based on clinical observations that word-finding deficits are one of the most common complaints reported in the cancer treatment centers where this study occurred. Finally, in line with neuropsychological theory and research (e.g., Griffin, Mindt, Rankin, Ritchie, & Scott, 2002; Kareken, Gur, & Saykin, 1995; Lezak, 1995), the Wide Range Achievement Test-3 (WRAT-3) Reading subtest (Wilkinson, 1993) was included as an estimate of overall premorbid functioning. In general, this battery was designed to evaluate a broad range of cognitive domains, and the specific selection of tests was based on neuropsychological batteries used in prior research with cancer patients (e.g., Ahles et al., 2002;Meyers et al., 1995;van Dam et al., 1998;). It included those tests determined to be most sensitive to changes secondary to chemotherapy treatment for cancer.

Psychological variables were measured with the *Hesitation Scale* and the *Profile of Mood States - Short Form (POMS-SF)*. The Hesitation Scale is a 20-item measure of willingness to seek social support. Previous research using this scale (Farmer, Clark & Sherman, 2003)

demonstrated that reluctance to seek social support was significantly related to perceptions of lesser social support and lower quality of life. The POMS-SF, which is a 37-item version of the original 65-item POMS, was developed by Shacham (1983) for use with cancer patients. There are six subscales -- Depression, Vigor, Confusion, Tension, Anger, and Fatigue -- with internal consistency reliabilities ranging from 0.78 to 0.91 (Baker, Denniston, Zabora, Polland, & Dudley, 2002).

Social role functioning was measured with a questionnaire designed to assess individuals' perceptions of their competency in fulfilling important social roles (Bettencourt & Sheldon, 2001; Sheldon & Bettencourt, 2002). This measure was developed as part of a body of research examining the theory that successful social role involvement may promote authentic self-expression while still enhancing group connectedness (Bettencourt & Sheldon, 2001; Sheldon & Bettencourt, 2002). This measure has been found to predict subjective well-being (Bettencourt & Sheldon, 2001) and depression among cancer survivors (Talley, Molix, Schlegel & Bettencourt, in press). Subscales from this measure evaluate perceived competency in social roles (internal reliabilities = .78-.80), providing an index of perceived functioning in four possible roles: as a spouse/partner, a parent, an employee, and any other role identified by each participant (e.g., volunteer, caregiver). Participants are asked to indicate their level of agreement using a 6 point Likert scale in response to items such as: “I feel as if I am fully functioning in my role as a spouse/partner.”

Community Integration Questionnaire (CIQ) was administered to measure general community involvement as well as engagement in home activities, social activities, and work activities (Willer, Rosenthal, Kreutzer, Gordon & Rempel, 1993). Research with other groups with chronic medical conditions (e.g., TBI) has reported internal consistencies ranging from .79 to .90 (Corrigan & Deming, 1995).

Functional Assessment of Cancer Therapy-Breast (FACT-B) is a commonly used measure of quality of life in breast cancer survivors. The FACT-B includes items designed to assess quality of life (QOL) in terms of patients' relationships with their physician(s) as well as physical, emotional, social, functional well-being. This measure includes items from the FACT-General as well as 9 additional items specifically selected to evaluate QOL issues in breast cancer survivors. Per a validation study (Brady et al., 1997), the total score from this measure has acceptable internal consistency (Chronbach's alpha=.90) and test-retest reliability (.85). Construct validity was suggested by high correlations with other measures of QOL, such as the Functional Living Index - Cancer (r=.87).

Procedure

Women who were receiving adjuvant chemotherapy treatment for breast cancer were recruited at 3 sites in a Midwestern city (an academic hospital, a private hospital, and a private oncology practice). They were informed of the study by a health care provider working with them (typically their treating physician or nurse) prior to the completion of their last cycle of chemotherapy. Those who expressed an interest in the study were contacted by a member of the research team, either in person or via telephone, so that a description of the study could be provided and any questions answered. All participants provided informed written consent in accordance with the Institutional Review Board informed consent guidelines at each site. Participants then completed a data collection session at 1-month following the completion of their chemotherapy, which was an average of 5 months following the diagnosis of cancer for study participants. Efforts were made to ensure that these appointments coincided with the participants' follow-up appointments with health care providers at each site.

