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The Relationships between Fatigue and Early Postoperative Recovery Outcomes Over Time in Elderly Coronary Artery Bypass Graft (CABG) Surgery Patients

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Abstract

BACKGROUND—Despite successful coronary artery bypass graft (CABG) surgery, some patients continue to experience fatigue following their surgery.

OBJECTIVE—The purpose of this secondary analysis study was to examine the relationships of fatigue and early recovery outcomes (psychosocial and physiological functioning, and physical activity) over time (6-weeks and 3-months) among older adult subjects, age 65 years and older, following CABG surgery. Comparison groups were those subjects who had fatigue at 3-weeks after surgery and non-fatigued subjects.

DESIGN—A prospective, comparative design was used for this secondary analysis study.

SAMPLE—Subjects in this study were drawn from the control group of subjects enrolled in the larger, parent study. Subjects (N=119) were dichotomized into fatigue (n=66) and non-fatigued (n=53) groups based on their 3-week self-report of postoperative fatigue.

RESULTS—At 6-weeks after surgery, fatigued subjects had significantly ($p<.05$) more impaired psychosocial functioning, [role-emotional ($t=1.9$), social ($t=2.6$), and mental ($t=1.9$) functioning],

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based Medical Outcome Study short form-36 (MOS SF-36). They had significantly ($p<.005$) higher anxiety ($t=-3.6$) and depression ($t=-2.9$) mean Hospital Anxiety and Depression subscale (HADS) scores. Anxiety ($t=-2.3$, $p<.05$) remained significantly ($p<.05$) impaired at 3-months. At 6-weeks, role physical functioning, measured by the MOS SF-36, was significantly impaired ($t=2.4$, $p<.01$). There were no significant differences in physical activity variables as measured by a RT3® accelerometer and self-report diary.

CONCLUSIONS—Persistent fatigue can hamper early recovery following CABG surgery. Tailored interventions are needed to address fatigue management and improve patient outcomes.

INTRODUCTION

Fatigue is often a major and persistent problem for many cardiac patients. In spite of the many benefits derived from cardiac revascularization, there are patients who experience less than optimal outcomes. The presence of existing and sometimes new symptoms, such as fatigue, following coronary artery bypass graft (CABG) surgery can adversely affect patient recovery and quality of life. Fatigue, and associated states of vital exhaustion, can impair cardiac patients' quality of life and physical capacity.¹ Moreover, these symptoms are prognostic indicators of future cardiac events (e.g., myocardial infarction).² Factors, such as fatigue, that influence or contribute to poor outcomes following CABG surgery warrant further research. Evaluation of the role fatigue plays in recovery following CABG surgery can assist researchers in developing tailored interventions to reduce rehospitalizations and improve quality of life outcomes for high-risk patients. Therefore, the purpose of this subset analysis study was to examine the relationships of fatigue and early recovery outcomes (psychosocial and physiological functioning, and physical activity) over time (6-weeks and 3-months) among older adult subjects, ≥ 65 years old, following CABG surgery. Comparison groups were those subjects who had fatigue at 3-weeks after surgery and non-fatigued subjects. The specific aims of the study were to:

1. examine the relationships of fatigue and psychosocial functioning in the early recovery period (6-weeks and 3-months) after CABG surgery,
2. examine the relationship of fatigue and physiological functioning in the early recovery period (6-weeks and 3-months) after CABG surgery, and
3. examine the relationship of fatigue and physical activity in the early recovery period (6-weeks and 3-months) after CABG surgery.

The health outcomes research³ and symptom management⁴ models formed the basis of the conceptual model used to guide the larger parent study. An underlying assumption of the symptom management model⁴ is the need for professional and self-care strategies to manage symptoms as a means to prevent untoward outcomes, as well as facilitate more rapid improvement and recovery. Healthcare outcomes are reflected by the change in condition of patients following treatment, which requires the examination from multiple dimensions: functioning (psychosocial and physiological), clinical (e.g. postoperative problems), health care utilization, and patient satisfaction.⁵ Symptoms experienced following CABG surgery can influence the recovery and outcomes attained by patients. In the larger parent study, the impact of a symptom management intervention on healthcare outcomes of subjects in the early recovery period following CABG surgery was examined. In this subset analysis, a closer investigation of fatigue, a problematic symptom experienced by many patients following CABG surgery, was examined for its relationship to functioning and physical activity outcomes.

