Title
Predictors of Recovery in Older Adults Following Cardiac Surgery

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Predictors of Recovery in Older Adults Following Cardiac Surgery

by

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DISSERTATION

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DEDICATION

To Marshall V. Marchbanks, MD, FACS, who has guided and mentored me for over 20 years, first as a staff nurse, then as a nurse practitioner caring for cardiac surgery patients; and who has consistently modeled for me the link between caring and healing; thank you so much!

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ABSTRACT

Problem: Cardiac surgery is frequently performed in older adults, but little is known about the quality of recovery (QoR) during the first postoperative month. Older adults are less likely to regain prior functional status by hospital discharge and temporary postoperative functional loss may become permanent, adversely affecting QoR. Study aims were to: examine relationships between pain, wound healing, surgical risk, functional status, mood, quality of life (QoL) and QoR at discharge and 30 days; estimate effects of change over time in functional status, mood and QoL on the change in QoR from discharge to 30 days; describe factors hindering or promoting recovery and the amount of recovery achieved one month after cardiac surgery in older adults.

Methods: In this prospective cohort study, functional status, mood, and QoL were assessed preoperatively, at discharge, and 30 days postoperatively. Wound healing and pain were assessed for five days postoperatively and at 30 days. Surgical risk was assessed preoperatively. QoR was assessed at discharge and 30 days. A one-month interview assessed promoters and inhibitors of recovery, and percentage of achieved recovery. Non-parametric correlation and multi-level negative binomial regression were used for analysis.

Results: Subjects (n = 62) were mostly male (74.2%) with a mean age of 75.9 (SD 7.01). Preoperative functional status, measured with basic activities of daily living (BADL) and intermediate activities of daily living (IADL), correlated with QoR at discharge (rho = .35, .37) and 30 days (n = 59, rho = .46, .27). Preoperative mood and QoL correlated with QoR at 30 days (rho = -.43, .53). Multi-level models showed significant changes between the variables and QoR over time, with the greatest difference in QoR resulting from the change in IADL. Family support was identified as the most important promoter of recovery and mobility limits as the greatest hindrance, while 62% had perceived recovery levels of 75% at 30-days.

Conclusions: Functional status predicts QoR in older cardiac surgery patients. Future research needs to address methods of improving functional status in the first postoperative month to improve QoR in older cardiac surgery patients.

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Introduction

Cardiovascular disease (CVD) is a major health issue worldwide, and has been ranked the number one killer in the United States since 1900 (Rosamond et al., 2007). Most CVD is coronary heart disease (CHD) or valvular disease. CHD is disease of the coronary arteries that impairs coronary blood flow. Angina or myocardial infarction may result from the reduced blood supply to the myocardium. The prevalence of CHD increases with age. For those aged 60 to 79, 22.8% of men and 15.4% of women have CHD, and for ages 80 and older, the prevalence is 32.7% and 21.6% for men and women, respectively (Rosamond et al., 2008).

Disease of the heart's valves is also prevalent in the elderly. Thickening of the leaflets due to calcium deposits or prolapse of the leaflets into the chambers affects forward flow from the heart through the systemic circulation. Symptoms of dyspnea and fatigue may result from valvular dysfunction. In 2005, approximately 59,000 patients age 65 or older had valve replacement or repair compared to 34,000 between ages 44 and 64 (Rosamond et al., 2008).

Cardiac surgery is the treatment of choice to relieve symptoms and improve quality of life in patients whose coronary artery disease is not amenable to medicine, catheter based intervention or for those who require valve replacement or repair (Bojar, 2004). Patients well into their eighth decade, and in some instances, even those over 100 years of age, undergo coronary artery bypass grafting (CABG), valve procedures or combination surgeries (Bacchetta et al., 2003; Bridges, Edwards, Peterson, Coombs, & Ferguson, 2003). In 2005, 377,000 cardiac surgeries in this country were conducted on patients 65 years or older (Rosamond et al., 2007). Age alone, therefore, is not a contraindication to surgery.

The population of older adults is increasing. By 2030, over 51 million adults residing in the United States will be 65 or older, including more than seven million over age 85 (Conaway, et al, 2003). Characteristics of the aging population include an increase in chronic diseases and depression, and a decline in cognitive skills, functional ability and quality of life (*Healthy aging: Preserving function and improving quality of life among older Americans.*, 2008; Stotts & Hopf, 2005). Hospitalized older adults, particularly those that have experienced a prehospital functional decline, are less likely to achieve their prior functional status by the time of discharge (Covinsky et al., 2003). Considering the increasing number of older adults, and the high incidence of cardiac surgery in older adults, it is important to understand the factors that may improve the quality of their postoperative recovery.

Significance

Recovery from surgery is a particularly important concept for older adults, since loss of functional ability postoperatively may become permanent if not promptly addressed and treated. Thus, early recovery is a pivotal concept in the care of older adults (Stotts & Wu, 2007). To date, the quality of recovery in an elderly population after cardiac surgery has received little attention and literature addressing the quality of cardiac surgery recovery from the patient's point of view is limited. Studies of cardiac surgery in older adults initially examined mortality, morbidity, and costs as outcomes. Older age, female gender, comorbidities, nature and type of cardiac surgery (valve or CABG or combined valve/CABG; emergent vs. elective), and depression were associated with adverse outcomes (Almassi et al., 1999; Aziz & Grover, 1999; Beauford et al., 2003; Doering, Moser, Lemankiewicz, Luper, & Khan, 2005; Ghosh, Djordjevic, Schistek, Baier, & Unger, 2003). More recent studies examining the old and very old have shown that health related quality of life (HRQL), functional status, and cognitive outcomes were predictors of surgical mortality and morbidity. Mood states, particularly depression, have been examined primarily in cohorts younger than 65 years old (Doering, Cross, Magsarili, Howitt, & Cowan, 2007; Doering et al., 2005; Halpin & Barnett, 2005; Rankin, 1990; Utriyaprasit & Moore, 2005) with a few exceptions (Doering, Magsarili, Howitt, & Cowan, 2006; Halpin & Barnett, 2005). Increasingly, improved HRQL has been recognized as being a primary outcome of surgery in the oldest patients, yet the link between overall quality of life and quality of recovery has received less attention.

Factors that affect older cardiac surgery patients' recovery need further investigation, especially operative mortality risk, pain, wound healing, functional status, mood state, overall quality of life and factors that patients identify as inhibitors or promoters of recovery. Establishing parameters for quality of recovery in terms of these factors will contribute to providers' realistic expectations for older adults who are considering revascularization or valve surgery, as well as patients' own expectation of the recovery process. Understanding temporal relationships will contribute to nurses' ability to adequately plan measures to promote recovery, beginning preoperatively and continuing through rehabilitation. Awareness of the predictors of recovery and the factors that help or hinder the process in an aging population will permit care that is individualized. Determining the meaning of recovery to older adults facing cardiac surgery, and their expectations following surgery, as well as knowledge of the predictors, are fundamental to the development of targeted interventions to optimize recovery in this growing, at-risk population.

Aims

Thus, this study was conducted to examine the changes in bio-psychosocial factors that may influence recovery during the first month following cardiac surgery in older adults. The specific aims of the study were to:

1. Describe and examine the relationships of each of the following factors to quality of recovery at discharge and at 30 days after surgery:
   - 1.1 pain
   - 1.2 wound healing
   - 1.3 surgical risk
   - 1.4 functional status
   - 1.5 mood state
   - 1.6 global quality of life
2. Estimate the effects of the changes over time in the following factors on the change in the quality of recovery from discharge to 30 days after surgery:
   - 2.1 functional status
   - 2.2 mood state
   - 2.3 global quality of life
3. Describe older patients' perception of factors that promote and hinder their recovery after cardiac surgery;
4. Describe older patients' perception of the differences from their preoperative state and amount of recovery achieved one month after cardiac surgery.

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This chapter focuses on the literature that pertains to recovery of older adults following cardiac surgery. A description of cardiac surgery, recovery, and recovery of older adults after cardiac surgery is included. Pain, wound healing, health related quality of life (HRQL) and global quality of life (QoL), functional status, and mood are reviewed as components, or domains, of recovery from cardiac surgery in older adults. Within each topic, studies are presented in chronological order to illustrate what has been learned over time about selected domains of recovery in older cardiac surgery patients. The chapter ends with a conceptual model that illustrates the relationships suggested by the reviewed literature.

Papers reviewed for inclusion were identified by searches of PubMed, CINAHL-Plus, and Cochrane databases using the keywords cardiac surgery and aged, recovery, pain, mortality risk, functional status, wound healing, mood, and quality of life for the years 1990 to present. Citations were also abstracted from study references, including older studies that provide a foundation on which subsequent research, including this study, is based. The majority of studies included in this review are from the last 10 years, reflecting advances in surgical technique that are now standard and have been promoted as improving the recovery process. Papers in which the mean age of subjects was less than 65 are not reviewed here, unless the study included an older cohort.

Cardiac Surgery

Cardiac surgery patients face physiologic challenges that may affect their recovery. They are generally older, and may be deconditioned by not only underlying coronary artery or valve disease, but also by comorbidities such as obesity, diabetes, hypertension, renal and pulmonary disease. The conduct of the operation presents unique challenges to recovery as well. Because of the anatomical location of the heart, the majority of patients undergoing cardiac surgery have an incision which may extend from the sternal notch to the xyphoid process (Mill, Wilcox, & Anderson, 2003). Sternotomy incisions present unique challenges for healing, as the sternum is initially divided and then re-approximated at the end of the operation with stainless steel wire for stability. Patients must be particularly careful in supporting the sternum during daily activities and pulmonary toilet to prevent separation for the first three months after surgery until bone healing has advanced (Bitkover, Cederlund, Aberg, & Vaage, 1999).

Patients undergoing coronary artery bypass grafting (CABG) may also have leg or arm incisions at the vascular harvest site. Saphenous vein harvest sites, which are located in along the inner thigh or calf, can extend from the groin to ankle, and be several inches deep, if the vein is harvested by the traditional open method. Those with long leg incisions may find ambulation difficult because of increased pain and impaired healing, particularly if the patient's thighs touch or if the incision crosses the inner aspect of the knee. Endoscopic vein harvesting, in which the vein is dissected internally using a camera and cannula placed through small incisions located at the groin and knee, is now commonly performed and has alleviated much of this discomfort and impaired healing (Athanasiou et al., 2003). This approach is, however, not universally used because of increased cost and expertise required to obtain the vein.

Cardiopulmonary bypass (CPB), also known as extra-corporeal circulation or "on pump", is currently required for patients undergoing valve surgery or combination valve/CABG. During CPB, a cannula is placed in the inferior vena cava, blood is removed, passing through an oxygenator, and returned to the circulation via an aortic cannula. Cardiac function ceases, allowing the surgeon to work in a still, bloodless field. Other unique characteristics of cardiac surgery, such as myocardial cooling, hemodilution, and anti-coagulation increase risks for morbidity and mortality beyond those for the general surgery patient.

Because of exposure to a foreign body (plastic tubing), CPB initiates a state of systemic inflammation, which if severe, adversely affects homeostasis. To decrease this risk, technology now permits “beating heart” or “off pump” surgery during which CABG is conducted without CPB, although CPB is still required for most valve procedures. Operating on a beating heart requires additional surgical skills, and not all cardiac surgeons use this technique.

CPB was long thought to be the primary cause of postoperative cognitive changes caused by micro-bubbles and particulate matter entering the circulation, however, recent data show no difference in cognitive decline between CABG patients undergoing CPB (mean age 63.6[SD 9.4]) and non-surgical cardiac patients (mean age 65.9[SD 9.2]) (Selnes et al., 2008). Additionally, no differences have been shown in health related quality of life outcomes between those undergoing off or on pump CABG (Jensen, Hughes, Rasmussen, Pedersen, & Steinbruchel, 2006)

Recovery

Recovery is variously defined as a return to a normal state of health, a progression of healing following injury or illness, resumption of previous function, or the perception that one is recovering (Allvin, Berg, Idvall, & Nilsson, 2007; Stotts & Wu, 2007; Zalon, 2004). Surgical recovery is a phenomenon that is a result of a procedure performed on a patient to relieve, prevent, or repair a pathophysiologic problem. Recovery from surgery begins when anesthesia stops and continues until the patient achieves a similar or improved state than that possessed prior to surgery (Allvin et al., 2007). Postoperative recovery is described by Allvin et al., (2007) as

> an energy requiring process of returning to normality and wholeness as defined by comparative standards, achieved by regaining control over physical, psychological, social, and habitual functions, which results in returning to preoperative levels of independence/dependence in activities of daily living and an optimal level of psychological well-being.

Three phases of the recovery process have been identified: passivity, resumption of activity and stabilization (Baker, 1989). Achievement of recovery was obtained by sequential progression through the phases, and was based on pre-surgical states of physical, social & psychological being. Integrating input from professional and personal care providers, and personal coping styles determined how participants progressed along the continuum of recovery. Participants who were frustrated with their recovery progress described inhibitors such as fatigue that limited physical activity.

Perception is the ability to acquire and interpret sensory information via neurophysiological processes. Perception of recovery, therefore, can be defined as acquisition and interpretation of the information on physical, psychological and social states, with comparison to one’s preoperative status. An individual’s perception of recovery is by nature subjective. The quality of the recovery achieved, therefore, relates to the individual’s determination of the health status outcome reached after surgery (Myles et al., 2001; Myles et al., 1999).

The construct of quality of recovery (QoR) in this study has been measured by the QoR-40, an instrument developed and validated as a self-report measure of recovery from surgery and anesthesia (Myles, Viira, & Hunt, 2006). The instrument includes subscales of physical comfort, psychological support, physical independence emotional state, and pain that are summed for a global score. It is a subjective approach to quantifying the perception of the quality of recovery.

Recovery in Older Adults Following Cardiac Surgery

In older adults, surgical recovery may be compromised by decreased physiologic reserves, cognitive impairment, physical limitations and depressive symptoms (Zalon, 2004). Older adults have an increased risk for surgical mortality and morbidity if they have severe systemic disease, require emergency surgery, or are malnourished (Loran, Hyde, & Zwischenberger, 2005). Healing in older adults may be delayed because of a reduction in growth factor expression by senescent cells and impaired collagen formation. Clinically this may be manifested by an increased incidence of wound dehiscence because of reduced tensile strength (Gosain & DiPietro, 2004; Hunt & Hopf, 1997). Sensory loss and cognitive changes may limit an older adult's ability to understand and carry out instructions for postoperative care, putting the individual at greater risk for impaired healing and poor recovery (Stotts & Hopf, 2005). Additionally, self-efficacy perceptions affect self-care abilities in older adults (Easom, 2003), while health-related quality of life (HRQL) is related to self-efficacy and self care expectations in frail older adults (Stretton, Latham, Carter, Lee, & Anderson, 2006).

Hospitalized older adults are at risk for rapid functional decline (Volpato et al., 2007). Immobility from surgery or acute illness can result in decreased muscle mass, stiffness and weakness that negatively affect functional ability. Impaired functional ability may make it unsafe for an older patient to return to independent living after hospitalization, and can increase mortality risk (Graf, 2006). Additionally, hospitalized older adults with symptoms of depression are more likely to exhibit increased dependency in instrumental activities of daily living such as using a telephone, shopping, meal preparation, following medication instructions and managing finances (Covinsky, Fortinsky, Palmer, Kresevic, & Landefeld, 1997).

Cardiac surgery recovery has been described as a dynamic process involving bio-psychosocial factors that include healing, physical activity, relief of cardiac symptoms, emotional health, social relationships, cognition and satisfaction with life (King & Gortner, 1996). The first month after CABG has been characterized as being particularly difficult as patients experience distress from surgical pain, mood disturbances, fatigue, disturbed sleep, familial disruption, dyspnea, and in some instances, angina (Moore, 1997).

Older cardiac surgery patients are prone to specific complications because of physiologic changes. Adults aged 80 and above have more frequent need for reintubation, increased incidence of atrial fibrillation, and low cardiac output states, with associated increased length of stay and higher costs (Avery, Ley, Hill, Hershon, & Dick, 2001). Other researchers found the prevalence of atrial fibrillation in octogenarians following off-pump CABG to be 43%, compared to 19.4% for CABG in patients of all ages (Beauford et al., 2003). Diminished baroreceptor sensitivity, fewer sino-atrial cells, systemic hypertension, diminished chest wall and lung compliance, and weakened expiratory muscles caused by age-related changes in the heart and lungs, are responsible for the increased incidence of atrial fibrillation in older patients (Richards, 2007). Although findings demonstrated significantly lower physical function scores and higher bodily pain scores compared to age matched norms, 39 octogenarian long term survivors of cardiac surgery enjoyed good quality of life (Sjogren & Thulin, 2004). Another study showed that 81% of surviving octogenarians had positive feelings about the future and 94% said they would have the procedure again (Goyal, Henry, & Mohajeri, 2005). Data show that, given careful assessment and perioperative management, cardiac surgery in very elderly patients results in good outcomes and improved quality of life. However, there is little literature on the quality of recovery in older adults the first month after cardiac surgery.

Patients recovering from cardiac surgery must perform specific activities such as pulmonary exercises and increasing physical activity to promote return to health. Older patients who have been limited in their physical abilities preoperatively may experience difficulty understanding and performing these activities postoperatively. Functional status, mood state and overall perception of quality of life can affect an individual's belief that they have adequate ability, or self-efficacy, to carry out such activities successfully (Stretton et al., 2006). Limited recognition of the need to perform such activities may coexist with diminished confidence that activity performance is possible. In fact, one study demonstrated that a high self-efficacy expectation score explained 37% of the total variance in self-care/recovery performance 12 weeks after CABG (Carroll, 1995).

Outcomes of Cardiac Surgery in Older Adults

Pain

Postoperative pain in cardiac surgery patients is caused by surgical manipulation of the heart, the thoracic cage, vein harvest sites, and post-surgical procedures such as drain removal. Postoperative pulmonary toilet and mobility also contribute significantly to postoperative pain. Pain after cardiac surgery is acute, can become chronic, is related to placement and length of incisions, and is influenced by mood state, patient experience and perception (Lahtinen, Kokki, & Hynynen, 2006; Mueller et al., 2000; Nelson, Zimmerman, Barnason, Nieveen, & Schmaderer, 1998; Reimer-Kent, 2003).

As expected, data show that the most severe pain experienced by cardiac surgery patients occurs immediately after surgery and diminishes significantly for the most part in the early postoperative period. Research showed that CABG patients' postoperative sensory, affective and overall pain intensity decreased significantly between postoperative days 2 and 3, and that overall mean pain intensity was mild, decreasing from 1.1 on postoperative day (POD) 2 to 0.7 on POD 3 as measured on a 0 to 5 numeric rating scale (NRS) (Pozehl, Barnason, Zimmerman, Nieveen, & Crutchfield, 1995). Other data showed that while anxiety and pain intensity were significantly correlated on POD 2 and 3 and that pain perception was highest on POD 2, age was not significantly associated with postoperative pain severity (Nelson et al., 1998). Another study of CABG patients found that patients with short lateral thoracotomy incisions were able to get out of bed earlier but had more pain from coughing and getting out of bed the first two days postoperatively than patients with traditional midline sternotomy incisions (Walther et al., 1999). Pain severity in patients with a median sternotomy, highest on POD 1 and 2, decreased significantly by POD 3 and 7 (Mueller et al., 2000). Patients over age 60 in this study experienced less pain severity than the younger cohort. Pain location also changed over time, with patients experiencing more bone and joint discomfort on the seventh postoperative day. Aydin et al., (2005) noted that older women had resolution of pain faster than older men after CABG. Ballan and Lee (2007) found that patients had higher levels of pain six weeks postoperatively than preoperatively but the difference in pain scores was not significant. Effective management for postoperative pain following cardiac surgery is possible using around the clock non-steroidal anti-inflammatories and opiods on an as needed basis (Reimer-Kent, 2003).

Pain has been assessed in studies determining HRQL following cardiac surgery. Bodily pain improved significantly (p = .02) 12 months after cardiac surgery, but patients with continued pain and poor sleep experienced poor quality of life (p = .002) (Hunt, Hendrata, & Myles, 2000). Pain, in combination with depression and fatigue, was examined as a predictor of poor functional status and self-perception of recovery in older adults following abdominal surgery (Zalon, 2004). Although pain alone was not predictive of poorer perception of recovery, 31% of the variance in functional status 30 days postoperatively was attributed to the combination of pain, fatigue, and depression. For older women undergoing CABG, angina was a source of dissatisfaction preoperatively, but not postoperatively, and did not affect quality of life (Penckhofer et al., 2005). Few studies have been published that discriminate between pre-existing pain syndromes and acute postoperative pain and the effect on the recovery process.

Wound healing

Wound healing in older adults is affected by age, comorbidities, surgical expertise, and environmental factors (Stotts, 2007). Surgical site infection (SSI) is an important manifestation of impaired wound healing with the prevalence of SSI in all incisions ranging from 1.3 to 12.8% (Centofanti et al., 2007). Yet the clinical manifestations of infection are subtle in older adults (Stotts & Hopf, 2005), which may lead to under detection and delayed treatment. Older adults face healing of the sternum, the sternal incision and possibly vein harvest sites after cardiac surgery, and can have as many as five wounds. Additionally, increased pain has a deleterious effect on healing by increasing vasoconstriction and decreasing tissue oxygenation and perfusion (Ueno, Hunt, & Hopf, 2006). The overall pooled mean rate of deep sternal wound infection in 2004 was 2.19% (*National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004*, 2004), however, data were not reported by age. With the advent of endoscopic saphenous vein harvesting, impaired healing and infection incidence at the vein harvest sites decreased significantly (Athanasiou et al., 2003), but this method is not used by all surgical teams. Predictors of superficial sternal wound infection included obesity, diabetes in those over 65 years, and current smoking. In addition, when compared to those of normal weight, obese diabetic patients had a 7.7 times greater risk of deep sternal infection (Olsen et al., 2003). Similarly, in those older than 75, obesity was associated with a higher incidence of SSI (Maurer, Luchsinger, Wellner, Kukuy, & Edwards, 2002).

Investigation of the relationship between age and SSI yielded contradictory findings (Kaye et al., 2005). By randomly dividing a large sample (n = 144,485) of consecutive surgical patients with an infection rate of 1.2% into derivation and validation cohorts, the team developed a model that related age to SSI risk. Cardiothoracic SSI rates (2.3%) ranked second, and the mean overall age for patients with SSI was higher than for those without. Age greater than or equal to 65 was a significant predictor of SSI, but after age older than 74 became a protective factor in the total cohort. The researchers concluded that there was a complex relationship between age and SSI and that perhaps, as age increased and patients became frailer, that surgery was less commonly performed. "Hardy survivor" effects such as good overall health and functional status may explain the decreased infection rate in those over 80 years old. The findings suggested that age greater than 65 does not increase the SSI risk; however, the investigators were unable to track infections that occurred after hospital discharge and thus were not able to include those patients in the analysis.

Impairment of wound healing following cardiac surgery has been evaluated using the ASEPSIS wound assessment tool (Wilson, Treasure, Sturridge, & Gruneberg, 1986a). Data using this instrument showed correlates of impaired saphenous vein harvest site healing to be preoperative use of antibiotics and body mass index (Wipke-Tevis, Stotts, Skov, & Carrieri-Kohlman, 1996). Higher tissue oxygen levels were associated with lower (better) ASEPSIS scores post-CABG (Heiner, Whitney, Wood, & Mygrant, 2002).

Studies using ASEPSIS following cardiac surgery have not specifically targeted the elderly. Surveillance of older adults utilizing ASEPSIS, particularly those with comorbidities associated with SSI, would provide useful information and early identification of impaired wound healing, and allow early intervention.

