CHAPTER I
INTRODUCTION

PROJECT DESCRIPTION

The study reported herein was part of the ongoing project being conducted at Carolinas Medical Center. The purpose of the project at the hospital was to test the validity of the observation by clinicians that the physical, psychological and nutritional status of a patient, prior to surgery, is important to the outcome of coronary artery bypass grafting (CABG). To this end, a battery of tests of physical fitness, exercise tolerance, psychological function, and quality of life has been selected and was administered to a group of CABG patients pre-operatively and at 3 and 12 mo post-operatively. A dual energy x-ray absorptiometry (DEXA) scan, to measure body composition and bone density, is a component of this battery of tests.

Controlling for co-morbidities known to influence surgical outcomes, the results of the pre-operative tests were analyzed to ascertain if any or all are independent predictors of the outcome of surgery and/or prolonged recovery. The patients that participated in the project were followed for one year. The objectives of the project at Carolinas Medical Center were:

1) To determine the degree to which measures of exercise capacity and physical activity could be measured in patients about to undergo CABG;
2) To determine if the measures in "1)" are variables influencing surgical morbidity, mortality and quality of life after CABG.

The study herein used data collected from subjects that participated in the project at the hospital. The primary focus of the study was to evaluate functional capacity, physical activity levels, and sleep quality pre-surgically and 3 mo post-surgically. The study will also evaluate mental status and health complaints at the testing times.

INTRODUCTION

Increased awareness of sleep disturbance has occurred over the past decade. It has been approximated that 15%-35% of the adult population suffers from poor sleep (Buysse, D.J., Reynolds, C.F., Monk, T. H., Berman, S.R., & Kupfer, D.J., 1988). Although sleep disturbance can occur in many forms, including frequent awakenings and delayed sleep onset, all have the potential to result in the perception of disturbed sleep. Sleep disturbance can interrupt anyone's sleep pattern but some groups show a greater susceptibility to such a disturbance. One group that frequently report sleep disturbances is the group suffering from coronary artery disease (CAD). Sleep disturbance with CAD has been reported to be associated with increased mortality (v Diest R., 1990). This group often reports poor sleep quality because of symptoms arising out of CAD; however, many of the symptoms can be medically treated to alleviate the discomfort caused by the disease. A greater concern of those suffering from severe CAD is the sleep loss occurring while recovering from procedures used to help treat their condition. One procedure often used to treat CAD is a coronary artery bypass graft (CABG). Reports detailing an individual's progression through the post-CABG recovery often show sleep disturbance as a frequent occurrence in the months following this procedure.

Sleep is a necessary requisite in the healing process (Evans, J.C., French, D.G., 1995). Certain physiological correlates of sleep have been reported to aid in healing (Adam, K., Oswald, I., 1983). During sleep the body is capable of repairing tissue and restoring energy loss that may have occurred during the previous day’s events. A loss of sleep increases an individual's susceptibility to fatigue, memory lapses, cognitive slowing, and depression (Monk, 1991). Medication is the most frequently used treatment for sleep disturbance; however, this treatment is usually prescribed for those suffering from severe sleep deprivation and is not usually prescribed for periodic sleep loss. Therefore, an intervention that can be used by all those recovering from CABG, no matter the degree of sleep loss, needed to be investigated.

One intervention currently under investigation is the relationship between exercise and sleep. Published research of this relationship has been conducted on several groups (King, A.C., Oman, R.F., Brassington, G.S. et al., 1997; Singh, N.A., Clements, K.M., Fiatarone, M.A., 1997). These studies have found a significant relationship between exercise and sleep; however, research does not exist evaluating the relationship between exercise and sleep within patients recovering from CABG. An investigation evaluating functional capacity, physical activity involvement and sleep quality within this group would be of significant value. Physical capacity, as measured by functional capacity, and physical activity involvement may serve as sleep enhancing tools within a post-CABG group.

STATEMENT OF THE PROBLEM

It has long been thought that sleep is a natural bodily response following a traumatic experience such as surgery. During sleep the body is able to promote tissue repair and restore energy levels. However, when an individual suffers from sleep loss while the body is healing, side effects may occur including fatigue, depression, memory lapses, and delayed healing processes. Many of the individuals that experience sleep loss during the healing process often report poor sleep quality. Sleep quality is a subjective measure of one's sleep. Frequent reports of disturbed sleep and poor sleep quality during the recovery phase following a CABG have been published. Although medication is the primary treatment for the sleep loss, research is limited evaluating other possible remedies that can help promote sleep.

Exercise is one intervention for sleep disturbance currently under investigation in several groups. Exercise has been shown to promote sleep and decrease sleep fragmentation. Training studies and studies using the chronically ill have shown a significant improvement in sleep after an exercise intervention. Based on research evaluating sleep and exercise, it is evident that a physically active individual will not suffer from sleep disturbances to the degree that an inactive individual will. Although this has been shown to be true within healthy and depressed subjects, it seems logical that one could extrapolate these conclusions and apply them to patients recovering from CABG.

It may occur that as the incidence of CAD increases the need for CABG may increase as well. With an increase in CABG, we are likely to see increased reports of sleep disturbances in the patients. Tools effective in alleviating sleep disturbances post-CABG should be investigated. Exercise has been shown to positively influence sleep and may be a useful intervention for sleep loss following a CABG; however, exercise has not been investigated as a remedy for sleep disturbances within post-CABG subjects. Therefore, the purpose of this study was to investigate the relationship between functional capacity, as measured by the Veterans Specific Activity Questionnaire, and sleep quality, as measured by the Pittsburgh Sleep Quality Index. The relationship between physical activity, as measured by the Paffenbarger Physical Activity Questionnaire, and sleep quality will also be investigated as part of this study.

RESEARCH QUESTIONS

The purpose of this research was to investigate the following:

1. The differences in sleep quality among CABG patients with different levels of exercise tolerance, pre-surgically and 3 mo post-surgically.
2. The difference in sleep quality 3 mo post-surgically between two groups of CABG patients with different levels of physical activity.
3. The influence of increases in functional capacity on sleep quality from pre-CABG to post-CABG.

In addition to the primary purposes of this research, mental status and health complaint data will also be collected pre-CABG and 3 mo post-CABG. Relationships between Beck depression scores, health complaints, and subscales of sleep also will be analyzed.

SIGNIFICANCE OF THE STUDY

The main goal of health care providers following a CABG is to promote complete recovery and return the patient to daily activities as quickly as possible. However, individuals suffering from poor sleep quality often find it difficult to return to these activities without bouts of fatigue, moodshifts, and depression. This investigator was unable to locate published research evaluating the implications of physical activity involvement or functional capacity on sleep quality in patients that have undergone CABG surgery. The research reported herein was unique in that it was the first to investigate whether functional capacity or physical activity influenced perceived sleep quality in post-CABG subjects. This research may be used as a foundation for future research in sleep disturbance, post-CABG. The results of this study are also important in that they predict those patients, based on self-reporting of functional capacity and physical activity levels, that would be more susceptible to sleep disturbances following a CABG.

This study also evaluated the prevalence of symptoms associated with CAD. Pain frequency, psychological status, and health complaint data were collected from each subject.

Ideally, post-CABG patients would not exhibit signs of depression, pain or other health-related symptoms. However, each of these symptoms may occur in varying degrees in patients following bypass surgery. Based on the results of this study, patient symptom profiles could be used to predict recovery time and status within CAD patients.

DELIMITATIONS

The following delimitations were incorporated into the design of the study:

1. Subjects were undergoing a first-time CABG;
2. Subjects had not been previously diagnosed with a sleeping disorder;
3. The dependent measure of sleep quality was determined by the scores on the Pittsburgh Sleep Quality Index immediately before surgery and 3 mo post-surgery;
4. Functional capacity was determined by the Veterans Specific Activity Questionnaire given immediately before surgery and 3 mo post-surgery;
5. Physical activity involvement was assessed at 3 mo post-surgery using the Paffenbarger Physical Activity Questionnaire (Ainsworth, B.E., Leon, A.S., Richardson, M.T., Jacobs, D.R., Paffenbarger, R.S. Jr., 1993);
6. Medical complaints prior to CABG and 3 mo post-surgically were determined by the Health Complaint Scale (Denollet, J., 1994);
7. Depression was evaluated before surgery and 3 mo post-surgery using the Beck Depression Inventory, Version-2, BDI-II, (Beck, A.T., Steer, R.A., Ball, R., Ranieri W.F., 1996).

LIMITATIONS

The following limitations were inherent in the design of the study:

1. Subjects were recruited from a volunteer pool of patients undergoing a first-time CABG;
2. Sleep quality, functional capacity, and physical activity were measured by subjective means, i.e. by a questionnaire;

3. Pre-surgical data were collected prior to hospital admission and may have been influenced by the psychological stress associated with medical and surgical events;
4. Smoking habits, alcohol intake, and the use of sleep medications were not controlled in this study

BASIC ASSUMPTIONS

The following assumptions were made by the investigator:

1. The subjects could understand and answer each questionnaire truthfully;
2. The subjects were able to accurately estimate and report their physical activity status, sleep quality, and functional capabilities;
3. All interviewers used the same data collection format and their interviewing skills were proficient so as to not influence the subjects' responses;
4. The questionnaires used in the study were reliable and valid measurements.

DEFINITIONS AND SYMBOLS

The following definitions and symbols will assist with understanding this study:

1. MET- Unit used to express the metabolic cost of physical activity
2. Functional Capacity (FC). An individual's maximal workload expressed in METS, as measured by the Veterans Specific Activity Questionnaire.
3. Kilocalorie (kcal). A measure of energy expenditure equal to 1,000 calories.
4. Physical Activity. Characterizes human movement; associated with work, play and exercise; physical activity is expressed in kcals as measured by the Paffenbarger Physical Activity Questionnaire.
5. Subjective Sleep Quality. A self-evaluation of one's quality of sleep.
6. Sleep Latency. The time from the decision to sleep until sleep onset (Richards. K.C., 1996).
7. Sleep Duration. The number of hours of actual sleep per night (King et al, 1997).

8. Habitual Sleep Efficiency. The total sleep duration divided by time in bed (King et al, 1997).
9. Sleep Disturbance. Any disturbance that causes an individual to awaken from sleep.
10. Obstructive Sleep Apnea (OSA). Failure of autonomic control of respiration which becomes more pronounced during sleep.
11. Body Mass Index (BMI). Measure of body composition which is the ratio of body weight (kg) to height (m^2).
12. Ejection Fraction (EF). The percentage of blood in ventricle ejected by the heart in a single contraction.
13. Coronary Artery Bypass Graft (CABG). Replacement of a blocked coronary artery with another vessel to permit blood flow to the myocardium.

SUMMARY

As the incidence of CAD increases in adults, the need for medical intervention will increase as well. Invasive techniques, such as CABG, can place a great deal of stress on the body; therefore, during the months that follow a CABG the body needs time to heal. A great deal of healing occurs while a patient is sleeping. During sleep the body is rejuvenated and damaged tissues are healed. However, if sleep is disturbed, not only is there a loss of sleep quality, but also there is a loss of valuable healing time. It is important that remedies for disturbed sleep be investigated to help reduce sleep loss in post-CABG patients. The remedies should be practical for all patients, no matter what their economic status or degree of sleep loss. Research has shown that physical activity is a practical sleep enhancement intervention. Interventions involving physical activity and functional capacity need to be investigated in post-CABG patients to determine whether these interventions may influence sleep.

CHAPTER II
LITERATURE REVIEW

INTRODUCTION

Sleep is a complex physiological state. During sleep, the body undergoes periods of activity and inactivity. These periods occur in cycles throughout a sleeping bout. It has been reported that an adult averages 7-8 hours of sleep per night (O'Connor et al, 1995). It has also been reported that approximately 15-35% of the adult population suffers from sleep disturbances (Buysse et al., 1988). Sleep disturbances often interrupt an adult's sleeping routine and often result in poor sleep quality. Sleep disturbances can affect anyone, regardless of gender or race, but some groups are more susceptible to disrupted sleep than others.

One group frequently affected by sleep disturbance is the group suffering from coronary artery disease (CAD). Incidence of sleep disturbance within this group has been associated with increased risk of mortality (v Diest R., 1990). Many individuals affected by CAD must undergo treatment to alleviate the symptoms associated with the disease, however reports of disrupted sleep continue to occur even after patients have undergone surgical procedures (Krachman, S.L., D'Alonzo, G.E., & Criner, G.J., 1995). Post-CABG patients often report sleep disturbances immediately following surgery (Simpson, T., Lee, E.R., 1996) and up to a year post-surgery (Magni et al., 1987). Research has identified possible reasons for the sleep disturbance in the post-CABG patients. Environmental factors associated within the intensive care unit, ICU, (Krachman et al., 1995), as well as physiological responses (Redeker, 1993) following surgery have been identified as potential causes for sleep loss. This lack of sleep during the post-CABG recovery phase is a concern of medical professionals.

As the body undergoes different periods of sleep, varying physiological responses occur. Many of the responses are associated with restoring energy or repairing damages to the body that have occurred while awake. Researchers have identified a number of physiological activities that are associated with the different phases of sleep cycles (Evans et al., 1995). These activities involve healing of damaged tissue and muscle. A disruption in sleep may influence these healing processes. Sleep enhancement techniques may be needed to encourage healing responses.

Research cites physical activity as a possible sleep enhancement tool. The relationship between physical activity and sleep has been investigated in different groups. These investigations have focused on implementing a training protocol within a group of subjects and evaluating the sleep response. The research describes various fitness protocols, including resistance training or cardiovascular training, at varying intensities. Current research also focuses on groups, such as the elderly (King et al., 1997), or depressed (Singh, N.A., Clements, K.M., & Fiatarone, M.A., 1997) that have no other medical conditions that may influence a sleeping bout. Medical interventions such as CABG may inhibit or influence sleep quality.

In order to conduct the study reported herein properly, it was necessary to review the research relevant to this study. The research reviewed for this study included the physiology of sleep, sleep disturbances, sleep and healing, and exercise and sleep. It was also important to understand previous testing procedures used within different literature. Due to the uniqueness of this study, measuring functional capacity, physical activity involvement, and sleep quality in post-CABG patients, the investigator had to evaluate and recognize a testing protocol best suited for the studied group. This chapter will review literature in several categories: sleep physiology, sleep and cardiac disease, sleep and healing, sleep disturbances, and exercise and sleep.