LITERATURE REVIEW

Fatigue in the cardiac population

Fatigue is a universal complaint, affecting most people at one time or another.⁶ It is more common as people age, as over 50% of older, community-dwelling subjects (N=199) reported mild or higher levels of fatigue.⁷ Fatigue is a multidimensional phenomenon delineated or classified as either physiologic acute or chronic fatigue. Further distinction is made between chronic fatigue (duration of ≥ 6 -months) and chronic fatigue syndrome; which is a condition distinguished by fatigue and accompanying symptoms (e.g., headache, sore throat, muscle pain).⁸ Fatigue is a common symptom associated with many chronic medical and neurological conditions such as renal failure, arthritis (both rheumatoid and osteoarthritis), cancer, Parkinson's, chronic obstructive pulmonary disease (COPD), heart failure, anemia, multiple sclerosis, and lupus.⁸ In the cardiac population, fatigue is often considered an indicator of "functional reserve".⁹

Patients who undergo surgery, including cardiac surgery, tend to experience fatigue that peaks between 2- to 4-weeks postoperatively.¹⁰⁻¹¹ Cytokine levels and opioid use can contribute to the sleep disturbances linked to this early postoperative fatigue.¹²⁻¹³ The presence of fatigue, for up to several weeks following surgery, is further attributed to loss of muscle tissue and function, to cardiovascular deconditioning response to exercise, patients' preoperative levels of fatigue¹⁴ and can be related to decreased cortisol levels.¹¹

Fatigue seems to exist and often persists among cardiac patients even with optimal surgical and medical management. Extreme fatigue, referred to as exhaustion, following a cardiac event or associated with a cardiac condition is associated with recurrent myocardial infarction and cardiac mortality.^{2, 15} Fatigue is one of the most commonly experienced, persistent and bothersome symptoms experienced by heart failure patients, and usually occurs in conjunction with dyspnea, shortness of breath and weakness.¹⁶⁻¹⁹ Fatigue was reported by 41% of myocardial infarction (MI) patients (N=114), to be present even at 5 months post-MI.²⁰ Percutaneous coronary intervention (PCI) patients often report fatigue during early recovery, from 2- to 6-weeks after their PCI,²¹⁻²⁴ with up to 25% of PCI patients (N=710) progressing on to develop chronic fatigue.² Similar to PCI patients, fatigue was the most prevalent and persistent symptom experienced (N=35) at 2-, 4- and 6-weeks following CABG surgery.²⁵ Even at 8-weeks after CABG surgery, 50% of the patients (N=34) reported fatigue and tiredness, despite being able to resume their usual activities and routines.²⁶

Other factors associated with fatigue

Depression plays a key role in the experience of fatigue among cardiac patients. Fatigue experienced following myocardial infarction (MI) is frequently associated with concomitant depression.²⁷⁻³¹ Fatigue was significantly correlated with depression ($r=0.52$) among female patients at 6- to 12-months after their MI²⁷; with depression and sleep disturbance explaining 32.7% of the variance ($p<.001$) in predicting fatigue. Heart failure patients (N=52) who experienced more physical symptoms, such as fatigue, had less physical functioning and were more likely to be depressed.¹⁷

However, there are patients who experience fatigue, without having any associated depression following their cardiac event (e.g., MI, heart failure).³¹ Fatigue not associated with depression, tends to be more prevalent among females, older patients and those patients with lack of or limited social support.³² Moore³³ reported during the first month following surgery, female CABG subjects (n=20) specifically reported fatigue and exhaustion and a "craving for naps". At 1-month after CABG surgery, 97% of the females (n=39), compared to 67% of men (n=27) reported fatigue, although these differences were not statistically significant.³⁴ Females

(n=47), compared to men (n=132), reported more physical symptoms, which included symptoms of fatigue, at 1-, 3-, and 6-weeks after CABG surgery.³⁵ These physical symptoms were slower to dissipate over time among the female respondents. Another study (N=65) found 74% of females compared to 35% of the males reported fatigue at 3-months after CABG surgery.³⁶ While the severity and frequency of fatigue peaked at 6-weeks among male CABG subjects, females did not experience peak fatigue levels until 3-months after CABG surgery.³⁶ Fatigue persisted for 84% of female subjects (N=61) at 3-months after CABG surgery.³⁷ Among older, female MI patients, 67% (N=84) fatigue persisted even at 6- to 12-months after their MI.²⁷