Quality of life

Global or overall quality of life (QoL) is conceptually complex; it has been described as 'not just an absence of death but life with the vibrant quality that we associate with the vigor of youth' (Elkinton, 1966, in Huber, Goeber, Berdat, Carrel, & Eckstein, 2007, pg. 1099). Multiple subjective factors contribute to an individual's perception of his or her life's value. These factors include functional ability, employment, social activities, family relationships, and sexual activity as well as perception of health

(Rankin & Fukuoka, 2003). Quality of life can be conceptualized as a range of states that relate to self-satisfaction and well being, derived from aspects of life that are personally important to the individual (Ferrans & Powers, 1992).

Much of the recent literature focusing on older patients' outcomes following cardiac surgery has analyzed HRQL rather than overall QoL. Improved HRQL after cardiac surgery was associated with relief of cardiac symptoms, better functional ability, and is integral to a "good" recovery (Conaway et al., 2003). In an older cohort, HRQL, rather than longevity, may be a more important outcome (Bridges, Edwards, Peterson, Coombs, & Ferguson, 2003; Goyal et al., 2005; Jarvinen, Saarinen, Julkunen, Huhtala, & Tarkka, 2003). Qualitative studies reporting on QoL following cardiac surgery described patient experiences with recovery and rehabilitation as complex and extending over a protracted time period (Gardner, Elliott, Gill, Griffin, & Crawford, 2005; Tolmie, Lindsay, & Belcher, 2006). Women have been reported to have higher morbidity and mortality following CABG than men, but HRQL or global QoL has been evaluated in females in an inconsistent manner (Baldassarre, Arthur, Dicenso, & Guyatt, 2002; Penckofer, Ferrans, Fink, Barrett, & Holm, 2005). Preoperative health status was identified as a predictor of postoperative HRQL, with those in poorer health more likely to experience improved HRQL than those whose HRQL was good preoperatively (Markou & Noyez, 2007). Age alone was not a predictor of poorer HRQL following CABG (Dunning et al., 2008).

A Canadian retrospective cross-sectional study measured HRQL in octogenarians (n = 127) following cardiac surgery using the Medical Outcomes Study Short Form-36 (SF-36), and additionally for those that had CABG, the Seattle Angina Questionnaire

(SAQ) (Fruitman, MacDougall, & Ross, 1999). Data showed greater role limitations in physical ($p = .003$) and emotional ($p = .0001$) health compared to general population norms, but higher emotional well-being ($p = .0001$) and social function ($p = .01$). At follow-up, 84% of the survivors were living in their own homes, with 36% living independently, but most were receiving support from a variety of sources.

The utility of the Fruitman et al. study is the use of a general measure (SF-36) and a disease specific measure (SAQ) to assess HRQL. Although no correlations between measures were reported, the investigators stated that the combination included all aspects of HRQL and that a good overall quality of life was achieved in surviving octogenarians. However, this statement applied only to the 82% of subjects in the sample that had CABG. Mortality and relative risk in this sample were similar to that of younger cardiac surgery patients but all patients were reviewed to determine candidacy for surgery by a medical team, introducing a possible selection bias.

Poor HRQL was associated with persistent pain ($p = .02$), and those with persistent pain were 5.1 times more likely than those without pain to rank their HRQL as poor to very poor ($p = .002$) in a study ($n = 123$, mean age 64) using summed SF- 36 scores following cardiac surgery (Hunt et al., 2000). No gender differences were shown in HRQL, in contrast to findings by others. Younger patients reported greater improvement in HRQL, but no statistics were provided to support this finding. Use of summed SF-36 scores to measure of HRQL had not been validated at the time of the study. Two homogeneous samples were used to compare changes in self-perception of HRQL since baseline data were not available for the sample of interest, indicating that data must be cautiously interpreted.

A prospective longitudinal study by the same research team examined the relationship between quality of recovery and HRQL in a sample (n = 120, mean age 63) three months after cardiac surgery (Myles et al., 2001). CABG was the most common procedure (79%). The Quality of Recovery-40 Index (QoR-40) was utilized to measure postoperative health status and quality of recovery. The SF-36 was used to measure HRQL. Baseline measurements on both instruments were obtained preoperatively. The QoR-40 was administered postoperatively on days one through three, and at one month and three months. The SF-36 was repeated at one and three months postoperatively. Data indicated that QoR on POD 3 was predictive of HRQL at three months ($p < .0005$), and that while participants had lower HRQL than age based norms preoperatively, at three months scores met or exceeded those norms. Longer operative times, pulmonary complications, and increased length of stay were significantly associated with low QoR-40 scores on POD 3. Similarly, postoperative respiratory complications (OR 7.94 [95% CI 1.2-51.2], $p = .012$), acute renal failure (OR 10.1 [95% CI 0.87-118], $p = .025$) and any major complication (OR 7.72 [95% CI 1.49-19.8], $p = .005$) were associated with poor quality recovery at one month. However, the width of the confidence intervals suggests that the number of patients with specific complications perhaps was too small for drawing conclusions.

Data indicated that there was a significant correlation between QoR and HRQL and that a poorer QoR-40 score on POD 3 was a reliable predictor of poor HRQL three months following cardiac surgery. Since participants who exhibited physiologic distress during their hospitalization received targeted interventions, the investigators suggested that the correlations between measures were less than they might have been had physiologic distress been untreated. A potential limitation of the study was the use of summed SF-36 scores as an indicator of HRQL, as this approach has not been validated. Multicollinearity between the instruments was addressed by removing similar dimensions from both instruments. The Myles, et al study had a stronger design than the Hunt, et al study, in that it utilized baseline measurements in the sample, supporting more robust inference.

HRQL in the elderly was assessed as a domain of health status and functional recovery one year following cardiac surgery (Conaway et al., 2003). The study described improvements in health over time in an older cohort (age > 75, n = 156) compared to younger subjects (age ≤ 75, n = 534) and established a database defining symptom relief, physical function and improved HRQL after CABG. The physical ability, frequency of angina, and quality of life subscales of the Seattle Angina Questionnaire (SAQ) were utilized to assess health status changes from baseline to one year postoperatively. Data showed similar mortality in the perioperative period for older and younger patients, but at one year, mortality was greater in older patients (11.5% vs. 5.4%, p = .008). In survivors, there was no difference in physical function, angina frequency, or HRQL.

Additionally, the SAQ subscales were administered to a subset (n = 224) of participants monthly for the first six months and at 12 months postoperatively. To compare recovery rates between older (n = 56) and younger (n = 168) cohorts in the subset, changes in SAQ scores were evaluated by repeated measures analysis of variance using age, time and age by time interaction as independent variables. Comparison of mean scores revealed a sharp decrease in physical function for both cohorts at one month, with a return to baseline in the younger group by six weeks, whereas the older group required six months to achieve baseline. At 12 months, both groups showed improvement in functional scores. The age by time interaction term was significant ($p = .009$), thus indicative of a slower recovery and improvement of physical function for those over 75 years of age. Angina relief was similar for both groups ($p = .86$). HRQL scores improved equally rapidly in both groups over time ($p = .44$). Despite a higher incidence of mortality in the first postoperative year, older patients gained equal benefits in improved physical functioning, angina relief, and HRQL as their younger peers.

Important identified limitations included selection bias, as the investigators had no means to compare study participants to those who did not have surgery. Approximately 27% of the original study sample was lost to complete follow-up at 12 months due to death or other reason, however, the research provided information on covariates of surgical recovery (symptom relief, improvement in physical functioning, and HRQL) in an older population. Data showed that recovery in older adults takes longer, but that at one year, health status benefits were similar between older and younger patients.

A secondary analysis ($n = 120$) of the Best Bypass Surgery trial examined HRQL in older adults following randomization to off-pump or on-pump CABG in a single center (Jensen et al., 2006). Mean age for the on-pump (CCAB) arm of the study was 75 (SD 4.2) and for the off-pump (OPCAB) arm, 76 (SD 4.8). The outcome was measured as the change between preoperative and three month postoperative scores on the SF-36 and Major Depression Inventory Scale (MDI), which was also used as a screening instrument.

Data showed no difference between groups at baseline with the exception of lower educational levels in the CCAB group, which was considered an incidental finding and not controlled for in the analysis. Both cohorts showed improvement in HRQL at three months. Baseline scores were lower than those found in the general population, but a number of subscale domains improved to the norm or better. Change scores from baseline to three months were not significantly different between groups, except for the CCAB group who had higher role emotional scores ($p = .04$), indicating better emotional role function. Data showed no significant difference in the incidence of depression between groups (OPCAB: OR 1.03[95% CI -.16 to .26] CCAB: OR .96, [95% CI -.37 to .14]), and no differences in the change in depressive symptoms (OPCAB: $p = .64$, CCAB: $p = .33$). This study was the first to describe HRQL in a randomized study between CCAB and OPCAB surgery, demonstrating that surgical approach has little effect on HRQL.

As evaluated by the SF-36, HRQL remained impaired 6 weeks after CABG in 54 Australian CABG patients with a mean age of 66.4 (SD 10.23) (Ballan & Lee, 2007). Physical function ($p < .001$), energy/vitality ($p = .004$) and general health perception ($p < .001$) subscales changed significantly from baseline, with significant improvement in physical component scores ($p < .001$) postoperatively while mental health scores remained unchanged. Pain increased from baseline; although the change was not significant, the researchers suggested that inadequate pain control perhaps had a negative effect on HRQL. As did Baldassarre et al., (2002), these investigators noted that pre-operative stress and other major life events may affect scores, making it difficult to assess the impact of CABG on quality of life.

A retrospective study investigated HRQL in Swiss octogenarians (n = 136) with a mean age of 82.3 (SD 2.1) following cardiac surgery using a modified SAQ (Huber et al., 2007). Follow-up data were obtained from 120 survivors with a mean follow up time of 30 months (range 2.3 months to 62 months). The SAQ was modified by the addition of questions on dyspnea severity for patients who underwent valve surgery. Thirty day and five year survival was 95% and 73%, respectively.

Symptoms decreased in 93%, and 72% had no angina or dyspnea, while 70% had no or only mild limitations in exercise capacity. Overall, 77% of the sample was very satisfied and 93% reported enjoying life. At the time of follow-up, 97% of patients were living in their own homes and caring for themselves. The authors concluded that HRQL improved in surviving octogenarians after cardiac surgery, and that acceptable mortality rates make surgery an option for very old patients. The study added more information about improvement in functional status, emotional state and perception of HRQL to the literature on cardiac surgery in the elderly, with results similar to other studies. Using the SAQ alone to assess HRQL was more appropriate in an older population, according to the authors, because of the instrument’s shorter length and specific attention to cardiac symptoms. The time span from surgery to follow-up may have affected the results, as those closer to surgery have less improvement than those farther out from operation.

Following cardiac surgery, overall functional HRQL improved after recovery (Koch et al., 2007). HRQL was assessed by the Duke Activity Status Index (DASI); the study objective was to determine the predictive ability of the postoperative DASI on survival of patients who had achieved recovery, although recovery was not defined. The sample (n = 6305), with a mean age of 66, was followed for a median of 8.6 years. Data showed that patients with lower HRQL had shorter survival; thus leading to the conclusion that long-term survival was directly impacted by the amount of functional recovery achieved. The authors justified use of the DASI as a quality of life measure since it is an instrument that uses peak oxygen capacity to measure physical function. However, the DASI does not assess mental health and the authors noted this as a limitation. The concept of achieved postoperative functional status as a predictor of long-term survival is intriguing and replication of this study in an older cohort would be an important addition to the literature.

Changes over time in women's quality of life were examined in a sample ($n = 74$) with a mean age of 65.13 (SD 9.94) undergoing isolated CABG (Penckofer et al., 2005). The researchers based their study conceptually on a quality of life model that links objectively measured data to the subjective experience of HRQL (Wilson & Cleary, 1995). Biologic and physiologic variables, symptom status, functional status, individual characteristics, environmental characteristics, general health perception, and overall quality of life were included in the model and measured preoperatively and at three months following surgery. Findings included significant decreases in the proportion of angina ($p < .001$) and dyspnea ($p = .014$), but not fatigue. Lower anxiety ($p < .001$), improved vitality ($p = .021$), health ($p < .001$), and well being ($p = .021$) contributed to overall psychological health at three months. Improvement in overall QoL ($p < .004$) was attributed to greater satisfaction with health and physical function ($p < .001$). A significant effect for time ($p < .001$) was found with simultaneous evaluation of all subscales on the Quality of Life Index, but not in univariate analysis. There were no differences between pre- and postoperative perceived usual activity levels, and 49% of participants reported taking part in cardiac rehabilitation or structured exercise ($p < .001$).

The investigators concluded that using Wilson and Cleary's framework provided a comprehensive picture of the effects of CABG on women's lives in this sample. Fewer cardiac symptoms, better psychological states, increased exercise program participation, and a better health perception contributed to higher global quality of life scores. Non-health related aspects contributed to poorer QoL. The higher levels of dyspnea and higher levels of fatigue at three months were attributed to the increased prevalence of cardiac disease with concomitant diabetes in the study sample than in other studies. Although emotional distress decreased, 25% of this sample continued to experience depression, leading to the conclusion that routine screening for emotional disturbances with treatment as indicated would improve outcomes. Although generalization may be limited, since the sample was small, and relatively healthy, the domains conceptualizing quality of life are well illustrated.

Wilson and Cleary's conceptual framework was used to examine the reciprocal relationship between patient assessment of global QoL and health status, with the researchers proposing that if QoL is an outcome of cardiac surgery that also affects perception of health, then it is difficult to determine the effect of the surgery on the outcome (Mathisen et al., 2007). This secondary analysis of CABG patients ($n = 120$, mean age 64.2) assessed the strength of the causal relationships at three, six and 12 months by using a stand alone question for Global Quality of Life (gQoL), the Norwegian Quality of Life survey (QoLS-N), and the general health subscale of the SF-

36. Causal relationships were examined reciprocally with structural equation modeling rather than in the customary linear and unidirectional fashion.

Global QoL was shown to be an independent predictor of the greatest change in general health status, which occurred between the preoperative and three months measurements ($p < .05$). However, the simultaneous reciprocal model was a better fit, demonstrated by significant path coefficients at three and six months from gQoL to general health (0.33 and 0.28, respectively).

Predominant paths emerged between both quality of life measures and general health in the simultaneous models, and in the cross-lagged model between global quality of life and general health between baseline and three months, the time of greatest change in general health perception. Between six and 12 months, a time of less physiologic stress, the predominant path was from general health towards QoLS-N. A similar temporal path existed in the simultaneous model.

Data also showed a wide variation in the regression coefficients between gQoL and general health perception, indicating to the investigators that either true variation existed between stable concepts, or that changing beliefs following surgery led to a structural variation that was not identified by the model. Additional variables to potentially explain the variance were not entered into the model because of the small sample size. The investigators hypothesized that the positive or negative physiologic effects of recovery from cardiac surgery affected the strength of the bidirectional paths between general health and QoL, and cautioned that discussion of the clinical impact of surgery with patients should be limited to functional status and symptom improvement, rather than improvement of QoL. The investigators also concluded that unidirectional causal models do not adequately explain the effect of cardiac surgery when QoL is an outcome. Replication of this study in a larger sample with an older and more heterogeneous population may reveal some differences in the strength of the pathways, enhancing decision-making and preparation for surgical recovery.

Analysis: Comparing findings between studies examining HRQL or global QoL as an outcome of cardiac surgery in older adults is challenging. Different measures are used to quantify the concept, at different times of measurement. Penckhoffer et al., (2005) and Baldaserre et al., (2002) both examined women's quality of life. The studies were similar in design and measurement time, but used very different instruments to measure the concept. Penckhofer et al.'s study measured Wilson & Cleary's five dimensions of increasingly complex factors affecting overall or global QoL, while Baldasserre et al. used a VAS and the SF-36 to measure HRQL. Though both studies showed increased QoL scores, Baldassarre et al. found that older women had higher mental health summary scores and lower physical component scores at three months than younger women, while Penckhofer et al. provided more detail about symptoms and function. The Penckhofer et al. study included more information on non-health aspects of QoL. Both studies contributed to the body of knowledge on women, an often over-looked segment of the population. Additional studies examining global QoL and its relationship to recovery in even older women would be useful.

Hunt et al., (2000) found that persistent pain, female gender, and poor sleep was associated with poor HRQL in 22% of subjects who did not improve 12 months after surgery. Scores on the SF-36 were lower than established norms preoperatively (Ballan & Lee, 2007; Jensen et al., 2006; Myles et al., 2001; Sjogren & Thulin, 2004; Tranmer &

Parry, 2004). Over time, scores improved to normal or higher in most instances, with the exception of physical scores in octogenarian survivors (Sjogren & Thulin, 2004), and women improved more than men in bodily pain and role physical subscales (Aydin, Yavuz, Duver, & Kutsal, 2006). Long-term surviving octogenarians had lower physical function but less pain than a non-surgical cohort (Sjögren & Thulin, 2004). Jensen et al., (2006) found improvement but no significant difference in HRQL randomized to OPCAB or CCAB. Mathisen et al., (2007) explored the reciprocal causal relationship between health perception and HRQL determining that changes in perception of health influence and are influenced by perception of global QoL. Factors other than cardiac surgery make it difficult to determine the impact of the operation on HRQL (Baldassarre et al., 2002; Ballan & Lee, 2007; Mathisen et al., 2007).

The concept of quality of life is operationalized differently depending upon the investigator's perspective. Makou & Noyex (2007) asked patients to rate their current state of health on a visual analogue scale from 0 to 100 as a measure quality of life. Goyal et al., (2005), used an investigator-developed questionnaire that required a dichotomous response regarding independence, contentment, feelings, and living status. Koch et al., (2007) operationalized HRQL as functional status using the DASI. Others used the SAQ as a measure of HRQL because it includes domains specific to patients with coronary artery disease. The most common method of assessing HRQL was the SF-36, and in some instances, subscale scores were summed for HRQL assessment (Hunt et al., 2000; Myles et al., 2001).

Although the SF-36 was developed to measure health domains, the SAQ to measure the effect of coronary disease, and the DASI to measure functional status, these instruments have been accepted as measures of HRQL. The SF-36 has also been used as a measure of functional ability and as an estimate of recovery following cardiac surgery (Barnason, Zimmerman, Anderson, Mohr-Burt, & Nieveen, 2000; Barnett & Halpin, 2003; Zimmerman et al., 2007). Mathieson et al., (2007) used the SF-36 to measure perception of general health. The question then arises: what is being measured with these instruments? Is it quality of life? Is it function? Is it general health? Is it recovery? Clarification of these questions may illuminate the concepts being measured and assist interpretation of findings utilizing the measures. However, these studies provide rich data on the phenomenon of HRQL following cardiac surgery in older adults. Researchers investigating HRQL in older adults universally concluded that for many older adults, the benefit of surgery outweighs the risks, although recovery may be slower. More information is needed on older patients' short-term recovery and its relationship to QoL to assist patients, families and providers in making decisions regarding the risks and benefits of cardiac surgery in older adults.

Functional status

Functional status is the ability to carry out required daily physical activities (Cohen & Marino, 2000), and improvement in the ability to carry out these activities of daily living is a marker of recovery (Barnason, Zimmerman, Nieveen, & Hertzog, 2006). Functional status has been examined as a predictor of mortality, an outcome, and as a domain of quality of life in old and very old cardiac surgery patients (Barnason et al., 2000; Barnett & Halpin, 2003; De Feo et al., 2002; Ghosh, Djordjevic, Schistek, Baier, & Unger, 2003; Mayer, Ergina, Morin, & Gold, 2003). Self-efficacy beliefs regarding ability have been found to be predictive of functional status post cardiac surgery (Allen, Becker, & Swank, 1990). A cross-sectional study compared functional status using subjective and objective measures at a mean of 74 days postoperatively, finding moderate correlations between perceived and physical performance deficits (LaPier, 2007). Preoperative functional status was found to be a more reliable predictor of survival and post operative function than age following CABG in an elderly sample (Mayer et al., 2003). In this study, women were more likely than men to have a poorer preoperative functional levels, possibly explaining the poorer outcomes in older women post CABG. There were no differences over time on SF-36 subscale scores between older and younger patients after CABG in a study examining functional status outcomes (Barnason et al., 2000).

The DASI was used to assess the functional status of 292 patients post CABG to determine the impact of age on functional outcome when age was divided into less than 70 years and 70 years and older (Hedeshian, Namour, Dziadik, Stewart, & Campos, 2002). The researchers hypothesized that if a significant negative effect was found in elderly patients (mean age 76.3 [SD 4.8]) between preoperative and six-month functional status, then CABG should be performed at an earlier age in patients with atherosclerotic disease to maximize functional benefits. The DASI scores showed significant increases from baseline in both groups. Mean baseline DASI scores were significantly lower in the older cohort ($p = .002$) and at six months ($p = .0001$) than in younger subjects, but the mean change in the score between groups was not significant; tercile results were similar. The researchers concluded that age does not have a negative effect on functional outcome after CABG at six months, so early surgery is not warranted.

Change in functional health status, operationalized as scores on the physical and role function components of the SF-20, was evaluated in older patients (n = 565, mean age 72.7 [SD 4.9]) during the first two years following CABG (Barnett & Halpin, 2003). Increases in physical function scores for both women and men were significant between baseline and one year ($p < .039$, $p < .001$, respectively), but not between the first and second years following surgery. Not surprisingly, the largest increase in physical function scores occurred in the youngest cohort, aged 65 to 69 years. Physical function scores declined between one and two years in the 75 to 79 year olds, but for those aged 80 to 84 increased 22% in the same period. Mean physical function scores for 80 to 84 year olds were higher at baseline than those aged 75 – 79, lower at 1 year, but higher at 2 years. Females had lower physical functional status scores at baseline, but improved at nearly twice the rate of men in the first year. Although women's gains were smaller during the second year, they had a 3% greater increase in physical function scores than men. Mortality data were not included.

Limits included lack of knowledge about attrition by age group or gender, low response rates, and no responses received from the oldest cohort, which perhaps was reflected in the higher mean score for the older age group. However, the study findings suggested that functional status improves in older adults following elective CABG, particularly in those aged 80 to 84.

An Italian study examined the impact of comorbidities, mood, and disability on functional recovery in older cardiac surgery patients (n = 204, mean age 75 [SD 3.8]) (De Feo et al., 2002). Functional capacity was determined by the 6 Minute Walk Test after admission to an inpatient rehabilitation unit. Disability was determined by the score on a nursing needs index, which assessed ability to carry out activities of daily living. A visual analogue scale (VAS) was used to determine self-perception of health status. Findings showed no correlation between clinical and psychological factors. Depression and anxiety, while correlated, were not related to recovery or the perception of health status. Age was weakly negatively correlated with the perception of well being at discharge from rehabilitation ($r = -.25$, $p < .05$). Disability was weakly negatively correlated with perception of well being at rehabilitation admission ($r = -.39$, $p < .05$) but was not correlated with perception of well being at discharge. Both functional recovery and health status perception improved with rehabilitation. The study provided additional information on the benefits of cardiac rehabilitation in older adults, by demonstrating significant improvement in functional status, health perception, and independence.

A prospective study compared lower extremity strength, and perception of mental and physical status between two groups of older adults ($n = 65$) following CABG (Dolansky & Moore, 2004). A pretest-posttest design was used to determine differences between those enrolled in a phase II cardiac rehabilitation program (CRP), and those who were not. Group determination was by self-selection. Mean age for the CRP group was 76.1 (SD 3.3) and for the no CRP group, 77.8 (SD 4.3). The intervention group achieved greater strength ($p < .05$) and balance ($p < .001$), and greater perception of physical function ($p < .001$). There was no difference in mental status perception. The data indicated that participation in cardiac rehabilitation promoted optimal outcomes in older cardiac surgery patients by improving lower extremity function and preventing physical decline.