RESULTS

Wilcoxon Signed Rank tests were computed to assess for relative deficits for each cognitive domain. Next, backwards selection regression analyses were conducted to determine what variables predict the outcome measures of interest. For each regression model, possible predictor variables included medical variables (i.e., number of chemotherapy treatments, POMS-SF Fatigue subscale), psychological variables (i.e., POMS-SF Depression subscale, Hesitation Scale), and cognitive variables (i.e., composite indices of Executive Functioning and Verbal Fluency). Three composite indices (Immediate Memory, Delayed Memory, Attention) were excluded from regression analyses based on findings from initial Wilcoxon Signed Rank tests that revealed no evidence of deficits in these domains.

Cognitive functioning

First, composite variables were created for each cognitive domain of interest by converting each individual's raw test scores to *z*-scores utilizing age, education, and gender based normative data. Thereafter, an average of each person's *z*-scores for tests comprising each domain was computed.

For the initial analyses, we were interested in determining whether participants may be experiencing a decline in cognitive functioning compared to estimated premorbid abilities. As noted above, in the absence of pre-treatment data, the WRAT-3 Reading test was used as a proxy of premorbid functioning, a procedure that has support in both clinical literature (e.g., Lezak, 1995) and research literature (Johnstone, Hexum, & Ashkanazi, 1995). Thus, for these analyses, a new variable was created reflecting the difference between each individual's estimate of premorbid abilities (WRAT-3 Reading) and her composite score for each domain.

Wilcoxon Signed Rank tests were computed to determine if the mean change in composite test scores was significantly different from zero. Results indicated that at 1-month post-chemotherapy, participants were demonstrating significantly lower scores in Executive Functioning ($t = -2.71$, $p = .01$) and Verbal Fluency ($t = -4.54$, $p < .001$) than would have been expected based on premorbid estimates. Conversely, the mean Immediate Memory and Delayed Memory scores were significantly higher than expected (Immediate Memory: $t = 3.06$, $p < .01$; Delayed Memory: $t = 4.08$, $p < .001$). See Table 3 for mean scores. A review of the distribution of difference scores revealed that 21.7% were performing >1 SD below premorbid estimates in Executive Functioning, while 41.3% were performing >1 SD below premorbid estimates in Verbal Fluency (see Figure 1).

Correlations between Outcome Variables

Pearson correlation analyses were performed to better understand the relationships between the multiple measures of functional outcomes, which included FACT-B (Brady et al., 1997), Community Integration Questionnaire (Willer et al., 1993) and the Social Roles Measure (Bettencourt & Sheldon, 2001). As evidenced in Table 4, measures of social functioning (FACT-B Social Well-Being, CIQ Social Integration, Social Roles) were significantly correlated (all r's > .34, all p's < .05). Significant correlations were also observed among measures of productivity (FACT-B Functional Well-Being, CIQ Productivity, CIQ Total: all r's > .35, all p's < .05). Finally, consistent with prior research (Bettencourt & Sheldon, 2001; Talley et al., in press), social role functioning was also correlated with emotional well being (FACT-B Emotional Well-Being, $r = .589$, $p < .01$).

Predicting Functional Outcomes

Backwards selection regression analyses were conducted to evaluate the relationships between functional outcomes of interest and several predictor variables. Based on a priori hypotheses that they may impact participants' outcomes, predictors entered into the equation for each model included medical variables (number of chemotherapy treatments, POMS Fatigue subscale) and psychological variables (POMS Depression subscale, Hesitation scale). Additionally, to evaluate the potential effects of cognitive decline on functional outcomes, composite scores from domains where a relative decline in cognitive functioning was evidenced in initial analyses -- Executive Functioning and Verbal Fluency -- were included.

Quality of life—Regression analyses were conducted to determine whether these predictor variables were associated with reports of quality of life. As noted above, the FACT-B index of quality of life is comprised of multiple subscales, each of which was evaluated separately. The model for FACT-B Social Well-Being was significant, $F(2, 38) = 8.93$, $p = .001$, accounting for 32% of the variance. Examination of the individual betas showed that higher levels of depression and greater hesitation to seek support were associated with poorer social well-being: POMS Depression was marginally significant at $p = .079$, while Hesitation was significant at $p = .017$. Similarly, the model for FACT-B Emotional Well-Being was significant, $F(2, 38) = 21.29$, accounting for 53% of the variance. A review of the individual betas revealed that POMS Depression and Hesitation were again significant predictors in this model ($p = .017$ and $p < .001$, respectively), revealing that higher levels of depression and a greater reluctance to seek social support were also associated with poorer emotional well-being.