Relationships of fatigue and functioning

When associated with a medical condition, fatigue along with pain, are strongly associated with lower levels of self-reported physical, role and social functioning, and overall independent functioning among older adult subjects (N=225).³⁸ Fatigue is commonly cited as a barrier to participation in physical activity following MI.³⁹ Female cardiac patients, at 3- to 12-months after MI, actually altered their activities (e.g., reducing activity pace, stopping activity) to relieve their fatigue.⁴⁰ Female cardiac patients used activity management strategies to deal with their fatigue, which included such actions as pacing activities, “pushing on” despite fatigue, and recognizing cues of overexertion with activities.⁴¹ Similarly, at 5-months after MI, subjects (N=21) reported the most bothersome condition was their fatigue, which limited physical activity when the “fatigue” was interpreted (illness representation) as a threat to health.²⁰ Even when female MI patients (N=85) met minimal levels of physical activity recommended for secondary risk factor modification, as measured by kilocalories expended per week, fatigue still persisted.²⁷ Fatigue consistently was the symptom which had the highest interference on physical activity at 2-, 4- and 6-weeks after PCI (N=37).²¹ Similarly, fatigue had the greatest interference on physical activity and enjoyment of life among CABG surgical patients, in the first 6-months after surgery.⁴²

Fatigue, along with other symptoms such as edema and cough, are commonly occurring chronic symptoms of heart failure patients. Patients with heart failure symptoms, (e.g., edema, fatigue) have limitations in their daily physical activities,¹⁸ physiological functioning⁴³ and psychosocial functioning (e.g., depression).¹⁴ Patients with heart failure often do not recognize symptoms such as increased or worsening of fatigue as significant, resulting in delayed reporting of the change in their heart failure condition and subsequently poor outcomes.¹⁹

Fatigue is often associated with greater emotional distress. Female patients with heart failure (N=169) had poorer perceptions of their physical health; as well as viewed their fatigue as having more severe consequences.¹ Their symptoms of fatigue were significantly correlated with higher levels of depression, anxiety and healthcare utilization.¹ Fatigue not only limited heart failure patients’ abilities to be physically active, it was a constant reminder of their ongoing heart problem.⁴⁴

Study Significance

The previous literature frames the experience of fatigue that commonly occurs among cardiac populations. Both qualitative and quantitative measures, as summarized in Table 1, have been used to examine fatigue in various cardiac populations and following cardiac events. However, the majority of studies have only descriptively focused on the presence of fatigue and its persistence over time in association with cardiac conditions and following cardiac events. This study uniquely contributes to the literature by further examining the relationships of fatigue and early recovery outcomes following CABG surgery. In summary, while there have only been a limited number of studies examining fatigue among cardiac patients, the previous studies

demonstrate the prevalence and persistence of fatigue following significant cardiac events that can be associated with poorer functioning and quality of life. Therefore, closer examination of the relationships of fatigue and early recovery outcomes following significant cardiac events, such as this study is warranted.

METHODS

Design

A prospective, comparative design was used for this subset analysis study. The parent study had used a two group (symptom management intervention and control groups) repeated measures experimental design.

Sample

The sample of subjects for this subset analysis was comprised of the control group of subjects who had completed participation for 3-months or longer in the parent study. Subjects had been recruited from midwestern, regional tertiary centers. A total of 119 older adult patients, age ≥ 65 years old, were included in this subset analysis of 103 males and 16 female subjects. Since there were no significant differences between groups on preoperative levels of fatigue or demographic variables, subjects were dichotomized into either the “fatigued” or “non-fatigued” group based on self-report of experiencing fatigue (present or not present) at 3-weeks after CABG surgery using the Cardiac Symptom Survey (CSS)⁴⁵ for purposes of this subset analysis. All subjects were first-time CABG surgical patients. The fatigued group had an average age of 71.2 (± 5.6) years old, compared to the non-fatigued subjects with a mean age of 70.1 (± 5.3) years. Refer to Table 2 for descriptive characteristics of the groups.

Data Collection

Data were collected by telephone interview conducted by the same research nurse at each time period (6-weeks and 3-months after CABG surgery) to obtain subjects’ responses to the measures of psychosocial and physiological functioning; using the Medical Outcomes Study Short Form 36 (MOS SF-36) and Hospital Anxiety and Depression Scale (HADS). At each time (6-weeks and 3-months after CABG surgery), physical activity was measured by having subjects wear an accelerometer (RT3®) for three consecutive days (two weekdays and one weekend day), and having subjects complete a self-report exercise diary for the same 3-day period.