A randomized controlled pilot study by Barnason and colleagues (2006) examined the effects of home communication and home care on the functional recovery of older patients (mean age 75.3 [SD 5.1]) after CABG (n = 50). The intervention consisted of a patented home telehealth communication device to augment standard home care support. Participants answered scripted questions related to symptom management daily for 12 weeks, and transmitted responses telelphonically. The SF-36 was used to measure physiologic and psychological function before discharge (baseline), at six weeks, and 12 weeks postoperatively. The experimental group had higher overall health functioning ($p < .01$) than the control group at 12 weeks. With home care visits as the covariate, no significant differences over time were discovered between the groups on the physiologic subscales of the SF-36. Both groups experienced improvement over time in physical function, but the experimental group had higher scores at both follow-up measurements. There were fewer emergency department visits for the experimental group. The study, though small, demonstrated potential benefits of an augmented home care program to enhance postoperative recovery; however, cost versus benefit analysis was not included.

An additional analysis on a subset (n = 40) of the above study examined the effect of the symptom management intervention on physical functioning and activity in older women (mean age 72.05[SD 5.4]) after CABG (Zimmerman et al., 2007). In the subset analysis, women in the intervention group had lower fatigue ($p < .05$) at six weeks and higher levels of physical activity ($p < .05$) at 12 weeks than the control group. Moderate correlations were found between symptoms and physical function. The researchers suggested development of targeted interventions to meet women's unique needs.

Changing functional capacity in older adults after cardiac surgery was evaluated using New York Heart Association (NYHA) classification, which is based on ability to perform physical activities. Class I individuals experience no limitations, Class II patients have no resting symptoms, but experience dyspnea, palpitations and/or fatigue with ordinary exertion, Class III patients remain comfortable at rest but experience symptoms with minimal activity, and Class IV patients experience symptoms at rest, with increased discomfort with activity (Bojar, 2004). The percentage of NYHA Class I/II patients increased from 34% preoperatively to 81% after cardiac surgery in a sample of octogenarians (Huber et al., 2007), which supported the findings of earlier studies justifying cardiac operations in the oldest old (Fruitman et al., 1999; Kumar, Zehr, Chang, Cameron, & Baumgartner, 1995).

A study examining 30-day mortality and outcomes in surviving octogenarians after cardiac surgery found that mean NYHA classification improved significantly following CABG, dropping from 2.7 to 2.0 ($p < .03$) (Schmidtler et al., 2008). Valve patients' functional classifications also improved significantly, with 80% of survivors living at home at the time of follow-up. The authors conclude that despite perioperative mortality approaching 10%, the clinical benefits of surgery outweigh the risks.

Analysis: Research findings support improvement of functional status after cardiac surgery in an older age group. Data show preoperative functional status as predictive of postoperative ability (Barnett & Halpin, 2003; Mayer, Ergina, Morin, & Gold, 2003), although the Barnett study was limited by a low response rate. Age was not a factor in the change in functional status over time since there was significant improvement from baseline in older and younger patients during the first post CABG year (Barnason et al., 2000). Interventions such as participation in Phase II cardiac rehabilitation (De Feo et al., 2002; Dolansky & Moore, 2004) and telehealth interventions improve functional status in older adults (Barnason et al., 2006; Zimmerman et al., 2007), however costs of the interventions were not addressed. Using the NYHA classification system assesses functional outcomes as an estimate of activity tolerance based on symptom experience. Studies using this measure have consistently shown improvement in function, which supports operating on older and oldest patients (Huber et al., 2007; Schmidtler et al., 2008).

Functional status is an important factor when considering cardiac surgery in older adults, especially those in the oldest age ranges. Research has shown that in older adults, functional status improves in the majority of subjects, if they survive the operation and its attendant risks. Investigation of activity performance over the first 30 days after surgery may yield opportunities for evaluating the impact of focused activities to improve functional status in older adults.

Mood state

Self-limiting or prolonged psychological changes ranging from mild to severe occur in patients undergoing cardiac surgery with symptoms unrelated to severity of cardiac disease (Gardner & Worwood, 1997). Relief of depression, anxiety, fatigue, and anger, in addition to relief of physiologic symptoms, characterizes recovery (Allvin et al., 2007). Studies on faith based coping skills (Ai, Peterson, Bolling, & Rodgers, 2006) and self-efficacy (Allen et al., 1990) have linked positive coping and attitude to better postoperative outcomes. In older adults, altered mood affects overall health and quality of life. An estimated 7 million older Americans are depressed, which negatively affects treatment for cardiac disease and other chronic illness (*Healthy aging: Preserving function and improving quality of life among older Americans*. 2008). Acutely ill older adults with six or more symptoms of depression were more likely to have poorer health following hospitalization than those with fewer depressive symptoms, although a causal effect has not been established (Covinsky et al., 1997). Pain, depression and fatigue accounted for 31% of the variation in functional status and 33% of the variation in self perception of recovery in older adults after abdominal surgery (Zalon, 2004). Depression after CABG was associated with impaired wound healing, increased infections, and poor recovery outcomes (Doering, Moser, Lemankiewicz, Luper, & Khan, 2005). A pessimistic outlook was associated with longer ventilation times and permanent neurological dysfunction in a sample of older adults undergoing elective CABG (Halpin & Barnett, 2005).

In a review of the literature examining the psychological effects of cardiac surgery, Gardner and Worwood (1997) described studies addressing psychiatric, psychological, and cognitive changes following CABG. These researchers found difficulty in study comparison, with much overlap between neuropsychological and psychiatric disturbances. A full continuum of psychological disturbances was reported, with multiple reports of increased depression following cardiac surgery. Preoperative depression seemed to have the most significant effect on postoperative depressive symptoms in the majority of the studies, with depression contributing to increased postoperative mortality. A review of studies with anxiety as a variable revealed that, as expected, anxiety was higher preoperatively and much reduced following surgery. Anxiety levels in cardiac surgery patients were similar to those of other acutely ill subjects, and that those with persistent anxiety often had a significant depressive component. Gardner and Worwood (1997) recommended that psychological symptoms in this population of surgical patients needs to be addressed and treated, with attention paid to therapeutic interventions.

Altered mood states persist after cardiac surgery while postoperative depression and anxiety can be predicted by preoperative mood (Andrew, Baker, Kneebone, & Knight, 2000). To examine the relationship between mood state and postoperative cognitive deficits, preoperative mood was compared to postoperative mood (n = 184, mean age 64.9, [SD 10.2]). Half the patients who were depressed prior to surgery remained depressed postoperatively, while only 13% of patients without preoperative depression exhibited depression after surgery. Sixty-seven percent of anxious patients preoperatively remained so postoperatively, while anxiety was present postoperatively in 37% of the subjects who were not anxious before surgery. Postoperative stress occurred in 11% who had not been stressed preoperatively, while 33% of those who experienced preoperative stress were also stressed postoperatively. Changes in mood state did not affect changes in neuropsychological function; however, a significant relationship existed between preoperative mood, attention, and memory deficits postoperatively. Higher levels of anxiety and depression before and after surgery were prognostic of poorer attention and verbal memory scores. Stress before surgery was not related to postoperative neuropsychological dysfunction. Postoperative mood alone was not found to be predictive of neuropsychological dysfunction, and the researchers concluded that altered postoperative mood was a continuation of previously present depression, stress, and anxiety.

Depression was found to be predictive of mortality in a younger (mean age 61 [SD 10.2]) sample of CABG patients (Blumenthal et al., 2003). In an older (mean age 66.08 [SD 9.57]) sample of male CABG patients, mortality risk and depressive symptoms were predictive of two year mortality in a prospective Veterans Administration study (Burg, Benedetto, & Soufer, 2003). Univariate analysis revealed that risk of depressive symptoms was among the factors that made a significant contribution (χ^2 -4.7, $p < .03$) to two-year mortality. The multivariate analysis showed depression ($p < .05$) and surgical risk ($p < .03$), when postoperative comorbidities were controlled for, to be the significant factors affecting long-term mortality. Similar studies in older women are not available.

Psychiatric and psychosocial outcomes were examined prospectively in an older cohort (mean age 68.2 [SD 9.7]) of patients (n = 34) undergoing on-pump cardiac surgery (Rothenhausler et al., 2005). Eleven subjects experienced postoperative delirium. At discharge, 13 subjects had clinically relevant cognitive deficits, 11 subjects were found to have adjustment disorder with features of depression, 6 had evidence of post-traumatic stress disorder (PTSD), and 6 were found to have major depression. Increasing age ($p < .05$) and higher (greater dysfunction) baseline cognitive function scores ($p < .001$), were significantly correlated with risk for altered cognitive function at discharge and at one year, although the number of subjects with cognitive deficits at one year was half that at discharge. One year after operation, depression and anxiety had returned to baseline, with 12 subjects reporting symptoms of minor depression, dysthymia, agoraphobia, undifferentiated somatoform disorder, partial post-traumatic stress, and generalized anxiety. Subjects with cognitive deficits had poorer HRQL ($p < .05$) than those with intact cognition. The study reinforced previous results of prevalence of major depression and PTSD prior to discharge in cardiac surgery samples. Subjects in this study were referred for treatment of these disorders, potentially affecting the long-term findings. The researchers suggested that these findings demonstrated the need for mental health evaluation prior to cardiac surgery, with need for early treatment, to avoid poor long-term outcomes.

Female gender has also been associated with increased social isolation, anxiety and depression in CABG patients (Czajkowski et al., 1997). Doering and colleagues (2006) described the frequency of symptoms and the incidence and course of clinical depression for six months after CABG in women with a mean age of 62.5 (SD 10.0). Clinical depression was found in 31% of the depressed sample ($n = 17$), including findings of major depression in 7% prior to discharge. Frequency of clinical depression decreased to 13% at six months. In addition, those with any depressive symptoms preoperatively remained depressed for the first month after surgery ($p < .001$) and at six months ($p = .01$). The incidence of major depressive symptoms (5.5%) in the sample at six months was similar to that of the general population. Younger age and increased number of complications were associated with clinical depression prior to discharge ($p = .02$, $p = .03$, respectively). A history of depression increased the risk of postoperative clinical depression (OR 3.3, $p = .02$). Symptoms of anhedonia, dysphoria and fatigue were greater among depressed women than those without depression, however data for these variables were not provided. Careful evaluation of women who experience complications after surgery and have symptoms of depression and those reporting continuing symptoms of anhedonia, dysphoria and fatigue was recommended (Doering, Magsarili, Howitt, & Cowan, 2006).

Examination of the differences in mood disturbance and sleep patterns shortly after CABG were the aims of a secondary cross-sectional analysis comparing subjects who underwent either OPCAB (mean age 71 [SD 7.2]) or CCAB (mean age 66 [SD10.6], p = .009) (Hedges & Redeker, 2008). Data showed that mood disturbances between groups were not significant, and mean scores for both groups on the POMS-SF did not indicate major mood disturbances in either group. Thus, conduct of the operation has no significant effect on mood in older CABG patients.

Analysis: Mood disorders in patients undergoing cardiac surgery are similar to those of the general population; however, depression has been the predominant mood state evaluated in the cardiac surgery literature. There is growing documentation that depression carries significant risks for recovery, particularly in women (Doering et al., 2006; Doering et al., 2005). Anxiety is generally relieved postoperatively, but in patients with concomitant depression, anxiety often persists and negatively affects attention and memory (Andrew et al., 2000). Other negative mood states such as anger, fatigue, anxiety, and confusion have been examined less thoroughly, particularly in older adults.

Positive moods also affect recovery. Penckhofer, et al (2005) found that with time, improvement in mood states occurred in older women after CABG, with a perceived increase in quality of life. Preoperative assessment of mood state is needed to understand the impact of cardiac surgery on postoperative mood. Additional research investigating the effect of age appropriate therapeutic interventions to alleviate altered mood states and promote coping skills is needed to improve outcomes following cardiac surgery in older adults.

Conceptual Framework

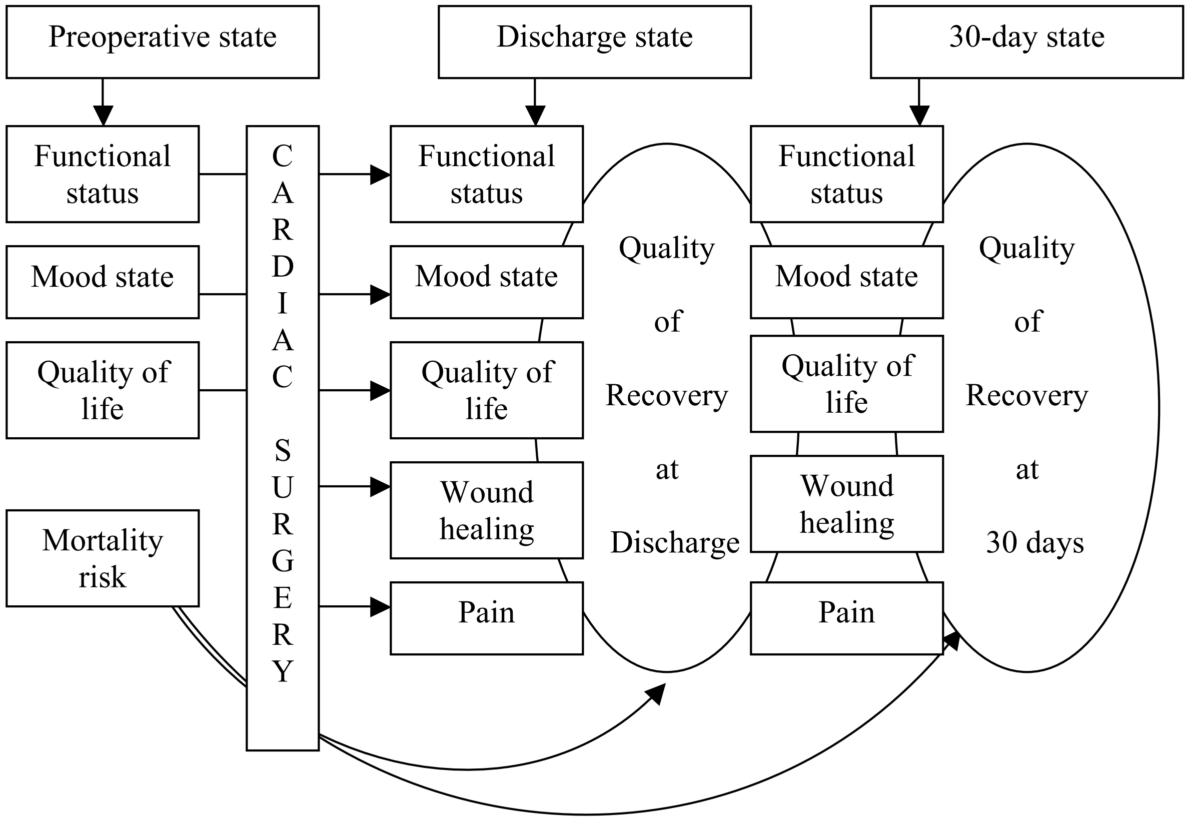

Figure 1. Conceptual model of relationships of selected domains of recovery and quality of recovery at discharge and 30 days following cardiac surgery in older adults

Summarizing data from the literature on quality of recovery after cardiac surgery in older adults is challenging. The hypothesized relationships that exist between domains of recovery, addressed as outcomes in the literature review, and the phenomenon of quality of recovery are depicted in Figure 1. In this model, the variables of interest are operative mortality risk, functional status, mood state, and quality of life, pain and wound healing. The dynamic nature of the relationships between these variables and quality of recovery at hospital discharge and at 30 days after surgery is depicted in the model. The assessment of these variables preoperatively, at discharge and at 30 days after surgery are times at which patients are undergoing change: preoperatively, anticipating surgery; at discharge, moving from acute care to home or a rehabilitation setting; and at 30 days, experiencing resumption of activities such as driving. Understanding the patients' perception of factors that contribute to quality of recovery is important to develop interventions that promote recovery in a vulnerable segment of the population.

Conclusion

The breadth and depth of the cardiac surgery literature pertaining to domains of recovery for older adults is extensive. Multiple studies on surgical outcomes, functional status, and health related quality of life for older adults exist, while mood state, wound healing and pain have fewer citations. Recovery has been described as a multi-phasic process, completed by sequential progression and return to a former state of being (Allvin et al., 2007; Baker, 1989). However, recovery for cardiac surgery patients is frequently defined from the investigator's perspective, leading to difficulty when comparing studies to assess the recovery process on older adults. Factors that affect older patients such as functional state, physiologic changes, HRQL and mood are more often examined as outcomes rather than predictors of the recovery process. The quality of that recovery has not been examined often in older adults.

Recovery from cardiac surgery clearly encompasses many aspects, or domains, of life: wound healing, pain management, mood state, functional ability, and quality of life, as well as relief or prevention of cardiac related symptoms that mandated the procedure. It is a complex, dynamic and inclusive process that is not limited to resolution of physical symptoms. Additional data are needed to explicate the process of cardiac surgery recovery in an aging and growing population in the United States.

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This chapter describes the methods utilized to examine the relationships between pain, wound healing, surgical risk, quality of life, functional status, and mood states and the quality of recovery at discharge and at 30 days in older patients who have undergone cardiac surgery. Study design, instruments, sample, procedures and analysis plan are presented.

Methods

Study design

A prospective repeated measures cohort study was used to explore the changes in bio-psychosocial factors that influence the quality of recovery during the first month following cardiac surgery in older adults.

Setting

Two non-profit community hospitals of moderate size, 292 and 147 beds, respectively, located in northern California, were chosen as study sites. Both had active cardiac surgery programs, each performing 100 to 250 operations per year. Study approval was obtained from each facility's institutional review board and the Committee on Human Research at the University of California, San Francisco.

Sample

Subjects were recruited from three cardiothoracic surgery practices utilizing one or both of the study sites. Inclusion criteria were age 65 and older, scheduled for cardiac surgery, able to understand English or Spanish, accessible by telephone, and not incarcerated. Memory function was assessed preoperatively using the Memory Impairment Screen (MIS) after written consent was obtained (Buschke et al., 1999).

Participants were excluded if they scored ≤ 4 on the MIS, or were classified as American Society of Anesthesiology Class V or VI because of poor potential for survival.

NQuery v.6.0 (Statistical Solutions Ltd, Saugus, MA) was used for an *a priori* power analysis to determine sample size. For a moderate effect size (r^2=.50) for change in quality of recovery over time, 73 participants would provide 80% power with $\alpha = .05$ to detect an increase in r^2 of .05.

Study Instruments

Instruments were used to screen memory function and assess pain severity, wound healing, surgical risk, functional status, mood state, quality of life and quality of recovery.

Memory Impairment Screen. The Memory Impairment Screen (MIS) (Appendix A) is a delayed recall screening test for impaired memory and dementia. Four test words in separate categories (animal, city, vegetable, and musical instrument) are presented, and following a two-minute delay, free recall begins with cued recall provided by the examiner for missed items. The score ranges from 0 to 8, with a score of 4 or less indicative of memory impairment and possible dementia. Alternate form reliability, internal consistency, construct validity and discriminative validity have been established (Buschke et al., 1999; Dierckx, Engelborghs, De Raedt, De Deyn, & Ponjaert-Kristoffersen, 2007).

Buschke and colleagues examined reliability, and construct and discriminative validity of the MIS during a larger study of subjects with known dementia. The intraclass correlation coefficient for alternate forms of the MIS was .69, and Cronbach's α was .67, indicating high-level reliability and consistency between forms. The score below which subjects were considered to have dementia, or cut score, on the Free and Cued Selective Reminding Test (FCSRT), a gold standard test for dementia, was used to establish construct validity for the MIS as a screening tool for memory impairment. Memory impairment on the MIS (a score of 4 or less) had a strong association with the cut score on the FCSRT with a kappa of .62. As a screening tool for dementia, the ROC for the MIS was .94, indicating good discriminative validity. At the cut score of 4, sensitivity was .87 and specificity was .96 for Alzheimer's disease (AD). The positive predictive value ranged from .54 at a 5% base rate of AD to 85% for a base population rate of 20%.

The MIS is not affected by age, language or education, and has good discriminative validity when healthy persons are compared with impaired elderly individuals (Lorentz, Scanlan, & Borson, 2002).

Pain severity. A numeric rating scale (NRS) was used to evaluate pain severity. The NRS is used to assess postoperative pain severity by asking subjects to rate discomfort on a 0 to 10 scale anchored by descriptors of severity: "little or no pain" and "worst pain imaginable". A study conducted by Gagliese and colleagues (2005) compared the NRS to a horizontal visual analogue scale (VAS-H), a vertical visual analogue scale (VAS-V), and a verbal descriptor scale (VDS) to determine the feasibility and validity of each scale in a sample of older and younger surgical patients.

Error rates to determine feasibility were calculated for each scale. The error rate for the NRS was approximately 6%, compared to 18% for the VAS-H. The order in which the scales were completed was also analyzed and found to have no difference on the error rate. No significant difference of error rates was found between older and younger patients on the NRS. Face validity was highest for the NRS, as 40% subjects ranked it as the easiest to use, approximately 60% considered it the most accurate, and approximately 45% preferred it to the other scales. Age explained very little of the variance in perception of use ($eta^2 = .08$), accuracy ($eta^2 = .03$) and preference ($eta^2 = .04$) in the scales. Convergent validity analysis was established for both age groups between each of the intensity scales. Significant correlations between the scales for older subjects ranged from r = .72 to r = .91. There was no difference by age. The McGill Pain Questionnaire (MPQ), which measures quality of pain, was used as an index of divergent validity against the intensity measures. Divergent validity was gauged by the hypothesis that since intensity and quality of pain were related, but distinctly different, correlations would be lower between quality and intensity than the correlations between intensity measures. The NRS and the MPQ were moderately correlated (r = .42 - .53) in the older group, lower than the correlations between the NRS and other intensity measures, indicating divergent validity.

Construct and criterion validity measurement utilized principal component analysis to construct a composite intensity measure. As expected, the four measures loaded onto one component and were not distinguished by age. The factor loading for the older subjects' NRS was .97 and .96 for both age groups, supporting the validity of using this scale in an older population.

In a recent review of the literature on pain scales, the NRS was found to be more sensitive to change in pain intensity than a verbal rating scale (Williamson & Hoggart, 2005). (Bijur, Latimer, & Gallagher, 2003) found a high significant correlation between the NRS and a visual analogue scale (VAS) (r = .94, 95% CI .93 to .95), with a regression slope of 1.01 (95% CI .97 to 1.06) indicating a strong level of agreement between the two scales. On the other hand, regression lines of .86 for the VAS and .95 for the NRS suggested that the scales were not in agreement despite strong correlation (DeLoach, Higgins, Caplan, & Stiff, 1998). According to Williamson and Hoggart, this is an indication that similar information about pain may be elicited with different scales, but direct conversions between scales are not appropriate. These reviewers reiterated that pain is subjective, variable in nature, and the sole means of successful pain analysis is to believe the patient.

Wound healing. ASEPSIS (Appendix B) is an acronym for **A**dditional treatment, **S**erous discharge, **E**rythema, **P**urulent exudates, **S**eparation of deep tissues, **I**solation of bacteria, and **S**tay as inpatient longer than 14 days. It was developed to determine the efficacy of antibiotic regimens following cardiac surgery and has evolved as a surveillance measure and definition of surgical site infection and disruption of healing (Wilson, Treasure, Sturridge, & Gruneberg, 1986a). Wounds are measured and assigned points depending on the percentage of the wound affected. Points range from 0 to 5 for serous exudate or erythema extending more than 5 mm laterally from the incision and from 0 to 10 for purulent exudate and separation of deep tissues. Wounds are measured daily for the first five postoperative days, and the daily score summed. Additional points are added over the length of the surveillance period for antibiotic administration past the expected period, drainage or debridement, positive wound culture, and prolonged stay. Although the daily assessment can be somewhat subjective, the additional objective measures are intended to decrease bias. A total score of 0 to 10 indicates satisfactory healing; 11 to 20 disruption of healing; 21 to 30 minor wound infection; 31 to 40 moderate infection; and greater than 40 severe wound infection.