The model for FACT-B Functional Well-Being was significant, $F(3, 37) = 12.11$, $p < .001$, accounting for 50% of the variance. A review of the individual beta weights revealed that poorer functional well-being, an index of the ability to participate in important daily activities (including work and leisure activities), was associated with greater reluctance to seek social support (Hesitation: $p = .001$), more chemotherapy treatments ($p = .061$), and higher levels of fatigue (POMS Fatigue: $p = .001$). The FACT-B includes a subscale seeking ratings on one's Relationship with his/her Doctor, and this model was significant, $F(1, 39) = 4.00$, $p = .052$, accounting for a modest 9% of the variance. A review of betas revealed that greater reluctance to seek social support, indexed by the Hesitation scale, was associated with reports of less satisfying relationships with doctors ($p = .052$). Finally, the model for the FACT-B Physical Well-Being subscale was also significant, $F(1, 39) = 5.162$, $p < .05$, accounting for 12% of variance. POMS Fatigue was the single variable that remained significant in this backwards selection model ($p = .029$), indicating that increased fatigue was associated poorer physical well-being.

Community involvement and productivity—Regression analyses were conducted to determine what variables were associated with five measures of community involvement and productivity included in this study. As noted above, the Community Integration Questionnaire (CIQ) provides three subscale scores as well as a total score; regression analyses were computed using each as an outcome measure. The model for CIQ Social Integration was significant, $F(1, 39) = 5.490$, $p < .05$, with predictors accounting for 12% of the variance. A review of the betas revealed that better executive functioning was associated with enhanced social integration (Executive Functioning: $p < .024$). Executive functioning ($p = .05$) as well as depression (POMS Depression: $p = .05$) were significant predictors accounting for 22% of the variance in a model for CIQ Productivity ($F(2, 38) = 5.26$, $p = .01$), indicating that productivity was lowered by poorer executive functioning and increased symptoms of depression. The model for CIQ Home Integration did not reach significance.

Finally, the model for the CIQ Total Score was significant, $F(2, 38) = 5.73$, $p < .01$, accounting for 23% of the variance. A review of the betas revealed that better executive functioning and less fatigue were associated with enhanced overall community involvement (Executive Functioning: $p = .10$; POMS Fatigue: $p < .05$).

Finally, the Social Roles questionnaire was also utilized as an index of participants' perceived effectiveness in important social roles. The model for social roles functioning was significant, $F(2, 37) = 9.35$, $p < .001$, accounting for 34% of the variance. A review of the betas revealed that better executive functioning and less reluctance to seek social support were associated with enhanced social role functioning (Executive Functioning: $p = .01$; Hesitation: $p < .01$).

DISCUSSION

The present study was undertaken to ultimately provide direction for improving the lives of women breast cancer survivors by offering initial insight into how cognitive deficits relate to functional outcomes in the early stages of recovery following chemotherapy. Although the etiology remains unknown, research to date has suggested that a portion of women will experience modest cognitive decline following chemotherapy (Ahles & Saykin, 2001), and the present study supported this observation. Specifically, there was a significant decline in executive functioning and verbal fluency skills compared to estimated premorbid abilities among participants at 1-month following the completion of chemotherapy. These findings are consistent with reports from other research, which suggest that these complex cognitive skills may be most susceptible to adverse effects of chemotherapy (e.g., Ahles et al., 1998; Freeman & Broshek, 2002; Schagen et al., 1999; van Dam et al., 1998; Wienke & Dienst, 1995;).

Subsequent analyses were conducted to clarify whether these cognitive deficits may be impacting quality of life and daily functioning; findings provided mixed support for this possibility. First, data did not support the hypothesis that the observed cognitive deficits were having a significant impact on quality of life as measured by the FACT-B. Rather, consistent with prior research on quality of life (Visser & Smets, 1998), symptoms of depression were associated with social and emotional well-being among this group of cancer survivors. Also consistent with a growing body of literature (e.g., Tchen et al., 2003) was the finding that increased fatigue is associated with poorer quality of life among women following treatment for breast cancer.

The present research revealed some novel findings regarding quality of life among cancer survivors as well. Specifically, individuals who were more reluctant to seek social support, as measured by the Hesitation Scale, were also more likely to report relatively poorer social and emotional well-being, as well as poorer doctor-patient relationships. These findings are in line with some of the literature on coping, which has suggested that social support seeking as a coping style may have a significant impact on emotional well-being (Holland & Hollahan, 2003; Stanton & Snider, 1993).