SLEEP PHYSIOLOGY

Sleep cycles are composed of two phases: non-rapid eye movement (NREM) and rapid eye movement (REM).   NREM sleep is further divided into four stages (stages I, II, III, IV). Sleep is initiated during stage 1. During this stage, physiological responses, for example body temperature and muscle relaxation, begin to slow down. Stages II, III, and IV comprise what is known as “true sleep.”   The deepest sleep occurs during stage IV. This stage is characterized by the lowest oxygen consumption and the greatest difficulty awakening a person (O’Connor et al., 1995). REM sleep, the latter phase, is characterized by an increase in central and peripheral nervous system activity (O’Connor et al., 1995). During this phase of sleep blood flow is increased, heart rate and blood pressure are increased, and dreaming frequently occurs.

As previously mentioned, adults usually obtain 7-8 hours of sleep per night. Approximately 75% of a usual night’s sleep is NREM. Stage I comprises ~5%, stage II comprises ~50%, stages III and IV combined comprise ~20%. REM sleep comprises ~25% of sleep. A NREM-REM cycle occurs within a period of 90 minutes (Knapp-Spooner et al., 1992). There are usually four to six NREM-REM cycles during a night's sleep.

Both objective and subjective measurements are used to assess sleep. One of the most popular tools for objectively measuring sleep is an electroencephalogram (EEG). This tool uses sensitive electrodes on the scalp and records signals produced by electrical activity of the brain as it occurs during sleep. These brain waves are often captured on a computer screen. Although this measurement is very accurate, it can be costly and can be used only in a clinical setting. Subjective measurements of sleep are typically collected via questionnaires. This method of data collection has been historically used as a benchmark for data collection on sleep quality. Subjective measurements are economical and may be used either as a self-reporting format or an interview format. Sleep quality questionnaires may use either closed-ended and open-ended questions, or Likert scales to evaluate one's sleep. The Pittsburgh Sleep Quality Index (PSQI) uses a combination of closed-ended questions and multiple choice questions on the questionnaire. Detailed information about the PSQI is in Appendix A.

SLEEP AND CORONARY ARTERY DISEASE

It has been suggested that sleep disturbance may interact with coronary artery disease to increase the risk of overt clinical disease (Barry, J., Campbell, S., Yeung, A.C., Raby K.E., Selwyn, A.P., 1991). It has also been suggested that sleep disturbance with CAD can increase the risk of mortality (v Deist R., 1990). These two findings suggest that physiological occurrences during sleep may initiate or aggravate symptoms associated with CAD. A study conducted by R. Asplund (1994) focused on the relationship between sleep and CAD within healthy subjects. Results of this study found that cardiac arrhythmia was increased significantly in subjects who woke up too early every morning when compared to those who stated early awakenings less than once a month. Asplund also found that angina pectoris occurred more frequently when subjects had frequent nocturnal awakenings due to anxiety. Frequent angina occurrence was also found in a study conducted in 1997 (Newman, A.B., Enright, P.L., Manolio, T.A., Haponik, E.F., Wahl, P.W.). Newman et al. (1997) found that angina was significantly associated with difficulty falling asleep ($p < 0.05$). Physiological reasons for these findings were not discussed by the investigators of these two studies, therefore, one may question whether angina actually caused the sleep difficulties or if the sleep disturbances triggered the angina. It has been reported that in those with heart disease the intensity of REM sleep may trigger angina or arrhythmia. Further research is needed to determine the relationship between angina and sleep.

Many CAD patients exhibit breathing difficulties during sleep that result in sleep disorders. Cheyne-Stokes respiration, a series of increasingly deep breaths followed by a brief cessation of breathing, is often associated with those suffering from CAD. Obstructive sleep apnea, a condition which results in periods of interrupted breathing while sleeping, is also associated with CAD. Women with coronary heart disease have high occurrence of disordered breathing (Mooe, T., Rabben, T., Wiklund, U., Franklin, K.A., Erikson, P., 1996).

Patients suffering from coronary artery disease also exhibit confounding variables that may place them at high risk for sleep disturbances. These variables include body mass index > 27, severe depression, and ejection fraction $\leq$ 30. These variables coupled with sleep disturbances in CAD patients may place the individuals at an increased risk for sudden death.

SLEEP DISTURBANCES

Physiological Factors

Disrupted sleep is often reported following surgical procedures. These disruptions have been reported to exist while patients are in the intensive care recovery unit (ICU) and at home. A review of nurses' notes in 1993 reported sleep disturbances in post-CABG patients during the first 4 nights of recovery (Edell-Gustafsson, U., Aren, C., Hamrin, E., & Hetta, J., 1994). These notes also showed a decrease in the number of patients suffering from sleep disturbances from night 1 to night 4.

The most common health conditions reported by the nurses to be causes of patient sleep disturbance were, in descending order: pain, nausea and vomiting, and coughing. However, the notes concerning sleep patterns were often unclear and the continuity of the documentation between the night nurses and day nurses was inadequate. Although the post-CABG patients showed signs of sleep disturbances, the notes regarding the sleep patterns were not thorough and were not organized adequately to evaluate as data. Sleep disturbances occurring in an ICU have been reported by Krachman et al. (1995), who evaluated sleep disturbance and identified several environmental factors associated with the intensive care unit that may be causes for sleep loss. Krachman et al. identified noise levels within the ICU as a cause of sleep disturbance for many patients. Noise levels in the ICU have been reported to be 42.5dB while the noise levels of a quiet bedroom at night is reported to be 20-30dB. This elevated noise level can cause frequent awakenings in patients or cause difficulty in sleep onset. The administration of medication, the collection of laboratory tests, alarm sounds from monitors, and bed changing were also identified as factors contributing to disturbed sleep. These environmental factors were confirmed in a study conducted in 1996 by Simpson et al.

Simpson et al. (1996) surveyed 102 patients recovering from cardiac surgery to identify factors disturbing sleep in the ICU. Results from this survey revealed nursing activity and equipment noise as environmental reasons for sleep disturbances. The researchers also investigated physiological factors that influenced sleep in post-CABG patients. Nearly 75% of those surveyed reported an inability to simply get comfortable. Pain was the second most frequently reported reason for sleep loss. These reasons for sleep loss reiterated the previous findings by Redeker (1993).

Redeker investigated post-CABG symptoms in 129 adults. Data were collected, using a questionnaire, at three intervals: during hospitalization (Time 1), third through fifth post-operative weeks (Time 2), and six weeks post-surgery (Time 3). The results during Time 1 showed pain (48%) and edema (41%) to be the most frequently occurring symptom. During this time period sleep problems were reported in 30% of the patients and listed as the sixth most frequently reported symptom. Between Time 1 and Time 2, reported sleep problems increased within the subject pool. During Time 2, 66% of patients complained of sleep problems, 80% identified pain, and 67% identified edema as a problem. Six-weeks post-CABG, sleep disturbances were reported as the most frequently occurring symptom (40%) as compared to edema and pain (each at 39%). The results of this study showed that all symptoms decreased in frequency during the investigated time frame. Redeker suggested that the reduction in the number of symptoms showed a positive progression of recovery; however, the persistence of sleep disturbances showed that patients were still hindered by surgical side effects. The results of the study did not find the persistence of sleep problems to be related to age and gender.

Moore (1995) also found that gender did not influence reports of sleep disturbances. Moore evaluated men's and women's symptoms during recovery from CABG. Twenty men and 20 women were questioned on symptoms occurring while recovering from CABG. Both genders reported sleep problems occurring one day before being discharged from the hospital. Sleep problems decreased in both men and women over the month following surgery. Sleep problems also contributed to delayed sleep onset, frequent awakenings with difficulty returning to sleep, and bad dreams. Studies (Schaefer, K.M., Swavely, D., Rothenberger, C., Hess, S., Williston, D., 1996) report difficulty with sleep loss to affect patient's 6 mo following surgery.

Schaefer et al. (1996) interviewed 49 post-CABG patients four times via the telephone, one week, one month, three months, and six months. Results from this investigation found that more than half of the subjects reported sleep disturbances at each measurement (61% at one week, 69% at one month, 57% at 3 mo, 68% at 6 mo). The quality of sleep improved significantly from one week to one month ($p < 0.07$), one week to 3 mo ($p < 0.0001$), and one month to 3 mo ($p < 0.0001$). Reasons for sleep disturbance were found to change over time. During the first week the reason for sleep disturbance was reported to be primarily the result of incisional pain, difficulty finding a comfortable position, and nocturia. Frequency of pain decreased over time but persisted for 6 mo post-discharge. Difficulty in finding a comfortable position and nocturia persisted for 2 to 3 mo. This study found no significant differences in study variables based on gender.

Psychological Factors

Depression (McKhann, G.M., Borowicz, L.M., Goldsborough, M.A., Enger, C., & Selnes, O.A., 1997) and stress (Knapp-Spooner, C., Yarcheski, A., 1992) have been found to be prevalent in post-CABG patients. These two psychological variables have also been found to cause disruptions in sleep. Knapp-Spooner et al. (1997) evaluated sleep and stress in 24 patients at three data collection points: before admission to the hospital, and on the third and sixth post-operative mornings. Stress was categorized into two groups, illness-related stress and hospital-related stress. Illness-related stressors were defined as stressors arising out of the patient's condition, such as pain and discomfort. Hospital-related stressors were stressors arising out of the hospital environment, such as monitor alarms and nursing procedures. Results of the study found a positive correlation between illness-related stress and sleep supplementation, but illness-related stress did not predict post-operative sleep disturbances. The results of the study also found hospital-related stress to be positively related to sleep disturbance and inversely related to sleep effectiveness. Additional analyses found that hospital-related stress predicted increased sleep disturbance and decreased sleep effectiveness during the sixth post-operative night.

In 1997, McKhann et al. evaluated another psychological component often reported following surgery. In this study, McKhann et al. (1997) evaluated depression and cognitive skills in subjects recovering from CABG. McKhann et al. found that 32% of the subjects were depressed for some time after surgery. Post-surgical testing occurred at 1 mo post-CABG and 1 year post-CABG. The purpose of the study was to evaluated the relationship between depression and cognitive skills. The results found that only one cognitive area, visuoconstruction, fared better for those who were not depressed before surgery ($p \leq 0.05$). Motor speed at 1 mo post-surgery and 1 year post-surgery, and verbal memory at 1 year post-CABG were found to be correlated with a change in pre-operative depression scores from 1 mo post-CABG and from 1 year post-CABG scores.

The study herein, analyzed the mental status of the subjects before surgery and 3 mo post-surgery. To test for the presence of self-reported depression, the Beck Depression Inventory, (Version 2; BDI-II), was administered (Beck, A.T., Steer R.A., Ball, R., Ranieri, W.F., 1996). The BDI-II uses a 5-point scale ranging from 0-4. A total score is reported, according to subjects' answers, indicating the severity of the self-reported depression. Measurements for validity and reliability can be found in Appendix A.

The Health Complaint Scale (HCS) was used to analyze the subjects' health complaints pre-surgery and 3 mo post-CABG (Denollet, 1994). The HCS was designed by Denollet in

1993. Denollet designed the HCS after identifying somatic and cognitive health complaints that occur frequently in patients recovering from a coronary event. After an analysis of the data, Denollet addressed the 24 most frequently reported health complaints consisting of 12 somatic and 12 cognitive health complaints. Detailed information, including validity and reliability measurements can be found in Appendix A.

SLEEP AND HEALING

It is believed that a great deal of healing occurs during sleep; a loss of or disturbed sleep, however may hinder healing (Landis, 1997). One theory explaining healing during sleep is known as the restorative theory (Webb, 1979). This position holds that sleep is a period of recovery or restoration of physiological, neurological and/or psychological states. A review by Evans et al. (1995) describes the physiological healing process as it occurs during sleep. Healing of different anatomical areas occurs during different cycles of sleep. Emotional healing, brain restoration, and growth is promoted during REM sleep, whereas, physical healing occurs during NREM sleep, particularly stages III and IV. As individuals pass through successive sleep cycles, NREM and REM, their REM phase increases in length while stages III and IV of the NREM completely disappear following the first two complete cycles. Approximately 70% of the total 24-hour secretion of growth hormone occurs during stages III and IV of the NREM (Lee, K., Stotts, N., 1990). This growth hormone secretion elevates liver production of somatomedins to promote bone and cartilage growth. Hormonal secretions continue to facilitate healing processes during REM sleep.

Loss of NREM sleep leads to decreased tissue repair and decreased pain tolerance. It has been reported that a decrease in stage IV can lead to decreased muscle strength and fatigue (Hartmann, E. I., 1973). Both of these characteristics are signs of a decrease in the energy available for tissue repair and healing.

EXERCISE AND SLEEP

Conflicting research exists concerning the relationship between exercise and sleep; however, most of the research supports the notion that exercise positively influences the parameters of sleep. Vouri, I., Urponen, H., Hasan, J., & Partinen, M. (1988) investigated factors which promoted sleep. According to self-evaluations of 1,600 people, the most important factor promoting sleep quality and falling asleep was exercise. Research also exists that measures the relationship between exercise and sleep (Stevenson, J.S., Topp, R., 1990; Singh, N.A., Clements, K.M., &Fiatarone, M.A., 1997; King, A.C., Oman, R.F., Brassington, G.S., Blivwise, D.L., & Haskell, W.L. 1997). Much of this research has found exercise to influence sleep quantity and sleep quality. Although much of the research supports a relationship between one parameter of sleep, sleep quantity or sleep quality, and exercise, not all of the research supports a relationship between both parameters of sleep and exercise.

Research was conducted in 1990 by Stevenson et al. identifying improvements in sleep quantity but no change in sleep quality with exercise. Seventy-two volunteers, over the age of 60, participated in the 9 mo study. Participants were tested at three intervals: baseline, after 4.5 mo, and at the end of 9 mo. Self-reported data were collected for sleep patterns, perception of health, and mental status. Cardiovascular data were collected using a stress-test modified for elders. The subjects were assigned to two intensity groups: a moderate intensity group (60-70% max HR) or a low-intensity group (30-40% max HR). The results of this study were that neither group reported an improved quality of sleep but both groups reported a significant increase in the duration of sleep. The longer duration of sleep was due to less bedtime sleep latency and less difficulty returning to sleep after awakening. Following the 9 mo testing, both groups reported improved perceptions of future health and more positive feelings about the adequacy of sleep. A study subsequently conducted in 1996 found an improvement in sleep quality following a 10-week training protocol (Singh et al., 1997).

