HHS Public Access

Author manuscript

Int J Behav Med. Author manuscript; available in PMC 2015 June 03.

Published in final edited form as:

Int J Behav Med. 2013 March ; 20(1): 13–21. doi:10.1007/s12529-011-9194-1.

Self-regulatory Fatigue in Hematologic Malignancies: Impact on Quality of Life, Coping, and Adherence to Medical Recommendations

Lise Solberg Nes,

Department of Psychiatry and Psychology, Mayo Clinic, Mayo West 11, 200 First Street SW, Rochester, MN 55905, USA

Shawna L. Ehlers,

Department of Psychiatry and Psychology, Mayo Clinic, Mayo West 11, 200 First Street SW, Rochester, MN 55905, USA

Christi A. Patten, and

Department of Psychiatry and Psychology, Mayo Clinic, Mayo West 11, 200 First Street SW, Rochester, MN 55905, USA

Dennis A. Gastineau

College of Medicine, Mayo Clinic, Mayo West 11, 200 First Street SW, Rochester, MN 55905, USA

Lise Solberg Nes: lsolbnes@umn.edu

Abstract

Background—Hematopoietic stem cell transplantation (HSCT) is an intensive cancer therapy entailing numerous physical, emotional, cognitive, and practical challenges. Patients' ability to adjust and cope with such challenges may depend on their ability to exert control over cognitive, emotional, and behavioral processes, that is, ability to self-regulate. Self-regulatory capacity is a limited resource that can be depleted or fatigued (i.e., “self-regulatory fatigue”), particularly in the context of stressful life events such as cancer diagnosis and treatment.

Purpose—This is one of the first studies to examine self-regulatory fatigue in a cancer population. The current study aimed to (1) extract items for a specific scale of self-regulatory capacity and (2) examine the impact of such capacity on adaptation in patients with hematologic malignancies preparing for HSCT.

Methods—Factor analysis of four existing scales gauging psychological adjustment and well-being in 314 patients preparing for HSCT (63% male and 89% Caucasian) identified 23 items (α=0.85) related to self-regulatory control or fatigue. This measure was then examined using existing clinical data obtained from 178 patients (57% male and 91% Caucasian) undergoing treatment for hematologic malignancies in relationship to quality of life, coping, and self-reported adherence to physicians' recommendations.

Correspondence to: Lise Solberg Nes, lsolbnes@umn.edusolbergnes@msn.com.

Results—Controlling for pain severity, physical fatigue, and depression, self-regulatory fatigue scores were incrementally associated with decreased quality of life, use of avoidance coping strategies, and decreased adherence to physicians' recommendations.

Conclusion—These results emphasize the potential role of self-regulatory capacity in coping with and adjusting to hematologic cancers and future research is warranted.

Keywords

Hematologic malignancies; Hematopoietic stem cell transplantation; Self-regulatory fatigue; Adjustment; Quality of life; Coping

Introduction

Being diagnosed with cancer entails an abundance of physical, emotional, and practical challenges. Hematopoietic stem cell transplantation (HSCT) is primarily a second-line treatment for hematologic malignancies which have not responded to first-line treatments such as chemotherapies and radiation therapies or for hematologic malignancies which have poor prognostic indicators [1, 2]. HSCT is an intensive treatment with potential for a multitude of complications, and patients' ability to adjust to and cope with such stressors may depend on their capacity to self-regulate. Self-regulatory capacity is a limited resource that can be depleted or fatigued [3], and this may particularly be the case in the context of stressful life events such as a cancer diagnosis and intensive cancer treatment such as HSCT. Research addressing the impact of self-regulation on illness is in its infancy, and the current study sought to examine the impact of self-regulatory fatigue on patients diagnosed with hematologic malignancies and preparing for HSCT.

Self-regulation

Self-regulation theory [4] describes human behavior as a never-ending process towards or away from goals, and central in these processes are the ideas of self-regulation and self-regulatory fatigue. Self-regulation is the global ability to exercise control over reactions and behavior [4–6] and involves cognitive processes, such as, ability to control thoughts, urges and impulses, and ability to make decisions and set goals; emotional processes, such as, ability to control feelings and moods; and physiological processes such as sympathetic (e.g., flight/fight response) and parasympathetic (e.g., relaxation response) activation [7]. In sum, self-regulation is broadly defined as the ability to pursue goals, whether they be cognitive, emotional, physiological, or behavioral.

Despite the importance of self-regulatory ability, research indicates that this capacity is a resource that can be depleted or fatigued (i.e., self-regulatory fatigue [8–10]). Research on self-regulatory fatigue or depletion has mostly been limited to tightly controlled experimental lab conditions. In brief, participants are randomly assigned to a laboratory task involving self-regulatory demand (e.g., attention control task and self-control task) and tested on an outcome measure of ability to persist toward goal attainment (e.g., anagram task and persistence task). Higher demands or effort consistently leads to self-regulatory fatigue and thus less ability to pursue future goals [5, 8, 10, 11]. The concept of self-regulation is well established in laboratory settings, and self-regulatory strength and fatigue likely play

essential roles in people's day to day life, perhaps particularly in the context of chronic stress and chronic illness.