Instruments Used in the Study

In this subset analysis study, the Cardiac Symptom Survey (CSS) tool was used only to dichotomize subjects into groups of fatigued and non-fatigued subjects at 3-weeks following CABG surgery. Those subjects who reported the presence of fatigue on the CSS were assigned to the “fatigued” group. The CSS is a 10-symptom scale developed by the research team. Symptoms measured by the CSS include: fatigue, angina, shortness of breath, depression, sleeping difficulty, incision pain, swelling in the legs, fluttering/rapid heart beats (palpitations), anxiety, and poor appetite. Each symptom is assessed in three dimensions (presence of the symptom, evaluation of the symptom and response to the symptom). Subjects are asked to indicate the presence of a symptom (yes or no). If a subject has a symptom, the subject then evaluates the symptom (symptom evaluation) by rating the frequency and severity of the symptom. The subject then rates the interference of the symptom on physical activity, and rates the symptom interference on enjoyment of life; as these ratings comprise the response to symptoms dimension of the CSS. Each of these items has a possible range of 0 to 10. The evaluation of symptom score is obtained by calculating a mean of the frequency and severity items separately for each symptom. Response to symptom items are single-item scores

indicating the interference of the symptom on physical activity and interference of the symptom on enjoyment of life.

Content validity of the CSS was assessed in initial tool development using questionnaires and interviews with both CABG patients themselves and nurse researchers. Furthermore, literature reviews helped to determine which symptoms should be included in the CSS, and which components of the symptoms would best describe the symptom experience in this population, without producing an unreasonably long instrument. A panel of cardiovascular clinical nurse specialists confirmed further content validity (the relevance of each item to the domain of the symptom experience of post-operative CABG patients, and clarity of the items). Internal consistency for each symptom evaluation score was demonstrated in pilot data ($n = 120$) through Cronbach's alphas between the two items (frequency and severity).²⁵ In studies conducted by the research team using the tool, alphas exceeded the desired criterion of 0.70 for new scales and 0.80 for mature scales.⁴⁶ Alpha ranged from 0.85 to 0.98 at 2-weeks, 0.91 to 0.98 at 4-weeks, and 0.89 to 0.98 at 6-weeks following cardiac revascularization.^{21,25,36,42,45}

The Medical Outcomes Study Short Form-36 (MOS SF-36, version 2.0)⁴⁷ was used to measure the subjects' psychosocial and physiological functioning. The MOS SF-36 consists of 8-subscales measuring both psychosocial and physiological functioning (general health, physical, role-physical, role emotional, social, bodily pain, mental health, and vitality). Each subscale has a range from 0 to 100, with higher scores indicating better psychosocial functioning. Satisfactory reliability has been estimated by Cronbach's alpha of .78-.93.⁴⁸⁻⁵⁰ Mean item discriminant validity was 92.5%, exceeding correlation standards by $\geq$ two standard deviations.⁴⁹ Three of the four MOS SF-36 psychosocial subscales were used as measures of psychosocial functioning. These included mental health (5 items), social (2 items), and role limitations due to emotional problems (3 items) functioning subscales. Physiological functioning was measured using two of the four MOS SF-36 physiological functioning subscales: physical functioning (10 items), and role limitations due to physical problems (4 items).

The Hospital Anxiety and Depression Scale (HADS)⁵¹ was used in the study to measure additional aspects of psychosocial functioning, anxiety and depression. Each subscale has seven items, with a four point (0-3) response range. Each subscale can range from 0 to 21 for both the anxiety and depression components. Generally, a normal score on either subscale is ranges from 0 to 7; with scores ≥ 11 considered indicative of the respective mood disorder of either anxiety or depression.⁵²