Singh et al. (1997) used a different component of fitness, as a training regimen, to investigate the influence of exercise on sleep. Instead of using a training protocol which included cardiovascular exercise, Singh et al. (1997) used a strength training protocol. This study involved resistance training in 28 depressed subjects. An intervention group and a control group were identified. The intervention group exercised large muscle groups 3 days/wk. The control group engaged in health education programs including lectures and videos. At the conclusion of this study, the intervention group was found to significantly improve both long-term and short-term measures of self-reported sleep quality, as compared to the control group. Subjective sleep quality improvements were also found in a study conducted by King et al. (1997).

In the King et al. (1997) study, 29 women and 14 men were placed in an intervention group or a control group. Participants in the intervention group engaged in 4 exercise sessions per week, lasting 60 minutes each. The control group did not participate in a regular exercise program. The study was conducted for 16-weeks. Data collection occurred at baseline and at 16-weeks. Subjective measurements of sleep were obtained using the Pittsburgh Sleep Quality Index (PSQI). Sleep diaries were also kept by the subjects as an additional assessment of sleep. Cardiovascular data were collected via a treadmill test using a Balke-type protocol. Improvements in sleep quality from baseline to 16-23 wks. were noted in the exercise group. PSQI subscales also had significant improvements in the exercise group. These subscales included sleep quality ($p = 0.03$), sleep onset latency ($p = 0.007$) and sleep duration ($p = 0.05$). Sleep duration increased by almost an hour among the exercise group, while minimal improvement was found in the control group.

Most of the studies examining the effects of exercise on sleep use an objective measure, such as a treadmill test, to calculate maximal METs; however, in patients undergoing CABG it is unrealistic to exercise the individuals to their maximal capacity. Therefore, within the subjects studied herein, a questionnaire was used to determine functional capacity before surgery and 3 mo post-surgery. The questionnaire chosen for this study was the Veterans Specific Activity Questionnaire, VSAQ (Myers, J., Do, D., Herbert, W., Ribisl, P., Froelicher, V.F., 1994). The VSAQ was designed in 1994 to determine which specific daily activities were associated with symptoms of cardiovascular disease. Physical activities are listed according to MET demand in progressive order from low to high demand. Detailed information on the VSAQ along with validity data are presented in Appendix A.

The study herein also used data on physical activity of the subjects 3 mo post-CABG. The Paffenbarger Physical Activity Questionnaire (PPAQ) was chosen to assess the subject's involvement in physical activity (Paffenbarger, R.S., Wing, A.L., Hyde, R.T., 1978). Physical activity involvement was reported by each subject and converted to kilocalories of energy expenditure over a 7-day period (Singh et al., 1997). Walking, stairclimbing and other recreational activities are reported on the PPAQ. Additional information on the PPAQ is in Appendix A.

SUMMARY

The literature cited evidence establishing the importance of sleep on the healing process. This evidence raised concern about the impact of sleep loss on an individual recovering from a traumatic experience, such as CABG. Sleep loss has been frequently reported as a common symptom after CABG in much of the existing literature. Therefore, it was necessary to examine potential sleep enhancement tools in post-CABG patients that would benefit the patient's recovery process. Considerable research has identified exercise as such a sleep enhancement tool. However, after reviewing the literature, it was obvious that the investigation of exercise and sleep in post-CABG patients is an area of study that has received little attention. Researchers have not come to a consensus on the most appropriate means by which to evaluate the influence of exercise on sleep. Much of the research utilized training protocols within their studied groups and used subjective measurements to evaluate sleep variables. The uniqueness of the study herein caused the investigator to identify the most appropriate means to measure the variables under investigation. Due to the limitations inherent in the subjects and the goals of the study, it was not reasonable to implement a training protocol before surgery. Based on the vast amount of literature reporting sleep disruptions and the absence of literature evaluating sleep enhancement tools in post-CABG patients, it was evident that investigation in this area was warranted.

CHAPTER III

MANUSCRIPT

PREPARED FOR JOURNAL

SLEEP

Self-Rated Sleep Quality, Functional Capacity, and Physical Activity Status Three Months After Coronary Artery Bypass Graft Surgery

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(ABSTRACT)

Summary: The relationship between sleep, self-rated aerobic exercise capacity and physical activity was evaluated in 55 subjects who underwent CABG surgery. Secondary analysis investigated the possible concurrent influences of post-CABG health complaints and depression on sleep function. Measures included the Pittsburgh Sleep Quality Questionnaire; the Veterans Specific Activity Questionnaire; the Paffenbarger Physical Activity Questionnaire (PPAQ); the Health Complaint Scale, Beck Depression Inventory, Version II, and the physical measure of percent body fat. Measures were completed just prior to surgery and repeated at 3 mo post-CABG. Pre- and post-surgical sleep, functional capacity, depression and health complaints were significantly correlated ($p < 0.05$). A significant correlation was not found between post-CABG sleep and physical activity. Prediction equations were constructed, using somatic health complaints, Beck depression scores and skinfold measures, as predictors for pre-surgical sleep ($R^2 = 0.52$) , as well as post-surgical sleep ($R^2 = 0.78$). Functional capacity was not a significant predictor of sleep. The findings of this study suggest that although a modest correlation exists between functional capacity and sleep in CABG patients, predictors including health complaints, depression and skinfold measures serve as better indicators for sleep outcome before and after CABG surgery.

Key words: sleep disturbance; coronary artery bypass graft; exercise; physical activity

INTRODUCTION

During the past decade, there has been an increased awareness of the physiological and emotional implications of disturbed sleep. Approximately 15-35% of the adult population suffers from some form of sleep disturbance, such as frequent awakenings or delayed sleep onset (1). Sleep disturbances may be attributed to a number of problems, such as those associated with acute and chronic psychological conditions, and those that are physiologically based, e.g. central and obstructive sleep apneas. Obstructive sleep apnea (OSA) is a disorder that results in periods of interrupted breathing while sleeping and often affects coronary artery diseased patients. Thirty percent of women with coronary artery disease have been shown to have high occurrence of disordered breathing, such as OSA (2). Frequent occurrences of sleep disturbances and confounding health problems, such as depression, high body mass index (BMI), and low ejection fraction (EF), may increase the risk of mortality in the presence of coronary artery disease (3). Sleep disturbances and confounding health problems are often evident in patients that undergo coronary artery bypass graft (CABG) surgery (4). Sleep disturbances among post-CABG patients have been reported from studies conducted immediately following surgery (5) and up to a year post-surgery (6). Environmental (4), physiological (7), and psychological (8) factors all have been implicated as contributing factors in efforts to explain sleep loss during the period of convalescence following CABG surgery. Disturbed sleep during the recovery phase post-CABG may result in a loss of physiological and emotional healing that occurs throughout sleep cycles (9). A loss of sleep during this time may prolong the recovery process and result in a delayed return to daily activity. Sleep enhancement tools should be investigated to avoid delayed healing time and minimize mortality risks in post-CABG patients.

Research has suggested that physical activity may serve as a helpful mediator in promoting sleep for patients with various disease conditions (10-12). Physical training studies consisting of cardiovascular or resistance exercise have focused on sleep effects within the elderly and the depressed populations (10-12). These studies have shown significant sleep improvements following training. The results of these studies promote physical activity as an effective sleep enhancement tool, but the application of these studies is limited to groups exhibiting similar characteristics as the studied groups, i.e. age and psychological status. Physical activity is considered to be a preventative tool for coronary artery disease (CAD) and is hypothesized to promote sleep in CABG patients. A clinical evaluation of the effects of physical activity on sleep in CABG patients does not exist. Therefore, the purposes of this study were: (1) to explore the relationships between sleep, self-rated aerobic functional capacity, and physical activity during convalescence in patients 3 mo after CABG surgery, and (2) to evaluate these influences on sleep when the effects of other powerful clinical factors are considered, i.e. health complaints, psychological depression scores, body composition, and low ventricular performance.

METHODS

Study Sample

The study procedures used were submitted and approved by the IRB at the Carolinas Medical Center. Volunteers undergoing a first-time CABG were recruited from an ongoing project being conducted at the Carolinas Medical Center from November 1996 to December 1997. Subjects were required to be > 45 yr of age in order to participate. Those who had myocardial infarctions within the 5 days before surgery, were undergoing other surgeries concomitantly with CABG, or had a diagnosed sleeping disorder were excluded. A total of 1104 consecutive surgical patients were admitted into the hospital during this time to undergo CABG surgery. Two hundred patients were evaluated before surgery and 55 of these individuals were selected to participate in the study based on the above inclusion and exclusion criteria.

Data Collection

Study patients were evaluated by interviews and questionnaires just before surgery and again at 3 mo post-surgery. Pre-surgery data were collected for functional capacity, sleep quality, health complaints, depression, and body composition. Three-month data collection was performed either at the hospital or via a telephone interview. For those subjects who agreed to return to the hospital (N = 44) for follow-up testing, data collection was identical to the pre-surgery protocol. In addition, physical activity was assessed at the 3 mo post-CABG evaluation. Data collection for functional capacity, sleep quality, and physical activity was conducted via telephone for those subjects who did not return to the hospital (N = 11) for 3 mo follow-up testing. Measurements of depression and health complaints were not collected at 3 mo for those subjects who did not return to the hospital, due to the additional time and attention that would have been needed for the subject to complete the questionnaires over the telephone. It was decided that problems may have occurred with the subjects' attention span, as a result of the prolonged telephone interview, that may have influenced the accuracy of certain questionnaire responses.

OUTCOME MEASURES

Sleep

The Pittsburgh Sleep Quality Index (PSQI) was used to evaluate subjective sleep quality, retrospectively, for each patient for the 6-wk interval preceding completion of the questionnaire (1). The PSQI elicits 19 self-rated responses, 18 of which are used to obtain a subjective sleep score. The questionnaire has seven subscales, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction, which are weighted equally on a 0-3 point scale. The PSQI global score is calculated by summing the scores for the seven subscales, resulting in a range of global scores from 0 – 21. A score of 0 indicates no difficulty with sleeping while a score of 21 indicates severe difficulty with sleep. Test-retest reliability of the global PSQI score was 0.85 ($p < 0.001$), and it has been reported that global PSQI scores > 5 provided a sensitivity and specificity of 89.6% and 86.5%, respectively, when compared to sleep variables obtained by polysomnography (1).

Self-rated Aerobic Functional Capacity

The Veterans Specific Activity Questionnaire (VSAQ) was completed by patients to determine the specific activities that could be performed without the onset of symptoms of cardiovascular disease (fatigue, chest pain and shortness of breath) (13). The questionnaire presents a hierarchy of physical activities, scaled according to relative requirements for oxygen consumption (in multiples of resting metabolism, i.e. METs). The MET level for patients was determined as the most demanding aerobic activity they could perform, without limitations caused by symptoms of the disease. Myers et al. (13) used a stepwise multiple regression to predict exercise capacity and peak METs by VSAQ, obtaining an $R^2 = 0.63$ ($p < 0.0001$). The validity increased to 0.82 after an age-adjusting factor, representative of subjects in the study conducted by Myers et al. (13), was entered into the equation.

Physical Activity

Physical activity data were collected using a modified version of the Paffenbarger Physical Activity Questionnaire, PPAQ (14). Patients were queried using the PPAQ to estimate their daily physical activity; this information then was converted to kilocalories of energy expenditure over a 7-day period (12). The PPAQ scale contains subsections specific to walking, stairclimbing, sports, and other recreational activities. Involvement in physical activity is recorded in terms of frequency per day, and into intensity categories ranging from sleeping to vigorous exercise. Test-retest reliability of the PPAQ was $r = 0.72$ ($p < 0.05$). PPAQ data were validated against measures of cardiorespiratory fitness, body fat, motion detection, and physical activity records resulting in an adequate $r = 0.69$ ($p < 0.05$) (15).

Health Complaints

The Health Complaint Scale (HCS) was used to collect data on somatic and cognitive health complaints (16). The questionnaire is comprised of 24 questions, divided equally in two groups for somatic and cognitive information. Each health complaint question uses a 5-point scale of distress, with 0 meaning no distress to 4 representing extreme distress. The somatic and cognitive health complaint scores were validated against The Heart Patients Psychological Questionnaire and were found to correlate ($r = 0.53$ to 0.66) (16). The HCS also has a high internal consistency ($\alpha \geq 0.89$) and adequate test-retest reliability ($r \geq 0.69$) (16).

Depression

The Beck Depression Inventory (Version II, BDI-II; The Psychological Corporation, San Antonio, TX), created in 1996, was used to measure the severity of self-reported depression in adolescents and adults according to the *Diagnostic and Statistical Manual of Mental Disorders* (17). Within this scale subjects are requested to answer 21 questions dealing with traits commonly associated with stress and depression. Each question is answered using a 4-point scale with 0 revealing no association with the trait and 1, 2, or 3 revealing an increasing association with the trait. The BDI-II is scored by summing the highest ratings for each of the 21 questions (18). Total scores range from 0-63, with 0-19 representing "minimal to mild" depression and 20-63 representing "moderate to severe" depression. Test-retest reliability for the BDI was 0.93 ($p < 0.001$). Validity of the BDI-II was measured against the BDI-IA (19). The association between the BDI-II and the BDI-IA was 0.93 ($p < 0.001$) (18).

Skinfold Measures

Skinfold measures, using Harpenden calipers (Harpenden Vital Signs, Country Tech. Inc., Gaysmills, WI), were collected from the subjects before and after surgery. Skinfold sites used for women included the triceps, thigh and the suprailiac, while the chest, abdomen, and thigh skinfold sites were used for men. Skinfold results from the three sites were summed together to obtain a total skinfold measure for each subject. Body composition determined from skinfold measurements correlates well ($r \geq 0.80$) with body composition determined by hydrostatic weighing (20).

STATISTICAL ANALYSIS

Spearman's Rho correlation was used to determine relationships between sleep scores, self-rated aerobic functional capacity, physical activity, mental status and health complaint scores. The student t-test was used to evaluate changes for group means from pre-CABG to post-CABG for the global sleep scores and the sleep subscale scores, as well as for functional capacity, health complaints, and mental status. The Wilcoxson Rank Sum test was used to determine any differences in characteristics of subjects who returned to the hospital at 3 mo for follow-up testing vs. those who were interviewed via telephone. Stepwise multiple regression was used to predict sleep outcomes before and after surgery. Statistical procedures were performed on JMP statistical software developed by SAS (SAS Institute, Inc., Cary, NC). A p level of 0.05 was considered significant.