In the initial trial (Wilson, et al., 1986a), wound scores were obtained as part of a randomized trial of two different antibiotic treatments. To establish concurrent validity, the authors compared the ASEPSIS scores to a previously published grading system which ranked wounds on a severity index of 1 to 3 where 1 was normal healing, 2 was presence of inflammation and 3 was wound breakdown with purulent exudates (Wells, Newsom, & Rowlands, 1983). ASEPSIS scores were in agreement with the earlier grading system for severely infected wounds. Wounds that were Wells grade 2 (inflammation) ranked from normal healing to moderately infected wounds on the ASEPSIS scale, indicating that ASEPSIS was was more sensitive to levels of wound impairment. To assess reliability, the investigators scored another sample of patients (n=51) in the same trial using two independent observers. Bland–Altman plots (Bland & Altman, 1986) were calculated using the difference in scores between the two observers against the mean for sternal and vein harvest wounds. Coefficients of repeatability were calculated for sternal wounds (4.1 points) and for leg wounds (3.2 points). Between two independent observers, 95% of the differences in the wound scores should be less than these coefficients (Wilson, Webster, Gruneberg, Treasure, & Sturridge, 1986b).

A subsequent study by the same investigator compared ASEPSIS specificity and sensitivity with traditional wound infection definitions such as evidence of pus (Wilson, Weavill, Burridge, & Kelsey, 1990). The ability of ASEPSIS to predict risks for wound disruption, and efficacy of use were also examined. ASEPSIS scores of above 10, 20, 30 and 40 were compared to a previously published wound scale developed by Leigh (1981). Leigh scale grade I wounds exhibit inflammatory changes with serous discharge, grade II wounds exhibit purulent discharge and superficial breakdown, and grade III wounds exhibit purulent discharge and major breakdown (Leigh, 1981). Residual ASEPSIS scores of greater than 20 demonstrated equal sensitivity and significance ($p < .01$) compared to Leigh grades and evidence of pus for the outcome measures of antibiotic use, need for additional surgery and prolonged stay.

The ASEPSIS score showed greater precision by discriminating impaired healing from infection in cardiac and general surgery when compared to the criteria established by the Center for Disease Control and the National Nosocomial Infection Surveillance index (Hall & Hall, 1996; Wilson et al., 2004). Results indicated that ASEPSIS works well in identification of both clinical and subclinical infection.

Society of Thoracic Surgeons (STS) risk assessment

The STS algorithm (Appendix C) uses demographics, clinical and operative details, and specific risk factors to determine probability of 30-day morbidity and mortality. Data are entered into a proprietary algorithm to produce the probabilities of mortality and seven morbidities. Mortality and morbidity are calculated for isolated CABG and isolated valve procedures. Mortality probability alone is calculated for combined CABG/valve replacement.

Validity and reliability for the STS tool has been assessed by comparing the Euroscore risk profile and the STS mortality risk stratification (Nilsson, Algotsson, Hoglund, Luhrs, & Brandt, 2004; Shroyer et al., 2003). In one study, the predictive accuracy was calculated by comparing expected to observed mortality (Nilsson, et al., 2004). Findings, using the Hosmer-Lemeshow goodness-of–fit test, produced p values of .81 for the Euroscore and .84 for STS, indicating that both algorithms provided good accuracy. Analysis of the receiver operating characteristic (ROC) curve revealed significantly larger discriminatory power for Euroscore than STS ($p < .00005$), leading the investigators to conclude that the Euroscore algorithm is a better predictor of 30-day mortality than the STS model. Differences are likely due to the populations on which the algorithm designs are based.

Criterion validity of the proprietary STS risk model for mortality and morbidity has been established by examining observed to expected ratios across United States hospitals participating in the national database (Shroyer et al., 2003). This study was designed to identify the preoperative predictors associated with postoperative complications and early mortality by univariate and multivariate analysis for isolated CABG. The observed 30-day mortality was 3.05% and morbidity 13.4%. The c-index, or area under the ROC curve, for mortality and morbidity combined was .71, indicating good model performance in the STS population. Since the STS algorithm is proprietary, it has not been included in many studies evaluating discriminatory power. It was chosen for use in this study since it is widely used in this country and both study sites participate in the database.

Functional Status Questionnaire. The Functional Status Questionnaire (FSQ) (Appendix D) is a 34 item self administered questionnaire measuring functional status in 8 domains: physical role, psychosocial role, basic and intermediate activities of daily living (ADL), mental health, work performance, social activity, and quality of interactions (Jette & Cleary, 1987). The instrument's questions were adapted from the Functional Status Assessment Instrument, the Sickness Impact Profile, and the Health Insurance Experiment Survey (Cleary & Jette, 2001). In CABG patients, Cronbach's α was calculated as a measure of internal consistency reliability prior to surgery and six months postoperatively. The mean age of the sample (n not reported) was 60.2 and was 85.8% male. Cronbach's α for basic ADL (BADL) was .72 preoperatively and .69 6 months postoperatively. Intermediate ADL (IADL) alphas were .90 preoperatively and .71 at six months. Cronbach's α for social activity was .87 preoperatively and .76 at six months, and mental health Cronbach's α was .80 preoperatively and .82 at six months.

The FSQ was used to assess recovery in a sample of patients undergoing either laparoscopy or incisional hernia repair (Swan, Maislin, & Traber, 1998). Cronbach's α for BADL was .75 prior to operation, .82 24 hours postoperatively, .61 four days postoperatively, and .67 one week postoperatively. For IADL, Cronbach's α was .86 prior to operation, .47 24 hours postoperatively, .80 four days postoperatively, and .85 one week postoperatively. The subscales for social activity and mental health were not utilized in this study.

Construct, criterion, and concurrent validity have been established for the FSQ in primary care, Parkinson's disease and in elderly patients following valvuloplasty (Jette et al., 1986; Rubenstein et al., 1998; Tedesco et al., 1990). The FSQ has not been used previously with elderly cardiac surgery patients; however, data suggest that the instrument is reliable and valid across a variety of patients and settings.

Profile of Mood States-Short Form

The Profile of Mood States-Short Form (POMS-SF) (Appendix E) is derived from the original POMS which contained 65 adjectives to measure an individual's psychological distress (McNair, Lorr, & Droppelman, 1981; Shacham, 1983). The POMS has been utilized in a variety of health states to assess mood state (Curran, Andrykowski, & Studts, 1995). Both POMS and POMS-SF yield a global distress score and scores on six subscales: anger-hostility, fatigue-inertia, vigor-activity, depression-dejection, confusion-bewilderment, and tension-anxiety. Psychometric properties of the POMS-SF were examined in cancer and renal patients, and a healthy sample. Comparison was made to psychometrics for the original POMS (Curran et al., 1995). Cronbach's alphas for the subscales in all samples of the POMS-SF ranged from .76 for confusion-bewilderment in healthy volunteers to .95 for depression-dejection in the healthy sample and were similar to the Cronbach's alpha subscales for the POMS. The internal consistency estimate for the total POMS-SF score in the sample subjects ranged from .87 in the healthy sample to .92 in patients with benign breast disease. The alphas in the POMS for the same samples ranged from .75 in healthy subjects to .92 in patients with benign breast disease. Adjusted interclass correlations (ICC) between the POMS and POMS-SF total scores ranged from .88 in healthy subjects and candidates for bone marrow transplant, to .95 in renal transplant patients and benign breast disease patients. The mean ICC for the subscales ranged from .81 for confusion-bewilderment to .95 for depression-dejection across the study samples. Reliability and validity for the POMS in cardiac surgery are well established (Gortner & Jenkins, 1990; Moore & Dolansky, 2001; Utriyaprasit & Moore, 2005).

Quality of Life Index-Cardiac Version IV. The Quality of Life Index-Cardiac Version-IV (QLI-CV-IV) (Appendix F) is a 70-item, self -administered index designed to assess overall quality of life (QoL), and the effects of components specific to cardiac disease (Ferrans & Powers, 1985). There are four subscales: health and functioning, psychological and spiritual, socio-economic, and family domains. Part 1 of the scale measures satisfaction with each of the domains, and Part 2 measures the importance of each to the patient. To calculate the score for each response, satisfaction is weighted with importance. The reliability of the generic index is well established with acceptable internal consistency published for the whole scale (Cronbach's $\alpha = .93$) and the individual subscales (health and functioning, $\alpha = .87$; psychological and spiritual, $\alpha = .9$; socio-economic, $\alpha = .82$; and family, $\alpha = .77$). Construct and content validity were established by factor analysis and correlation with other previously published scales, and review of the literature, respectively (Ferrans & Powers, 1985, 1992). The cardiac version was used in a study evaluating a conceptual model of quality of life in women after cardiac surgery; Cronbach's alpha was .91 preoperatively and .95 postoperatively (Penckofer, Ferrans, Fink, Barrett, & Holm, 2005).

Quality of Recovery-40. The Quality of Recovery-40 (QoR-40) (Appendix G) is a 40-item questionnaire designed to measure five dimensions of postoperative recovery experienced in the previous 24 hours: emotional state (9 items), physical comfort (12 items), psychological support (7 items), physical independence (5 items), and pain (7 items) (Myles, Weitkamp, Jones, Melick, & Hensen, 2000). The instrument is divided into parts A, which asks how the respondent has been feeling, and B, which asks about symptoms. Part A items are ranked on a Likert scale from 1 to 5, where 1 equals none of the time, or poor, and 5 equals all of the time, or excellent. Part B scoring is reversed; 1 equals none of the time, or excellent, and 5 equals all of the time, or poor.

Initial validity and reliability of the QoR-40 was assessed in a sample of patients ($n = 160$) with a mean age of 44 after general anesthesia. Since no other generally accepted instruments measuring quality of recovery were available for comparison, a global visual analogue scale ranging from 0 (poor recovery) to 100 (excellent recovery) and inter-item correlations were used to establish convergent validity. Construct validity was examined by comparing scores between males and females, as prior research had shown that women had poorer recovery than men. Test-retest reliability was examined by having participants complete the instrument twice, the second time later on the same postoperative day. Internal consistency reliability was examined by correlating the items in each dimension, and each item to its own dimension. Split half reliability was examined by measuring correlation between split segments of the instrument; however, how the instrument was split was not reported. Responsiveness, the ability to detect clinically relevant change over time, was measured using standardized response means. Acceptability was assessed by the length of time it took to recruit the sample, the time taken to answer the questionnaire, and the rate of successful completion and return.

Correlation between the QoR-40 and the VAS was strong ($r = .68$, $p < .001$), establishing convergent validity. Lower mean scores for females (162 [SD 26]) than males (173 [SD 17]) ($p < .002$) supported construct validity, as well as a negative correlation between the QoR-40 and length of hospital stay (rho = -.24, $p < .001$). Test-retest measures yielded an ICC of .92, $p < .001$, a Cronbach's α of .93, $p = .001$, and a split-half coefficient of .83 ($p < .001$), demonstrating reliability. The median item correlations and Cronbach's α for each dimension were moderate and supportive of internal consistency reliability. The inter-dimension α was .85. The standardized response mean for the total score was 0.65, with a 9% change from baseline, indicating a strong ability to assess clinical changes over time. Acceptability, which is the length of time it takes to complete the instrument and the proportion of patients who find it difficult (Herrera, Wong, & Chung, 2007), was demonstrated by a mean completion time of 6.3 minutes and an 87% completion rate. The overall focus of the QoR-40 was establishing a method to determine the patient's assessment of the quality of recovery after surgery.

Another study investigated the levels of agreement between a self-administered QoR-40 and the investigator administered QoR-40 in a sample of 62 patients within 48 hours of general anesthesia (Gower, Quigg, Hunt, Wallace, & Myles, 2006). The instrument was completed first by the patient without assistance. In the second assessment, obtained 30 minutes following self-administration, the investigator read the QoR-40 to the patient and recorded responses. Time to complete both assessments was recorded. The inter-class correlation coefficient (ICC) and Bland-Altman (1986) method were used to examine levels of agreement. The Bland-Altman method uses the mean difference, or bias between the scores on the two methods method to calculate 95% limits of agreement, or 2 standard deviations from the mean, within which 95% of the differences fall (Bland & Altman, 1986; Myles & Cui, 2007). The methods were strongly correlated with an inter-class correlation coefficient (ICC) of .86 and limits of agreement from - 22 to 28. There was no significant difference between the scores on the patient administered or investigator administered QoR-40 ($p = .056$). The time to complete the investigator administered questionnaire was 253 (SD 16) seconds, and for the patient administered questionnaire 362 (SD 19) seconds ($p < .001$). Although both methods were determined to be valid, investigator administration of the Qor-40 was more efficient and data were more complete. Additionally, the researchers noted that they were unable to identify any surgical or patient factors that biased the results. The time span between administrations of the Qor-40 was chosen to minimize appreciable change in the quality of recovery, and the researchers randomized the order of administration to avoid testing effects.

Myles, et al (2001) examined the association between the quality of recovery three days after cardiac surgery and quality of life three months later. A secondary aim of the study was to assess the utility of the QoR-40 in cardiac surgery. The QoR-40 was used to measure health status and quality of recovery following cardiac surgery on postoperative days (POD) one through three, and at one month and three months postoperatively. The SF-36 was used to assess HRQL at one and three months postoperatively. Poorer QoR was defined as a score less than 1 standard deviation below the group mean. Findings included a significant change between mean preoperative and postoperative QoR-40 scores over the first month ($p < .0005$) and for HRQL at three months ($p < .0005$), but not at one month ($p = .29$). Participants had less than age related norms on all SF-36 subscales, but had reached or exceeded the normative scales at three months. A moderate correlation existed between the POD 3 QoR-40 and the three-month SF-36 ($r = .39$, $p < .0005$). Stepwise regression established that the preoperative QoR-40 and the POD 3 QoR-40 were predictive of HRQL at three months ($r = .52$, $p < .0005$). Factors associated with a poorer QoR-40 on POD 3 were a longer operative time, pulmonary complications, and increased hospital length of stay. Cronbach's α for the preoperative QoR-40 was .81; POD 1, $\alpha = .64$; POD 2, $\alpha = .66$; POD 3, $\alpha = .75$; one month, $\alpha = .82$; and 3 months, $\alpha = .81$ ($p < .0005$). Standardized response means were - .94, - .47, - .18, and + .05 at POD 1, POD 3, one month and three months, respectively, demonstrating the ability of the instrument to measure changes in health in cardiac surgery patients. The investigators concluded that the Qor-40 was able to quantify recovery as shown by the increase in the instrument's scores during the first postoperative month, and that HRQL, measured by the SF-36, is correlated with quality of recovery.

Several limitations in the study were identified (Myles et al., 2001). The authors used a summed score on the SF-36 for a global measure of HRQL, which was not validated. Because the instruments contain similar items, it was expected that correlations would be demonstrated; however, the correlation remained after similar items were removed. Another potential source of bias is the use of an instrument intended to measure recovery prior to an operation. Although such use may provide a baseline estimate of health, it is possible that the individual items have different meanings to the respondents preoperatively and postoperatively. Additionally, while participants in the psychometric evaluations ranged in age from 18 to 87, the tool has not been specifically evaluated in older adults.

Operational definitions

Operational definitions for study variables are listed in Table 1.

Table 1. Operational definitions

Variable	Measure
Memory impairment	Memory impairment is a MIS $\leq$ 4.
Pain severity	Pain severity was measured and recorded by participants' nurses using a standard 11 item NRS (0 equals little or no pain to 10 equals most severe pain ever experienced or imaginable) on POD 1 through POD 5. Average daily pain scores were calculated by adding scores recorded from midnight to 11 pm, and dividing by

	number of times the pain score was recorded. Additional pain data were abstracted from the QoR-40 instrument on the frequency (none of the time = 5, some of the time = 4, usually = 3, most of the time 2, all of the time = 1) of moderate and severe pain at discharge and 30 days.
Wound healing	Wound healing was evaluated by the ASEPSIS score at the end of 30 days, where a score ≤ 10 indicates normal healing; 11 – 20, disturbance of healing; 21 - 30, mild infection; 31 - 40, moderate infection; > 40 severe infection.
Mortality risk and demographic data	The STS surgical risk assessment algorithm was used to determine prospective 30-day mortality and morbidity. Demographic and physiologic variables included age, height, weight, gender, ethnicity, type of operation, timing, comorbidities, and cardiac physiologic data. Scores reflect the probability of mortality and morbidity for common complications.
Functional status	Functional status was measured by scores on the FSQ. Good function is defined as ≥ 88 on the Basic Activities of Daily Living (BADL) subscale; ≥ 78 on the Intermediate Activities of Daily living (IADL) subscale; ≤ 71 on mental health subscale; ≥ 79 on the work performance subscale (if still employed); ≤ 79 on social activity subscale; and ≤ 70 on the quality of interaction subscale.

Mood state	The POMS-SF global score (summed) was used to measure mood state. The summed score ranges from -20 to 100, and subscale scores range from 0 - 20. Higher total score indicates mood disturbance; higher subscale scores for tension, anger, fatigue, depression, and confusion indicate disturbance in these domains. The subscale score for vigor is subtracted from the total, reflecting the positive nature of the domain.
Quality of life	Quality of life was measured with the QLI-Cardiac Version IV, which measures overall quality of life (QoL). Scores on four subscales (health and functioning, social and economic, psychological/spiritual, and family) and the overall score range from 1 - 30. The cardiac version incorporates questions relating to angina and dyspnea. A higher score indicates better QoL.
Quality of recovery	Quality of recovery was measured with the QoR-40, which incorporates aspects of recovery; emotions, physical symptoms, independent function, pain, and support. The overall score ranges from 40-200; a higher score indicates a better quality of recovery. The maximum score for the emotional state subscale is 45; for physical comfort 60; for psychological support 35; for physical independence 25; and for pain 35. QoR is poor if an individual's score is less than 1 SD below the group mean.

Protocol

The timing for assessment reflects the expected trajectory of recovery in older cardiac surgery patients. Surgical site infection generally declares itself within 10 to 14 days postoperatively with surveillance continuing for 30 days (Mangram, Horan, Pearson, Silver, & Jarvis, 1999). The 30 day post surgery interval was selected to characterize early recovery in an older cohort, since most patients' activity restrictions are lifted four to six weeks after surgery at which time sternal healing is adequate for moderate upper body physical activity (Bojar, 2004).

After approval by the institutional review boards of two Northern California hospitals and the UCSF Committee on Human Research, eligible patients scheduled for cardiac surgery were identified by the surgeons at the initial office visit, or when seen for consultation in the hospital setting. With patient approval, referral was made to the principal investigator (PI). Potential subjects were contacted by the PI in person or by phone for further explanation of the study purpose and procedures. Written informed consent was obtained by the PI.

At the time of the preoperative visit at the respective hospitals, the following assessments were conducted: the MIS, the POMS-SF, the FSQ, and the QLI-Cardiac Version IV (Table 2). At each assessment time, participants were offered the choice of self-administration or administration by the PI. Assessments were conducted in private, or included a spouse or significant other if the participant so desired. Postoperatively, sternal incisions and leg wounds, if present, were inspected daily on days one through five. Pain severity as recorded by nursing staff in the medical record was abstracted. If participants were discharged prior to postoperative day five, a telephone assessment (Appendix H) of wound healing and pain severity was made.

Table 2: Instruments and administration

Concept	**Instrument**	**Preop**	**POD 1-5**	**Discharge**	**30 day**
Memory impairment	MIS	x		x	x
Mortality risk	STS score:	x			
Quality of life	QoL Index	x		x	x
Functional status	FSQ	x		x	x
Mood state	POMS-SF	x		x	x
Wound healing	ASEPSIS		x		x
Pain severity	Mean pain NRS		x		x
Quality of recovery	QoR-40			x	x
Recovery perception	Interview questions				x

At the time of discharge or transfer to a rehabilitation facility, the MIS, the POMS-SF, the FSQ, and the QLI were repeated. Quality of recovery was assessed by completion of the QoR-40. Three weeks postoperatively, participants were contacted by phone to arrange the final assessment, which was conducted in person by the PI approximately 30±2 days after surgery in the setting in which the participant was residing. The MIS, the POMS-SF, the FSQ, the QLI and the QoR-40 were repeated, wounds examined, and current pain severity assessed.

A short structured interview was conducted at 30 days. Participants were asked if they felt they had returned to their pre-surgical state of being. Those participants answering “no” were asked to describe differences between their preoperative and 30-day postoperative state. All participants were asked to describe factors that helped or hindered their recovery and to estimate the percentage of recovery achieved on a 0 to 100 NRS.

Data were recorded on data collection sheets, including physiologic and operative data, and entered into SPSS v. 13 (SPSS Inc, Chicago, IL) and Stata v. 10 (StataCorp LP, College Station, TX) for analysis. Demographic data were collected from inpatient medical charts, and surgical risk calculated prior to surgery.

Statistical analysis

All data were entered into SPSS v. 13 and were validated for accuracy by a second individual. Measures of central tendency were used to describe the sample. Data were not normally distributed so non-parametric measures were used for correlations and comparison of means. Correlations between independent variables and recovery perception were analyzed using Spearman’s rho. Wilcoxon’s matched pairs signed rank test was used for pretest-posttest comparison of means.

Because not all patients completed every questionnaire, a multilevel regression analysis method was used that allowed inclusion of cases where some data was missing. The outcome variable, quality of recovery, measured by the QoR-40, was skewed to the left, and did not meet assumptions for linear regression. The variable acted like a Poisson distribution, that is, it was distributed as though it were count data (the number of times an event occurs), despite being interval data. Additionally, the data were overdispersed, in which the variance was greater than the mean (Gardner, Mulvey, & Shaw, 1995). Therefore, multi-level negative binomial regression, with random effects and maximum likelihood estimation, using STATA v. 10, was the method of choice to estimate the effect of functional status, mood, and quality of life on quality of recovery during the first 30 days after cardiac surgery (Finkelstein & Brown, 2005; Hutchinson & Holtman, 2005). The outcome variable was reverse scored, or reflected, to meet the right-skewed distribution requirements of negative binomial regression. Baseline measurements were included in the models as fixed covariates. Deviation from baseline (within-person) scores were calculated for use as changing covariates.

Models were specified for each variable to examine the changing relationships between the predictors and quality of recovery over time. The first model was the unconditional model of the estimate of change across time for recovery quality measured by the QoR-40. The average association between each predictor & the outcome variable at baseline (discharge) was entered as the main effect in the second model. The third model estimated if the average association between the quality of recovery and the predictor across time was significant. The fourth model examined the cross-level interaction across time between recovery quality and the predictor, that is, whether the association between the quality of recovery and the predictor at discharge differed from the association between the quality of recovery and the predictor at 30-days postoperatively, controlling for the influence of the predictor pre-operatively. To estimate the expected change in the quality of recovery between discharge and 30 days per unit change in functional status, mood state and quality of life, the estimated effect of the predictor on the natural log scale. This effect was then transformed to the original scale to estimate the effect on the quality of recovery (at the intercept) of a one-unit increase on the predictor (personal communication, Bruce A. Cooper, PhD, 2/24/09).

Participants' responses during the structured interview were grouped by themes to identify differences between preoperative and postoperative states. A similar process was employed to analyze the responses to the questions about obstacles to and promoters of recovery, and the percentage of recovery achieved. Data were reported as frequencies.