While cognitive decline following treatment for breast cancer did not predict quality of life in this study, there was evidence that deficits in executive functioning were adversely impacting other functional outcomes. Specifically, women who were experiencing greater deficits in executive functioning were less engaged in social and community activities, and they were reporting greater difficulties functioning effectively in important social roles (e.g., spouse, parent, employee, etc.). These findings validate breast cancer survivors' anecdotal reports that difficulties with multi-tasking, particularly during treatment and in the early stages following treatment completion, hinder their functioning at work and at home. They

are also significant because there may be long-term consequences of an initial decline in cognitive functioning and functional abilities (e.g., women may be more inclined to quit a job or disengage from other important responsibilities during this period). Moreover, while some of these women may experience a recovery in cognitive functioning over time, prior research has indicated that these deficits persist for a portion of those affected. Thus, this study points to the potential need for interventions in the early stages of recovery following treatment for breast cancer.

Several limitations of the study are worth noting. First, although this procedure is consistent with a majority of studies in this area (see Minisini et al., 2004), the absence of pre-chemotherapy data restricts our ability to draw conclusions regarding the extent of cognitive decline following treatment. However, it is also true that cognitive testing immediately prior to starting chemotherapy may not provide the best indication of baseline functioning. Specifically, it is well known that the time from diagnosis to the initiation of treatment is a cognitively taxing and emotionally stressful period. Given the adverse impact that emotional distress can have on cognitive functioning, it could be argued that testing during this period may not provide a true index of premorbid abilities.

Second, multiple analyses were conducted on a dataset having a relatively large number of variables and a modest sample size. Efforts were made to address this limitation in several ways. For example, the number of variables in each model was minimized by creating composites for the neuropsychological test scores, and the number of medical and psychological variables was limited in each model. Moreover, all models were developed based on a priori hypotheses, and efforts were made to uncover converging evidence to support conclusions about relationships between the predictor and outcome variables. Despite this, future projects can improve upon this work by relying on a larger sample size.

While deficits in executive functioning have been among the most consistently documented following treatment for breast cancer (Anderson-Hanley et al., 2003), it is worth noting that conceptually this domain of functioning encompasses a wide range of cognitive abilities. In this study's test battery, two measures were utilized that are often described as indices of set shifting (Trails B) and response inhibition (Stroop test). Research abounds indicating that executive functioning is not a unitary construct, and that in fact different measures of executive functioning rely on intact processing in a variety of neural regions (Posner & Peterson, 1990). Thus it would be informative to administer a broader range of executive functioning measures to women following treatment for cancer. This could help to determine whether it is appropriate to conclude that there are impairments in the broad range of skills typically associated with executive functioning or whether the deficits are relatively more circumscribed.

With regards to understanding the cognitive changes experience with cancer treatment, it is interesting to note that study participants performed better on immediate and delayed memory tasks than would have been predicted based on WRAT-3 Reading test scores. This raises some questions regarding the utility of this measure as an estimate of pre-morbid functioning with this sample. While this test is commonly used in research and clinical work to estimate pre-morbid abilities, research comparing IQ test scores with various estimates of pre-morbid abilities has suggested that the WRAT-3 Reading test may underestimate abilities among individuals with higher intellectual functioning (Johnstone, Callahan, Kapila, & Bouman, 1996; Weins, Bryan, & Crossen, 1993). As a group our participants had a high level of education (33% had completed some college, and an additional 33% had college degrees or higher), which is known to be correlated with higher intellectual abilities (Neisser et al., 1996). If their intellectual functioning was in fact also above average, WRAT-3 Reading scores may have underestimated their pre-morbid functioning, which

could have implications for analyses attempting to determine whether cognitive decline had occurred. However, it is noted that the primary goal of this research was to examine relationships between cognitive deficits and functional outcomes, and that regression analyses addressing this aim utilized cognitive composite scores and did not rely on comparisons with estimated pre-morbid abilities.

IMPLICATIONS FOR CLINICAL PRACTICE

Literature on the experiences of cancer survivors has provided ample evidence of a decline in cognitive functioning among a portion of women who have undergone treatment for breast cancer. Data from the present study document this occurrence and further suggest that cognitive difficulties after treatment can have significant implications for real world functioning. Specifically, it appears that those women experiencing cognitive decline following treatment may experience greater difficulties engaging in productive activities, such as being involved in their communities and being effective in important social roles.

These observations provide support for the ongoing development of interventions for cognitive deficits following chemotherapy, which has already received some attention to date. Potentially useful treatments may include medications such as methylphenidate, which has demonstrated positive effects (National Cancer Institute, 2005). Additionally, psychological interventions focused on providing emotional support and training in metacognitive strategies, similar to those being offered for other populations with mild cognitive decline (e.g., mild traumatic brain injury) have promise and are currently being developed (Ferguson et al., 2007; Tannock et al., 2003).