RESULTS

This study represented 5% (N = 55) of 1104 patients who underwent CABG surgery at Carolinas Medical Center over the 13 mo data collection period from November 1996 to December 1997. The medical histories for study subjects and patients that underwent CABG at Carolinas Medical Center but was not included in this study (non-researched patients) were similar for diabetes, chronic obstructive pulmonary disease and congestive heart failure. However, non-researched patients included a greater proportion with a family history of premature CAD when compared to subjects (49% vs. 38%). Differences were also apparent in the percentage of non-researched patients (49%) when compared to subjects in the study (38%) who had experienced a myocardial infarction. Within the group of patients and subjects who had previously experienced an MI, 24% of non-researched patients had experienced the attack 1-7 days prior to surgery, whereas only 5% of the subjects had experienced a MI in this time frame. The greatest difference between study subjects and non-researched patients occurred in the percentage that had experienced a MI > 21 days before surgery. Sixty-two percent of the study subjects versus 19% of the non-researched patients had an MI greater than 21 days prior to surgery. This difference between the two groups may have been a result of the inclusion and exclusion criteria used to select subjects for this study. Slight differences of 7-8% were found between the groups for peripheral vascular disease and hypercholesterolemia. Table 1 lists the clinical and descriptive characteristics of the subjects selected to participate in the study reported herein.

The final study sample, which contained patients with both pre-CABG and 3 mo post-CABG data, included 55 individuals. Eighty percent of those subjects (N = 44) returned to the hospital for 3 mo follow-up testing while the remaining 20% (N = 11) completed their 3 mo measurements by telephone interview. These two 3 mo subgroups were compared to determine if there were any important differences in their clinical features which might preclude pooling their results for the analysis. Significant differences, for pre-surgical PSQI and VSAQ, as well as medical history and secondary questionnaire data, were not found between the two groups. Therefore, based on the comparable findings of the two groups, the subjects could be pooled together, without any biases, for the purposes of this study.

Table 2 presents pre-CABG and post-CABG results for data collected via the five questionnaires used in this study. Functional capacity, as measured by the VSAQ, increased significantly ($p < 0.005$) between the two data collection times. This type of response is expected after CABG. Ideally the patient should be able to engage in activities after CABG without being limited by CAD symptoms that may have been experienced prior to surgery. Global sleep scores, as measured by the PSQI, did not exhibit significant changes pre-CABG to post-CABG, however significant improvements were noted in two of the sleep subscales. Significant improvements were noted in health complaints and Beck depression scores when comparing post-CABG to pre-CABG ($p < 0.05$).

Sleep and functional capacity were correlated before surgery (Table 3) and after surgery (Table 4). The strongest correlation between these two variables occurred before surgery ($p < 0.005$). At both testing times, functional capacity significantly correlated with at least three sleep components. Before surgery, the sleep subscales that correlated with functional capacity included sleep quality, sleep latency and sleep disturbance. Post-surgical sleep scores that correlated with functional capacity included sleep quality, sleep latency and sleep efficiency ($p < 0.05$). The group of subjects did not reveal a correlation between physical activity and sleep or sleep subscales at 3 mo post-surgery. The 25% of subjects exhibiting the highest physical activity involvement and the lowest physical activity involvement were separated into two groups and analyzed. The analysis between sleep and physical activity in these two groups did not reveal a significant correlation between the two variables after surgery.

Confounding variables that may influence sleep, including health complaints, depression, BMI > 27, and EF $\leq$ 30, were also analyzed. Each of these variables has been found to disturb sleep patterns and increase incidences of sleep disturbances. Each of these confounding variables, excluding high BMI, were found to correlate with the subjects' sleep scores. Somatic health complaints, cognitive health complaints and Beck depression scores were significantly correlated with global sleep score and sleep subscales before (Table 3) and after (Table 4) surgery. Beck depression scores exhibited the strongest correlation with global sleep score before surgery ($r = 0.55$; $p < 0.001$) while somatic health complaints had the strongest correlation with global sleep score after surgery ($r = 0.82$; $p < 0.0005$). Subjects exhibiting an ejection fraction (EF) $\leq$ 30 were pooled and analyzed as a group. This group had a significant ($r = 0.85$; $p < 0.05$) correlation between pre-CABG sleep score and pre-CABG functional capacity. Significance for post-CABG variables were not noted within this group.

In an effort to identify variables which may have the greatest influence on sleep outcome, a multiple stepwise regression equation was constructed to predict sleep outcome before and after surgery. Pre-surgical variables, including somatic health complaints, depression scores, and sum of skinfold measures were found to be the strongest predictors of pre-CABG sleep outcome with an $R^2 = 0.60$ (Table 5). Somatic health complaints was found to be the strongest predictor for pre-surgical sleep ($p < 0.005$) followed by Beck depression scores ($p < 0.05$) and skinfold measures ($p < 0.5$). The post-surgical sleep outcome prediction equation exhibited a very strong correlation $R^2 = 0.72$ (Table 5). Again, somatic health complaints, depression scores and sum of skinfold measures were predictors included into this equation.

DISCUSSION

This study is the first to evaluate the role of functional capacity and physical activity on self-reports of sleep function for patients just before first-time CABG surgery and again at 3 mo follow-up. The primary focus of this study was to evaluate the relationship between functional capacity, physical activity, and sleep. It has been reported previously that exercise can affect sleep cycles and sleep disturbances (11, 12). Singh et al. (12) reported a reduction of 35% in mean PSQI score following a 10 week resistance training protocol. This reduction in PSQI score resulted in a significant change from poor to good sleepers. King et al. (11) also reported significant improvements in sleep for subjects following an aerobic training protocol. Although there was no correlation found between physical activity involvement and sleep in the study reported herein, there was a correlation exhibited between physical capacity, as measured by the VSAQ, and sleep that tends to agree with previous literature.

The subjects in the study reported here had a significant correlation between sleep and functional capacity before and after surgery. Although, statistically significant, the functional capacity, as measured by the VSAQ, was found to only explain approximately 16% of the influence on sleep at both testing intervals (Tables 3 and 4). This contribution would appear to have marginal importance in the clinical setting since, 84% of the variance in sleep may be contributed to other variables. The modest correlation found in this study, when compared to other studies, may be the result of several things. First, the subjects had been under physician prescription that restricted physical activity involvement to minimal walking activities up to 2 mo post-CABG. Therefore, the 3 mo data collected for this study exhibited only the physical activities the subjects had been able to participate in for a month or less and may not have been an accurate indication of the subjects' capabilities. Secondly, the subjects had undergone traumatic physical injury during the surgical procedure. Although, symptom limitations specific to the surgery were not directly evaluated for these subjects, the physical symptoms associated with CABG reported in previous research may have been a contributing factor to the findings of this study. Redeker (7) followed post-CABG patients for 6 mo to evaluate changes in symptoms. He found that physical symptoms such as pain and edema were frequently reported by over 50% of the patients up to 3 mo post-surgery. These findings have been confirmed in at least one other study (21). The study reported herein, did not evaluate symptoms as a result of the surgery, therefore it is not possible to determine if these symptoms may have influenced post-surgical sleep as is evident in previous studies.

A secondary analysis found evidence suggesting health complaints, Beck depression scores and low EF may affect sleep in CABG patients and may also inadvertently affect the interaction between functional capacity and sleep. Somatic health complaints revealed a strong correlation with sleep and sleep subscales both before and after surgery. Beck depression scores and cognitive health complaints also exhibited a strong correlation with global sleep score and sleep subscales. Analysis of subgroups exhibiting an EF $\leq$ 30 found a significant pre-surgical correlation between sleep and functional capacity. This finding suggests that sleep and functional capacity at a pre-surgical state may be interrelated with low ventricular function. The prevalence of depressed left ventricular function and heart disease is associated with excess morbidity and mortality (22). Studies have found that many CAD patients often exhibit either diagnosed or undiagnosed obstructive or central sleep apnea. Low ejection fraction combined with sleep apnea increases cardiovascular morbidity, including pulmonary hypertension (23). Pulmonary hypertension can lead to difficulties with breathing that may occur while sleeping. Patients are often aroused from sleep under hypertensive conditions (24) resulting in poor sleep quality. CAD patients exhibiting depressed ejection fractions should be further investigated to determine the possible effects of functional capacity on sleep within this high risk group.

A prediction equation for sleep outcome before and after surgery was constructed to assist in the understanding of the contributions of various factors involved with this sleep study. Both before and after surgery, somatic health complaints and Beck depression scores were found to be indicators of sleep outcome. Although, skinfold measures were not found to correlate with sleep or sleep subscales, these measures were found to contribute in the multivariate prediction equation of sleep outcome before and after surgery. Somatic health complaints, depression, and body composition have been documented to influence sleep (8, 25, 26). Somatic health complaints were found to be the highest predictor for sleep before and after surgery. Physical limitations, such as angina, have been shown to disrupt sleep in CAD patients (25). The Beck depression score was the second highest predictor in the equation both pre-CABG and post-CABG. Previous research has shown that subjects affected by moderate to severe depression are highly susceptible to sleep disturbances (8). The third predictor in the equation is the physical measurement that relates to body composition, i.e. skinfold measures. It has previously been demonstrated that obese individuals are at increased risk for obstructive sleep apnea (26), a condition known to profoundly disturb sleep. As previously mentioned, OSA, results in breathing difficulties during sleep, therefore those who have higher levels of body fat may have breathing difficulties associated with OSA. The post-surgical prediction equation, using somatic health complaints, Beck depression score, and sum of skinfold measures as indicators, accounted for 72% of the variance in sleep status for this patient sample.

The findings from the study reported herein suggest that a small correlation between self-rated aerobic functional capacity and sleep exists. Although, significance was evident between these two variables the correlation was so weak that it would not be realistic to use functional capacity as a tool to improve or predict sleep in CABG patients. However, the results in this study suggested that within a group of CABG patients exhibiting low ejection fraction before surgery, the correlation between functional capacity and sleep is very strong and deserves further investigation and consideration by clinicians. Health complaints and Beck depression scores were strongly correlated with sleep as was evident when used as indicators of sleep outcome pre-CABG and post-CABG. This study has shown that although a modest correlation may exist between functional capacity and sleep in a group of CABG patients with varying degrees of severity, the stronger indicators of sleep outcome include health complaints, Beck depression scores, and skinfold measures. These indicators can be used by clinicians to predict pre-surgical and post-surgical sleep outcome and at the same time be used to assess patients' mortality and morbidity risks.

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Table 1. Descriptive and clinical characteristics of study patients (N = 55[a])

Variable	Mean*	Study Group, %
Age (yr)	64.4 8.8	
BMI (kg/m^2)[b]	27.6 5.2	
SSM (lbs)[c]	65 21	
MI History[d]		38
MI 1-7 Days		23
MI 7-21 Days		14
MI > 21 Days		62
Ejection Fraction ≤ 30		15
Number of Diseased Vessels		
2 vessel disease		40
3 vessel disease		60
Smoking History		82
Current Smoker		31
Family History of CAD[e]		49
Other Diagnoses		
Diabetes		35
Hypercholesterolemia		72
COPD[f]		18
PVD[g]		25
CHF[h]		7
Angina		89

*Values are listed with means and SD

[a]Male:Female = 44:11; [b]BMI = Body Mass Index; [c]SSM = Sum of Skinfold Measures; [d]MI History = number of days prior to surgery that MI occurred [e]CAD = Coronary Artery Disease; [f]COPD = Chronic Obstructive Pulmonary Disease; [g]PVD = Peripheral Vascular Disease; [h]CHF = Congestive Heart Failure

Table 2. Pre-surgical and post-surgical outcomes for sleep, fitness, physiological and psychological questionnaire data

Variable	Pre-CABG	Post-CABG	Change, %	t-ratio
VSAQ[a]	4.2 3.6 – 4.8	5.3 4.7 – 5.9	+26	3.9***
PSQI[b]	6.1 5.1 – 7.2	6.2 5.1 – 7.3	2	0.21
HCS[c]				
Somatic HC	14.3 11.3 – 17.4	8.6 6.6 – 10.5	-41	-3.0**
Cognitive HC	14.8 11.2 – 18.4	9.3 7.0 – 11.6	-37	-4.3**
BDI[d]	9.4 6.4 – 12.4	5.6 4.0 – 7.2	-40	-3.7***
PPAQ[e]		1417 1033 – 1801		

Values are listed with means and 95% confidence intervals
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$
[a]VSAQ = Veterans Specific Activity Questionnaire (N = 55); [b]PSQI = Pittsburgh Sleep Quality Index (N = 55); [c]HCS = Health Complaint Scale (Pre-CABG N = 42; Post-CABG N = 43); [d]BDI = Beck Depression Inventory (Pre-CABG N = 41; Post-CABG N = 43); [e]PPAQ = Paffenbarger Physical Activity Questionnaire (N = 38)

Table 3. Spearman Rho correlation coefficients for pre-surgical questionnaire data

PSQI[a]	VSAQ[b]	Somatic HC[c]	Cognitive HC	BDI[d]
Global Score	-0.40**	0.51***	0.40**	0.55***
SQ[e]	-0.27*	0.48**	0.36*	0.57***
SL[f]	-0.46***	0.42**	0.36*	0.51***
SD[g]	-0.06	0.16	0.12	0.26
SE[h]	-0.26	0.23	0.20	0.25
SDS[i]	-0.42**	0.52***	0.33*	0.24
SM[j]	-0.23	0.39*	0.35*	0.31*
DD[k]	-0.26	0.40*	0.33*	0.31*

R-values are listed for each questionnaire
*$p < 0.05$; ** $p < 0.01$, ***$p < 0.001$
[a]PSQI = Pittsburgh Sleep Quality Index; [b]VSAQ = Veterans Specific Activity Questionnaire; [c]HC = Health Complaint; [d]BDI = Beck Depression Inventory; [e]SQ = Sleep Quality; [f]SL = Sleep Latency; [g]SD = Sleep Duration; [h]SE = Sleep Efficiency; [i]SDS = Sleep Disturbance; [j]SM = Sleep Medication; [k]DD = Daytime Dysfunction

Table 4. Correlation results for 3 mo post-CABG physiological, psychological and sleep questionnaires

PSQI[a]	VSAQ[b]	PPAQ[c]	Somatic HC[d]	Cognitive HC	BDI[e]
Global Score	-0.34*	-0.08	0.82***	0.41**	0.40**
SQ[f]	-0.27*	-0.21	0.60***	0.52***	0.33*
SL[g]	-0.29*	0.06	0.68***	0.39**	0.40**
SD[h]	-0.09	-0.05	0.36*	-0.08	0.05
SE[I]	-0.34*	0.12	0.60***	0.38*	0.20
SDS[j]	-0.17	-0.11	0.58***	0.42**	0.24
SM[k]	-0.21	-0.14	0.43**	0.07	0.06
DD[l]	-0.14	0.04	0.53***	0.30*	0.35*