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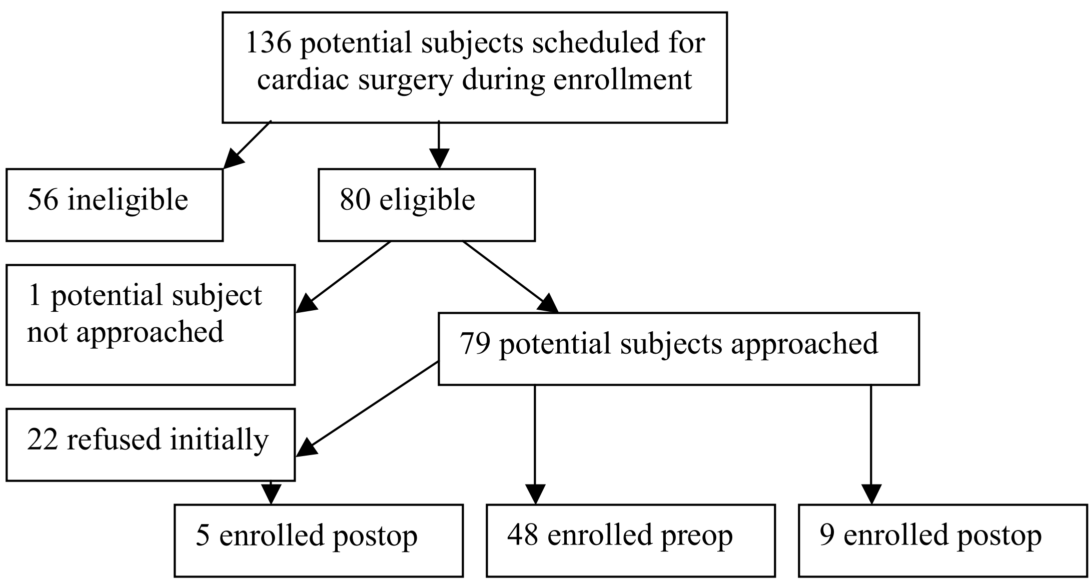
Study findings are presented in this chapter. Recruitment data are described initially, followed by a description of the study sample. Subsequently, findings for each study aim are presented.

Recruitment and Sample

Recruitment

During the recruitment period from October 20, 2008, through June 10, 2008, 80 of 136 persons scheduled for cardiac surgery were eligible for participation. One subject was not approached due to investigator unavailability. Sixty-two participants enrolled in the study (Figure 2), 48 prior to surgery and 14 postoperatively. Initially 22 patients declined to participate because of lack of interest, fatigue, anxiety, too close to operation, and spousal refusal.

Figure 2: Subject recruitment and enrollment



Those refusing were asked if they might be contacted after surgery for postoperative enrollment, and if willing were subsequently enrolled. Of necessity, interviews were structured around participants' need for rest, teaching and medical therapies. The Memory Impairment Screen (MIS) was used to assess cognitive levels and all participants scored 6 or higher. Attrition was 4.8% (3/62); two patients expired prior to discharge and one was unwilling to continue due to respiratory failure and prolonged hospitalization.

Sample

Demographic data are presented in Table 3. The mean age of the sample was 75.9 (SD 7.0) years; 74% were male. Most (90.3%) of the participants were Caucasian and were living with a significant other (69.4%). Almost 34% were employed or volunteered on a regular basis, including several in the oldest age group. Hypertension was the predominant comorbidity (90.3%), while 35.5% were diabetic. Mean body mass index (BMI) was 28.1 (SD 4.41). A history of acute myocardial infarction prior to surgery was reported by 27.3%. Mean ejection fraction prior to surgery was 54.5% (SD 12.92).

Operative data are listed in Table 4. The most common operation (50%) was off-pump coronary bypass (OPCAB). Over 60% of the surgeries were conducted on an urgent or emergent basis, defined as an operation required at the time of hospitalization because of presenting symptoms or anatomical considerations (STS National Database: Adult Cardiac Surgery Database Training Manual v2.61, 2008). Operative time was defined as operating room entrance and exit, to account for differences in surgical and anesthetic technique (J.R. Riebman, MD, personal communication, 7/11/08). Mean

Table 3. Demographic data

Characteristic	*n (%)*	*Mean (SD)*	*Characteristic*	*n (%)*
Gender			**Ethnicity**	
Female	16 (25.8)		White	56 (90.3)
Male	46 (74.2)		Hispanic	4 (6.5)
Age		75.9 (7.01)	Other	2 (3.2)
65-74	27 (43.5)			
75-84	26 (41.9)		**Status**	
85+	9 (14.5)		Living alone	16 (25.8)
Mortality risk		5.6 (9.81)	Living with another	43 (69.4)
Body mass index		28.1 (4.41)	Veteran's Home	3 (4.8%)
Ejection fraction		54.5(12.92)		
Comorbidities			**Work**	
Hypertension	56 (90.3)		Retired	41 (66.1)
Diabetes	22 (35.5)		Full/part time	16 (25.8)
AMI	17 (27.4)		Volunteer	5 (8.1)
COPD	14 (22.6)			
CVD	10 (16.1)			
Smoker	6 (9.7)			
Dialysis	3 (4.8)			
Endocarditis	2 (3.2)			

AMI = acute myocardial infarction COPD = chronic obstructive pulmonary disease
CVD = cerebrovascular disease

operative time was 4.9 (SD .99) hours. Mean length of time to extubation after surgery was 19.8 hours (SD 24.92, median 12.2), excluding 1patient with prolonged respiratory failure necessitating a tracheostomy. The sample was too small to assess statistical significance between surgeons, type of operation and the primary outcome. Atrial fibrillation was the most common complication, occurring in 37.1% of the sample. Forty-five percent of the sample experienced no complications (Table 4).

Table 4. Operative data

Characteristic	*n(%)*	*Characteristic*	*n(%)*	*Mean (SD)*
Operation		**Complications**		
OPCAB	31 (50.0)	None	28 (45.2)	
CCAB	14 (22.6)	Atrial fibrillation	23 (37.1)	
AVR	7 (11.3)	Prolonged intubation	6 (9.7)	
CAB + valve	6 (9.7)	Reoperation	2 (3.2)	
MV Repair	1 (1.6)	Mortality	2 (3.2)	
MVR	1(1.6)	Stroke	1 (1.6)	
AVR/MVR	1 (1.6)			
3 valves + CAB	1 (1.6)	**Operative time (hours)**		4.9 (.99)
Operative timing		**Intubation hours***		19.8 (24.92)
Elective	24 (38.7)	**IABP**	3 (4.8)	
Urgent/ emergent	38 (61.3)			

OPCAB = off pump coronary artery bypass
CCAB = conventional coronary artery bypass
MV = mitral valve AV = aortic valve R = replacement IABP = intraaortic balloon pump
* excluding 1 with respiratory failure > 30 days

Details of participants' hospital stay are presented in Table 5. Mean hospital stay postoperatively was 7.8 (SD 6.40) days. Participants spent an average of 68 (SD 52.96) hours in the intensive care unit, excluding one who remained in the intensive care unit for over six weeks.

Table 5: Hospital data

Characteristic	*n(%)*	*Mean(SD)*	*Characteristic*	*n(%)*
Hospital LOS (days)		10.6 (8.40)	**Discharge location**	
ICU hours		68 (52.96)	Home	37 (59.7)
Postop LOS (days)		7.8 (6.40)	Rehab/SNF	23 (37.1)
Rehab LOS (days)		3.5 (6.11)	Never discharged	2 (3.2)
Readmission	5 (8.1)			
30 day location				
Home	54 (87.1)			
Rehab/SNF	3 (4.8)			
Acute care	2 (3.2)			

LOS = length of stay ICU = intensive care unit SNF = skilled nursing facility

Most (87.1%) were discharged home, and those who went to a rehabilitation facility spent an average of four days. At the time of the 30-day assessment, 87.1% of the sample had returned home. Three (4.8%) were still in rehab, and two (3.2%) had been readmitted to acute care. Three additional participants were rehospitalized within the first month for cardiac arrhythmias. Two participants remained hospitalized in critical care at 30 days, one for prolonged respiratory and renal failure, and the other for multiple organ failure.

Aim 1

Describe and examine the relationships of each of the following factors with quality of recovery at discharge and at 30 days after surgery: pain, wound healing, surgical risk, functional status, mood state, and global quality of life

Descriptive findings for the variables are shown in Tables 6 through 8, comparisons of differences between measurements are shown in Table 9, and correlations between pain, wound healing, surgical risk, functional status, mood state, quality of life and quality of recovery are shown in Figures 6 through 10.

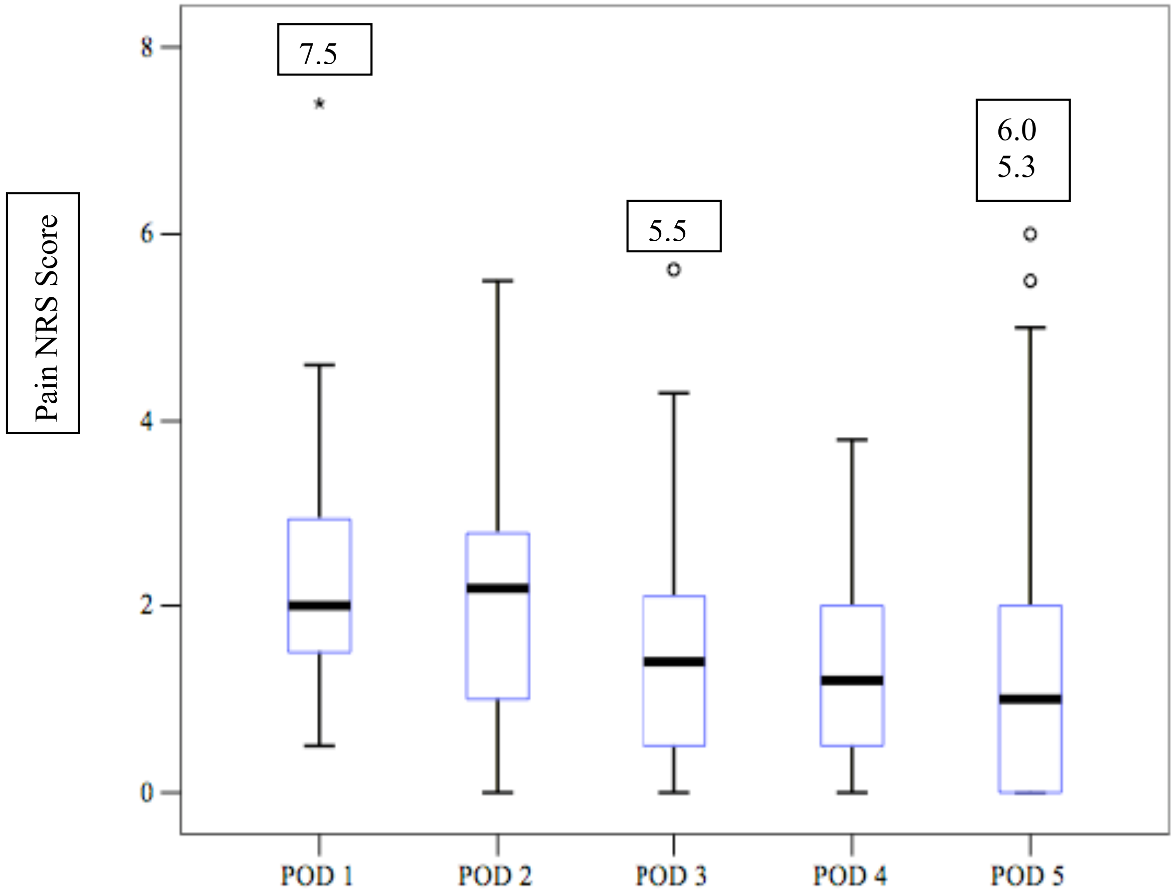
Pain

Pain intensity scores were evaluated daily for the first five postoperative days (Table 6). Individual mean pain scores ranged from 0 to 7.4 over the five days (n = 62). Median daily pain scores for the sample were less than 3 on the NRS (Figure 3). Three participants had scores that were over 1.5 times the interquartile range (IQR) on Pod 3 and POD 5, and one participant experienced a mean pain score that was over three times greater than the IQR on POD 1.

Table 6. Descriptive statistics: pain

	POD 1	*POD 2*	*POD 3*	*POD 4*	*POD 5*
Mean	2.2	2. 1	1.5	1.3	1.4
Median	2.0	2.2	1.4	1.2	1.0
Std. Deviation	1.08	1.23	1.25	1.03	1.55

Figure 3: Boxplot of daily pain scores (n = 62)



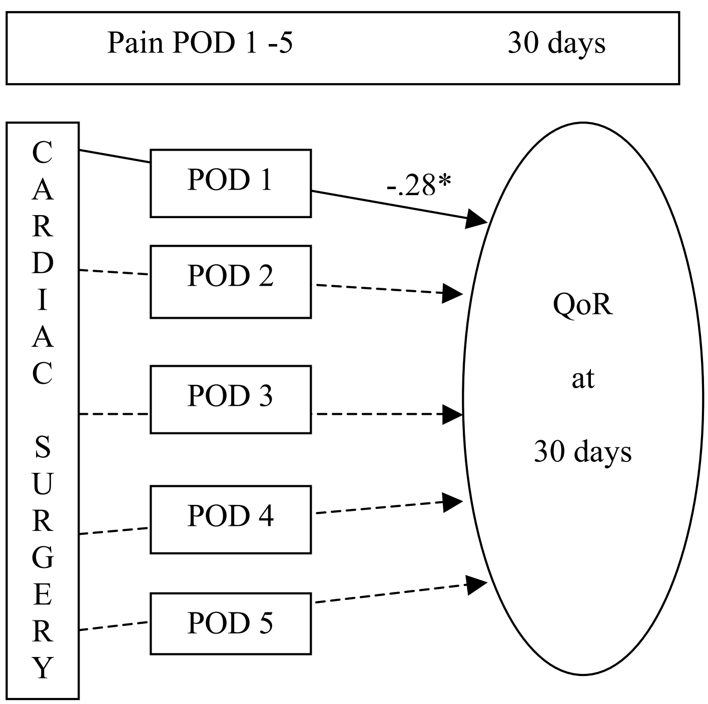
POD = postoperative day * = outlier 3 times > the IQR   o = outliers 1.5 times > IQR

Two questions on the QoR-40 asked participants to rate pain on a Likert scale that was ranked 5 (none of the time), 4 (some of the time), 3 (usually), 2 (most of the time), and 1 (all of the time). The questions were "Have you had any moderate pain in the last 24 hours?" and "Have you had any severe pain in the last 24 hours?" Higher pain scores on the QoR-40 were indicative of less pain. At discharge (n = 59) 23.7% of the participants reported no moderate pain, 67.8% experienced moderate pain some of the time, with 3.4% reporting moderate pain usually, and 5.1% reporting moderate pain most of the time. No participants reported moderate pain all the time. At discharge, 74.5%

experienced no severe pain and 25.4% of participants reported severe pain some of the time. No participants reported severe pain usually, most, or all the time.

At 30 days (n = 59), 69.4% of participants experienced no moderate pain, 20.3% experienced moderate pain some of the time, 8.5% reported usually having moderate pain, and 1.7% reported moderate pain most of the time. No participants reported moderate pain all the time. At 30 days, 93.2% had no severe pain, while 6.8% of participants had severe pain some of the time. No participants reported severe pain usually, most, or all the time.

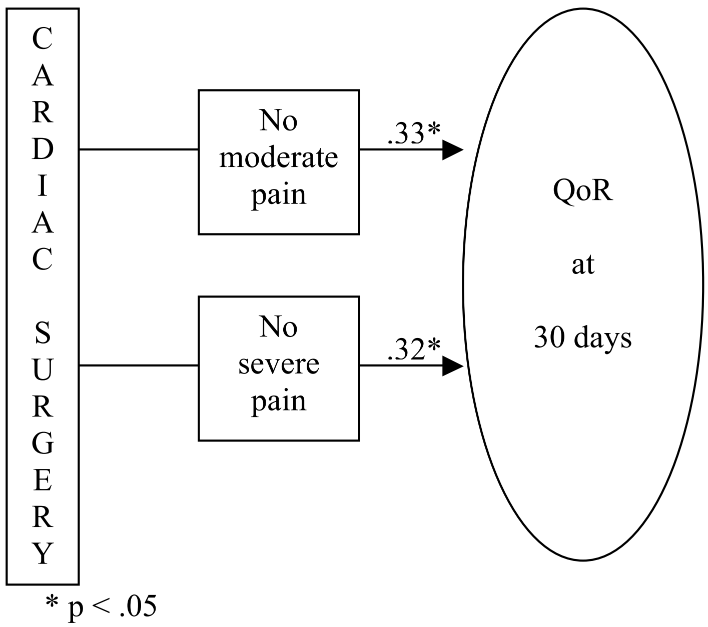
Figure 4. Relationship of postoperative pain day 1 through 5 to QoR at 30 days



* $p < .05$, dashed lines = $p > .05$

A weak negative association existed between pain on postoperative day one and quality of recovery at 30 days (rho = -.28, p = .03) (Figure 4). Following removal of the pain question scores from the total QoR-40 scores at discharge and 30 days, moderate or severe pain at discharge was not correlated with recovery quality at discharge. Absence of moderate pain at 30 days was moderately correlated with quality of recovery at 30 days (rho = .41, p = .001). Absence of severe pain at discharge and at 30 days was moderately correlated with recovery quality at 30 days (rho = .33, p = .011; rho = .32, p = .014) (Figure 5).

Figure 5. Relationship between moderate and severe pain and QoR at 30 days



Wound healing

The ASEPSIS scores for wound healing, which were right-skewed, are shown in Table 7. All participants had sternal wounds and 22.6 % (n = 14) had conventional long vein harvest site incisions in one or both lower extremities. Endoscopic vein harvesting, accessing the vein through small incisions at both ends of the vein segment, was performed in 50% (n = 31). The mean ASEPSIS score for all wounds was 6.1 (SD 7.28), indicating no disturbance of wound healing for the study sample. Individual scores ranged from zero to 26. Eighty-one percent of the sample had scores of 10 or less. As shown in Figures 9 and 10, there was no correlation between wound healing and quality of recovery at discharge (rho = -.24, p = .07) or 30 days (rho = -.17, p = .20).

Table 7. ASEPSIS scores

Score	*0-10*	*11-20*	*21-30*
n (%)	50 (80.6)	9 (14.6)	3 (4.8)

Mortality risk

Mortality risk scores were skewed to the right, and ranged from 0.5% to 65.3%. The mean STS risk score for the sample was 4.2% (SD 5.1). There was no correlation between STS risk and quality of recovery at discharge (rho = .08, p = .56) (Figure 6) or 30 days (rho = -.18, p = .19) (Figure 7).

Functional status, mood, quality of life, and quality of recovery

Descriptive statistics are shown in Table 8, and comparison of means at the different measurement points is shown in Table 9. Correlations between the predictors and the outcome are presented in Figures 6 through 10.

Mean scores for basic ADLs at discharge decreased from preoperative or baseline measurement, and rose towards baseline at 30 days. Good preoperative function for the sample was indicated by a mean score greater than 88, but was impaired at discharge, and close to baseline but still impaired at 30 days. Intermediate ADLs were impaired at baseline as indicated by a score of less than 78, and dropped to near zero at discharge, since IADLs such as driving, shopping, and walking several blocks are not performed in the hospital. At 30 days, IADLs remained impaired.

Mood state scores at baseline indicated low-level disturbance, and some worsening of mood state at discharge. At 30 days, mood state scores had decreased, indicating an improved mood over baseline. QLI scores rose from baseline to 30 days, and overall QoL scores indicated a fair amount of satisfaction. Quality of recovery scores were measured at discharge and increased at 30 days. Better quality of recovery, defined as an individual score greater than 1 SD below the group mean (Myles et al., 2001), was experienced by 57.6% (n = 34) of the sample at discharge, and by 59.3% (n = 35) at 30 days.

Table 8. Descriptive statistics: mean (SD)

Instrument	*Score*	*Preoperative*	*Discharge*	*30 Days*
FSQ (BADL)	0 to 100%	93.8 (11.54)	67.2 (21.57)	86.1 (17.21)
FSQ (IADL)	0 to 100%	67.4 (25.53)	3.3 (10.99)	39.9 (28.11)
POMS-SF	-20 to 100 pts	16.6 (17.86)	20.8 (14.19)	10.4 (15.26)
QLI	0 to 30 pts	22.8 (4.30)	23.5 (4.07)	25.1 (3.38)
QoR-40	40 - 200 pts		170.3 (14.43)	185.8 (12.06)

FSQ: Functional status questionnaire, BADL: basic activities of daily living, IADL: intermediate activities of daily living, POMS-SF: Profile of Mood States-Short Form, QLI: Quality of Life Index, QoR-40: Quality of Recovery Index

The Wilcoxon matched pairs signed ranks test was used to test the significance of the differences from the preoperative or baseline score to discharge and 30-day mean scores (Table 9). There were significant differences for basic and intermediate activities

Table 9. Differences between pairs of observations (Wilcoxon signed ranks test)

Instrument	*Preop/Discharge*	*Preop/ 30 days*	*Discharge/30 days*
FSQ (BADL)	-5.75**	-4.09**	-4.80**
FSQ (IADL)	-6.57**	-4.93**	-6.10**
POMS-SF	-2.15*	-1.56	-4.36**
QLI	-.73	-4.48**	-4.30**
QoR-40			-5.31**

*p < .05 **p < .01

of daily living scores between baseline and discharge, baseline and 30 days, and discharge to 30-days ($p < .01$). For total mood state, there were significant differences between baseline and discharge ($p < .05$), discharge and 30 days ($p < .01$), but not between baseline and 30 days. Quality of life scores differed significantly between baseline and 30 days, between discharge and 30 days ($p < .01$), but not between baseline and discharge. Quality of recovery scores also differed significantly between discharge and 30 days ($p < .01$).

Correlations between ADLs, mood, QoL, and quality of recovery (QoR) are shown in Figures 6 through 10. There were moderate positive associations between preoperative basic activities of daily living (BADL) and intermediate activities of daily living (IADL) and quality of recovery at discharge ($p = .01$). There were no significant correlations between preoperative mood state, measured by the POMS-SF, and QoL, measured by the QLI, and QoR at discharge.