Self-regulation and Chronic Illness

Illness and chronic conditions require daily engagement in goals to maintain and optimize health (e.g., treatment adherence and rehabilitation), theoretically resulting in self-regulatory fatigue and thus less ability to pursue these goals and related health outcomes (for a review, see [12]). A recent lab-based study found patients diagnosed with chronic pain conditions such as fibromyalgia and temporomandibular disorders to be more vulnerable to self-regulatory fatigue than matched pain-free controls [13] in terms of reduced ability to pursue laboratory task goals. Impact of chronic pain conditions on goal pursuit was mediated by pain in the study but not by any other factors such as psychological status, physical fatigue;, or baseline physiology differences such as heart rate variability cortisol, or blood glucose. This suggests that patients with chronic pain conditions may suffer from effects of chronic self-regulatory fatigue, above and beyond effects of traditional factors such as depression and physical fatigue. In essence, the results of this study underline the importance of self-regulatory fatigue as a concept distinct from more traditional factors such as physical fatigue, distress, and depression.

Apart from chronic pain conditions, the self-regulation paradigm has to our knowledge not been tested among patients with other challenging or stressful medical conditions (e.g., cancer diagnosis with ongoing cancer treatments). A cancer diagnosis can be an overwhelming and traumatic experience [14], followed by taxing treatment that likely will take a toll on patients physically as well as psychologically [15]. Hematologic malignancies are cancer types affecting the blood, bone marrow, and/or the lymph nodes (e.g., leukemia, lymphoma, and myeloma). Treatments for these cancers vary and often include “watchful waiting,” blood transfusions, and also chemotherapy and radiation. For life threatening variations or stages, HSCT may be recommended. HSCT is an intensive cancer therapy entailing numerous risks and challenges, from short-term side effects such as nausea, vomiting, pain, bleeding, and mucositis, to longer-term side effects such as graft-versus-host disease, increased medical comorbidity, and reduced quality of life [16–19]. Mortality rates for these HSCTs are also daunting and range from 1% to 10% for autologous transplants (receiving own cells), to 20% to 30% for allogeneic transplants (receiving donor cells), and probability of being alive 10-years post-allogeneic HSCT has been indicated at approximately 85% [16, 19].

A number of studies have documented psychological effects from cancer diagnosis and treatment in the form of symptoms of posttraumatic stress disorder [14, 20], including patients undergoing HSCT [21], and studies have suggested significant impact of general health, cancer, and other chronic conditions on personal goal pursuit [22, 23]. Living with a cancer diagnosis and preparing for or undergoing challenging treatment such as HSCT likely takes a significant toll on a person's physical and mental resources, and self-regulatory capacity may play a crucial role in adaptation, coping and adjustment for such patients.

Depending on condition, chronic illness, whether chronic pain or cancer, is often associated with physical fatigue, pain, and mood dysregulations such as depression and anxiety [15,

24]. Health conditions frequently also impact quality of life [25, 26], as well as choice of coping strategies [27–29]. Self-regulatory strength or fatigue likely impact these concepts as well (for a review, see [12, 13]), and self-regulatory fatigue may, due to decreased capacity for goal pursuit, even be associated with decreased ability to follow and adhere to medical recommendations. The current study aimed to examine the impact of self-regulatory fatigue on pain, physical fatigue, depression, quality of life, coping strategies, and adherence to physician's recommendations in patients undergoing treatment for hematologic malignancies and preparing for HSCT.

Study Aims

Self-regulatory capacity has so far been measured in experimental (i.e., laboratory) settings, where the self-regulatory fatigue or depletion research paradigm usually involves two consecutive, seemingly unrelated tasks of self-control [5]. A few studies have sought to create scales measuring self-regulation. For example, The Self-Regulation questionnaire [30] measures self-regulation in the form of ability to develop, implement, and maintain planned behavior in order to achieve goals, and the State Ego Depletion Scale [31] seeks to measure state resource depletion. However, to our knowledge, no scale exist specifically measuring self-regulatory capacity or fatigue at this point. Aiming to advance the understanding of self-regulatory fatigue and its potential impact on cancer patient outcomes, the current study first sought to take this concept out of the laboratory setting by using a scale to measure self-regulatory capacity or fatigue. Using existing clinical data, our first step was to identify scale items measuring self-regulatory capacity for use in populations with hematologic malignancies.

The new measure was then employed to examine the impact of self-regulatory fatigue on adaptation in patients with hematologic malignancies preparing for HSCT. We hypothesized that higher self-regulatory fatigue would be associated with decreased quality of life, less use of adaptive coping strategies, and less compliance or adherence with medical recommendations. Because we expected, based on the literature, that higher self-regulatory fatigue would be associated with higher pain severity, physical fatigue, and depression, we controlled for these variables in our analyses, and also controlled for demographic and socioeconomic factors.

Methods

Procedure Overview

This study was approved by the Institutional Review Board. Examining measures related to psychological adjustment and well-being from an existing clinical database of patients preparing for HSCT (N=314), two independent raters identified items related to self-regulatory control or capacity. A factor analysis of these items was then conducted and a scale measuring self-regulatory fatigue extracted. See the statistical analyses section for more details. The new scale was then examined in patients undergoing treatment for hematologic malignancies and preparing for HSCT who provided general research authorization (N=178) in relation to symptom burden.