R-values are listed for each questionnaire
*p < 0.05; **p < 0.01; ***p < 0.001
[a]PSQI = Pittsburgh Sleep Quality Index; [b]VSAQ = Veterans Specific Activity Questionnaire; [c]PPAQ = Paffenbarger Physical Activity Questionnaire; [d]HC = Health Complaint; [e]BDI = Beck Depression Inventory; [f]SQ = Sleep Quality; [g]SL = Sleep Latency; [h]SD = Sleep Duration; [i]SE = Sleep Efficiency; [j]SDS = Sleep Disturbance; [k]SM = Sleep Medication; [l]DD = Daytime Dysfunction

Table 5. Prediction equations for sleep outcome before and after surgery

[a]**Pre-CABG Sleep Outcome (PRSO)** = 4.1 + 0.20 (SHC[c]) + 0.17 (BDI[d]) - 0.10 (SSM[e])
[b]**Post-CABG Sleep Outcome (PSSO)** = -0.2 + 0.71 (SHC[c]) - 0.33 (BDI[d]) + 0.09 (SSM[e])

[a] **<u>Pre-CABG Sleep Outcome (N = 37)</u>**

<u>Outcome</u> = Pre-surgical sleep

- **Adjusted $R^2 = 0.60$**
- **<u>Probability > F for predictors</u>**

  [c]**SHC = Somatic Health Complaints: p = 0.0021**
  [d]**BDI = Beck Depression Inventory: p = 0.0069**
  [e]**SSM = Sum of Skinfold Measures: p = 0.0779**

[b] **<u>Predicted Post-CABG Sleep Outcome (N = 24)</u>**

<u>Outcome</u> = Post-surgical sleep

- **Adjusted $R^2 = 0.72$**
- **<u>Probability > F for predictors</u>**

  [c]**SHC = Somatic Health Complaints: $p \le 0.0001$**
  [d]**BDI = Beck Depression Inventory: p = 0.0226**
  [e]**SSM = Sum of Skinfold Measures: p = 0.1817**

CHAPTER IV
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

SUMMARY

Sleep disturbances have been found to be associated with increased mortality in patients with coronary artery disease. Frequent awakenings and shortened sleep phases contribute to angina and increases in heart rate within cardiac diseased patients. In severe incidences of coronary artery disease, patients often undergo CABG. Sleep disturbances are frequently reported by patients during the post-CABG recovery phase. Due to the emotional and physiological healing that occurs during sleep, one needs an adequate amount of sleep during this time. Due to the increased risk of mortality within these patients caused by sleep loss, remedies to elicit sleep are a growing need within the clinical setting. Literature cites physical activity as a sleep enhancement tool in the depressed and the elderly but has not been investigated within CABG patients.

This study investigated the influence of functional capacity and physical activity on sleep in CABG patients. Initially, this study was designed to evaluate the differences in sleep for subjects in high vs. low functional capacity groups and physical activity groups. However, sleep scores obtained by the subjects were variable within each group. This variability suggested that the focus of the study should not be to evaluate the effects of different levels of functional capacity or physical activity on sleep but rather to establish whether a correlation between these variables actually existed within the CABG subjects (N = 55). Therefore, analyses were conducted to determine if a correlation existed between sleep, functional capacity, and physical activity. The correlation between sleep and Beck depression scores, and sleep and health complaints were also evaluated. Additionally, subjects exhibiting confounding variables associated with coronary artery disease were placed into subgroups and analyzed for additional correlation's between the variables.

CONCLUSIONS

In conclusion, this study suggested that a modest correlation existed between sleep and functional capacity. In a group exhibiting low ejection fraction, a very strong correlation was evident between functional capacity and sleep before surgery. Physical activity was not correlated with sleep in this study. Although, a correlation was apparent between sleep and functional capacity, a stronger correlation existed between Beck depression scores, health complaints and sleep. Somatic health complaints and Beck depression scores were used as indicators, combined with sum of skinfold measures, in a multivariate equation to predict pre-surgical sleep outcome ($R^2 = 0.60$) as well as post-surgical sleep outcome ($R^2 = 0.72$).

RECOMMENDATIONS FOR FUTURE RESEARCH

The study reported herein was conducted over a 3 mo data collection period. Data collection was conducted on subjects that met inclusion and exclusion criteria for the study. After an evaluation of the testing procedures and the subject criteria used in this study, several recommendations arise for future research.

The first recommendation for future research would be to conduct follow-up testing later than 3 mo as conducted in this study, e.g. 6 mo post-CABG. At 3 mo post-surgery, many of the subjects were still suffering from symptoms associated with the surgical procedures, such as pain and fatigue. Many of these subjects were tender in the incision area and were hesitant about engaging in activity that could cause soreness. Many of the subjects, at 3 mo, were recently released from the physician's exercise prescription of periodic walking and had not had the opportunity to participate in other forms of activity. Collection data, at 6 mo following surgery, for functional capacity and physical activity, may be more synchronous with the subjects' capabilities and limitations.

Another recommendation for future research is to further investigate the association between sleep and functional capacity in groups exhibiting an ejection fraction ≤ 30. This study found a very strong correlation between pre-surgical self-reported aerobic functional capacity and sleep, however the sample size used in this study was small. A study evaluating a group of subjects (N = 50) using the same pre-surgical data collection procedures and the same post-surgical data collection procedures at 6 mo post-CABG would be of great benefit for clinicians. Low ejection fraction patients suffering from sleep disturbances are at high risk for mortality, therefore studies evaluating a relationship between activity and sleep may assist clinicians when evaluating potential sleep remedies for these patients when undergoing CABG.

A third recommendation would be to evaluate subjects, undergoing CABG, that have been diagnosed with sleeping disorders, e.g. obstructive or central sleep apnea. Research confirms that approximately 30% of women with coronary artery disease suffer from obstructive breathing patterns. Sleep apnea also places patients at a high risk for mortality as well as morbidity. A study using the same procedures as listed in the previous recommendation, except using subjects with sleeping disorders, could be helpful when evaluating sleep enhancement measures for these patients before and after surgery, as well as evaluating the effects of the sleeping disorder on the relationship between functional capacity and sleep.

RECOMMENDATIONS FOR CLINICAL PRACTICE

A correlation between functional capacity and sleep was found before and after surgery, however only 16% of the influence of sleep was explained by functional capacity. This contribution would have marginal importance in the clinical setting since 84% of the variance in sleep may be contributed to other variables. Although, results of this study did not find a strong correlation between sleep and functional capacity, the interaction between these two variables in CABG patients with varying degrees of disease severity, deserves further investigation. Reports indicate that coronary artery disease combined with sleep disturbances, places individuals at increased risk of mortality. This study found a very strong correlation between pre-surgical responses in a group exhibiting low ejection fraction, however the sample size was smaller than desired. Further research evaluating CABG patients is needed to clarify the relationship between functional capacity and sleep responses in patients exhibiting physiological and psychological symptoms associated with CAD. Beck depression scores and health complaints had a much stronger correlation with sleep than was exhibited between functional capacity and sleep. Due to the vast amount of information collected and analyzed in the study reported herein, equations were constructed to determine which variables were the strongest indicators and contributors to sleep in these subjects. Somatic health complaints, Beck depression scores and skinfold measures were used for both the pre-surgical and post-surgical sleep outcome equations. Although, the equation was initially constructed in an attempt to determine the strongest contributors of sleep, the equations for pre-surgical and post-surgical sleep outcome exhibited a confidence of 60% and 72%, respectively. Therefore, these equations could be used within a clinical setting. The pre-surgical prediction equation ($R^2 = 0.60$) allows for a great deal of error. This equation should be coupled with other measures in order to properly evaluate pre-surgical sleep outcomes. The post-surgical prediction equation ($R^2 = 0.72$) maintains a great deal of confidence. This equation, alone, could be used by clinicians as a valid measure for predicting patient sleep outcomes 3 mo following a coronary artery bypass graft surgery.

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APPENDIX A
METHODOLOGY

SUBJECTS

A volunteer pool of 55 subjects, 11 women and 44 men, were recruited at the Carolinas Medical Center. Descriptive characteristics of these subjects can be found in Table 1. The subjects, aged ≥ 45 yr., were recruited between November 1, 1996 and December 31, 1997 and were undergoing a first-time coronary artery bypass graft. Subjects were excluded from the study if they had an acute myocardial infarction < 5 days prior to surgery or were undergoing any other concomitant cardiovascular surgery. Subjects were also excluded if they had been clinically diagnosed with a sleeping disorder. If subjects met the inclusion requirements they were invited to participate in the study.

BASELINE DATA COLLECTION

The investigator was able to approach the subjects in two ways depending on the availability of the subject. First, if a subject had been admitted into the hospital, all measurements were collected in the subject's hospital room. Second, if a subject was entering the hospital on the same day as the surgery, the investigator met with the subject the day that the subject arrived to have pre-surgery admittance testing completed. For those subjects entering the hospital on the same day as their surgery, all the measurements were collected in a physician's room at the hospital. After introductions by the potential subject and the investigator, the subject was briefed about the study. Upon agreement to participate in the study, the investigator reviewed an informed consent (Appendix B) with the subject. After the subject's questions concerning the study were answered, the subject was asked to sign the informed consent.

Baseline data were collected before surgery for functional capacity, sleep quality, health complaints, and depression. Physical measurements for body composition, using skinfolds, were also taken before surgery. Functional capacity was measured using the Veterans Specific Activity Questionnaire (Myers, J., Do, D., Herbert, W., Ribisl, P., Froelicher, V.F., 1994). Subjective sleep quality was determined using the Pittsburgh Sleep Quality Index (Buysse, D.J., Reynolds, C.F., Monk, T. H., Berman, S.R., & Kupfer, D.J., 1988). Copies of the VSAQ and PSQI can be found in Appendix C and D. An interview, in which questions were verbally asked by the investigator and verbally answered by the subject, was used to collect data for the VSAQ and the PSQI. The subject's health complaints were assessed using the Health Complaint Scale (Denollet, 1994). The Beck Depression Index, Version II; BDI-II, was utilized to determine depression in the subjects (Beck AT, Steer RA, Ball R, Ranieri WF, 1996). The HCS can be found in Appendix F. After the VSAQ and the PSQI data were collected, the investigator gave the subject the HCS and the BDI-II to complete on the subject's own time. Upon completion of the BDI-II and HCS, the subject gave the forms to the nurse assigned to the subject's hospital room or to the nurse that admitted the subject the day of the surgery. After the nurse received the HCS and BDI-II, the questionnaires were placed in the subject's hospital file, according to instructions listed on the top of the HCS and BDI-II. A nurse recruited to assist with the project at Carolinas Medical Center collected the questionnaires and returned them to the investigator.

THREE MONTH DATA COLLECTION

The subjects were contacted by phone 3 mo after their CABG. They were asked to return to the Carolinas Medical Center for follow-up testing. If the subject agreed to return, a date and time for the testing was selected. Upon returning to the hospital, the subjects were escorted into the testing room. Skinfold measurements from the subject were taken at the beginning of the meeting. An interview, in which questions were verbally posed by the investigator and verbally answered by the subject, was completed to collect data from the VSAQ and the PSQI. An interview was also used to collect 3 mo post-CABG physical activity involvement data for the subjects. Physical activity data were determined by the Paffenbarger Physical Activity Questionnaire (Paffenbarger, R.S., Wing, A.L., Hyde, R.T., 1978). A copy of the PPAQ can be found in Appendix E. The Health Complaint Scale and the BDI-II were also completed by the subject and returned to the investigator before leaving the hospital. If the subject preferred not to return to the Carolinas Medical Center, data for functional capacity, sleep quality, and physical activity were collected via a telephone interview. For these subjects, the questions listed on the VSAQ, PSQI, and PPAQ were read over the telephone by the investigator and answered by the subjects. The telephone interview lasted approximately 15 minutes. The BDI-II and the HCS data were not collected for these latter subjects. The reason the BDI-II data and the HCS data were not collected during the telephone interview was due to the extended time and attention that would have been needed by the subject to complete the questionnaires. It was determined that problems might occur with the subjects' attention span and this problem might influence the results.

Determination of Sleep Quality

The Pittsburgh Sleep Quality Index (PSQI) was designed to evaluate an individual's subjective sleep quality during a six-week interval (Buysse et al., 1988). The PSQI elicits 19 self-rated responses, 18 of which are used to obtain a subjective sleep quality score. The questions assess a wide variety of factors relating to sleep. Questions are grouped into seven categories, each weighted equally on a 0-3 scale. These seven categories, or subscales, include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. The seven category scores are summed to yield a global score. Subjects can receive scores ranging from 0 to 21. A score of 0 indicates no difficulty with sleeping while a score of 21 indicates severe difficulty with sleep. A test-retest analysis of the PSQI scores revealed a correlation coefficient for the global PSQI scores of 0.85 ($p < 0.001$). The PSQI represents a sensitivity of 89.6% and a specificity of 86.5% (Buysse et al., 1988).

Determination of Functional Capacity

The Veterans Specific Activity Questionnaire (VSAQ) is designed to determine which specific daily activities were associated with symptoms of cardiovascular disease, (fatigue, chest pain, and shortness of breath (Myers et al., 1994). The questionnaire presents a hierarchy of physical activities according to MET demand. The activities are listed in a progression from low MET demand to higher MET demand. The MET levels are given beside each of the listed activities. Activities that can be completed without being limited by chest pain, shortness of breath, or fatigue are underlined by the subject. The raw MET level for a patient is recorded as the level of the most difficult sustainable activity. Myers et al. (1994) analyzed achieved (treadmill response) versus predicted (VSAQ measured) for predicted exercise capacity. Using stepwise multiple regression to predict exercise capacity, the peak METs by VSAQ obtained an $R^2 = 0.63$ ($p < 0.001$). After adding an age-adjustment factor the $R^2 = 0.82$.

Determination of Physical Activity

Physical activity data were collected using a modified version of the Paffenbarger Physical Activity Questionnaire (Paffenbarger et al., 1978). Subjective reports of daily activity are solicited by the PPAQ and converted to kilocalories of energy expenditure over a 7-day period (Singh et al., 1997). Subsections specific to walking, stairclimbing, sports, and other recreational activities are included in the questionnaire. Involvement in physical activity is recorded in terms of frequency and times per day. These activities are further divided into five intensity levels ranging from sleeping or reclining to vigorous activity. Ainsworth et al. (1993) analyzed the test-retest reliability of the PPAQ and found the correlation coefficient to be $r = 0.72$ ($p < 0.05$). Ainsworth et al. (1993) also found an adequate validity correlation coefficient of 0.69 ($p < 0.05$).