Physical activity was measured by using the RT3® accelerometer (Stayhealthy, Inc.) and an activity diary. The RT3® is a triaxial accelerometer that uses advanced microcomputers to register body motion in the three-dimensional space (anteroposterior axis, medial-lateral axis, and vertical axis).⁵³ Triaxial accelerometers have established validity with indirect calorimetry resulting in correlations ranging from .48 - .92.⁵³⁻⁵⁷ Reliability has been demonstrated with correlation values of .85 reported between RT3 activity counts and SVO₂,⁵⁸ .51 for activity counts and heart rate,⁵⁹ and .32 - .91 for energy expenditure with indirect calorimetry.⁵⁹⁻⁶⁰ Generalizability coefficients (ICCs) for the RT3® accelerometer with 3 days of data at three data collection points were high (.85 - .97).⁶¹ Activity variables collected from the RT3® accelerometer included the *average kJ/kg/day* expended Physical activity was also measured using an Activity Diary, as a self-report measure of type of exercise and exercise duration. The activity diary was kept for a 3-day period, corresponding to when subjects were wearing the RT3®. Three-day activity diaries, such as the one used in this study, have acceptable reliability and validity.⁶¹⁻⁶³ Generalizability coefficients for the variables

measured by the diary over 3-days has acceptable levels of reliability.⁶¹ The diary data for physical activity was computed as the *average number of minutes spent exercising per day*.

Data Analysis and Findings

Aim1: Examine the relationship of fatigue and psychosocial functioning in the early recovery period (6-weeks and 3-months) after CABG surgery—In this study, fatigued and non-fatigued subject groups were compared at 6-weeks and 3-months to determine the influence of fatigue on psychosocial functioning. The fatigued group had significantly ($p \leq .05$) poorer psychosocial subscale scores of mental (e.g., mood, emotional well-being), role emotional (e.g., emotional status interfered with the amount or type of work), and social functioning (e.g., experienced interference in ability to participate in normal social activities). Refer to table 3 for an overview of the psychosocial functioning subscale scores of the MOS SF-36 survey by groups.

Fatigued subjects also had significantly ($p < .05$) higher anxiety and depression as measured by the HADS at 6-weeks after CABG surgery. At 3-months after CABG surgery the fatigued subjects continued to have significantly higher mean anxiety scores ($t = -2.9$, $p < .005$), refer to table 3.

The individual items of the anxiety and depression subscales were further examined, using chi-square analyses, to examine if there were any differences in the distribution of responses to each item by subject groups. There were significant differences in the distribution response by the groups at 6-weeks after surgery, with the fatigued subject group expressing more anxiety on the following items: a) “I feel tense and wound up” (X^2 (df=1) = 8.5, $p < .01$), b) “I get a sort of frightened feeling as if something awful is about to happen” (X^2 (df=1) = 9.7, $p < .001$), c) “I feel restless as if I have to be on the move” (X^2 (df=3) = 10.8, $p < .01$), and d) “I get sudden feelings of panic” (X^2 (df=1) = 6.9, $p < .01$). At the 3-month time, the groups had significant differences ($p < .05$) in the item response distributions; with fatigued subjects’ response patterns continuing to express more presence of and intensity of two anxiety-related items: a) “I get sudden feelings of panic” (X^2 (df=2) = 5.9, $p < .05$), and b) “Worrying thoughts go through my mind” (X^2 (df=2) = 6.8, $p < .05$). At 6-weeks after surgery, with the fatigued subjects expressed significantly more depression on the following items: a) “I still enjoy the things I used to enjoy” (X^2 (df=2) = 13.3, $p < .001$) and b) “I look forward with enjoyment to things” (X^2 (df=2) = 7.8, $p < .05$). Refer to table 4.

Aim 2: Examine the relationship of fatigue and physiological functioning in the early recovery period (6-weeks and 3-months) after CABG surgery—Physiological functioning, specifically role-physical (one’s physical ability impairing amount and type of work) was significantly impaired (t (df=113) = 2.45, $p < .01$) for the fatigued subject group at 6-weeks after CABG surgery. There were no significant differences in the mean subscale scores of physical (e.g., physical ability limiting activities—walking, stair climbing, activities of daily living) functioning by groups at either follow-up time. Table 3 summarizes the mean scores and t-test analyses by groups for these two MOS SF-36 subscales at each follow-up time.

Further analysis of item response distributions by group to the physical and role-physical functioning subscales were conducted, using chi-square analyses. Refer to table 4. Fatigued subjects had significant impairment at 3-months for physical subscale item responses (X^2 (df=2) = 6.9, $p < .05$) regarding how the subject’s health limited moderate activities (e.g., moving table, pushing a vacuum cleaner).