Measure Scale Extraction

Participants—Patients diagnosed with, and undergoing treatment for, hematologic malignancies at a major medical center in the USA. All measures were collected while patients were preparing for HSCT. Participants were 20–75 years old (median age=58 years old), 63% male, 37% female, and the majority were Caucasian (89%). Patients were diagnosed with multiple myeloma (44%), lymphoma (27%), amyloidosis (17%), and leukemia (12%). The majority of participants were scheduled for autologous stem cell transplant (86%), and the remaining group for allogeneic transplant (14%).

Measures—Scale Item Extraction—Self-regulation entails ability to control thoughts, emotions, and behavior. In this study, we first identified four measures estimated to represent features of such ability, focusing on aspects of personality, state and trait anger and anxiety, and impact of diagnosis and preparation for transplantation. Two raters then independently identified items from these measures considered to be capturing aspects of self-regulatory capacity. Any item indicative of ability to regulate or control activities (e.g., persistence, energy, and initiative), or of impaired capacity to do such (e.g., impulsivity, outbursts, and fatigue) were identified and extracted for factor analysis.

Big Five Inventory: The Big Five Inventory (BFI) [32] is a 44-item multidimensional self-report personality inventory designed to measure the Big Five personality dimensions [33]. Items are scored on a 5-point Likert scale. The BFI has acceptable psychometric values [see 34]. In terms of self-regulation, the BFI was selected in order to capture aspects of state as well as trait ability to exercise control over reactions and behavior from a personality perspective (i.e., general ability to control thoughts, mood, and behavior as well as cope with stressors).

Impact of Events Scale: The Impact of Events Scale (IES) [35] is a 15-item measure assessing cognitive and emotional impact of traumatic events. The measure focuses on experience of intrusive thoughts, avoidance, and emotional numbing related to a stressful event. The measure has good reliability with a Cronbach alpha of 0.92 [36]. The IES was chosen for self-regulation item extraction in order to capture ability to control and cope with thoughts and emotions related to impact of the illness (i.e., impact of diagnosis and preparation for HSCT).

State Trait Anger Expression Inventory: The State Trait Anger Expression Inventory (STAXI-2) [37] is a 57-item self-report measure of the intensity of anger as an emotional state (state anger), and the disposition to experience angry feelings as a personality trait (trait anger). The STAXI-2 consists of six scales and measures the intensity of anger and the disposition to experience angry feelings [37]. Items consist of 4-point scales. Internal consistencies for the STAXI is acceptable (α=0.73–84 [37]). The STAXI-2 was utilized for item extraction in this study as representative of emotional and behavioral control.

The State Trait Anxiety Inventory: The State Trait Anxiety Inventory (STAI) [38] is a 40-item measure of state and trait anxiety, measuring the severity of overall anxiety level. Test–retest reliability of the STAI is acceptable at r=.54 (state) and r=.86 (trait) [38]. In terms of

self-regulation and item extraction, items from the STAI are considered to be indicators of cognitive and emotional control.

Statistical Analyses—All statistical analyses were carried out using the Statistical Package for the Social Sciences, Release 15.0 (SPSS Inc., 1989–2007). Following item extraction, a principle factor analysis with oblique rotation [39] was employed to examine possible factor structures and identify specific items for a scale measuring and reflecting self-regulatory capacity or fatigue. Factor loadings of r=.7 or above are generally considered high, while loadings below r=.4 are considered low [39]. In the current study we therefore excluded items that loaded with less than r=.4 on any factor.

Relationship of Self-regulatory Fatigue to Clinical Patient Outcomes

Participants—Patients diagnosed with, and undergoing treatment for, hematologic malignancies at a major medical center in the USA. All measures were collected while patients were preparing for HSCT. Participants were 22–74 years old (median age 57 years old), 57% male, 43% female, and the majority were Caucasian (91%), with 3% African American, 3% Native American or Alaska Indians, 1% Asian, and 2% other or unknown. Of this sample, 18% had completed post-graduate studies, 19% had a 4-year college degree, 31% had completed the equivalent of 2 years of college, 26% had graduated high school, and 6% had less than 12 years of education. Most participants were married (75%), with 11% being single, 7% divorced, and 6% widowed. A majority of the sample were retired (41%), with 31% being employed, 15% work disabled, 7% unemployed, 3% self-employed, and 2% were full time home makers. Of the participants, 27% reported financial concerns pre-transplant, and 73% reported no financial concerns. Patients were diagnosed with multiple myeloma (46%), lymphoma (28%), amyloidosis (15%), and leukemia (11%). The majority of participants were scheduled for autologous stem cell transplant (84%), and the remaining group for allogeneic transplant (16%).

Outcome Measures

Functional Assessment of Cancer Treatment General (FACT-G): The FACT-G [40] is a 27-item measure of four primary quality-of-life domains involving physical, social/family, emotional, and functional well-being. The FACT-G distinguishes between stages I, II, III, and IV disease (p <.05) and has acceptable validity and reliability [40].

Coping: The brief COPE [41] is a 28-item brief version of the coping measure COPE [42] comprising 14 subscales for approach or avoidance coping including active coping, planning, positive reframing, acceptance, humor, religion, using emotional support, using instrumental support, self-distraction, denial, venting, substance use, behavioral disengagement, and self-blame. The brief COPE has alpha reliabilities at or above 0.50 with similar or identical scales from the COPE [41], which is extensively used in health settings and considered to have acceptable reliability and validity [42].