Determination of Health Complaints

The Health Complaint Scale was used to collect data on an individual's health complaints. The questionnaire consists of 12 somatic and 12 cognitive health complaints. Subjects rate health complaints according to how much they are bothered by each complaint. Subjects respond to each health complaint using a 5-point scale of distress with 0 meaning no association with the complaint to 4 representing extreme distress. Denollet (1994) tested the validity, internal consistency, and test-retest reliability of the HCS. The Heart Patients Psychological Questionnaire was used as the standard to determine the validity of the HCS. The somatic and cognitive health complaint scores of the HCS were found to correlate with The Heart Patients Psychological Questionnaire ($r = 0.53$ to 0.66). The HCS was also found to have a high interval consistency ($\alpha \geq 0.89$) and an adequate test-retest reliability of $r \geq 0.69$ (Denollet, 1994).

Determination of Depression

The Beck Depression Inventory, Version II, BDI-II, created in 1996, is used to assess a subject's mental status. The BDI-II, a modified version of the BDI-IA, was constructed to measure the severity of self-reported depression in adolescents and adults according to the *Diagnostic and Statistical Manual of Mental* (American Psychiatric Association, 1994). The BDI-II is comprised of 21 questions. Each question lists a trait commonly associated with stress and depression. The subjects answer each question on a 4-point scale ranging from 0-3. Each answer listed as 0 is identified as having no evidence of the trait. Answers scored as 1, 2, or 3 reveal an increasing association with the trait, so that 3 identifies individuals as having a great deal of association. The BDI-II is scored by summing the highest ratings for each of the 21 questions with the disorder (Beck et al., 1996). The total scores range from 0-63. A total score ranging from 0-13 represent "minimal" depression, total scores from 14-19 are "mild," total scores from 20 to 28 are "moderate," and total scores from 29 to 63 are "severe." According to Beck, the test-retest reliability for the BDI-II was high ($r = 0.93$, $p < 0.001$). Analyses were conducted to estimate the convergent validity of the BDI-II. These analyses were conducted by administering the BDI-IA and the BDI-II to subjects during an evaluation. The BDI-IA has been found to have a specificity of 82% and sensitivity and validity of 83% (Beck, A.T., Ward, C.H., Mendelson, M., Mock, J., Erbausgh, J., 1961). The correlation between the BDI-II and the BDI-IA was 0.93 ($p < 0.001$) (Beck et al., 1996).

Determination of Body Composition

Skinfold measurements, using Harpenden Calipers (Harpenden Vital Signs, Country Tech. Inc., Gaysmills, WI) were used to calculate the subject's percent body fat. Skinfold sites were dependent on gender. Skinfold sites for men included the chest, thigh, and abdomen. Skinfold sites for women included the triceps, thigh, and suprailiac. All measurements were taken on the subject's right side (American College of Sports Medicine, 1995). The investigator placed the calipers approximately 1 cm away from the thumb and finger, perpendicular to the skinfold, and halfway between the crest and the base of the fold. The investigator waited 1 to 2 seconds before reading the calipers. All measurements were taken to the nearest 0.2 mm. Each site was measured two times, rotating through all sites once before taking a second measurement at the same site. The skinfold sites were retested if the measurements were not within 1 to 2 mm.

The skinfold site taken at the triceps is a vertical fold, on the posterior midline of the upper arm, halfway between the acromion and olecranon processes, with the arm held freely to the side of the body (ACSM, 1995). The chest skinfold measurement for men is a diagonal fold, one-half the distance between the anterior axillary line and the nipple. The skinfold site taken at the suprailiac is a diagonal fold, inline with the natural angle of the iliac crest taken in the anterior axillary line immediately superior to the iliac crest. The abdominal skinfold measurement is a vertical fold, 2 cm to the right side of the umbilicus. The skinfold site taken at the thigh is a vertical fold, on the anterior midline of the thigh, midway between the proximal border of the patella and the inguinal crease (ACSM, 1995).

Body composition determined from skinfold measurements correlates well ($r \geq 0.80$) with body composition determined by hydrostatic weighing (ACSM, 1995).

STATISTICAL PROCEDURES

Spearman's Rho correlation was used to determine relationships between sleep scores, self-rated aerobic functional capacity, physical activity, mental status and health complaint scores. The student t-test was used to evaluate changes for group means from pre-CABG to post-CABG for the global sleep scores and the sleep subscale scores, as well as for functional capacity, health complaints, and mental status. The Wilcoxson Rank Sum test was used to determine any differences in characteristics of subjects who returned to the hospital at 3 mo for follow-up testing vs. those who were interviewed via telephone. Stepwise multiple regression was used to predict sleep outcomes before and after surgery. Statistical procedures were performed on JMP statistical software developed by SAS (SAS Institute, Inc., Cary, NC).

APPENDIX B
INFORMED CONSENT

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

Clinical, Physical, and Quality of Life Variables in Patients after
Coronary Artery Bypass Graft Surgery

INTRODUCTION

You are being asked to participate in a research study to be conducted by Joseph Cook, M.D. at the Carolinas Heart Institute (CHI). The purpose of this study is to determine if physical, psychological, and nutritional status are important factors in determining how well patients do after coronary artery bypass surgery. This will involve completing questionnaires and having non-invasive measurements made before and after your surgery. You will be one of approximately 200 people involved in this research at CHI, and your participation will last approximately 1 year.

PROCEDURE

Two types of test will be used. Some will involve answering questions about yourself and will include evaluation of how you feel about your ability to tolerate activities involving exercise, your ability to perform self care and daily living activities at home, your feeling of well being, your health, your quality of life, and your diet. Other non-invasive tests will include determining your body composition by measuring the thickness of a skin fold, grip strength by squeezing a hand-held device, and upper body strength by pushing against or pulling on a small machine with your hands.

These test will be done at the time of your surgery and/or at 3 and 12 months after surgery. Also a at three months after your surgery and again at 12 months, you will be tested to maximum effort on a treadmill, and your ECG, heart rate, and blood pressure will be evaluated by a physician. In addition, at surgery and at 12 months, you will receive a non-invasive low-energy x-ray scan (DEXA) to determine the percentage of your body that is fat or muscle and to determine the quality of your bones.

RISKS

None of the test should cause any foreseeable risks or discomfort. The strength tests are of low intensity and the treadmill test will be the same maximal effort evaluation you took before you surgery. These test will be closely monitored during their administration. The amount of x-ray exposure from the DEXA scan will be very low.

____

Patient/Guardian

Initials

EXCLUSION CRITERIA

You should not participate in this study if:

You have any circulatory, joint, nerve, or emotional disorders that would not allow completions of the items being tested.

You are taller than 6’ or you weigh more than 220 lb.

BENEFIT

There may be not direct benefit to you for participating in this study, but the information gained may benefit others with your condition. Being able to better predict who will benefit most from coronary artery bypass surgery would result in better treatment and rehabilitation planning for future patients. At the conclusion of participation in the study, your results will be forwarded to your personal physician and may be used in planning your future health care.

ADDITIONAL COST

There will be no additional cost to you for participating in this study.

COMPENSATION

In the event that physical injury occurs as a result of this research project, medical treatment will be available. This treatment, as well as other medical care expenses, will be your responsibility or may, in some instances, be paid for you by your health insurance. No compensation or reimbursement will be available from the Carolinas HealthCare System, or from Joseph Cook, M.D., John Fedor, M.D., Parks Griffith, M.A., William Herbert, Ph.D., Warren Ramp, Ph.D., Gary Keibzak, Ph.D., or James Norton, Ph,D.

WITHDRAWAL

Participation in this study is voluntary. You may refuse to participate or you may withdraw from the study at any time. This will result in no penalty or loss of benefits to which you are otherwise entitled. You will be notified of significant new findings that may affect your treatment or your willingness to continue in the study.

CONFIDENTIALITY

The record of your visits will be in your medical record and is accordingly confidential. Other study records will be maintained by the investigator in a likewise confidential manner. Records pertaining to this study may be examined and/or copied by Joseph Cook, M.D. This research may result in scientific presentations and publications, but precautions will be taken to make sure that you are not identified by name.

____

Patient/Guardian
Initials

FINANCIAL INTEREST OF THE INVESTIGATOR

As the principal investigator, I (Joseph Cook, M.D.), as well as the co-investigators (John Fedor, M.D., Parks Griffith, M.A., William Herbert, Ph.D., Warren Ramp, Ph.D, Gary Kiebzak, Ph.D., and James Norton Ph.D.), will not receive compensation for your involvement in this study.

QUESTIONS

For more information concerning the research and research-related risks or injuries, you may contact the principal investigator, Dr. Joseph Cook at (704) 373-1500. In addition, you may contact the chairman of the Institutional Review Board of the Carolinas HealthCare System for information regarding patient rights in a research study. You can obtain the name and number of this person by calling (704) 355-3158.

CONSENT

I hereby give my consent to participate in this study. I have read all of the above or have heard it read to me. I have had the opportunity to ask questions about this study, and my questions have been answered. A copy of this consent form has been provided to me.

____

Patient Printed Name

______________________________ ____________

Patient/Guardian Signature Date

______________________________ _____________

Witness Signature Date

Investigator Signature	Date

APPENDIX C
PITTSBURG SLEEP QUALITY INDEX

PITTSBURG SLEEP QUALITY INDEX (PSQI)

Name ________________________ SSN# _____________ Date __________ Age ____

Instructions:
The following questions relate to your usual sleep habits during the past 6 weeks only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past six weeks, when have you usually gone to bed at night?
   Usual Bed Time ______________

2. During the past six weeks, how long (in minutes) has it usually taken you to fall asleep each night?
   Number of Minutes _____________

3. During the past six weeks, when have you usually gotten up in the morning?
   Usual Getting Up Time _______________

4. During the past six weeks, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed.)
   Hours of Sleep Per Night _______________

For each of the remaining questions, check the one best response. Please answer all questions.

5. During the past six weeks, how often have you had trouble sleeping because you..

(a) Cannot get to sleep within 30 minutes

Not during the past month _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(b) Wake up in the middle of the night or early morning

Not during the past six wks _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(c) Have to get up to use the bathroom

Not during the past six wks _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(d) Cannot breathe comfortably

Not during the past six wks_____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(e) Cough or snore loudly

Not during the past six wks _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(f) Feel too cold

Not during the past six wks _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(g) Feel too hot

Not during the past six wks _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(h) Had bad dreams

Not during the past six wks_____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(i) Have pain

Not during the past six wks _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

(j) Other reason(s), please describe

____

____

How often during the past six weeks have you had trouble sleeping because of this?

Not during the past six wks _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

6. During the past six weeks, how would you rate your sleep quality overall?

    Very good ___________
    Fairly good __________
    Fairly bad ___________
    Very bad ____________

7. During the past six weeks, how often have you taken medicine (prescribed or “over the counter”) to help you sleep

Not during the past six wks _____	Less than once a week____	Once or twice a week ______	Three or more times a week ________

8. During the past six weeks, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past six wks _____ Less than once a week____ Once or twice a week ______ Three or more times a week ________

9. During the past six weeks, how much of a problem has it been for you to keep up enough enthusiasm to get things done?

No problem at all _______________
Only a very slight problem ____________
Somewhat of a problem ____________
A very big problem ______________

10. Do you have a bed partner or roommate?

No be partner or roommate ___________
Partner/roommate in other room __________
Partner in same room, but not same bed __________
Partner in same bed ______________

If you have a roommate or bed partner, ask him/her how often in the past month you have had….

(a) Loud snoring

Not during the past six wks _____ Less than once a week____ Once or twice a week ______ Three or more times a week ________

(b) Long pauses between breaths while asleep

Not during the past six wks _____ Less than once a week____ Once or twice a week ______ Three or more times a week ________

(c) Legs twitching or jerking while asleep

Not during the past six wks _____ Less than once a week____ Once or twice a week ______ Three or more times a week ________

(d) Episodes of disorientation or confusion during sleep

Not during the past six wks _____ Less than once a week____ Once or twice a week ______ Three or more times a week ________

(e) Other restlessness while you sleep, please describe

____
____

Not during the past six wks _____ Less than once a week____ Once or twice a week ______ Three or more times a week ________

APPENDIX D
VETERANS SPECIFIC ACTIVITY QUESTIONNAIRE

The Veterans Specific Activity Questionnaire (VSAQ)

Draw one line below the activities you are able to do routinely with minimal or no symptoms such as shortness of breath, chest discomfort, fatigue

1 MET - Eating, getting dressed, working at a desk.

2 METs - Taking a shower, walking down eight flights of steps.

3 METs - Walking slowly on a flat surface for one or two blocks. A moderate amount of work around the house, like vacuuming, sweeping the floors or carrying groceries

4 METs - Light yard work, i.e., raking leaves, weeding or pushing a power mower. Painting or light carpentry

5 METs - Walking briskly, i.e., four miles in one hour; social dancing; washing the car; spreading dirt with a shovel; carrying, loading, or stacking wood.

6 METs - Play nine holes of golf carrying your own clubs. Heavy carpentry; mow lawn with a push mower.

7 METs – Perform heavy outdoor work, i.e., digging, spading soil, etc. Play tennis (singles), carry 60 pounds, shoveling 10-15 pounds per minute.

8 METs – Move heavy furniture, job slowly, climb stairs quickly, carry 20 pounds upstairs.

9 METs - Bicycling at a moderate pace, sawing wood, jumping rope (slowly), heavy shoveling (digging ditches).

10 METs. – Brisk swimming, bicycle up a hill, walking briskly up a hill, job 6 miles per hour.

11 METs – Cross country ski, play basketball (full court), running 9 minutes per mile.

12 METs - Running briskly, continuously (level ground, 8 minutes per mile)

13 METs - Any competitive activity, including those which involve intermittent sprinting. Running competitively, rowing, backpacking.

1. Looking at the VSAQ, underline the activities that you are now able to do routinely with minimal or not symptoms such as shortness of breath, chest discomfort, or fatigue.