Correlations between preoperative BADL, IADL, mood, QoL, STS risk and QoR at 30 days are shown in Figure 6. There were moderate positive associations between

Figure 6. Correlation between independent variables at preop and QoR at discharge

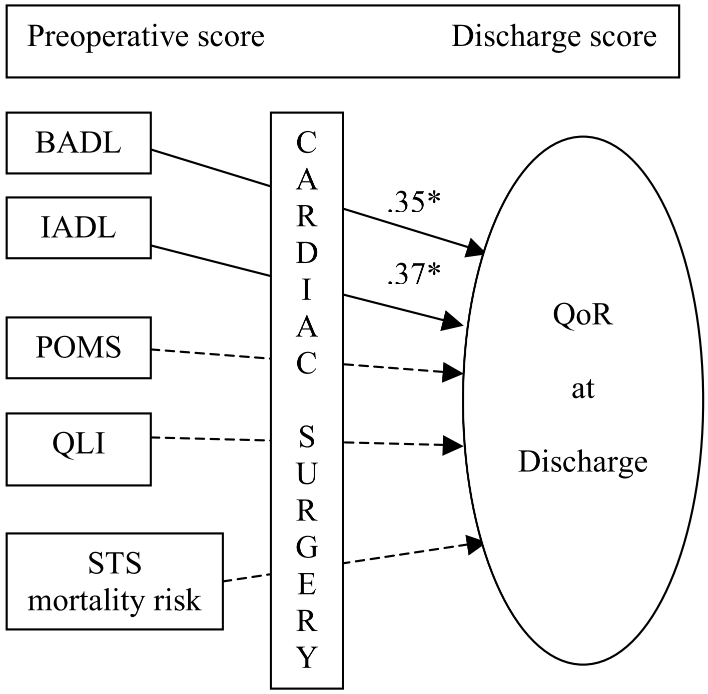
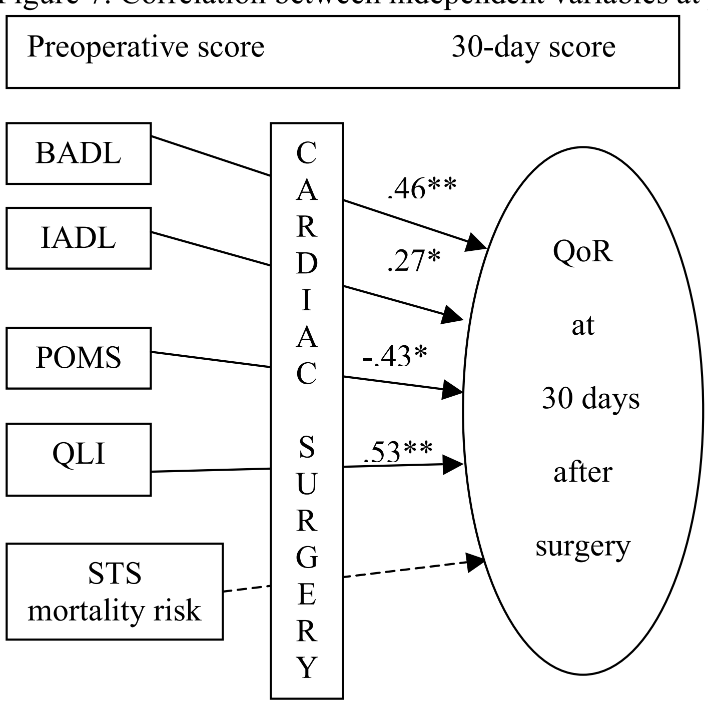


Figure 7. Correlation between independent variables at preop and QoR at 30 days

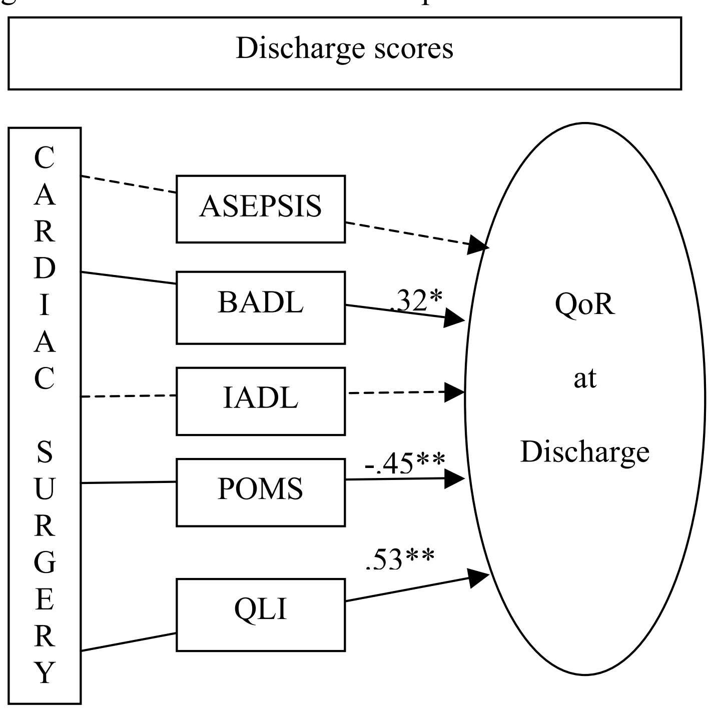


*p < .05; **p < .001; dashed arrows = p > .05

preoperative BADL ($p = .00$), IADL ($p = .04$), and QoR at 30 days. There was a strong positive correlation between QLI and QoR at 30 days($p = .00$). There was a moderate negative correlation between preoperative mood scores and 30-day QoR ($p = .01$). The negative correlation is indicative of the fact that lower scores reflect less mood disturbance. No association was found between mortality risk and 30-day QoR.

Correlations between BADL, IADL, mood and QoL at discharge and QoR at discharge are shown in Figure 8. A moderate, positive correlation was found between BADL at discharge and QoR at discharge ($p = .02$), however, no significant association between IADL and QoR at discharge was shown. There was a moderate negative association between discharge mood and recovery quality ($p = .00$), and a large positive association with QoL and QoR at discharge ($p = .00$).

Figure 8. Correlation between independent variables at discharge and QoR at discharge



*$p < .05$; **$p < .001$; dashed arrow = $p > .05$

Figure 9. Correlation between independent variables at discharge and QoR at 30 days

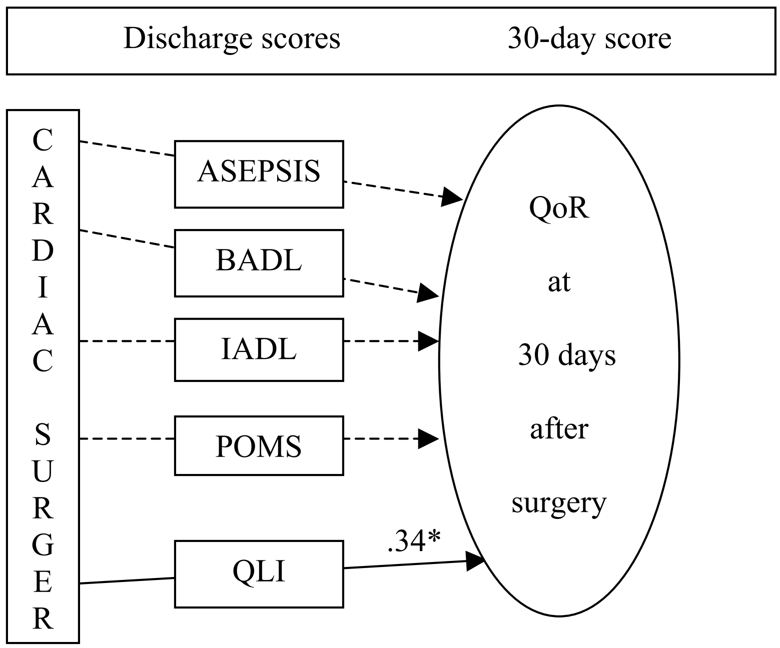
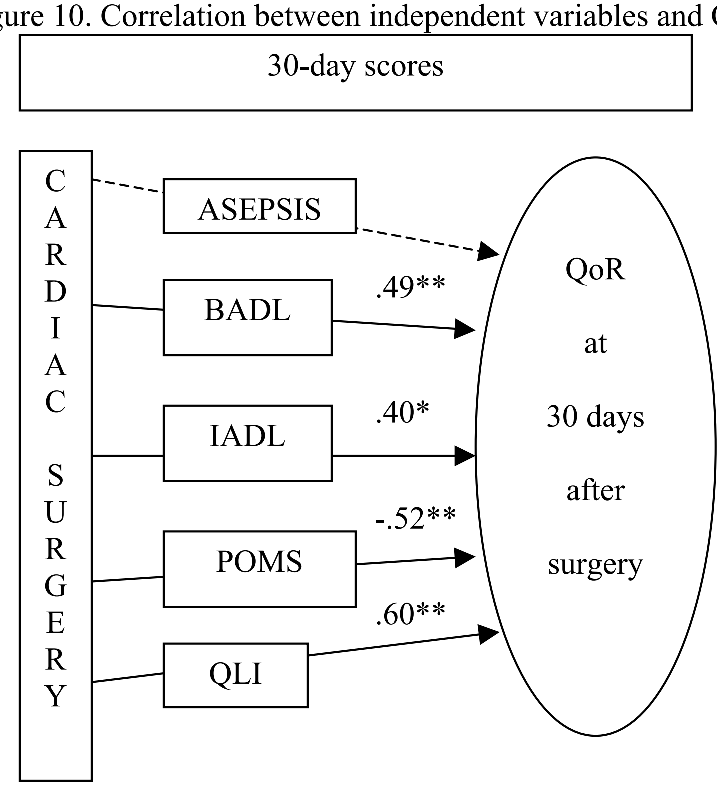


Figure 10. Correlation between independent variables and QoR at 30 days



*p < .05; **p < .001; dashed arrows = p > .05

The associations between wound healing, as measured by ASEPSIS, BADL, IADL, mood, and QoR at discharge and QoR at 30 days are shown in Figure 9. Only QoL at discharge was significantly positively associated with 30-day QoR ($p = .01$). Associations between wound healing, BADL, IADL, and mood at discharge and QoR at 30 days were not significant.

Associations between 30-day wound healing, BADL, IADL, mood, QoL and QoR are shown in Figure 10. Positive moderate correlations were shown between BADL, IADL and QoR at 30 days ($p = .00$). There was a large negative correlation between mood and recovery quality at 30 days ($p = .00$), and a large positive association between 30-day QoL and QoR ($p = .00$). There was no association between wound healing and QoR at 30 days.

Aim 2

Estimate the effects of the changes over time of each of the following factors on the change in the quality of recovery from discharge to 30 days after surgery: functional status, mood state and global quality of life

Estimation of the effects of functional status, mood state and quality of life were analyzed using techniques for negative binomial regression, since the QoR-40 scores were distributed in a manner similar to that of a count variable. For the regression models, deviation scores between the preoperative and discharge assessments, and preoperative and 30-day assessments were calculated. The deviation scores were used as covariates and centered on the mean to eliminate multicollinearity between the variables and the interaction term. Predictors were centered at the grand mean, and interpreted for the average person at the value of the mean for the variable.

Models were specified as follows: Model 1 is the estimate of the change across time for QoR (unconditional model); Model 2 is the average association between the predictor and QoR at discharge; Model 3 is the estimation of the average association between the predictor and QoR across time; and Model 4 is the estimation of the differences in the association between the predictor and QoR at discharge and at 30 days controlling for the predictor preoperatively (interaction term).

The predicted effects are reported on the original scale, but calculations were performed using the reversed score on the QoR-40 to meet the assumptions of negative binomial regression. The effects are based on the prediction equation using transformation of the regression coefficients from the log scale to the QoR scale, which includes information about the differences in the within-person variance in the variable (as suggested by James W. Hardin, PhD, personal communication, Bruce A. Cooper, PhD, 12/16/08). The results of these calculations for each model are included in the tables for the predictors, but only results for the final model (Model 4) are reported in the text.

The unconditional model (Table 10) tested the effect of time to predict the change in quality of recovery. The incident rate ratio (IRR) was .445, $p < .01$ (95% CI .354, .558). From discharge to 30 days after surgery, there was a significant average predicted increase in average QoR-40 scores of 16.88 points.

Table 10. Unconditional model: estimate of change in QoR across time

QoR score (reflected)	*IRR*	*SE*	*z*	*p*	*95% CI*	
time centered at discharge	.445	.051	-6.99	0.000	.354	.558

IRR = incident rate ratio SE = standard error

Table 11. Models for basic activities of daily living

Predictor	*Model 1*		*Model 2*		*Model 3*		*Model 4*	
BADL variables	coef	IRR	coef	IRR	coef	IRR	coef	IRR
Time centered at discharge	-.810**	.445**	-.813**	.443**	-.592**	.553**	-.563**	.570**
BADL deviation from the mean			-.020**	.980**	-.022**	.978**	-.022**	.978**
Average change in BADL deviation from preop to discharge & 30-days					-.010**	.990**	-.006	.994
Time by change in BADL deviation							-.019*	.982*
Estimated effects of predictors on quality of recovery (QoR score)								
QoR from discharge to 30 days	16.88		16.74		11.98		12.12	
Association between QoR at discharge & preop BADL			.59		.59		.61	
Association between QoR & average change in BADL from preop					.28		.16	
Difference in the relationship between QoR & BADL from discharge to 30 days							12.50	

*p < .01 **p < .001

Basic activities of daily living

Models were specified for basic activities of daily living (BADL) on the FSQ, which were self-care ability, moving in or out of a bed or chair, and walking inside one's home (Table 11).

The multi-level negative binomial regression model (Table 11, Model 4) predicting change in quality of recovery from the deviation in BADL from the mean, the average change in BADL deviation from before surgery to discharge and 30 days, and the time by BADL deviation interaction was statistically significant ($\chi^2 = 108.60$, df = 4, $p < .001$). The deviation in BADL from the mean, and the time by BADL deviation interaction were significant ($p < .001$, $p < .01$). The effect of the average change in BADL deviation from before surgery to discharge and 30 days with the addition of the interaction term to the model was not significant at the .05 level.

The IRR for predicted change in quality of recovery over time (Table 11, Model 4) was .570, $p < .001$, (95% CI .461, .704). For each unit change in time, the change in QoR-40 scores from discharge to 30 days was predicted to be 12.12 points higher. The IRR for the BADL deviation from the mean was .978, $p < .001$, (95% CI .971, .986), meaning that the predicted effect on the Qor-40 scores at discharge was an increase of .6 point, holding preoperative to postoperative BADL deviation constant at the mean. The IRR for the interaction of time with the change in the BADL deviation was .981, $p < .01$ (95% CI .971, .992). For a one-unit increase in the BADL deviation score from preoperatively to postoperatively, there was a predicted increase in the change in the QoR-40 scores from discharge to 30 days of 12.5 points, holding preoperative BADL constant at the mean.

Although increases in the QoR-40 score were predicted for unit increases in deviation scores for patients at the mean in the models, the increases were small and may not be of clinical importance. However, the ability to perform basic ADLs after surgery is impaired, and the models suggest that quality of recovery improves over time as ability to perform BADL improves in the first 30 days following cardiac surgery in older adults.

Intermediate activities of daily living

Models were specified for intermediate activities of daily living (IADL) on the FSQ, which were ability to walk several blocks, climb stairs, do chores, housework or errands, drive or take public transit, and participate in vigorous activities (Table 12).

The multi-level negative binomial regression model (Table 12, Model 4) predicting change in quality of recovery from the deviation in IADL from the mean, the average change in IADL deviation from before surgery to discharge and 30 days, and the time by IADL deviation interaction was statistically significant ($\chi^2 = 55.17$, df = 3, $p < .001$). At discharge, study participants did not undertake IADLs, and no data was accrued; therefore the preoperative IADL to discharge IADL deviation was dropped from the model. The time by IADL deviation interaction ($p = .027$) was significant, but the average change in IADL deviation from before surgery to discharge and 30 days was not significant at the .05 level.

The IRR for predicted change in quality of recovery over time (Table 12, Model 4) was .431, $p < .001$, (95% CI .332, .560). For each unit change in time, the change in QoR-40 scores from discharge to 30 days was predicted to be 18.99 points higher. Although the average change in IADL deviation from before surgery to discharge and 30 days was not significant, the predicted effect for a one unit increase in IADL deviation on

Table 12. Models for intermediate activities of daily living

Predictor	*Model 1*		*Model 2*		*Model 3*		*Model 4*	
IADL variables	coef	IRR	coef	IRR	coef	IRR	coef	IRR
Time centered at discharge	-.810**	.445**	-.827**	.437**	-.860**	.423**	-.842**	.430**
IADL deviation from the mean			-.007*	.993*				
Average change in IADL deviation from preop to discharge & 30-days					.001	1.00	.005	1.00
Time by change in IADL deviation							-.009*	.991*
Estimated effects of predictors on quality of recovery (QoR score)								
QoR from discharge to 30 days	16.88		17.14		17.97		18.99	
Association between QoR at discharge & preop IADL			.20					
Difference in the relationship between QoR & IADL from discharge to 30 days					-.03		-.16	
Difference in the relationships between change in QoR across time & change in IADL across time							19.05	

*p < .05; **p < .001

the QoR-40 score was a decrease of .16 point, holding preoperative to postoperative IADL deviation constant at the mean. The IRR for the interaction of time with the change in the IADL deviation was .991, $p < .05$ (95% CI .984, .990). For a one-unit increase in the IADL deviation score from preoperatively to postoperatively, holding preoperative IADL constant at the mean there was a predicted increase in the change in the QoR-40 scores from discharge to 30 days of 19.05 points.

The ability to perform IADLs prior to surgery and the change in that ability postoperatively affected the change in quality of recovery across time. The models suggest that compared to BADL, IADL ability has a greater effect on quality of recovery across time. This may be since greater physical ability and effort is required to carry out IADLs than BADLs.

Mood state

Models were specified for the total score on the POMS-SF, which sums the scores on the tension, anger, fatigue, depression, and confusion subscales and subtracts the score on the vigor subscale for a total mood score (Table 13). Higher total mood scores are indicative of increased distress.

The multi-level negative binomial regression model (Table 13, Model 4) predicting change in quality of recovery from the deviation in the total POMS score from the mean, the average change in the total POMS deviation score from before surgery to discharge and 30 days, and the time by total POMS score deviation interaction was statistically significant ($\chi^2 = 98.03$, df = 4, $p < .001$). The deviation in the total POMS score from the mean, and the average change in the total POMS score deviation from before surgery to discharge and 30 days were significant ($p < .001$). The time by total POMS score deviation interaction term was not significant at the .05 level.

Table 13. Models for total mood state

Predictor	*Model 1*		*Model 2*		*Model 3*		*Model 4*	
POMS variables	coef	IRR	coef	IRR	coef	IRR	coef	IRR
Time centered at discharge	-.810**	.445**	-.853**	.426**	-.644**	.524**	-.643**	.526**
POMS deviation from the mean			.009*	1.01*	.021**	1.02**	.021**	1.02**
Average change in POMS deviation from preop to discharge & 30-days					.017**	1.02**	.016 **	1.02**
Time by change in POMS deviation							.003	1.00
Estimated effects of predictors on quality of recovery (QoR score)								
QoR from discharge to 30 days		16.88		18.05		13.32		13.38
Association between QoR at discharge & preop POMS				-.29		-.60		-.60
Association between QoR & average change in POMS from preop						-.48		-.46
Difference in the relationship between QoR & POMS from discharge to 30 days								13.09

*p < .01; **p < .001

The IRR for predicted change in quality of recovery over time (Table 13, Model 4) was .526, $p < .001$, (95% CI .417, .663). For each unit change in time, the change in QoR-40 scores from discharge to 30 days was predicted to decrease by 13.38 points. The IRR for the POMS deviation from the mean was 1.021, $p < .001$, (95% CI 1.014, 1.029), indicating that the predicted effect on the QoR-40 scores at discharge was a decrease of .6 point, holding preoperative to postoperative POMS deviation constant at the mean. The IRR for the averaged effect of the change in the POMS deviation from preoperatively to discharge and 30 days was 1.016, $p < .001$ (95% CI 1.008, 1.024). For a one-unit increase in the total POMS deviation score from preoperatively to postoperatively, there was a predicted decrease in the average change on the QoR-40 scores of .5 point, holding the preoperative total POMS score constant at the mean.

The models suggest that, as expected, altered mood states negatively affect quality of recovery across time. In the final model, with all the mood state predictors included, and controlling for preoperative mood, there was a small decrease in recovery quality at discharge. However, there is little predicted change in quality of recovery from discharge to 30 days in the models, suggesting that mood state has less effect on perception of recovery than functional status.

Quality of life

Models were specified for the total score on the Quality of Life Index (QLI), which incorporates scores on health and functioning, psychological and spiritual, socio-economic, and family subscales (Table 14).

The multi-level negative binomial regression model (Table 14, Model 4) predicting change in quality of recovery from the deviation in the total QLI score from

Table 14. Models for quality of life, measured by QLI

Predictor	*Model 1*		*Model 2*		*Model 3*		*Model 4*	
QLI variables	coef	IRR	coef	IRR	coef	IRR	coef	IRR
Time centered at discharge	-.810**	.445	-.824**	.439**	-.681**	.506**	-.699**	.497**
QLI deviation from the mean			-.047**	.954**	-.081**	.922**	-.079**	.924**
Average change in QLI deviation from preop to discharge & 30-days					-.073**	.930**	-.080**	.923**
Time by change in QLI deviation							.036	1.04
Estimated effects of predictors on quality of recovery (QoR score)								
QoR from discharge to 30 days	16.88		17.05		13.61		13.71	
Association between QoR at discharge & preop QLI			1.39		2.15		2.08	
Association between QoR & average change in QLI from preop					1.93		2.10	
Difference in the relationship between QoR & QLI from discharge to 30 days							14.30	

*p < .01; **p < .001

the mean, the average change in the total QLI score deviation from before surgery to discharge and 30 days, and the time by total QLI score deviation interaction was statistically significant ($\chi^2 = 98.76$, df = 4, p < .001). The deviation in the total QLI score from the mean, and the average change in the total QLI score deviation from before surgery to discharge and 30 days were significant (p < .001). The time by total QLI score deviation interaction term was not significant at the .05 level.

The IRR for predicted change in quality of recovery over time (Table 14, Model 4) was .497, p < .001, (95% CI .397, .623). For each unit change in time, the change in QoR-40 scores from discharge to 30 days was predicted to be 13.72 points higher. The IRR for the QLI deviation from the mean was .924, p < .001, (95% CI .896, .953), indicating that the predicted effect on the QoR-40 scores at discharge was an increase of 2.1 points, holding preoperative to postoperative QLI deviation constant at the mean. The IRR for the averaged effect of the change in the QLI deviation from preoperatively to discharge and 30 days was .923, p < .001 (95% CI .890, .958). For a one-unit increase in the total QLI deviation score from preoperatively to postoperatively, there was a predicted increase in the average change on the QoR-40 scores of 2.1 points, holding the preoperative total QLI score constant at the mean. Although not statistically significant, the predicted difference in the change on the QoR-40 score for a one unit increase in the preoperative to postoperative deviation score on the QLI, holding the preoperative QLI score constant at the mean, was 14.3 points.

Comparison of predicted effects

Table 15 summarizes the estimated effects of the predictors on the change in QoR from discharge to 30 days. For the estimated change in QoR from discharge to 30 days, time was centered at discharge. For the effect on QoR at discharge, the preoperative to postoperative change in the predictor was held constant at the mean. For the average effect on QoR at discharge, and for the predicted change for the full model, the predictor was held constant at the mean.

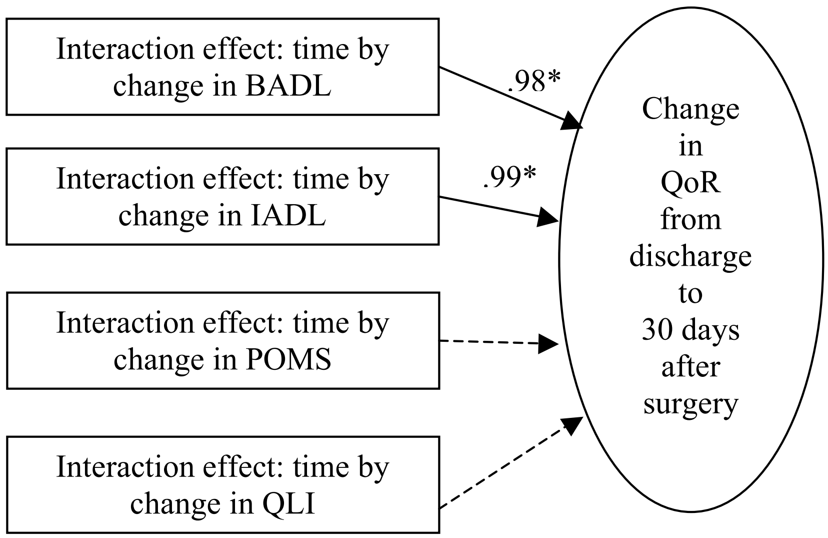
The models showed that the change in quality of recovery in relationship to the change in the predictors was highest for IADL, suggesting that the change in the quality of recovery from discharge to 30 days is affected more by ability to perform intermediate ADLs, than basic ADLs, mood state, and QoL. The changes in mood state and QoL had similar effects on quality of recovery across time, and were somewhat higher than the change in BADL. As previously noted, intermediate ADLs measured by the FSQ, were not routinely performed at discharge, so the estimation of the differences in the IADL score from baseline to discharge is not included, which may affect the results.

Table 15. Estimated effects of predictors on change in QoR across time (points)

Predictor	*Predicted change for 1 unit increase in time*	*Predicted change in QoR at discharge for 1 unit increase in predictor*	*Predicted average change for 1 unit increase in deviation score*	*Predicted change for full model*
BADL	12.12	.61	.16	12.5
IADL	18.99	_____	-.16	19.05
POMS	13.38	-.6	-.46	13.09
QLI	13.71	2.08	2.10	14.3

The relationships of the interaction terms are shown in Figure 11. There was a negative relationship shown in the interaction terms for the changes in BADL (IRR .98, p = .001, 95% CI .97, .99) and IADL (IRR .99, p = .03, 95% CI .98, 1.0) from preoperatively to postoperatively and the change in QoR from discharge to 30 days. The time by mood deviation interaction effect, time by QoL deviation interaction effect, and the change in QoR were not significant.