Patient Adherence: Self-reported current patient adherence to medical recommendations was measured through use of The Medical Outcomes Study Measures of Patient Adherence [43]. This is a five-item measure gauging self-reported current ability to adhere to general

physicians' recommendation. The measure has acceptable internal consistency reliability (α=0.81 [43]).

Covariates

Demographics, Socioeconomic Status, and Disease/Transplant specifics: Information related to gender, age, race, years of education, employment, and marital status, whether patients reported financial concerns related to illness and treatment, as well as type of illness (e.g., lymphoma, leukemia, and myeloma) and transplant (autologous vs. allogeneic) type was collected and included as covariates in the analyses.

Brief Fatigue Inventory: The Brief Fatigue Inventory [44] is a nine-item measure assessing degree and level of fatigue, focusing on impact on general activity, mood, walking ability, normal work, relations with other people, and enjoyment of life. The Brief Fatigue Inventory has reasonable psychometric properties [44], has been validated for use in a mixed cancer population, and entails cut-off scores for mild, medium, and severe fatigue.

Pain: Pain Assessment Scale [45]. Physical pain in the current study was measured through a three-item self-report measure assessing current pain, average pain, and worst pain over the past week. Each question is measured on a 0–10 Likert scale, with 0=no pain and 10=worst possible pain.

Beck Depression Inventory: The Beck Depression Inventory (BDI-II) [46] is a 21-item self-report inventory measuring severity of depression that includes cognitive and somatic symptoms. Reliability if the BDI-II is acceptable with test– retest reliability r=.93 and internal consistency α=0.92 [46].

Statistical Analyses—Multiple hierarchical linear regressions were used to examine the associations between self-regulatory fatigue scores (main independent variable) and physical fatigue, pain, depression, quality of life, coping strategies as well as self-reported adherence to medical recommendations (all dependent variables). All analyses examining relationship between self-regulatory fatigue, quality of life, coping, and adherence (main dependent variables) controlled for physical fatigue, pain severity, and depression in the first step. The analyses also controlled for demographics and socio-economic status (SES; i.e., gender, age, race, years of education, employment and marital status, and financial concerns), as well as type of illness and transplant type. The standard alpha level of 0.05 was used for all main statistical analyses.

Results

Factor Analysis—Measure Extraction

Thirty-eight items related to or reflecting ability for self-control were identified and extracted from four existing scales related to psychological adjustment and well-being (i.e., BFI, IES, STAXI-2, and STAI). All items were converted to a 1–5 Likert scale if not already measured that way. The final extraction following factor analysis consisted of 23 items (α=0.85) related to self-control or self-regulatory fatigue (see Table 1). It has been suggested

that self-regulatory capacity entails cognitive, emotional, and behavioral components [12], and further analysis with the examination of the scree plot and the pattern matrix did suggest loadings to three factors related to cognitive, emotional and behavioral control for the analysis (see Table 1). Factor 1 contained seven items related to attention (cognitive) control (α=0.93), factor 2 contained 11 items related to worry and emotion (emotional) control (α=0.84), and factor 3 contained five items related to behavioral control (α=0.79); see Table 1. As the aim of the current study was to examine impact of overall self-regulatory capacity on adaptation in this patient population, the total extracted scale (i.e., 23 items) was used to measure self-regulatory fatigue. Any potential impact of the three sub-factors separately was not explored. Internal consistency reliability for the total self-regulation scale was acceptable at α=0.85, and obtainable score range for the scale=23– 115, with higher number reflecting higher self-regulatory fatigue. Lowest reported self-regulatory fatigue score in the current study was 23 (2.8%), and highest score reported= 62 (0.6%). Mean self-regulatory fatigue score=37.43, median=37.50, and standard deviation=9.28.

Relationship of Self-regulatory Fatigue to Clinical Outcomes

Fatigue, Pain, and Depression—See Table 2 for descriptives related to outcome measures. As expected, higher self-regulatory fatigue scores (total score) was associated with higher level of self-reported physical fatigue (β=0.33, t= 4.61, p<.001), pain (β=0.21, t=2.81, p<.01), and BDI-II depressive symptom scores (β=0.50, t=7.67, p<.001). See also Table 3.

Quality of Life—After adjusting for physical fatigue, pain, and depression, self-regulatory fatigue was incrementally associated with decreased FACT-G overall quality-of-life scores (β=−0.47, t=−6.11, p<.001), particularly decreased social (β=−0.29, t=−3.51, p=.001) and emotional (β=−0.46, t=−6.29, p<.001) quality of life. Self-regulatory fatigue was not associated with physical (β=−0.05, t=−1.12, p=.26) or functional (β=−0.10, t=−1.56, p=.12) quality of life after controlling for physical fatigue, pain, and depression.

Coping—Self-regulatory fatigue was also significantly associated with higher use of COPE avoidant coping strategies (β=0.37, t=3.64, p< .001). In particular, higher self-regulatory fatigue was linked to higher use of behavioral disengagement (β=0.37, t=4.22, p<.001), denial (β=0.33, t =3.69, p<.001), distraction (β=0.21, t=2.39, p<.02), venting (β=0.33, t=3.93, p<.001), and self-blame (β=0.33, t= 3.79, p<.001). Self-regulatory fatigue was not associated with COPE active coping per say (β=0.00, t=0.001, p=.99) but was nevertheless associated with higher use of planning (β=0.22, t=2.40, p=.02).