Not look down the page and find the activity that you just underlined that appears closest to the bottom. What is the number that appears to the left of that activity?
__________ METs

2. Did you notice any new and unusual feelings of discomfort, pain, fatigue, or anything else in the past that seems to be associated with your heart disease condition, and caused you to have to reduce your physical activity? Please describe these fellings;____
____

3. Please estimate (as best as you can) when you first experienced these feelings.
(month, day, year)_____________________________

4. How long have you been at a reduced level of physical activity because of the sign/symptom?

____

5. Look back at the VSAQ. Think back to the period of time before you began to experience the symptoms that you just described. Find the activity that appears closest to the bottom of the page that you were able to routinely do with minimal or no symptoms such as shortness of breath, chest discomfort or fatigue. What is the number that appears to the lest of this activity?
________METs

APPENDIX E
PAFFENBARGER PHYSICAL ACTIVITY QUESTIONNAIRE

Paffenbarger Physical Activity Questionnaire

1. Aside from any regular exercise, how many city blocks or the equivalent do you normally walk each day?

   ________ Blocks/day (let 12 blocks = 1 mile)

2. What is your usual pace of walking? (Please check one.)

   a. _________ Casual or strolling (less than 2 mph)

   b. _________ Average or normal (2 to 3 mph)

   c. _________ Fairly brisk (3 to 4 mph)

   d. _________ Brisk or striding (4 mph or faster)

3. How many flights of stairs do you climb up each day? _________ (1 flight = 10 steps)

4. List any regular physical activity or recreation you have actively participated in during The last month. Please remember seasonal sports or events.

	Sport, Recreation or Other Activity	Number of Times/Week	Minutes
a.			
b.			
c.			
d.			
e.			
f.			

5. On a usual day, how much time do spend on the following activities? Total for each day should add up to 24 hours.

a.	Vigorous Activity (digging in the garden, strenuous sports, jogging, aerobic dancing, sustained swimming, brisk walking, heavy carpentry, bicycling on hills, etc.)	_____________ Hours/Day
b.	Moderate Activity (Housework, light sports, regular walking, golf, yard work, lawn mowing, painting, repairing, light carpentry, ballroom dancing, bicycling on level ground, etc.)	_____________ Hours/Day
c.	Light Activity (office work, driving a car, strolling, personal care, standing with little motion, etc.)	_____________ Hours/Day
d.	Sitting Activity (eating, reading, desk work, watching TV, listening to radio, etc.)	_____________ Hours/Day
e.	Sleeping or reclining	_____________ Hours/Day
		_____________ = 24 hours

APPENDIX F
HEALTH COMPLAINT SCALE

Part A

Below are a number of complaints that people with health problems often have. Please read each item carefully and indicate how much each problem has bothered you lately: (circle answer).

How much were you bothered by the following **specific** problems:

1) Sleep that is restless or disturbed
0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

2) Tightness of the chest
0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

1) Feeling that you are not rested
0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

4) Fatigue
0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

5) Trouble falling asleep
0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

6) Inability to take a deep breath
0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

7) Stabbing pain in the heart
0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

8) Feeling exhausted without and reason
0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

9) Shortness of breath

10) Pain in heart or chest

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

11) Feeling weak

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

12) Feeling you can t sleep

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

Part B

How much have the following **general** problems bothered you lately:

1) The idea that your bad health is the biggest problem in your life

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

2) Not being able to work fluently, also with hobbies

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

3)Being afraid of illness

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

4) The idea that you were able to take on much more work formerly

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

5) Feeling blocked in getting things done

6) The idea that you have a serious illness

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

7) Feeling you are not able to do much

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

8) The idea that something serious is wrong with your body

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

9) Feeling that you are no longer worth as much as you used to be

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

10) Feeling despondent (having lost all hope)

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

11) Worrying about you health

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

12) Thinking that all your worries would be over if you were physically healthy

0. Not at all
1. A little bit
2. Moderately
3. Quite a bit
4. Extreme

APPENDIX G
BECK DEPRESION INVENTORY, VERSION II

Beck Depression Inventory (Version II)
(The Psychological Corporation, San Antonio, TX)

Beck, A.T., Steer, R.A., Ball, R., Ranieri W.F. (1996). Comparison of Beck Depression Inventories –IA and –II in psychiatric outpatients. J Person Assess, 67(3), 589-597

APPENDIX H
PATIENT INFORMATION FORM

Patient Information

Full Name ______________________________

Today's Date _______________

Address: ____

City: ______________ State: ____________ Zip:____________

Telephone: (____) _______________

Date of Birth ______________ Age _______

Please check the highest education level that you obtained:

Grade __________ ___ completed high school

__ associate college degree ___ bachelor's degree

__ master's degree ___ Ph.D or M.D.

Race: ___ Caucasian ___ Black ___ Hispanic

___ Native American ___ Asian ___ Other

Gender: ___ Male ___ Female

APPENDIX I
PATIENT DATA COLLECTION FORM

Dynamometer Strength & Body Composition Data Collection Form

Patient Name ________________ Test Date ______/_____/_______

Patient ID___________________ Test Interval _________________

Strength Assessment

Grip: Position _____ Trial 1 ___ lbs Trial 2 ___ lbs Trial 3 ____lbs **Average____lbs**

Elbow Flexion: Trial 1 ___ lbs Trial 2 ___ lbs Trial 3 ____lbs**Average____lbs**

Knee Extension: Trial 1 ___ lbs Trial 2 ___ lbs Trial 3 ____lbs**Average____lbs**

Skinfold Assessment

Skinfold Sites for Men:

Chest: Trial 1____mm Trial 2____mm Trial 3____mm **Average______mm**

Abdominal: Trial 1____mm Trial 2____mm Trial 3____mm **Average______mm**

Thigh: Trial 1____mm Trial 2____mm Trial 3____mm **Average______mm**

Sum of 3 sites:________mm

Skinfold Sites for Women:

Triceps: Trial 1____mm Trial 2____mm Trial 3____mm **Average______mm**

Suprailliac: Trial 1____mm Trial 2____mm Trial 3____mm **Average______mm**

Thigh: Trial 1____mm Trial 2____mm Trial 3____mm **Average______mm**

Sum of 3 sites:________mm

Circumferences:

Waist Circumference: ________mm

Hip Circumference: __________mm

Waist/Hip Ratio = __________

Body Mass Index:

Weight: _______kg

Height: ________m

BMI=(kg/m^2) = _________

APPENDIX J
TABLES LISTING DESCRIPTIVE CHARACTERICS AND MEDICAL HISTORY OF SUBJECTS AND CORRELATION MATRIX FOR PREDICTION EQUATION VARIABLES PRE-CABG AND POST-CABG

SUBJECT MEDICAL HISTORY TABLE

Table 1. Medical history for patients undergoing coronary artery bypass graft surgery at Carolinas Medical Center[a]

Variable	Study Group* (N = 55)	Research Patients* (N = 200)	NR CMC Group*[b] (N = 904)
MI[c]	38	50	49
MI 1-7 Days	23	16	24
MI 7-21 Days	14	8	3.9
MI >21 Days	62	27	19
Family History of CAD[d]	49	63	64
Diabetes	35	43	35
Hypercholesterolemia	72	69	65
COPD[e]	18	20	15
PVD[f]	25	22	17
CHF[g]	7	16	13
Angina	89		

[a]Patients undergoing coronary artery bypass graft surgery between November 1996 and December 1997 (total = 1104)

*Values are presented in percentages of samples in studied group

[b]NR = Patients not participating in research; [c]MI = Myocardial Infarction; [d]CAD = Coronary Artery disease; [e]COPD= Chronic Obstructive Pulmonary Disease; [f]PVD = Peripheral Vascular Disease; [g]CHF = Congestive Heart Failure

CHARACTERISTICS OF RETURNING VS. NONRETURNING SUBJECTS AT POST-SURGICAL INTERVAL

Table 2. Characteristics between patients that returned to the hospital at 3 mo and the patients that did not return to the hospital.

Variable	Returning (N = 44) Mean Score	Not returning (N = 11) Mean Score	Z score
Pre-surgery			
VSAQ[a]	4.3	3.8	-1.53
PSQI[b]	5.7	8.0	1.29
Age (yr.)	65	64	-0.3
EF[c]	47	45	-0.67
BMI[d] (kg/m2)	28	28	0.43
BF[e] (%)	24	23	-0.39
SHC[f]	13	22	1.89
CHC[g]	14	20	0.84
BDI[h]	8	14	0.94
Post-CABG			
VSAQ	5.4	5.0	-0.74
PSQI	6.1	6.9	0.51

*p < 0.05; **p < 0.01; ***p < 0.001

[a]VSAQ = Veterans Specific Activity Questionnaire; [b]PSQI = Pittsburgh Sleep Quality Index; [c]EF = Ejection Fraction; [d]BMI=Body Mass Index; [e]BF = Body Fat; [f]SHC = Somatic Health Complaints; [g]CHC = Cognitive Health Complaints; [h]BDI = Beck Depression Inventory

CORRELATION MATRIX FOR PRE-SURGICAL VARIABLES

Table 3. Correlation matrix for data variables used in prediction equation for pre-surgical sleep outcome

Variable	Sleep Score	Somatic HC	BDI	%BF
Sleep Score	1.0000	0.7180	0.7047	-0.0716
Somatic HC[a]	0.7180	1.0000	0.6868	0.1110
BDI[b]	0.7047	0.6868	1.0000	0.0297
%BF[c]	-0.0716	0.1110	0.0297	1.0000

*Presurgical data presented in correlation matrix is restricted to variables noted of importance in the regression equation for pre-surgical sleep outcome

[a]HC = Health Complaints; [b]BDI = Beck Depression Inventory; [c]%BF = Percent Body Fat

CORRELATION MATRIX FOR 3 MO POST-SURGICAL VARIABLES

Table 4. Correlation matrix for data variables used in prediction equation for post-surgical sleep outcome

Variable	Sleep Score	Somatic HC	BDI	%BF
Sleep Score	1.0000	0.8025	0.4886	0.3295
Somatic HC[a]	0.8025	1.0000	0.8202	0.1214
BDI[b]	0.4886	0.8202	1.0000	-0.1138
%BF[c]	0.3295	0.1214	-0.1138	1.0000

*Post-surgical data presented in correlation matrix is restricted to variables noted of importance in the regression equation for post-surgical sleep outcome
[a]HC = Health Complaints; [b]BDI = Beck Depression Inventory; [c]%BF = Percent Body Fat

APPENDIX K
RAW DATA

DEFINITIONS FOR VARIABLES IN RAW DATA

1. ID# = Subject number
2. Age = Age in years
3. GND = Gender (1 = male; 0 = female)
4. VST = Visit hospital for follow-up tests at 3 mo post-CABG (1 = no; 0 = yes)
5. EF = Ejection fraction
6. PRBMI = Pre-CABG body mass index (kg/m^2)
7. PSTBMI = Post-CABG body mass index (kg/m^2)
8. PRSSM = Pre-CABG sum of skinfold measures (mm)
9. PSTSSM = Post-CABG sum of skinfold measures (mm)
10. FHX = Family history (1 = yes; 0 = no)
11. MI = Myocardial infarction (1 = yes; 0 = no)
12. MI? = When did myocardial infarction occur prior to CABG (2 = 1-7 Days; 3 = 7-21 Days; 4 = > 21 Days)
13. DIAB = Diabetes (1 = yes; 0 = no)
14. COPD = Chronic obstructive pulmonary disease (1 = yes; 0 = no)
15. PVD = Peripheral vascular disease (1 = yes; 0 = no)
16. CHF = Congestive heart failure (1 = yes; 0 = no)
17. ANG = Angina (1 = yes; 0 = no)
18. SMHST = Smoking history (1 = yes; 0 = no)
19. CURSM = Current smoker (1 = yes; 0 = no)
20. DISVES = Number of disease vessels
21. PRGLSL = Pre-CABG global sleep score (0 – 21)
22. PRSQ = Pre-CABG sleep quality (0 – 3)
23. PRSL = Pre-CABG sleep latency (0 – 3)
24. PRSDU = Pre-CABG sleep duration (0 – 3)
25. PRSE = Pre-CABG sleep efficiency (0 – 3)
26. PRSDS = Pre-CABG sleep disturbance (0 – 3)
27. PRSM = Pre-CABG sleep medication (0 – 3)
28. PRDD = Pre-CABG daytime dysfunction (0 – 3)
29. PRSHC = Pre-CABG somatic health complaints (0 – 48)
30. PRCHC = Pre-CABG cognitive health complaints (0 – 48)
31. PRBDI = Pre-CABG Beck depression score (0 – 63)
32. PRVSAQ = Pre-CABG functional capacity score (MET)
33. PSGS = Post-CABG global sleep score (0 – 21)
34. PSSQ = Post-CABG sleep quality (0 – 3)
35. PSSL = Post-CABG sleep latency (0 – 3)
36. PSSDU = Post-CABG sleep duration (0 – 3)
37. PSSE = Post-CABG sleep efficiency (0 – 3)
38. PSSDS = Post-CABG sleep disturbance (0 – 3)
39. PSSM = Post-CABG sleep medication (0 – 3)
40. PSDD = Post-CABG daytime dysfunction (0 – 3)

41. PSSHC = Post-CABG somatic health complaints (0 – 48)
42. PSCHC = Post-CABG cognitive health complaints (0 – 48)
43. PSBDI = Post-CABG Beck depression score (0 – 63)
44. PSVSAQ = Post-CABG functional capacity score (MET)
45. PSPPAQ = Post-CABG physical activity (kcal)

*An empty space indicates a lack of subject data for the item listed

ID#	AGE	GND	VST	EF	PRBMI	PSTBMI	PRSSM	PSTSSM
1	62	1	0	50	25.9	25.0	51	56
2	81	0	0	55	23.5	32.5	60	50
3	53	1	0	55	34.5	30.5	101	78
4	54	1	0	50	29.2	29.8	79	68
5	56	1	0	40	33.1	30.5	89	89
6	63	1	0	60	28.0	26.4	81	54
7	63	1	0	50	28.5	27.7	59	58
8	57	1	0	50	21.1	21.9	39	58
9	66	1	0	60	26.6	26.5	84	65
10	69	1	0	55	29.7	28.6	62	58
11	52	1	0	65	33.2	32.2	78	76
12	75	1	0	50	28.9	24.6	48	37
13	76	0	1	45	23.4		69	
14	68	1	0	30	21.5	21.0	25	24
15	76	1	0	65	23.5	22.8	35	33
16	71	0	0	50	27.7	28.0	71	71
17	70	1	0	50	24.2	25.3	44	43
18	63	0	1	70	27.8		49	
19	56	1	0	45	35.4	33.6	54	69
20	78	1	0	50	21.1		34	
21	68	1	0	40	23.6	23.9	57	57
22	60	1	0	50	45.5	43.2	121	142
23	56	1	1	60	25.6		65	
24	76	1	1	50	22.8		47	
25	55	1	0	60	27.5	27.5	87	94
26	59	1	0	45	28.2	26.9	75	71
27	63	1	0	30	24.3	24.6	49	58
28	54	1	1	55	29.8		74	
29	60	0	0	40	34.6	36.8	84	89
30	47	1	0	35	25.9	27.9	76	82
31	81	0	0	40	29.5	29.7	85	85
32	58	1	0	50	25.4	26.4	39	47
33	68	0	1	40	30.8		85	
34	51	1	1	30	30.3		71	
35	77	1	0	60	28.5		101	
36	60	1	0	30	28.6		75	
37	76	1	0	25	21.3		58	
38	56	0	0	65	41.9		116	
39	49	1	0	40	26.8		63	
40	60	1	1	45	35.9		61	