Figure 10. Effect of time by change in independent variable on change in QoR



IRR: *p < .05; dashed arrow = p > .05

Aim 3

Describe older patients' perception of factors that contribute to and hinder their recovery after cardiac surgery

At 30 days postoperatively, participants (n = 59) were asked questions about their recovery. When asked, “What was the biggest promoter of your recovery?” 58% reported that spousal and family support was a major factor in promoting recovery, followed by being home (25%) and provision of home health care (24%). For 19%, being able to sleep and rest was the most supportive. When asked, “What was the biggest hindrance to your recovery?” 39% reported that the mobility limits imposed by sternal precautions, particularly not being able to drive, were the major obstacle. Other medical problems and fatigue were the most hindering to 32% and 17% of the sample, respectively.

Aim 4

Describe older patients' perception of the differences from their preoperative state and amount of recovery achieved one month after cardiac surgery

In response to being asked, "On a zero to 100 scale, if zero was no recovery and 100 was fully recovered, how much have you recovered?" 62% felt they had achieved at least 75% recovery, and 22% felt they were at least 50% recovered. Participants were then asked if they had returned to their preoperative state. If the response was "no", they were asked to describe what was different from their preoperative state. Responses were grouped thematically for reporting purposes. Of the participants, 15 (25%) stated they were back to their preoperative state or better. The positive changes at 30 days were feeling better (47%), increased strength and energy (20%), and symptom relief (33%). Of the remaining 44 participants, 61% experienced weakness and fatigue, 57% experienced limited mobility and activity, and 25% were bothered by discomfort. Other related differences, reported by less than 13%, were poor sleep, poor appetite, shortness of breath, mood swings or memory problems. Those describing negative changes reported more than one difference from their preoperative state.

Reference list

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This study examined the quality of postoperative recovery in older adults following cardiac surgery from discharge to 30 days after surgery, and adds to the literature by documenting the impact of the selected bio-psychosocial variables on the recovery process. This chapter discusses the findings in relation to previously reviewed literature, the theoretical framework, and the study aims. Study limitations are addressed, as well as implications for nursing, and areas of additional research. The findings are discussed sequentially, beginning with the independent variables of pain, wound healing, mortality risk, functional status, mood state and quality of life, followed by the outcome variable, quality of recovery, including the results of the structured interview.

Pain

Findings from this study confirm earlier data showing that postoperative pain experienced by cardiac surgery patients may be relatively mild overall, despite sternal or leg incisions, or both (Mueller et al., 2000; Pozehl, Barnason, Zimmerman, Nieveen, & Crutchfield, 1995; Reimer-Kent, 2003). In the current study, mean and median daily pain scores, which were less than 2.5 on a 10-point NRS, decreased over the study period as expected. The highest mean scores occurred on postoperative days (POD) 1 and 2, supporting previous findings. Mueller et al (2000) reported mean pain intensity scores of 3.7 (SD 2), 3.9 (SD 1.9), and 2.6 (SD1.8), using a similar NRS, on postoperative days one, two and three, respectively. Pozehl et al (1995) reported mean pain intensity scores on POD 1 and POD 3 after CABG of 1.08 (SD 1.15) and .67 (SD .85) respectively; however, these were on a 5 point Likert scale ranging from 1 (little or no pain) to 5 (most severe) which limits comparison of findings. The lower scores reported by the sample in this study may be reflective of a greater emphasis on pain assessment and management established by the Joint Commission on Accreditation of Healthcare Organizations in 2001 (www.jcaho.org), and reflect effective pain relief by keeping overall pain at a mild level (Reimer-Kent, 2003).

At one month, moderate pain was reported by 30.5% of the sample in this study as occurring most of the time (n = 1), usually (n = 5) or sometimes (n = 12). Although no participants reported severe pain all of the time, most of the time, or usually, 6.8% (n = 4) did experience severe pain sometimes. Since the questions on the QoR-40 did not discriminate between incisional pain and other bodily pain, it is difficult to compare these findings to those of other studies examining residual post cardiac surgery pain. However, these pain levels are higher than those reported in a Finnish study that examined persistent sternotomy pain in CABG patients during the first year after surgery (Lahtinen, Kokki, & Hynynen, 2006) in which mean sternotomy pain was ranked as 1 at rest, 3 with coughing, and 2 with movement, all reflective of mild pain. Zalon (2004) found that at three months following abdominal surgery, participants reported pain that was related to pre-existing chronic conditions, rather than surgery, that affected recovery perception.

The weak correlations found between moderate pain, severe pain and QoR at 30 days is similar to that of earlier research. As the scores on the QoR-40 pain questions increased, meaning that patients experienced less pain, scores on the QoR-40 increased. Pain, in combination with fatigue and depression, was responsible for 33.2% of the variance in abdominal surgery patients' perception of recovery at 30 days postoperatively; additionally, there was a moderate negative association between pain and recovery perception (Zalon, 2004).

No studies were found that specifically examined the impact of postoperative pain on the quality of recovery in cardiac surgery patients. In the study examining the relationship between 30-day postoperative HRQL and 3-day postoperative QoR in cardiac surgery patients (Myles et al., 2001), comparison between the pain subscales on each instrument was not made. In the current study, there was a weak negative association between QoR and pain on the first postoperative day, implying that pain on postoperative day one may be a good predictor of quality of recovery.

The finding that a high proportion of participants in an older sample experienced moderate pain levels one month after surgery indicates the need for additional research that discriminates between incisional pain and other pain syndromes and examines the effect of other pain syndromes on the quality of recovery. Moderate or severe pain at 30 days after surgery may also indicate that pain management after discharge is not optimal, and that patients require additional support to adequately manage pain. In general, increased pain severity or the presence of pain from any source has a negative impact on quality of recovery.

Mortality Risk

Mortality and morbidity risk was included in the study as a means of estimating the effect of major comorbidities, physiologic parameters and the surgical procedure as a single parameter on QoR. New York Heart Association class is included in the risk algorithm as are ejection fraction and history of cerebrovascular accident, all of which may reflect physical ability. No other studies were found that utilized cardiac surgical risk in this manner. The small sample size may explain the lack of association between the risk of surgery and QoR. Additional research with a larger sample is needed to determine if any association exists, and if utilizing risk assessment in this manner is a useful tool for predicting quality of recovery.

Wound Healing

Wound healing in this study was unimpaired as indicated by a mean ASEPSIS score of less than 10. Normal healing occurred in 80.6%, and the remainder experienced disrupted healing (14.6%) or a minor wound infection (4.8%) as established by ASEPSIS criteria. None of the participants in this study experienced deep sternal wound infection or sternal dehiscence, in contrast to studies by others (Schimmer et al., 2008). There was no correlation between wound healing and quality of recovery.

While others have found SSI in 2.3% of patients following cardiac surgery using Centers for Disease Control criteria (Kaye et al., 2005), and deep sternal wound infection in 2.2% was reported by NNIS ("National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 through June 2004", 2004), only minor infection was seen in 4.8% (n = 3) of the sample in this study. These minor infections were all at saphenous vein sites obtained by the open harvest method. None of the endoscopic vein havest sites manifested infections. It is possible that the higher incidence of minor wound infection found here is explained by the increased discrimination of minor wound impairment that occurs when using ASEPSIS to evaluate healing, as agreement between definitions of SSI using ASEPSIS and Centers for Disease Control criteria is poor (Wilson et al., 2006). Although QoR-40 scores in this study indicated a better quality of recovery in the majority of the participants, a larger sample is needed to determine if there is an association between impaired wound healing and QoR.

Functional Status

The DASI, the SF-36, the SAQ, and NYHA classification all have been utilized by researchers to operationalize functional status as an outcome measure following cardiac surgery in older adults (Barnett & Halpin, 2003; Conaway et al., 2003; Hedeshian, Namour, Dziadik, Stewart, & Campos, 2002). Functional status has been measured at varying times following surgery but primarily over longer periods of time, e.g. years. A study by Barnett and Halpin (2003) showed steady improvement in physical function the first two years after elective CABG in older adults, with the greatest increase occurring in the first year following surgery. No studies have examined functional status, defined by ability to perform basic and intermediate ADLs, as a cardiac surgery outcome or as a predictor of recovery quality in older adults at hospital discharge and 30 days postoperatively.

However, findings of weak associations between basic and intermediate ADLs and quality of recovery at discharge in this study support those of other researchers. ADLs, assessed by a nursing disability index, were weakly associated with perception of well-being at rehabilitation hospital admission 12 (SD 7) days after cardiac surgery (De Feo et al., 2002), which is roughly analogous to the time of discharge from acute care in this study. Additionally, mean scores for BADL, and particularly IADL, decreased significantly between baseline and discharge, as expected, but approached baseline at 30 days, in agreement with those researchers who found improvement over time in older cardiac surgery patients (Conaway et al., 2003; Hedeshian et al., 2002; Schmidtler et al., 2008).

Although an increase in the QoR-40 score was predicted for unit increases in deviation scores for patients at the mean in the ADL models, the increase was small, and may not be of clinical significance. The deviation scores in the statistical analysis were calculated using the transformed scores on the BADL and IADL subscales of the FSQ, which had been converted to a 0 to 100 scale, with higher scores indicating better function, to enable clinicians to easily use the instrument to evaluate individual change. The transformed score is based on the mean raw score minus 1, multiplied by 100, and divided by the difference between the maximum and minimum response score. Thus, a 1-point change in the raw score is not equivalent to an equal percentage change. For example, 100% on the BADL subscale is the maximum score of 12 points. A score of 6 on the BADL is equal to 33.3%. Similarly, 100% on the IADL subscale is the maximum score of 24, while a score of 12 is equivalent to 33.3%. If an individual scores 100 at baseline and 44 at discharge, the deviation score between the two measurements is -56; likewise if the individual scores 89 at 30 days, the deviation score between baseline and 30 days is -11. Therefore, a 1-unit change in the BADL or IADL deviation score represents a variable percentage change that is not easily interpreted. The increase in the deviation score indicates an improvement in functional status; however the ability to perform basic and intermediate ADLs after surgery remains impaired. The models suggest that QoR improves over time as the ability to perform basic and intermediate activities of daily living improves in the first 30 days after cardiac surgery, and that ability to carry out IADLs has a greater effect on QoR than the ability to perform BADLs.

The relationship between the change in the ability to perform ADLs and the change in quality of recovery from discharge to 30 days postoperatively was significant, indicating that as the ability to perform ADLs improved following discharge, the quality of recovery also improved. The predicted difference in the change in quality of recovery was greatest for IADL, indicating that IADL ability has a greater effect on the quality of recovery than BADL, mood state or quality of life.

While the impact of the patient's ability to perform basic and intermediate ADLs on the quality of recovery has not been previously evaluated, the results from this study indicate that there is a relationship between functional status and the quality of recovery, and that the change in this ability is the basis for the relationship.

Mood State

Depression has been implicated in poorer physical and mental recovery and increased rates of surgical site infection following cardiac surgery (Doering, Moser, Lemankiewicz, Luper, & Khan, 2005). Preoperative anxiety, depression and stress were predictive of postoperative mood, and were associated with postoperative memory and attention deficits after cardiac surgery (Andrew, Baker, Kneebone, & Knight, 2000). In a sample of younger Thai patients undergoing CABG, disturbed mood was associated with an increased frequency of incisional pain, sleep disturbance, and musculoskeletal discomfort that interfered with recovery (Utriyaprasit & Moore, 2005). Depression, pain and fatigue contributed 33.2% of the variation in recovery perception one month after abdominal surgery in older adults (Zalon, 2004).

Mean total mood scores in this study were higher than normative data for a geriatric sample (McNair & Heuchert, 2007). Findings in the current study showed a significant increase in mood disturbance between preoperative and discharge measurements, which improved between discharge and 30 days. Mean scores were highest at discharge, but not indicative of great mood disturbance. Subscales on the POMS that detail fatigue, anxiety, depression, confusion, and anger were not analyzed in this study because of the study was not powered for these analyses. The associations between total mood state and quality of recovery indicated that as mood disturbance increased after surgery, quality of recovery at discharge and at 30 days was worse. The finding that impaired mood before surgery is related to quality of recovery at 30 days is similar to the findings by Doering, et al (2005) and supports the rationale for evaluating mood disturbances prior to surgery to promote better outcomes.

The regression analysis examined the effect of the change in mood scores on the quality of recovery over time. As expected, the statistical relationships indicated that as mood worsened, quality of recovery declined. The time by change in total mood interaction term in the final model was not significant, indicating that there was not a significant change in the association between mood and QoR at discharge and the association between mood and QoR at 30 days. The predicted differences in the change in the quality of recovery in the models for mood state indicated that mood has less predictive effect on quality of recovery than functional status. The small predicted effect on quality of recovery may reflect the lack of major disturbance of mood in the sample.

The findings in this study support those of others implicating the negative impact of mood disturbances on domains of recovery after cardiac surgery (Ai, Peterson, Bolling, & Rodgers, 2006; Allen, Becker, & Swank, 1990; Andrew et al., 2000). Careful assessment of mood states, particularly depression and anxiety, will alert providers to potential problems. Interventions can then be implemented to improve quality of recovery.

Quality of Life

Quality of life and recovery are concepts closely linked in the literature, as the recent emphasis on HRQL as an outcome of cardiac surgery in older and very old patients indicates. Studies examined HRQL using the SF-36, the SAQ, stand-alone questions, and the DASI (Ballan & Lee, 2007; Conaway et al., 2003; Goyal, Henry, & Mohajeri, 2005; Jensen, Hughes, Rasmussen, Pedersen, & Steinbruchel, 2006; Koch et al., 2007). Two studies incorporated additional domains of quality of life as described by Wilson and Cleary (1995) (Mathisen et al., 2007; Penckofer, Ferrans, Fink, Barrett, & Holm, 2005). Research has shown that other aspects of life besides those that are health related contribute to an individual's perception of life's quality (Ferrans, 2007; Rankin & Fukuoka, 2003). A stand–alone question or a visual analog scale assesses global QoL by including aspects of life that are individually weighted by the respondents (Ferrans, 2007). The current study utilized the QLI to measure the concept, since it includes socioeconomic and family domains, as a means of capturing a global perspective of quality of life and the relationship to quality of recovery.

The positive relationships between QoL and quality of recovery at discharge and 30 days were expected and lend credence to the overlap between the two concepts. The strongest correlation of all the study variables was between QoR and QoL at 30 days. Mean total QLI scores increased significantly between baseline and 30 days and discharge and 30 days. The increases across time may reflect symptom relief and the progressive nature of the recovery process; health and functioning, social and economic, psychological/spiritual, and family subscales were not analyzed because the study was not powered to do so. These findings are similar to research by others showing improvement in HRQL in older cardiac surgery patients over time (Aydin, Yavuz, Duver, & Kutsal, 2006; Jensen et al., 2006). The mean score on the QLI at 30 days indicated fairly good QoL in the sample, in contrast to Ballan and Lee (2007), who found impaired QoL indicated by low scores on the SF-36 six weeks postoperatively. The difference may be explained by use of the QLI that assesses global QoL, rather than focusing solely on health-related domains.

The regression analysis examined the predicted effect of the change in QLI scores on the quality of recovery over time. Although the change in QLI deviation from the mean, and the average change in QLI deviation from baseline to discharge and 30 days after surgery were significant, the predicted effects on QoR were small. However, as expected, as the change in QLI increased, the quality of recovery improved, although the time by change in QLI interaction term in the final model was not significant. Thus the relationship of QLI and QoR at discharge was similar to the relationship between QLI and QoR at 30 days.

Quality of Recovery

Few studies define recovery and describe it in a quantitative manner as an outcome of cardiac surgery. A qualitative study described the process of cardiac surgery recovery, finding that patients (n = 8) recalled being ill, reaching a point when they began to improve and eventually feeling better (Gardner, Elliott, Gill, Griffin, & Crawford, 2005). In the current study, there was a significant change in mean QoR-40 scores from discharge to 30 days after surgery, indicating that the quality of recovery improved over time in the sample. The independent function, emotions, physical symptoms, pain, and support subscales were not analyzed because of the small sample size. The unconditional negative binomial regression model was significant and predicted a positive change in quality of recovery from discharge to 30 days following cardiac surgery.

Analysis of the QoR-40 scores in terms of a good or poor recovery, as indicated by Myles et al., (2001), showed that 57.6% (n = 34) in this study experienced a good quality recovery at discharge and that improved to 59.3 % (n = 35) at 30 days postoperatively. Myles et al., (2001) reported an 18% incidence of poor QoR one month after cardiac surgery, in which any major complication was predictive of a poor QoR at month. The higher incidence of poor QoR in this sample may be reflective of an older sample (75.9 vs. 63) or other variables such as comorbidities, operative time, intubation hours or length of stay that were not entered into the analysis.

At 30 days after surgery, the mean overall perceived level of recovery achieved by this sample was 69.3%, compared to Zalon (2004), who found that the mean perceived level of recovery achieved was 81.4% 1 month after abdominal surgery. Approximately 62% of the participants in this study ranked their perceived level of recovery as 75% or better, and 22% reported perceived recovery between 50 and 74%. The lower mean percentage of recovery in the current study may be a result of an older sample, a different preoperative severity of illness, and procedural differences between abdominal and cardiac surgery. However, the fact that 84% of this older sample felt they had achieved at least 50% recovery was encouraging and supported findings in other studies examining outcomes in older cardiac surgery patients. The findings also illustrate the need to improve the rehabilitation process during the first postoperative month for patients with lower levels of perceived recovery, since it is now known that mood state, pain and functional status may negatively impact recovery (Conaway et al., 2003; Doering et al., 2005; Zalon, 2004).

Promoters and Hindrances

That family support was most helpful to the recovery process supports previous findings (Gortner, Dirks, & Wolfe, 1992). Research has demonstrated that social support is integral to promoting lifestyle changes to older adults after cardiac surgery (Rankin, Butzlaff, Carroll, & Reedy, 2005). The flexible nature of spousal relationships contributed to psychosocial adjustment and recovery after CABG, as the intimacy engendered by such relationships promotes role changes and adaptability during times of illness (Elizur & Hirsh, 1999). Participants without partners in this study reported support from friends and home care nurses in lieu of spousal support as promoters of recovery, emphasizing the importance of a postoperative support system.

The impact of mobility limitations imposed by sternal wound healing on recovery has not been previously examined. The participants in this study reported frustrations from not being able to drive which limited independence, and anxiety about “pulling something loose” when inadvertently straining the chest wall. At one month, patients are able to begin driving but are still restricted from lifting more than 20 pounds until 12 weeks postoperatively; however nonunion of the sternum, demonstrated by computed tomography, may persist for a year (Bitkover, Cederlund, Aberg, & Vaage, 1999). The current study showed that for many, limitations imposed by sternal precautions affected perception of recovery.

Strengths and Limitations

The study included participants that had a high proportion of urgent and emergent operations, unlike many previous studies. The STS risk score as a predictor incorporated a number of different physiologic and perioperative variables into one, which is not often found in the literature. Additionally the statistical analysis, by utilizing the deviation scores as covariates to predict change in QoR over time, predicts the within-person change and controls for individual differences from baseline. This is in contrast to the more common method of predicting between-person change.

The primary limitation of this study was the small sample size. Enhanced findings, such as comparisons between the oldest, older and youngest participants may have been possible with a larger sample size. The accessible population was limited by a low surgical census and urgent or emergent timing of the operations hampered enrollment. Older participants who were recruited after being hospitalized and who required urgent operation were often anxious and wished to enroll postoperatively, so baseline data were missed or subject to recall if appropriate. Data completeness was affected by delayed enrollment, mortality and intermittent reluctance on the part of participants to be interviewed at the time of discharge.

The nature of the sample also affects generalization. The sample was continuous, including all subjects from two community hospitals who had cardiac surgery. The participants were overwhelmingly Caucasian, male and retired. Further study in a more ethnically and economically diverse sample may yield different information on QoL and mood state.

Study limitations imposed by the instruments included the scoring on the FSQ, making it difficult to determine what a one-unit change in the deviation score meant clinically. The pain questions on the outcome measure, the QoR-40, did not differentiate between surgical pain and chronic pain syndromes, and thus there was lack of clarity when study patients had chronic pain from arthritis, old injuries, or from the surgical procedure. Additionally, questions relating to the amount of support participants experienced from hospital staff were not applicable following discharge, and so were coded as recommended by the author at the maximum response, which potentially biased the results (P. M. Myles, MBBS, MPH, MD, personal communication, December, 2007). Further work is needed to transform scores on the instrument to a 0 to 100 scale, and to develop a cut score from many studies that would indicate a better quality of recovery.

Additionally, multicollinearity between the instruments may exist, artificially strengthening relationships between the variables and the outcome. However, potential collinearity was mitigated by centering variables at the individual mean for the regression analyses, and by the time frame of responses on the instruments. For example, at 30 days, the instruments asked participants to rate responses based on abilities since discharge, while the responses on the QoR-40 were based on the previous 24 hours.

Clinical Implications for Nursing

Optimizing outcomes for older cardiac surgery patients is a multidisciplinary responsibility, in which nurses play a major role (Rosborough, 2006). As the population ages and older adults undergo cardiac surgery with greater frequency, nurses find their responsibilities for patient management and family/patient education increasing. Additionally, cardiac surgery is performed in community hospitals, where there may be fewer multidisciplinary team members than in urban university settings. Outcomes in older adults have focused on health-related quality of life, morbidity and mortality. Quality of recovery is often overlooked or equated with quality of life or functional status when outcomes are examined.

The findings of the current study provide additional information about older patients' quality of recovery after cardiac surgery. The process of recovery begins with the cessation of anesthesia, and as patients progress from intensive care to readiness for discharge, much of the responsibility for postoperative teaching can fall on staff nurses. Knowing that recovery is a dynamic process, and how patients perceive their progress will enable nurses to educate and reassure their elderly patients and families, particularly when discussing setting-specific activity goals. The importance of a support system to promote recovery and recovery perception cannot be over-emphasized; awareness of these needs will promote discharge planning and facilitate the process of recovery.

Particular attention to preoperative evaluation, when patients are scheduled electively for cardiac surgery, may identify those individuals in whom surgery is not efficacious. For example, in an older adult, evaluation of family or social support, mood, quality of life, and functional status may be as important as evaluation of the physiologic state to predict the recovery process. Knowledge that functional status is predictive of perception of recovery is useful to identify older adults who would benefit from preoperative exercise programs tailored to the setting in which the patient resides as a means of improving functional abilities. Self-efficacy, while not addressed in this study, has been shown to impact functional recovery (Allen et al., 1990), and can also be assessed and addressed during preoperative evaluation. Additionally, identifying patients with disturbed mood states, and providing therapeutic modalities for improvement prior to surgery will promote positive recovery quality. Nurses at every level across the health care spectrum are involved in preoperative, acute, and post-hospital care, with ample opportunity to interact with these patients and their families, and are integral to promoting and enhancing the modalities that improve patients' quality of recovery from cardiac surgery.

Implications for Research

There is a rich body of research investigating various aspects of cardiac surgery in older adults. Nursing literature examining this phenomenon spans interventions that improve morbidity, care costs, control of symptoms, functional status, knowledge, quality of life, behavioral activities, and psychological states (Whitman, 2004). However, in recent years as technology and health care have changed, opportunities remain for additional areas of study, particularly with adults aged 80 and older. More information on quality of recovery in this age group would be useful to determine factors affecting recovery that could assist patients, families and providers with appropriate decision-making.

The first month following surgery is an important period for older patients. They are frequently sent home with intermittent visits from home care agencies, and have limited interactions with their physicians. Symptoms such as fatigue, pain, and shortness of breath may or may not be resolving. Functional abilities are impaired, and the impact of depression and other mood states on healing is not completely understood. Studies designed to improve function, mood, and symptom relief that utilize cost-effective community based interventions are needed. As nursing research targets interventions that address the specific needs of older adults following cardiac surgery, optimal recovery outcomes can be achieved.