Aim 3: Examine the relationship of fatigue and physical activity in the early recovery period (6-weeks and 3-months) after CABG surgery—There were no significant differences, using t-test analyses, in the mean kcals/kg/day expended (RT3@

accelerometer) or minutes spent exercising per day (self-report exercise diary) at either time period by group, refer to table 3.

Discussion

A sizeable portion of CABG surgery subjects (55%) in this study reported fatigue following postoperative recovery from CABG surgery (present at 3-weeks after CABG surgery). These findings are consistent with previous research studies of fatigue presence following CABG surgery.^{25, 42} Fatigued CABG surgical subjects, in this study, had concomitant depressive symptoms. Such findings are congruent with the literature, which finds strong associations between fatigue and depression in other cardiac populations (MI and heart failure).^{17, 27–31}

This study further extended the understanding of the relationships of fatigue and functioning beyond just describing the fatigue trajectory in the early recovery period following CABG surgery. At 6-weeks after CABG surgery, psychosocial functioning, including the increased levels of anxiety and depressive symptoms, and role physical functioning was more impaired for the fatigued group of subjects. Even at 3-months after surgery, some residual aspects of having higher anxiety persisted for the fatigued subjects in this study. The variability in the item response differences by groups to the individual measurement items, as shown in table 4, helped to further explain in more detail which aspects of functioning were the most bothersome for the fatigued subjects.

While there was no significant difference in the daily energy expenditure (kcal/kg/day) or mean number of minutes exercised per day, study findings are in line with other study findings. Specifically, the mean daily energy expenditure and reported minutes of exercise at 3-months by both groups is consistent with findings from other researchers, who found older cardiac patients had a mean energy expenditure of 27.2 kcal/kg/day⁶⁴ and reported exercising $\approx$ 30 minutes per day.²⁷

The relationship of fatigue to recovery following CABG surgery has not fully been understood. The study findings help elucidate the relationship of the presence of fatigue to functioning and physical activity (e.g., limiting type and amount of work and activities). These findings are congruent with other studies of cardiac patients^{40–41} and CABG surgical patients,^{34–37} in which fatigued subjects managed their activity in response to fatigue by altering their activities and work patterns following their significant cardiac event.

Limitations

Some study limitations need to be acknowledged. This was a convenience sampling of the control group of CABG surgical subjects participating in a larger parent study, a RCT for symptom management following CABG surgery. In this study, the presence of fatigue was the only dimension of symptom examined in relation to early recovery outcomes. It would have been useful to measure multidimensional aspects of fatigue to further describe the subjective aspects of fatigue. This study only evaluated the relationship of fatigue and selected variables of functioning and physical activity, and did not conduct any regression analyses to determine factors associated with fatigue at each time (6-weeks and 3-months) of early recovery. Further study limitations include the small sample size of women, which did not allow for the study to test gender differences. This study only included elderly subjects, $\geq$ 65 years old, which limits the generalizability of study findings to younger CABG surgical patients.

Implications for Practice and Future Research

Additional study of the phenomenon should include what type of physical activity accounted for the daily energy expenditure, as well describing the type and intensity of exercise.

Consideration should be given to evaluating other types of measurement devices, besides an accelerometer, which might be better suited to capture physical activity in the older population of cardiac patients. Future studies need to examine how these variables may differ between fatigued and non-fatigued patients. In addition, further examination of the predictors of fatigue (e.g., sleep patterns, medication use, social support, cardiac rehabilitation participation, cortisol levels) following cardiac surgery and other cardiac events are needed. Additional study of the fatigue experience, including multiple dimensions of fatigue, following CABG surgery is warranted to determine which factors contribute to the presence and persistence of fatigue, as well as how to mitigate the effects of fatigue on functioning and physical activity. Another need is to determine if fatigue is more problematic for females versus male CABG surgical patients, when developing gender specific interventions to reduce fatigue. Assisting CABG surgical patients to recognize and interpret their perceptions of fatigue needs to be explored, as this may be useful in reducing the associated depressive and anxiety symptoms, which commonly occur after CABG surgery.

Findings from this study and previous research support the need to develop tailored interventions for CABG surgical patients when fatigue persists after postoperative recovery. Furthermore, there is a need to study the potential benefit of providing patients with more specific and tailored fatigue management interventions (e.g., activity management plan, sleep hygiene, cognitive-behavioral therapy) suggested by previous researchers, but not yet tested in cardiac or cardiac surgical populations.