Given the improving survival rates, cancer is increasingly being viewed as a chronic illness, with affected individuals benefiting from long-term follow-up and assistance in dealing with physical and psychological sequelae. Findings from this research suggest that cognitive issues may warrant similar attention in our efforts to understand and address factors that may affect daily functioning and long-term outcomes among cancer survivors.

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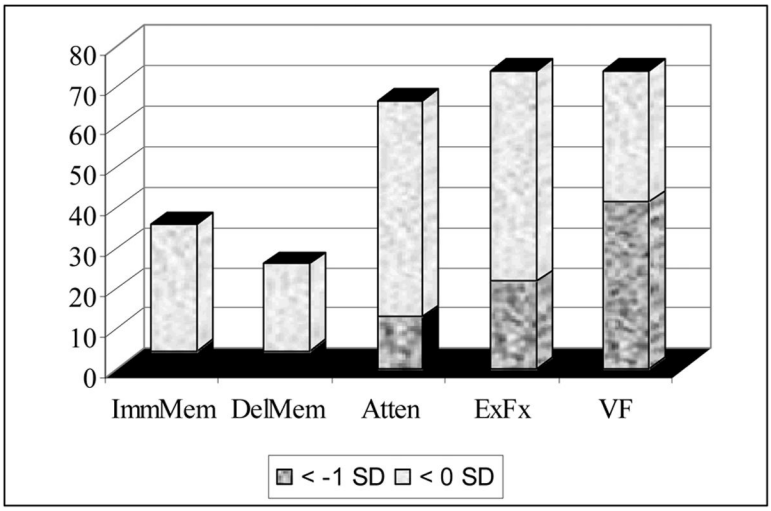

Figure 1.
Percentage of Participants with Relative Cognitive Weaknesses

Table 1

Demographic Information

Mean Age (years)	53.38 (9.61)
Marital Status	
Married	64%
Single	36%
Ethnicity/Race	
Caucasian	100%
Mean Education (years)	14.87 (2.56)
Employment Status	
30+ hours/week	70.7%
10-30 hours/week	10.4%
Not employed	18.9%

n = 46

Table 2

Neuropsychological Measures

Cognitive Domain	Measures
Immediate Memory	WMS-III Logical Memory I[a]
	WMS-III Visual Reproduction I[a]
Delayed Memory	WMS-III Logical Memory II[a]
	WMS-III Visual Reproduction II[a]
	Rey AVLT Delayed Recall[b]
Attention	Trail Making Test A[c]
	WAIS-III Digit Span[d]
Executive Functioning	Trail Making Test B[c]
	Stroop Test[e]
Verbal Fluency	COWAT[f]
	Category Fluency[g]

[a] (Wechsler, 1997a)

[b] (Taylor, 1959)

[c] (Reitan, 1955)

[d] (Wechsler, 1997b)

[e] (Golden, 1978)

[f] (Benton & Hamsher, 1989)

[g] (Spreen and Strauss, 1991)

Table 3

Group Mean z (difference) scores* for each Cognitive Domain

Cognitive Domain	Mean z (difference) score
Immediate Memory	.29 (.80)[a]
Delayed Memory	.49 (.81)[b]
Attention	-.04 (.84)
Executive Functioning	-.44 (1.10)[a]
Verbal Fluency	-.65 (.97)[b]

* z(difference) score = (Domain composite z-score) - (WRAT-3 Reading z-score)

[a] Wilcoxon Signed Rank test, p <. 05

[b] Wilcoxon Signed Rank test, p < .001

Table 4

Correlations between Outcome Measures

	FACT/SWB Subscale	FACT/RWD Subscale	FACT/EWB Subscale	FACT/FWB Subscale	CIQ/Home Integration Score	CIQ/Social Integration Score	CIQ/Productivity Score	CIQ/Total Score
FACT/RWD Subscale	.316*							
FACT/EWB Subscale	.571**	.121						
FACT/FWB Subscale	.713**	.363*	.674**					
CIQ/Home Integration Score	.024	-.085	.027	-.042				
CIQ/Social Integration Score	.506**	.021	.413**	.345*	.390**			
CIQ/Productivity Score	.224	.157	.174	.358*	-.104	.041		
CIQ/Total Score	.368*	.079	.335*	.306*	.677**	.699**	.471**	
Social Roles Average	.573**	.128	.589**	.451**	-.248	.341*	.026	.066

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).