Adherence—In addition, increased self-regulatory fatigue scores were associated with increased self-reported difficulty adhering to physician's recommendations (β=−0.21, t= −2.23, p<.03).

Discussion

The current study sought to examine the impact of self-regulatory fatigue in patients diagnosed with hematologic malignancies during a time in which they were preparing for

HSCT. Self-regulatory fatigue has generally been measured through experimental manipulations in the laboratory setting, but results from the current study indicate that the construct of self-regulatory fatigue translates to self-report measures and the clinical cancer and HSCT patient setting. The self-regulation scale contains items related to cognitive, emotional, and behavioral self-regulatory control, supporting the construct validity of self-regulatory capacity as ability to control internal, external, mental, and physical activities. To our knowledge, no study has so far examined the association of self-regulatory fatigue on quality of life, coping, and adherence to medical recommendations, nor among patients diagnosed with and undergoing treatment for cancer.

Existing research suggests that patients diagnosed with chronic illness likely suffer from high levels of self-regulatory fatigue, impacting adjustment and well-being [12, 13]. As expected, our findings indicate self-regulatory fatigue was associated with higher physical fatigue, pain severity, and depression. Self-regulatory fatigue was not related to demographics, SES, type of disease, or type of transplant in the current study. Because self-regulatory fatigue was found to be incrementally (i.e., controlling for pain, fatigue, and depression) associated with decreased quality of life, avoidance coping, and decreased adherence/compliance, this also suggests self-regulatory fatigue to be a distinct construct.

Self-regulatory fatigue was associated with decreased quality of life in this patient group, supporting the idea that fatigue of self-regulatory resources can impede capacity to regulate emotions and maintain or engage in social activities and relationships (for a review, see [12]), subsequently leading to decreased quality of life.

The connection between self-regulatory fatigue and choice of coping strategies has so far only existed in theory [12]. Our study provides evidence for this connection. Self-regulatory fatigue was indeed associated with higher use of avoidance coping strategies, including behavioral disengagement, denial, and distraction. Self-regulatory fatigue was also associated with use of venting (i.e., focusing on emotions), and self-blame, likely suggesting decreased capacity to actively approach challenges and problem solve issues. Self-regulatory fatigue was also associated with planning in the current study, indicating that participants continue to devote some remaining self-regulatory capacity toward active coping.

Finally, patients also reported decreased ability to adhere to recommendations from their physicians when self-regulatory fatigue was high, suggesting extension of our findings to behavioral outcomes. Hall and Fong [47] have suggested a framework referred to as Temporal Self-Regulation Theory (TST), aiming to understand or explain why reduced self-regulatory capacity might translate into health related outcomes. TST suggests that self-regulation is based on an interaction of self-regulatory capacity, motivation, and ecological factors at the moment of choice, for example choosing short-term positive outcomes (e.g., relaxing rather than exercising) at the cost of long-term investments (e.g., long-term positive impact of physical activity). There are also indications that executive functions play a role in ability to self-regulate [12, 48], and neuro-cognitive comprise has been associated with lower medical adherence among HIV+ adults [49] as well as survival time in the context of chronic illness [48]. The results from the current study add to a new line of research, examining the impact of self-regulatory fatigue on outcomes among cancer patients and

particularly patients preparing for HSCT, identifying significant and potentially detrimental links.

Limitations and Future Directions

The concept of self-regulatory capacity is a complex one, and can likely be measured in more ways than one depending on the population(s) at hand and their relevant challenges. Other questionnaires could also be of benefit, and development of a widely used self-regulation scale will likely be a continuing process, as has been the case with numerous psychosocial constructs and concepts (e.g., coping and quality of life). In addition to the overlying constructs of cognitive, emotional, and behavioral control, however, self-regulation also entails underlying aspects related to motivation and impulse control, and the measure in this study captures, to a large degree, aspects from all of these factors.

The proposed study involves secondary analyses of existing cross-sectional data that were not initially designed for this specific use. However, the existing data were broadly designed for analysis of psychosocial, health behavior, and medical outcomes, with exploratory analysis of base measures that comprise the self-regulatory fatigue scale. All participants in the current study were preparing for HSCT, indicating high severity of disease. It is possible that disease severity and progression could impact degree of self-regulatory fatigue, adding to this picture, and future studies should investigate this relationship further. Future studies examining outcomes over time with respect to quality of life and other cancer outcomes are clearly warranted.

This is the first study to translate the self-regulatory fatigue paradigm to a clinical setting with “real-world” (non-laboratory) stressors and outcomes, advancing our understanding of self-regulatory fatigue as a construct beyond the laboratory. Results indicate that patients preparing for HSCT may be vulnerable to self-regulatory fatigue, possibly as a consequence of their condition and the many challenges they face during this difficult time. Ability to cope with stressors and adhere to recommendations and guidelines is of essence for successful transplant outcomes, and quality of life may impact patient motivation and energy in a number of ways. If self-regulatory fatigue can be prevented, decreased, or at least improved [50], this may have significant impact on course of transplant for these patients. Future research is needed to advance translation of the self-regulation paradigm from theory to practice. Preliminary intervention work suggests that self-regulatory fatigue is amenable to intervention [51]. High potential exists to extend this research to clinical populations to improve self-regulatory capacity and patient health behaviors.