In conclusion, determining the relationship of fatigue to recovery functioning and physical activity outcomes following CABG surgery can be valuable to clinicians in the development of targeted interventions and their timing to reduce or ameliorate the effects of postoperative CABG surgery fatigue. In summary, fatigue can be problematic following cardiac surgery. Unmanaged fatigue can further impair recovery and delay or prevent achievement of optimal outcomes after cardiac revascularization.

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Table 1**Measurement of Fatigue in Cardiac Populations**

Instruments and Measurement of Fatigue		Cardiac Population Studied
Cardiac Symptom Survey (CSS)		Percutaneous Coronary Intervention (PCI) ²¹
○	10-symptoms related to recovery following cardiac revascularization	Coronary Artery Bypass Graft (CABG) Surgical ^{25, 36, 42, 45}
○	Each symptom rated by subjects related to frequency and severity of symptom (Symptom Evaluation)	
○	Each symptom rated by subjects related to interference of symptom on physical activity and enjoyment of life (Response to Symptoms)	
Grounded theory approach to analysis of patient interviews related to patients' thoughts, feelings and behaviors related to health and recovery		Myocardial Infarction ²⁰
Maastricht Questionnaire (MQ)		Myocardial Infarction ³¹
○	21-items measuring symptoms as either present or not presents	Percutaneous Coronary Intervention (PCI) ¹⁵
○	Symptoms included: feel tired, feel more listless, feel weak all over, wake up with exhaustion and fatigue, etc.	
Profile of Mood States (POMS)		Coronary Artery Bypass Graft (CABG) Surgical ³⁴
○	65 "feeling" items are rated on a 4-point Likert-type scale	
○	Profile of 6 mood states: anger, confusion, depression, tension, fatigue, and vigor	
Quality of Life Index (QLI)—Cardiac Version		Coronary Artery Bypass Graft (CABG) Surgical ³⁷
○	32-items measuring satisfaction and quality of life importance • Includes 4-subclasses: health and functioning, socioeconomic, psychological/spiritual and family	
Revised Piper Fatigue Scale		Myocardial Infarction ⁴⁰
○	22-items, with 4 fatigue dimensions using 0-10 numeric rating scales	
Structured interview (4-parts):		Coronary Artery Bypass Graft (CABG) Surgical ²⁶
○	Part 1 was a 4-point Likert-type scale related to perception of: • How generally feeling and presence of fatigue, sleep disturbances, appetite changes, bowel function changes, incision and other discomforts	
○	Part 2, if symptom present, then rated severity. Also asked how they dealt with symptom	
○	Part 3, subjects rated their activity level	
○	Part 4, subjects queried about their mood status	
Symptom Checklist		Heart Failure ^{19, 44}
○	13-items of heart failure symptoms experienced in previous 2-weeks	
○	Included symptoms: fatigue, exertional shortness of breath, waking up breathless at night, swelling in feet/ankles, etc.	
Symptom Inventory		Coronary Artery Bypass Graft (CABG) Surgical ³⁵
	• 20-items measuring physical symptoms experienced in the previous week on a 7-point Likert-type scale. Includes 2-items related to fatigue: being tired and feeling emotionally exhausted	
Symptom Representation Questionnaire (SRQ)		Heart Failure ¹
○	Has 14-items using a 5-point Likert-type response, and includes 5 subscales related to fatigue Measures perceptions of fatigue: causes of fatigue, timeline, consequences, cure/control and causing emotional distress	
Symptom Scale		Coronary Artery Bypass Graft (CABG) Surgical ³⁴
○	Assess perceive level of angina, shortness of breath, and fatigue. Patients also rate the symptom's interference on overall functioning	
Symptom Status		Coronary Artery Bypass Graft (CABG) Surgical ³⁷
○	Presence of any of cardiac-related symptoms: heart discomfort, shortness of breath, tiredness or fatigue.	

Table 2

Demographic Characteristics Fatigued and Non-Fatigued Groups.