ID#	**AGE**	**GND**	**VST**	**EF**	**PREBMI**	**PSTBMI**	**PRSSM**	**PSTSSM**
41	67	1	0	50	27.1	30.2	64	69
42	77	1	0	50	32.1	32.1	76	82
43	76	1	0	60	23.0		62	
44	71	1	0	15	28.8		66	
45	58	1	0	35	23.0		45	
46	70	1	0	50	18.2		31	
47	66	1	1	30	25.7		59	
48	53	1	0	35	21.1	20.7	55	50
49	65	0	1	25	23.5		36	
50	68	1	1	40	29.6		51	
51	57	1	0	40	23.7		71	
52	67	1	0	40	32.6	34.1	85	99
53	66	0	0	50	20.8		36	
54	68	0	0	50	29.0		97	
55	70	1	0	35	26.6		63	

ID#	FHX	MI	MI?	DIAB	HYC	COPD	PVD	CHF	ANG
1	1	0		0	1	0	0	0	1
2	1	0		0	1	1	1	0	1
3	1	0		0	1	0	0	0	1
4	1	0		0	0	0	0	0	1
5	1	0		1	1	0	0	0	1
6	0	1	4	0	0	0	0	0	1
7	0	0		1	0	0	1	0	1
8	0	1	2	0	1	0	0	0	1
9	1	0		0	1	0	1	0	1
10	0	0		1	1	0	0	0	1
11	0	0		0	0	0	0	0	1
12	0	0		1	1	0	0	0	0
13	0	1	3	0	1	0	0	0	1
14	1	0		1	0	0	0	0	1
15	0	0		0	1	0	0	0	1
16	0	1	4	1	1	0	0	0	1
17	1	0		0	1	0	0	0	0
18	0	0		1	1	0	0	0	1
19	0	0		1	1	0	1	0	1
20	0	0		0	0	1	0	0	1
21	0	1	4	0	1	0	0	0	1
22	0	0		0	1	0	0	0	1
23	0	0		0	1	0	0	0	1
24	1	0		1	0	0	1	0	1
25	1	0		0	1	0	0	0	1
26	0	0		0	1	0	0	0	1
27	1	1	4	0	0	1	1	0	1
28	1	0		0	1	0	0	0	1
29	0	1	4	1	0	0	0	0	1
30	1	0		0	1	0	0	0	1
31	0	1	3	1	1	0	1	1	1
32	1	1	2	1	1	1	0	0	1
33	1	1	4	0	1	0	0	0	1
34	0	1	4	0	0	0	0	0	1
35	0	0		0	1	0	0	0	1
36	1	1	4	0	1	0	0	0	1
37	0	0		1	1	0	1	0	1
38	1	0		1	1	1	0	0	0
39	1	0		1	1	1	0	0	1

ID#	FHX	MI	MI?	DIAB	HYC	COPD	PVD	CHF	ANG
40	1	0		1	1	0	1	0	1
41	0	0		0	0	0	0	0	1
42	1	0		0	1	0	0	0	1
43	1	0		0	1	0	0	0	1
44	0	1	4	0	0	0	0	0	0
45	1	1	4	0	1	0	0	0	1
46	1	0		0	0	1	1	0	1
47	0	1	3	1	1	0	0	1	1
48	1	1	2	0	0	0	0	0	0
49	0	1	4	0	1	0	0	1	1
50	1	1	4	1	1	1	0	0	1
51	1	1	4	0	1	1	1	0	1
52	1	1	2	0	1	0	1	1	1
53	0	0		0	0	0	1	0	0
54	0	0		1	1	0	1	0	1
55	0	1	2	0	1	1	0	0	1

ID#	SMHST	CURSM	DISVES
1	1	1	3
2	0	0	3
3	1	0	3
4	0	0	3
5	1	0	2
6	1	1	3
7	1	0	2
8	1	1	3
9	1	1	3
10	1	0	2
11	1	1	2
12	1	1	2
13	0	0	2
14	0	0	3
15	1	0	2
16	0	0	2
17	1	0	3
18	1	0	3
19	1	0	3
20	1	0	2
21	1	0	3
22	1	0	2
23	1	0	2
24	0	0	3
25	0	0	3
26	1	0	3
27	1	1	3
28	1	1	3
29	1	0	3
30	1	1	2
31	1	0	3
32	1	1	3
33	0	0	3
34	1	1	2
35	1	0	3
36	1	1	3
37	1	0	3
38	1	0	3
39	1	1	2
40	1	0	3

ID#	SMHST	CURSM	DISVES
41	1	0	2
42	1	0	2
43	1	0	2
44	1	0	3
45	1	0	3
46	1	0	3
47	0	0	3
48	1	1	2
49	1	1	2
50	1	0	2
51	1	1	2
52	1	1	3
53	1	0	3
54	0	0	3
55	1	0	2

ID#	PRGLSL	PRSQ	PRSL	PRSDU	PRSE	PRSDS
1	1	0	0	0	0	1
2	3	1	0	1	0	1
3	6	2	0	2	0	1
4	3	1	0	1	0	1
5	3	1	0	0	0	2
6	3	0	1	0	0	1
7	14	2	3	3	3	2
8	4	1	0	1	0	1
9	2	0	0	1	0	0
10	3	1	0	0	0	1
11	7	1	2	1	0	2
12	4	1	1	0	0	2
13	11	1	3	1	1	2
14	4	1	0	0	0	2
15	9	0	1	3	3	1
16	15	2	2	3	3	2
17	5	1	2	0	0	2
18	20	3	3	3	3	3
19	12	2	3	3	0	3
20	4	1	0	0	0	2
21	8	2	1	1	3	1
22	6	1	2	0	0	2
23	6	0	2	1	0	2
24	14	3	2	1	2	2
25	7	1	2	1	0	2
26	5	1	1	0	0	2
27	8	1	0	1	0	2
28	8	1	3	1	1	1
29	5	1	1	0	0	2
30	7	1	2	2	0	1
31	14	3	3	2	2	2
32	12	3	2	0	0	2
33	4	1	1	0	1	1
34	7	1	2	2	1	1
35	3	1	1	0	0	1
36	4	1	0	1	0	2
37	6	1	1	0	0	1
38	6	1	1	1	0	2
39	5	1	1	1	0	2
40	3	0	1	1	0	1

ID#	PRGLSL	PRSQ	PRSL	PRSDU	PRSE	PRSDS
41	1	0	0	0	0	1
42	9	1	3	0	0	1
43	7	1	1	1	0	1
44	6	1	0	1	0	1
45	4	1	0	1	0	1
46	4	1	0	1	0	1
47	3	0	1	0	0	1
48	3	1	0	1	0	1
49	9	3	2	0	0	1
50	3	1	1	0	0	1
51	5	0	2	0	0	2
52	3	0	1	0	0	2
53	1	0	0	0	0	1
54	6	1	0	0	3	2
55	2	0	0	0	0	1

ID#	PRSM	PRDD	PRSHC	PRCHC	PRBDI	PRVSAQ
1	0	0	9	16	2	9
2	0	0	5	2	3	5
3	0	1	18	8	16	6
4	0	0	11	2	2	7
5	0	0	22	3	2	6
6	0	1	12	27	8	5
7	0	1	30	15	13	4
8	0	1	4	4	4	9
9	0	1	10	15	11	4
10	0	1	12	23	8	3
11	0	1	10	14	9	7
12	0	0	11	8	2	3
13	3	0	34	35	7	3
14	0	1	8	7	3	7
15	0	1	1	3	1	7
16	0	3	30	29	17	5
17	0	0	6	9	4	4
18	3	2	39	40	51	7
19	0	1	24	44	26	3
20	0	1				4
21	0	0	7	7	9	5
22	0	1	17	10		5
23	0	1	25	4	5	8
24	3	1	27	22	12	5
25	0	1	7	9	7	9
26	0	1	7	15	12	9
27	3	1	16	15	6	3
28	0	1	6	7	6	3
29	0	1	18	9	4	4
30	0	1				10
31	0	2				3
32	3	2	36	41	34	3
33	0	0	13	26	9	4
34	0	0				9
35	0	0	12	18	18	3
36	0	0	16	24	8	5
37	3	0				3
38	0	1				3
39	0	0				4
40	0	0				3

ID#	PRSM	PRDD	PRSHC	PRCHC	PRBDI	PRVSAQ
41	0	0				5
42	3	1	15	9	10	5
43	3	0	7	8	12	9
44	3	0	12	20	6	5
45	0	1				7
46	0	1	13	18	8	4
47	0	1				7
48	0	0	2	12	1	11
49	3	0				3
50	0	0	11	4	8	3
51	0	1	25	33	16	4
52	0	0	3	3	3	3
53	0	0	5	2	0	6
54	0	0				6
55	0	1	6	2	2	6

ID#	PSGS	PSSQ	PSSL	PSSDU	PSSE	PSSDS	PSSM
1	2	0	0	0	0	2	0
2	4	0	1	1	0	1	0
3	9	2	2	1	0	2	1
4	5	1	0	2	0	1	0
5	5	2	1	1	0	1	0
6	5	0	1	1	1	1	0
7	12	1	2	2	3	1	3
8	2	0	0	1	0	1	0
9	4	0	0	1	0	0	0
10	9	1	2	1	2	1	1
11	8	1	2	1	1	2	0
12	3	0	1	0	0	1	1
13	7	1	1	1	2	1	0
14	2	1	0	0	0	1	0
15	2	0	0	1	0	1	0
16	11	1	3	2	3	2	0
17	1	0	0	0	0	0	0
18	15	2	3	3	3	1	3
19	5	1	1	1	0	1	0
20	3	1	0	0	0	1	0
21	12	2	2	2	3	2	0
22	2	0	1	0	0	1	0
23	3	0	0	1	0	1	0
24	3	0	1	1	0	1	0
25	4	0	1	1	0	1	0
26	3	0	1	0	0	1	0
27	9	1	1	1	0	2	3
28	4	0	1	1	1	1	0
29	8	1	1	1	1	2	1
30	6	1	2	1	0	1	0
31	14	3	2	2	1	2	3
32	13	2	3	1	3	2	0
33	7	1	1	1	3	1	0
34	11	2	3	2	0	1	3
35	6	1	2	1	1	1	0
36	6	1	3	0	0	2	0
37	10	1	3	1	0	1	3
38	3	1	0	0	0	2	0
39	8	1	3	1	1	1	0
40	5	1	1	1	0	2	0

ID#	PSGS	PSSQ	PSSL	PSSDU	PSSE	PSSDS	PSSM
41	1	0	0	0	0	1	0
42	8	0	2	1	0	1	3
43	7	0	0	1	1	1	3
44	12	1	2	1	1	2	3
45	2	0	0	1	0	1	0
46	6	1	2	1	1	1	0
47	2	0	0	0	0	1	0
48	4	1	1	1	0	1	0
49	14	1	3	3	3	1	3
50	5	1	0	1	0	1	0
51	7	0	3	1	1	1	0
52	17	3	3	2	3	2	3
53	0	0	0	0	0	0	0
54	5	1	0	1	2	1	0
55	2	0	0	1	0	1	0

ID#	PSDD	PSSHC	PSCHC	PSBDI	PSVSAQ	PSPPAQ
1	0	4	12	1	9	
2	1	5	5	7	5	
3	1	9	11	7	6	
4	1	6	1	0	7	
5	0	5	22	0	6	
6	1	3	7	4	5	
7	0			3	4	
8	0	0	0	0	9	
9	0	6	1	6	4	
10	1	14	15	6	3	
11	1	12	11	8	7	
12	0	2	7	3	3	
13	1				3	
14	0	6	14	7	7	700
15	0	1	2	0	7	
16	0	12	3		5	
17	1	7	9	3	4	3595
18	0				7	
19	1	6	6	6	3	392
20	1	5	18	7	4	168
21	1	14	22	8	5	2688
22	0	0	0	0	5	4606
23	1				8	280
24	0				5	1400
25	1	5	3	5	9	1480
26	1	9	18	13	9	1288
27	1	10	9	6	3	224
28	0				3	406
29	1	9	8	2	4	448
30	1	9	6	10	10	2122
31	1	21	15	8	3	1064
32	2	31	33	27	3	1794
33	0				4	112
34	0				9	1344
35	0	8	16	7	3	1344
36	0	20	21	6	5	2361
37	1	8	3	16	3	56
38	0	12	15	13	3	692
39	1	13	12	3	4	1428
40	0				3	56

ID#	PSDD	PSSHC	PSCHC	PSBDI	PSVSAQ	PSPPAQ
41	0	4	2	2	5	1572
42	1	15	4	9	5	1272
43	1	10	12	3	9	4944
44	2	18	11	0	5	672
45	0	0	3	5	7	1422
46	0	12	16	6	4	196
47	1				7	1463
48	0	2	3	1	11	
49	0				3	1068
50	2				3	739
51	1	9	13	7	4	2716
52	1	14	8	5	3	2352
53	0	0	0	0	6	1256
54	0	7	4	11	6	2081
55	0	5	0	0	6	2069

VITA

Dana L. Moye

Dana Lynn Moye was born on January 13, 1973. She is the daughter of Dale and Gail Moye of Pearisburg, VA., and has one sister, Tamatha. Dana attended Giles High School where she participated in basketball, volleyball, and tennis. She graduated from GHS in 1991. Dana attended Virginia Polytechnic Institute and State University and completed her undergraduate degree in the Communication Studies department in the spring of 1995. She began her graduate work at VPI&SU in the department of Human Nutrition, Foods, & Exercise in the fall of 1996. Her degree is in clinical exercise physiology with a concentration in cardiac rehabilitation. Upon completion of her degree, Dana plans to find employment that will complement both her undergraduate and graduate degrees. She is particularly interested in health promotion and health education within the elderly population. Other interests include marketing and sales in the healthcare industry.