Conclusions

These findings represent the first link between self-regulatory fatigue and patient outcomes in a clinical setting and in a cancer population, emphasizing the critical role of patients' ability to self-regulate in adjusting to a serious illness such as cancer. Controlling for associations with pain severity, physical fatigue, and depression, self-regulatory fatigue was incrementally associated with decreased quality of life, as well as avoidant coping strategies and decreased self-reported adherence to physicians' recommendations. The significant negative impact of self-regulatory fatigue on well-being, adjustment, coping, and health

behavior underline the need for further research in this area. Secondarily, our findings support validity of self-regulatory fatigue when measured via self-report questionnaires, and when translated from the laboratory to the clinical setting. Furthermore, development of tools that may improve self-regulatory capacity appears of essence.

Acknowledgments

This study was conducted using a database from a clinical practice intervention grant (CPI-10) from the Mayo Clinic. The authors would like to thank LeAnn Batterson for assistance with data collection and abstraction and would also like to thank the BMT practice group at the Mayo Clinic for all their support and assistance. Finally, we express gratitude to all the patients who volunteered use of their medical records to advance research.

References

1. Cutler C, Antin JH. An overview of hematopoietic stem cell transplantation. Clin Chest Med. 2005; 26:517–27. [PubMed: 16263393]
2. McDiarmid S, Hutton B, Atkins H, Bence-Bruckler I, Bredeson C, Sabri E, et al. Perfoming allogeneic and autologous hematopoietic SCT in the outpatient setting: effects on infectious complication and early transplant outcomes. Bone Marrow Transplant. 2010; 45(7):1220–6. [PubMed: 19946343]
3. Baumeister RF, Bratslavsky E, Muraven M, Tice DM. Ego depletion: Is the active self a limited resource? J Pers Soc Psychol. 1998; 74:1252–65. [PubMed: 9599441]
4. Carver, CS.; Scheier, MF. On the self-regulation of behavior. New York: Cambridge University Press; 1998.
5. Baumeister, RF. The self. In: Gilbert, DT.; Fiske, ST.; Lindzey, G., editors. Handbook of social psychology. New York: McGraw-Hill; 1998.
6. Higgins ET. The “self-digest”: self-knowledge serving self-regulatory functions. J Pers Soc Psychol. 1996; 71:1062–83. [PubMed: 8979379]
7. Vohs, KD.; Baumeister, RF. Understanding self-regulation. In: Baumeister, RF.; Vohs, KD., editors. Handbook of self-regulation: research, theory, and applications. New York: Guilford Press; 2004.
8. Baumeister RF. Ego-depletion and self-control failure: an energy model of the self's executive function. Self Ident. 2002; 1:129–36.
9. Muraven M, Baumeister RF. Self-regulation and depletion of limited resources: does self-control resemble a muscle? Psychol Bull. 2000; 126:247–59. [PubMed: 10748642]
10. Muraven M, Tice DM, Baumeister RF. Self-control as a limited resource: regulatory depletion patterns. J Pers Soc Psychol. 1998; 74:774–89. [PubMed: 9523419]
11. Segerstrom SC, Solberg Nes L. Heart rate variability indexes self-regulatory strength, exercise, and depletion. Psychol Sci. 2007; 18:275–81. [PubMed: 17444926]
12. Solberg Nes L, Roach AR, Segerstrom SC. Executive functions, self-regulation, and chronic pain: a review. Ann Behav Med. 2009; 37:173–83. [PubMed: 19357933]
13. Solberg Nes L, Carlson CR, Crofford LJ, de Leeuw R, Segerstrom SC. Self-regulatory deficits in fibromyalgia and temporomandibular disorders. Pain. 2010; 151:37–44. [PubMed: 20561749]
14. Andrykowski MA, Cordova MJ, Studts JL, Miller TW. Posttraumatic stress disorder after treatment for breast cancer: prevalence of diagnosis and use of the PTSD Checklist-Civilian Version (PCL-C) as a screening instrument. J Consult Clin Psychol. 1998; 66:586–90. [PubMed: 9642900]
15. Hann DM, Jacobsen P, Martin S, Azzarello L, Greenberg H. Fatigue and quality of life following radiotherapy for breast cancer: a comparative study. J Clin Psychol Med Set. 1998; 5:19–33.
16. Antman K. When are bone marrow transplants considered? Sci Am. 1996; 275:124–5. [PubMed: 8701281]
17. Andrykowski MA, Bishop MM, Hahn EA, Cella DF, Beaumont JL, Brady MJ, et al. Long-term health-related quality of life, growth, and spiritual well-being after hematopoietic stem-cell transplantation. J Clin Oncol. 2005; 23:599–608. [PubMed: 15659507]