Demographic Characteristics	Fatigued Subjects (n=66)	Non-fatigued Subjects (n=53)
Gender	Males=56 (84.8%) Females=10 (15.2%)	Males=47 (88.7%) Females=6 (11.3%)
Hospital Length of Stay	5.4 ($\pm$ 1.0) days	5.4 ($\pm$ 0.9) days
Ejection Fraction	53.2% ($\pm$ 8.1)	52.8% ($\pm$ 10.1)
Marital Status: Married	84.6% (n=56)	90.6% (n=48)
Work Status: Retired or not working outside of the home	55% (n=36)	47% (n=25)
Descriptive Characteristics	Fatigued Subjects (n=66)	Non-fatigued Subjects (n=53)
Previous Myocardial Infarction	15.2% (n=10)	15.1% (n=8)
Hypertension	77.3% (n=51)	71.7% (n=38)
Hypercholesterolemia	74.2% (n=49)	75.5% (n=40)
Diabetes Mellitus	27.8% (n=18)	15.1% (n=8)
Current Tobacco Use	12.1% (n=8)	11.3% (n=6)
History of Tobacco Use	56.1% (n=37)	47.1% (n=25)

Table 3

Psychosocial Functioning, Physiological Functioning and Physical Activity Over Time (i.e., at 6-weeks and 3-months) after CABG Surgery.

Tool & Measure	Mean (SD) 6-weeks		t-test (p-value)	Mean (SD) 3-months		t-test (p-value)
Psychosocial Functioning						
	Fatigued (n=66)	Non-Fatigued (n=51)		Fatigued (n=62)	Non-Fatigued (n=48)	
MOS SF-36: General mental health functioning subscale	88.9 (10.6)	92.1 (6.1)	t = 1.97 (p≤.05)	92.3 (7.3)	93.6 (5.5)	NS
MOS SF-36: Social functioning subscale	95.4 (12.9)	99.7 (1.8)	t =2.6 (p≤.01)	97.3 (10.9)	99.7 (1.8)	NS
MOS SF-36: Roleemotional functioning subscale	97.5 (9.9)	100 (0.0)	t =1.99 (p≤.01)	100 (0.0)	100 (0.0)	NS
HADS: Anxiety subscale	1.7 (2.7)	0.5 (0.9)	t = -3.6 (p≤.0005)	1.2 (2.2)	0.5 (1.1)	t = -2.3 (p=.02)
HADS: Depression subscale	1.9 (2.6)	0.8 (0.9)	t = -2.9 (p≤.004)	0.8 (1.4)	0.4 (0.7)	NS
Physiological Functioning						
	Fatigued (n=66)	Non-Fatigued (n=51)		Fatigued (n=62)	Non-Fatigued (n=48)	
MOS SF 36: Physical functioning subscale	77.4 (16.9)	81.3 (13.5)	NS	84.1 (15.2)	88.4 (12.3)	NS
MOS SF 36: Role-Physical functioning subscale	70.4 (25.3)	81.0 (19.8)	t = 2.45 (p≤.01)	86.3 (20.1)	91.4 (12.3)	NS
Physical Activity						
	Fatigued (n=56)	Non-Fatigued (n=42)		Fatigued (n=54)	Non-Fatigued (n=42)	
RT3: Average kcal/kg/day	28.0 (4.5)	27.0 (4.2)	NS	29.3 (5.4)	29.1 (6.2)	NS
	Fatigued (n=59)	Non-Fatigued (n=47)		Fatigued (n=58)	Non-Fatigued (n=41)	
Self-report Diary: Average minutes spent exercising per day	36.7 (19.6)	41.5 (27.0)	NS	33.7 (21.4)	34.7 (22.3)	NS

Table 4

Psychosocial and physiological functioning by groups (fatigued and non-fatigued): Item response differences

Tool & Measure	Item	X ² p-value	X ² p-value
Psychosocial Functioning		6-weeks	3-months
MOS SF 36: Mental health functioning subscale	Feel down-hearted and blue	8.1 (df=3) p<.003	NS
HADS: Anxiety subscale	I feel tense and wound up	8.5 (df=1) p<.003	NS
	I get a sort of frightened feeling as if something awful is about to happen.	9.7 (df=1) p<.001	NS
	I feel restless as if I have to be on the move	10.8 (df=3) p<.01	NS
	I get sudden feelings of panic.	6.9 (df=1) p<.008	5.91 (df=2) p<.05
	Worrying thoughts go through my mind.	NS	6.8 (df=2) p<.03
HADS: Depression subscale	I still enjoy the things I used to enjoy.	13.3 (df=2) p<.001	NS
	I look forward with enjoyment to things.	7.8 (df=2) p<.02	NS
Physiological Functioning		6-weeks	3-months
MOS SF 36: Physical functioning subscale	Health limits moderate activities such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.	NS	6.9* (df=2) p<.03