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APPENDIX A MEMORY IMPAIRMENT SCREEN

COW

NEW YORK

EGGPLANT

VIOLIN

INSTRUCTIONS

- Describe to patient as a memory test
- Instruct him/her to remember items for later recall
- Present paper to participant
- Ask individual to read items aloud
- Ask individual to identify and name each item when category cue given by investigator (e.g. animal = cow)
- Remove sheet
- Ask participant to count from 1 to 20 & back
- Ask for free recall of items in any order
- Present category cues to elicit recall of items not given in free recall, record responses for free recall and prompted recall

Scoring:

- Prompted recall =1 point for each achieved word recalled with prompt
- Free recall = 2 points for each word
- Cut score for dementia = 4

	Points for Daily wound inspection					
Wound characteristic	**Proportion of wound affected (%)**					
	0	< 20	20-39	40-59	60-79	>80
Serous exudate	0	1	2	3	4	5
Erythema	0	1	2	3	4	5
Purulent exudate	0	2	4	6	8	10
Separation of deep tissues	0	2	4	6	8	10

The ASEPSIS Wound Score

Criterion	***Points***
Additional treatment:	
Antibiotics	10
Drainage of pus under local anesthesia	5
Debridement of wound (general anesthesia)	10
Serous discharge*	daily 0 - 5
Erythema*	daily 0 - 5
Purulent exudates*	daily 0 - 10
Separation of deep tissues*	daily 0 - 10
Isolation of Bacteria	10
Stay as inpatient prolonged over 14 days	5
*given score on only 5 of 1st 7 postoperative days	

Category of infection: total score 0 - 10 = satisfactory healing; 11 - 20 = disturbance of healing; 21 – 30 = minor wound infection; 31 – 40 = moderate wound infection; > 40 = severe wound infection

(adapted from (Wilson, Treasure, Sturridge, & Gruneberg, 1986a)

Online STS Risk Calculator Dataset: 2.61

Definitions

Support

Help More about Risk Calculator New Print

Today's Date 2/11/2009

Procedure

Coronary Artery Bypass ☑ Yes ○ No ○ Missing

Ventricular Assist Device ○ Yes ☑ No ○ Missing

Valve Surgery ☑ Yes ○ No ○ Missing

Aortic
- ○ No
- ☑ Replacement
- ○ Repair/Reconstruction
- ○ Root Reconstruction with Valve Conduit
- ○ Replacement + aortic graft conduit (not a valve conduit)
- ○ Root Reconstruction with Valve Sparing
- ○ Resuspension Aortic Valve with replacement of ascending Aorta
- ○ Resuspension Aortic Valve without replacement of ascending Aorta
- ○ Resection Sub-Aortic Stenosis
- ○ Missing

Mitral
- ☑ No
- ○ Annuloplasty Only
- ○ Replacement
- ○ Reconstruction with Annuloplasty
- ○ Reconstruction without Annuloplasty
- ○ Missing

Tricuspid
- ☑ No
- ○ Annuloplasty Only
- ○ Replacement
- ○ Reconstruction with Annuloplasty
- ○ Reconstruction without Annuloplasty
- ○ Valvectomy
- ○ Missing

Calculations

Procedure Name	AVRepl+CABG
Risk of Mortality	9.3%
Morbidity or Mortality	43.0%
Long Length of Stay	22.5%
Short Length of Stay	8.1%
Permanent Stroke	5.2%
Prolonged Ventilation	27.9%
DSW Infection	0.7%
Renal Failure	22.5%
Reoperation	14.9%

2/11/09 8:

Pulmonic	(•) No ( ) Replacement ( ) Reconstruction ( ) Missing
Other Non-Cardiac Procedure	( ) Yes (•) No ( ) Missing
Other Cardiac Procedure	( ) Yes (•) No ( ) Missing
Left Ventricular Aneurysm Repair	( ) Yes ( ) No (•) Missing
Ventricular Septal Defect Repair	( ) Yes ( ) No (•) Missing
Atrial Septal Defect Repair	( ) Yes ( ) No (•) Missing
Batista	( ) Yes ( ) No (•) Missing
Surgical Ventricular Restoration	( ) Yes ( ) No (•) Missing
Congenital Defect Repair	( ) Yes ( ) No (•) Missing
Transmyocard Laser Revasc	( ) Yes ( ) No (•) Missing
Cardiac Trauma	( ) Yes ( ) No (•) Missing
Cardiac Transplant	( ) Yes ( ) No (•) Missing
Arrhythmia Correction Surgery	( ) None ( ) Permanent Pacemaker ( ) Permanent Pacemaker with Cardiac Resynchronization Technique (CRT) ( ) Automatic Implatend Cardioverter Defibrillator (AICD) ( ) AICD with CRT (•) Missing
Atrial Fibrillation Correction Surgery	( ) None ( ) Standard Surgical Maze Procedure ( ) Other Surgical Ablative Procedure ( ) Combination of Standard and Other Procedures (•) Missing
Aortic Aneurysm	( ) Yes ( ) No (•) Missing

Other ( ) Yes ( ) No (•) Missing

Procedure Name **AVRepl+CABG**

Demographics

Patient Age (years)	84
Gender	(•) Male ( ) Female ( ) Missing
Black / African American	( ) Yes (•) No ( ) Missing
Asian	( ) Yes (•) No ( ) Missing
Hispanic or Latino Ethnicity	( ) Yes (•) No ( ) Missing

Risk Factors

Weight (kg)	88
Height (cm)	176
Diabetes	(•) Yes ( ) No ( ) Missing
Diabetes Control	(•) None ( ) Diet ( ) Oral ( ) Insulin ( ) Missing
Last Creatinine Level Preop (mg/dl)	2.1
Dialysis	( ) Yes (•) No ( ) Missing
Hypertension	(•) Yes ( ) No ( ) Missing
Infectious Endocarditis	( ) Yes (•) No ( ) Missing
Infectious Endocarditis Type	( ) Treated ( ) Active (•) Missing

7

Chronic Lung Disease
- (•) No
- ( ) Mild
- ( ) Moderate
- ( ) Severe
- ( ) Missing

Immunosuppressive Therapy ( ) Yes (•) No ( ) Missing

Peripheral Vascular Disease ( ) Yes (•) No ( ) Missing

Cerebrovascular Disease (•) Yes ( ) No ( ) Missing

Cerebrovascular Accident (•) Yes ( ) No ( ) Missing

Previous CV Interventions

Previous Coronary Artery Bypass ( ) Yes (•) No ( ) Missing

Previous Valve ( ) Yes (•) No ( ) Missing

Previous Other Cardiac - PCI
- (•) Yes
- ( ) No
- ( ) Missing

Previous Other Cardiac - PCI Interval
- ( ) <= 6 Hours
- (•) > 6 Hours
- ( ) Missing

Preoperative Cardiac Status

Myocardial Infarction
- ( ) Yes
- (•) No
- ( ) Missing

Myocardial Infarction - When
- ( ) <=6 Hrs
- ( ) >6 Hrs but <24 Hrs
- ( ) >1 to 7 Days
- ( ) >8 to 21 Days
- ( ) >21 Days
- (•) Missing

Cardiac Presentation on Admission
No Symptoms or Angina
Symptoms Unlikely to be Ischemia
Stable Angina
Unstable Angina
Non-ST Elevation MI (Non-STEMI)
ST Elevation MI (STEMI)
Missing

Congestive Heart Failure
Yes No Missing

Classification - NYHA
Class I
Class II
Class III
Class IV
Missing

Cardiogenic Shock
Yes No Missing

Resuscitation
Yes No Missing

Arrhythmia
Yes No Missing

Afib / Aflutter
Yes
No
Missing

Preoperative Medications

Inotropes
Yes No Missing

Hemodynamics & Cath

Number of Diseased Coronary Vessels
None
One
Two
Three
Missing

Left Main Disease >= 50%
Yes No Missing

Ejection Fraction (%) 48

Aortic Stenosis (•) Yes ( ) No ( ) Missing

Mitral Stenosis ( ) Yes (•) No ( ) Missing

Aortic Insufficiency
- (•) None
- ( ) Trivial
- ( ) Mild
- ( ) Moderate
- ( ) Severe
- ( ) Missing

Mitral Insufficiency
- ( ) None
- (•) Trivial
- ( ) Mild
- ( ) Moderate
- ( ) Severe
- ( ) Missing

Tricuspid Insufficiency
- (•) None
- ( ) Trivial
- ( ) Mild
- ( ) Moderate
- ( ) Severe
- ( ) Missing

Operative

Incidence
- (•) First cardiovascular surgery
- ( ) First re-op cardiovascular surgery
- ( ) Second re-op cardiovascular surgery
- ( ) Third re-op cardiovascular surgery
- ( ) Fourth or more re-op cardiovascular surgery
- ( ) Missing

Status of the procedure
- ( ) Elective
- (•) Urgent
- ( ) Emergent
- ( ) Emergent Salvage

Missing

IABP
- Yes
- No (selected)
- Missing

IABP When Inserted
- Preop
- Intraop
- Postop
- Missing (selected)

ACTIVITIES OF DAILY LIVING During the past month, have you had difficulty with:	**usually did with no difficulty**	**some difficulty**	**much difficulty**	**usually did not do because of health**	**usually did not do for other reason**
1. Taking care of yourself, that is, eating dressing or bathing?	4	3	2	1	0
2. Moving in or out of a bed or chair?	4	3	2	1	0
3. Walking indoors, such as around your home?	4	3	2	1	0
4. Walking several blocks?	4	3	2	1	0
5. Walking one block or climbing one flight of stairs?	4	3	2	1	0
6. Doing work around the house, such as cleaning, light yard work or home maintenance?	4	3	2	1	0
7. Doing errands such as grocery shopping?	4	3	2	1	0
8. Driving a car or using public transportation?	4	3	2	1	0
9. Doing vigorous activities such as running, lifting heavy objects or participating in strenuous sports?	4	3	2	1	0

Please make an X in the box after each question that most accurately describes your feelings:

MENTAL HEALTH During the past month:	**All of the time**	**Most of the time**	**A good bit of the time**	**Some of the time**	**A little of the time**	**None of the time**
1. Have you been a very nervous person?						
2. Have you felt calm and peaceful?						
3. Have you felt downhearted & blue?						
4. Were you a happy person?						
5. Do you feel so down in the dumps that nothing could cheer you up?						

Please circle the number after each question that most accurately describes your activity:

SOCIAL ACTIVITY During the past month, have you had difficulty with:	**usually did with no difficulty**	**some difficulty**	**much difficulty**	**usually did not do because of health**	**usually did not do for other reason**
1. Visiting with relatives or friends?	4	3	2	1	0
2. Participating in community activities, such as religious services, social activities, or volunteer work?	4	3	2	1	0
3. Taking care of other people such as family members?	4	3	2	1	0

Please make an X in the box after each question that most accurately describes your activity:

SOCIAL/ROLE FUNCTION If you were employed during the past month, how was your work performance?	**All of the time**	**Most of the time**	**Some of the time**	**None of the time**
1. Done as much work as others as others in similar jobs?				
2. Worked for short periods of time or taken frequent rest periods because of your health?				
3. Worked your regular number of hours?				
4. Done your job as carefully and accurately as others with similar jobs?				
5. Worked at your usual job, but with changes because of your health?				
6. Feared losing your job because of your health?				

SOCIAL INTERACTION During the past month, have you:	**All of the time**	**Most of the time**	**A good bit of the time**	**Some of the time**	**A little of the time**	**None of the time**
1. Isolated yourself from people around you?						
2. Acted affectionate towards others?						
3. Acted irritable towards those around you?						
4. Made unreasonable demands on your family and friends?						
5. Gotten along well with other people?						

SINGLE ITEM QUESTIONS:
Please mark your answer by circling the number that most closely describes your activity.

1. Which of the following statements describes your work situation during the past month?
    - Working full time
    - Working part-time
    - Unemployed looking for work
    - Unemployed because of my health
    - Retired because of my health
    - Retired for some other reason
2. During the past month, how many days did illness or injury keep you in bed all or most of the time?
    - ______ days (from 0 to 31)
3. During the past month, how many days did you cut down on the things you usually do for one-half day or more because of your illness or injury?
    - ______ days (from 0 to 31)
4. During the past month, how satisfied were you with your sexual relationships?
    - Very satisfied
    - Satisfied
    - Not sure
    - Dissatisfied
    - Very dissatisfied
    - Did not have any sexual relationships
5. How do you feel about your health?
    - Very satisfied
    - Satisfied
    - Not sure
    - Dissatisfied
    - Very dissatisfied

6. During the past month, about how often did you get together with friends or relatives, such as going out together, visiting in each other's home, or talking on the telephone?

    - Every day
    - Several times a week
    - About once a week
    - 2 or 3 times a month
    - About once a month
    - Not at all

APPENDIX E PROFILE OF MOOD STATES-SHORT FORM

Directions: Below is a list of words that describes feelings that people have. Please read each one carefully. Then circle the number under the answer above which best describes how you have been feeling ***during the past month*** *including today.*

FEELING	Not at all	A little	Moderately	Quite a bit	Extremely
Tense	1	2	3	4	5
Angry	1	2	3	4	5
Worn Out	1	2	3	4	5
Lively	1	2	3	4	5
Confused	1	2	3	4	5
Shaky	1	2	3	4	5
Sad	1	2	3	4	5
Active	1	2	3	4	5
Grouchy	1	2	3	4	5
Energetic	1	2	3	4	5
Unworthy	1	2	3	4	5
Uneasy	1	2	3	4	5
Fatigued	1	2	3	4	5
Annoyed	1	2	3	4	5
Discouraged	1	2	3	4	5

FEELING	Not at all	A little	Moderately	Quite a bit	Extremely
Nervous	1	2	3	4	5
Lonely	1	2	3	4	5
Muddled	1	2	3	4	5
Exhausted	1	2	3	4	5
Anxious	1	2	3	4	5
Gloomy	1	2	3	4	5
Sluggish	1	2	3	4	5
Weary	1	2	3	4	5
Bewildered	1	2	3	4	5
Furious	1	2	3	4	5
Efficient	1	2	3	4	5
Full of pep	1	2	3	4	5
Bad-tempered	1	2	3	4	5
Forgetful	1	2	3	4	5
Vigorous	1	2	3	4	5

Ferrans and Powers
QUALITY OF LIFE INDEX©
CARDIAC VERSION - IV

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

HOW SATISFIED ARE YOU WITH:	Very Dissatisfied	Moderately Dissatisfied	Slightly Dissatisfied	Slightly Satisfied	Moderately Satisfied	Very Satisfied
1. Your health?	1	2	3	4	5	6
2. Your health care?	1	2	3	4	5	6
3. The amount of chest pain (angina) that you have?	1	2	3	4	5	6
4. Your ability to breathe without shortness of breath?	1	2	3	4	5	6
5. The amount of energy you have for everyday activities?	1	2	3	4	5	6
6. Your ability to take care of yourself without help?	1	2	3	4	5	6
7. The amount of control you have over your life?	1	2	3	4	5	6
8. Your chances of living as long as your would like?	1	2	3	4	5	6
9. Your family's health?	1	2	3	4	5	6
10. Your children?	1	2	3	4	5	6
11. Your family's happiness?	1	2	3	4	5	6
12. Your sex life?	1	2	3	4	5	6
13. Your spouse, lover, or partner?	1	2	3	4	5	6
14. Your friends?	1	2	3	4	5	6
15. The emotional support you get from your family?	1	2	3	4	5	6
16. The emotional support you get from people other than your family?	1	2	3	4	5	6

(Please Go To Next Page)

HOW SATISFIED ARE YOU WITH:	Very Dissatisfied	Moderately Dissatisfied	Slightly Dissatisfied	Slightly Satisfied	Moderately Satisfied	Very Satisfied
17. Your ability to take care of family responsibilities?	1	2	3	4	5	6
18. How useful you are to others?	1	2	3	4	5	6
19. The amount of worries in your life?	1	2	3	4	5	6
20. Your neighborhood?	1	2	3	4	5	6
21. Your home, apartment, or place where you live?	1	2	3	4	5	6
22. Your job (if employed)?	1	2	3	4	5	6
23. Not having a job (if unemployed, retired, or disabled)?	1	2	3	4	5	6
24. Your education?	1	2	3	4	5	6
25. How well you can take care of your financial needs?	1	2	3	4	5	6
26. The things you do for fun?	1	2	3	4	5	6
27. Your chances for a happy future?	1	2	3	4	5	6
28. Your peace of mind?	1	2	3	4	5	6
29. Your faith in God?	1	2	3	4	5	6
30. Your achievement of personal goals?	1	2	3	4	5	6
31. Your happiness in general?	1	2	3	4	5	6
32. Your life in general?	1	2	3	4	5	6
33. Your personal appearance?	1	2	3	4	5	6
34.Yourself in general?	1	2	3	4	5	6
35.The changes in your life that you have had to make because of your heart problem (for example, changes diet, physical activity, and/or smoking?)	1	2	3	4	5	6

(Please Go To Next Page)

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

HOW IMPORTANT TO YOU IS:	Very Unimportant	Moderately Unimportant	Slightly Unimportant	Slightly Important	Moderately Important	Very Important
1. Your health?	1	2	3	4	5	6
2. Your health care?	1	2	3	4	5	6
3. Having no chest pain (angina)?	1	2	3	4	5	6
4. Having no shortness of breath?	1	2	3	4	5	6
5. Having enough energy for everyday activities?	1	2	3	4	5	6
6. Taking care of yourself without help?	1	2	3	4	5	6
7. Having control over your life?	1	2	3	4	5	6
8. Living as long as you would like?	1	2	3	4	5	6
9. Your family's health?	1	2	3	4	5	6
10. Your children?	1	2	3	4	5	6
11. Your family's happiness?	1	2	3	4	5	6
12. Your sex life?	1	2	3	4	5	6
13. Your spouse, lover, or partner?	1	2	3	4	5	6
14. Your friends?	1	2	3	4	5	6
15. The emotional support you get from your family?	1	2	3	4	5	6
16. The emotional support you get from people other than your family?	1	2	3	4	5	6
17. Taking care of family responsibilities?	1	2	3	4	5	6

(Please Go To Next Page)

HOW IMPORTANT TO YOU IS:	Very Unimportant	Moderately Unimportant	Slightly Unimportant	Slightly Important	Moderately Important	Very Important
18. Being useful to others?	1	2	3	4	5	6
19. Having no worries?	1	2	3	4	5	6
20. Your neighborhood?	1	2	3	4	5	6
21. Your home, apartment, or place where you live?	1	2	3	4	5	6
22. Your job (if employed)?	1	2	3	4	5	6
23. Having a job (if unemployed, retired, or disabled)?	1	2	3	4	5	6
24. Your education?	1	2	3	4	5	6
25. Being able to take care of your financial needs?	1	2	3	4	5	6
26. Doing things for fun?	1	2	3	4	5	6
27. Having a happy future?	1	2	3	4	5	6
28. Peace of mind?	1	2	3	4	5	6
29. Your faith in God?	1	2	3	4	5	6
30. Achieving your personal goals?	1	2	3	4	5	6
31. Your happiness in general?	1	2	3	4	5	6
32. Being satisfied with life?	1	2	3	4	5	6
33. Your personal appearance?	1	2	3	4	5	6
34. Are you to yourself?	1	2	3	4	5	6
35. The changes in your life that you have had to make because of your heart problem (for example, changes diet, physical activity, and/or smoking?)	1	2	3	4	5	6

Date: _ _ / _ _ _ / _

Patient Survey (QoR – 40)

Name: ___________________ **study #:** ________ **Hospital UR #:** ___________

PART A

How have you been feeling in the last 24 hours?

(1 to 5, where : 1 = None of the time [poor] and 5 = All of the time [excellent]

For example: If you have been able to breathe easily all of the time, you should indicate this by circling the response 5 = ***all of the time*** as shown below:

	None of the time	**Some of the time**	**Usually**	**Most of the time**	**All of the time**
Able to breathe easily	1	2	3	4	(5)

	None of the time	**Some of the time**	**Usually**	**Most of the time**	**All of the time**
Comfort					
Able to breathe easily	1	2	3	4	5
Have had a good sleep	1	2	3	4	5
Been able to enjoy food	1	2	3	4	5
Feel rested	1	2	3	4	5
Emotions					
Having a feeling of general well-being	1	2	3	4	5
Feeling in control	1	2	3	4	5
Feeling comfortable	1	2	3	4	5

How have you been feeling in the last 24 hours?

(1 to 5, where : 1 = None of the time and 5 = All of the time)

	None of the time	Some of the time	Usually	Most of the time	All of the time
Physical Independence					
Have normal speech	1	2	3	4	5
Able to wash, brush teeth or shave	1	2	3	4	5
Able to look after your own appearance	1	2	3	4	5
Able to write	1	2	3	4	5
Able to return to work or usual home activities	1	2	3	4	5
Patient Support					
Able to communicate with hospital staff (when in hospital)	1	2	3	4	5
Able to communicate with family or friends	1	2	3	4	5
Getting support from hospital doctors (when in hospital)	1	2	3	4	5
Getting support from hospital nurses (when in hospital)	1	2	3	4	5
Having support from family or friends	1	2	3	4	5
Able to understand instructions and advice	1	2	3	4	5

PART B

Have you had any of the following in the last 24 hours?

(5 to 1, where: 5 = None of the time [excellent] and 1 = All of the time [very poor]

	None of the time	Some of the time	Usually	Most of the time	All of the time
Comfort					
Nausea	5	4	3	2	1
Vomiting	5	4	3	2	1
Dry-retching	5	4	3	2	1
Feeling restless	5	4	3	2	1
Shaking or twitching	5	4	3	2	1
Shivering	5	4	3	2	1
Feeling too cold	5	4	3	2	1
Feeling dizzy	5	4	3	2	1
Emotions					
Had bad dreams	5	4	3	2	1
Feeling anxious	5	4	3	2	1
Feeling angry	5	4	3	2	1
Feeling depressed	5	4	3	2	1
Feeling alone	5	4	3	2	1
Had difficulty falling asleep	5	4	3	2	1

Have you had any of the following in the last 24 hours?

(5 to 1, where: 5 = None of the time [excellent] and 1 = All of the time [very poor]

	None of the time	Some of the time	Usually	Most of the time	All of the time
Patient Support					
Feeling confused	5	4	3	2	1
Pain					
Moderate pain	5	4	3	2	1
Severe pain	5	4	3	2	1
Headache	5	4	3	2	1
Muscle pains	5	4	3	2	1
Backache	5	4	3	2	1
Sore throat	5	4	3	2	1
Sore mouth	5	4	3	2	1

Thank you for your assistance.

Please check that all questions have been answered.

If you have any questions, please contact: ___________________ through the hospital's switchboard.

APPENDIX H TELEPHONE SURVEY

Used for participants who have been discharged from the hospital before the 5th postoperative day

ID# ________________

POD #

Sternal Wound Leg wound

1. Has the wound been red?	Y	N
2. Has the wound discharged clear yellow fluid?	Y	N
3. Has the wound discharged pus?	Y	N
4. Has the wound broken open?	Y	N
5. Have you been given antibiotics for wound infection?	Y	N
6. Has the home care nurse had to dress the wound?	Y	N
7. Has the doctor opened or drained an abscess?	Y	N
8. Have you been readmitted to any hospital?	Y	N
9. Has the wound been opened/cleaned under general anesthesia in hospital?	Y	N

from **:**

Wilson AP, Hodgson B, Liu M, et al. Reduction in wound infection rates by wound surveillance with postdischarge follow-up and feedback. *British Journal of Surgery.* 2006;93(5):630-638.

Pain severity:

Please rate your average pain severity on a 1 to 10 scale with 10 being the worst imaginable pain, and being little or no pain:

For yesterday (POD # 4) ____________

Today (POD #5) ____________

Since you were discharged from the hospital

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