18. Syrjala KL, Langer SL, Abrams JR, Storer B, Sanders JE, Flowers MED, et al. Recovery and long-term function after hematopoietic cell transplantation for leukemia or lymphoma. JAMA. 2004; 291:2335–43. [PubMed: 15150205]
19. Wingard JR, Majhail NS, Brazauskas R, Wang Z, Sobocinski KA, Jacobsohn D, et al. Long-term survival and late deaths after allogeneic hematopoietic cell transplantation. J Clin Oncol. 2011; 29:1–11. [PubMed: 21115866]
20. Alter CL, Pelcovitz D, Axelrod A, Goldenberg B, Harris H, Meyers B, et al. Identification of PTSD in cancer survivors. Psychosom. 1996; 37:137–43.
21. Widows MR, Jacobsen PB, Fields KK. Relation of psychological vulnerability factors to posttraumatic stress disorder symptomatology in bone marrow transplant recipients. Psychosom Med. 2000; 62:873–82. [PubMed: 11139008]
22. Schwartz LA, Drotar D. Health-related hindrance of personal goal pursuit and well-being of young adults with cystic fibrosis, pediatric cancer survivors, and peers without a history of chronic illness. J Ped Psychol. 2009; 34(9):954–65.
23. Street H. The psychosocial impact of cancer: exploring relationships between conditional goal setting and depression. Psycho-Oncol. 2003; 12:580–9.
24. Aaron LA, Burke MM, Buchwald D. Overlapping conditions among patients with chronic fatigues syndrome, fibromyalgia, and temporomandibular disorder. Arch Int Med. 2000; 160:221–7. [PubMed: 10647761]
25. Mols F, Vingerhoets AJM, Coeberg JW, van de Poll-Franse LD. Quality of life among long-term breast cancer survivors: a systemic review. Euro J Cancer. 2005; 41:2613–9.
26. Perry SH, Kowalski TL, Chang CH. Quality of life assessment in women with breast cancer: benefits, acceptability and utilization. Health QoL Outcom. 2007; 5:24–38.
27. Carver, CS.; Scheier, MF.; Pozo, C. Conceptualizing the process of coping with health problems. In: Friedman, HS., editor. Hostility, coping & health. Washington, DC: American Psychological Association; 1992. p. 167-99.
28. Culver JL, Arena PL, Antoni MA, Carver CS. Coping and distress among women under treatment for early stage breast cancer: comparing African Americans, Hispanics, and non-Hispanic Whites. Psycho-oncol. 2002; 11:495–504.
29. Epping-Jordan JE, Compas BE, Osowiecki DM, et al. Psychological adjustment in breast cancer: process of emotional distress. Health Psychol. 1999; 18:315–26. [PubMed: 10431932]
30. Brown, JM.; Miller, WR.; Lawendowski, LA. The self-regulation questionnaire. In: VandeCreek, L.; Jackson, TL., editors. Innovations in clinical practice: a sourcebook. Sarasota: Professional Resource Press; 1999. p. 281-9.
31. Ciarocco, NJ.; Twenge, JM.; Muraven, M.; Tice, DM. Measuring state self-control: Reliability, validity, and correlations with physical and psychological stress. Monmouth, NJ: Monmouth University; unpublished
32. John, OP.; Donahue, EM.; Kentle, RL. The Big Five Inventory— versions 4a and 54. Berkeley, CA: University of California, Berkeley, Institute of Personality and Social Research; 1991.
33. Costa, PT., Jr; McCrae, RR. Revised NEO Personality Inventory (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) manual. Odessa: Psychological Assessment Resources; 1992.
34. Benet-Martınez V, John OP. Los Cinco Grandes. Across cultures and ethnic groups: Multitrait-multimethod analyses of the Big Five in Spanish and English. J Pers Soc Psychol. 1998; 75:729–50. [PubMed: 9781409]
35. Horowitz MJ, Wilner NR, Alwarez W. Impact of events scale. A measure of subjective stress. Psychosom Med. 1979; 41:209–18. [PubMed: 472086]
36. Sack WH, Seeley JR, Him C, Clarke GN. Psychometric properties of the Impact of events Scale in traumatized Cambodian refugee youth. Pers Individ Diff. 1978; 25:57–67.
37. Spielberger, CD. State-trait anger expression inventory: STAXI professional manual. Florida: Psychological Assessment Resources; 1991.
38. Spielberger, CD. Manual for the state-trait anxiety inventory STAI (Form Y). Palo Alto: Mind Garden; 1983.
39. Gorsuch, RL. Factor analysis. Hillsdale: Erlbaum; 1983.

40. Cella D, Tulsky D, Gray G, Sarafian B, Linn E, Bonomi A, et al. The Functional Assessment of Cancer Therapy Scale: development and validation of the general measure. J Clin Oncol. 1993; 11:570–9. [PubMed: 8445433]
41. Carver CS. You want to measure coping but your protocol's too long: consider the brief COPE. Int J Behav Med. 1997; 4:92–100. [PubMed: 16250744]
42. Carver CS, Scheier MF, Weintraub JK. Assessing coping strategies: a theoretically based approach. J Pers Soc Psychol. 1989; 56:267–83. [PubMed: 2926629]
43. Hays RD, Kravitz RL, Mazel RM, Sherbourne CD, DiMatteo MR, Rogers WH, et al. The impact of patient adherence on health outcomes for patients with chronic disease in the Medical Outcomes Study. J Behav Med. 1994; 17:347–60. [PubMed: 7966257]
44. Mendoza TR, Wang XS, Cleeland CS, Morrissey M, Johnson BA, Wendt JK, et al. The rapid assessment of fatigue severity in cancer patients: use of the Brief Fatigue Inventory. Cancer. 1999; 85:1186–96. [PubMed: 10091805]
45. Mayo Clinic. Pain Assessment Scale, MC3100-03. 2002. http://mayoweb.mayo.edu/man-ipm/pa-painmgmt.html
46. Beck, AT.; Steer, RA.; Brown, GK. Manual for the Beck Depression Inventory–II. San Antonio: Psychological Corporation; 1996.
47. Hall PA, Fong GT. Temporal self-regulation theory: a model for individual health behavior. Health Psychol Rev. 2007; 1:6–52.
48. Hall PA, Crossley M, D'Arcy C. Executive function and survival in the context of chronic illness. Ann Behav Med. 2010; 39:119–27. [PubMed: 20151234]
49. Hinkin CH, et al. Medication adherence among HIV+ adults: effects of cognitive dysfunction and regimen complexity. Neurology. 2002; 59:1944–50. [PubMed: 12499488]
50. Muraven M, Baumeister RF, Tice DM. Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. J Soc Psychol. 1999; 139:446–57. [PubMed: 10457761]
51. Solberg Nes L, Carlson CR, de Leeuw R, Schmidt JE, Segerstrom SC. Self-regulatory fatigue and chronic pain: From scale development to improving self-regulatory capacity. unpublished.

Table 1

Self-regulatory fatigue: item extraction

		Factor loadings (*r*)
Factor 1: Cognitive (attention) control		
IES_1	Thought intrusion	.678
IES_3	Memory avoidance	.693
IES_5	Strong feelings	.684
IES_7	Reminder avoidance	.690
IES_9	Suppressing need to talk	.579
IES_10	Flash backs	.757
IES_13	Thought suppression	.812
Factor 2: Emotional (worry and emotion) control		
BFI_4	Emotional STAbility (*R*)	.547
BFI_14	Moodiness	.530
BFI_17	Relaxed in stressful situations (*R*)	.763
BFI_21	Energetic (*R*)	.513
BFI_24	Calm in stressful situations (*R*)	.729
BFI_27	Tenseness	.599
BFI_34	Nervousness	.753
BFI_37	Worry	.715
STAI_22	Anxiety and restlessness	.522
STAI_27	Calmness (*R*)	.577
STAI_29	Excessive and unnecessary worry	.537
Factor 3: Behavioral control		
STAXI_4	Urges to yell	.825
STAXI_5	Urges to break	.843
STAXI_7	Urges to hit something	.682
STAXI_8	Urges to hit someone	.858
STAXI_10	Urges to swear	.721

Table 2

Descriptives for self-regulatory fatigue and clinical outcome measures

	Range	Min	Max	Mean	SD
Self-regulatory fatigue	39	23	62	37.43	9.28
Physical fatigue	82	0	82	31.55	21.33
Pain	10	0	10	2.39	2.36
Depression	39	0	39	8.91	6.41
Quality of life (QOL)					
Physical	28	0	28	7.56	5.90
Social	18	10	28	24.51	3.32
Emotional	20	4	24	17.68	3.89
Functional	25	3	28	17.71	6.18
Total QOL	45	38	83	67.37	8.22
Coping					
Active	12	4	16	11.29	3.06
Planning	7	1	8	5.30	1.86
Positive reframing	6	2	8	4.99	1.81
Avoidant	12	4	16	8.40	2.65
Acceptance	4	4	8	6.78	1.23
Humor	7	1	8	3.51	1.69
Religion	7	2	9	5.86	2.11
Emotional social support	6	2	8	6.78	1.43
Instrumental social support	6	2	8	5.49	1.77
Distraction	6	2	8	4.83	1.74
Denial	6	2	8	2.70	1.11
Venting	6	2	8	3.56	1.45
Substance use	4	2	6	2.20	0.67
Behavioral disengagement	3	2	5	2.47	0.91
Self-blame	6	2	8	2.43	0.90
Adherence to medical recommendations	5	1	6	5.43	1.04

Table 3
Impact of self-regulatory fatigue on clinical outcomes

	β	t	p
Physical fatigue	.33	4.61	<.001***
Pain	.21	2.81	.006**
Depression	.50	7.67	<.001***
Quality of life (QOL)			
Physical	−.05	−1.12	.26
Social	−.29	−3.51	.001**
Emotional	−.46	−6.29	<.001***
Functional	−.10	−1.56	.12
Total QOL	−.47	−6.11	.001***
Coping			
Active	.00	0.01	.99
Planning	.22	2.40	.02*
Positive reframing	.04	0.41	.69
Avoidant	.31	3.64	<.001***
Acceptance	−.12	−1.28	.20
Humor	−.06	−0.65	.51
Religion	−.09	−1.05	.30
Emotional social support	−.003	−0.37	.97
Instrumental social support	.17	1.77	.08
Distraction	.21	2.39	<.02**
Denial	.33	3.69	<.001***
Venting	.33	3.93	<.001***
Substance use	.15	1.62	11
Behavioral disengagement	.37	4.22	<.001***
Self-blame	.33	3.79	<.001***
Adherence to medical recommendations	−.21	−2.23	<.03*

* $p<.05$;

** $p<.01$;

*** $p<.001$, significant levels