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Coronary Artery Bypass Graft Surgery

Exploring a Broader Perspective of Risks and Outcomes

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Although the literature is replete with evidence related to physiological predictors and short-term outcomes of coronary artery bypass graft (CABG) surgery, there is still a paucity of data that encompass a broader perspective of risk and outcomes. The primary objective of this prospective cohort study was to explore the physiological and psychosocial dimensions of preoperative status that may be predictive of the short- and longer term outcomes of CABG surgery. Patients (N = 136) scheduled for elective/urgent CABG surgery were followed from the time of placement on the waiting list until 6 months after the surgery. Significant predictors of intensive care unit length of stay (LOS) included the following: age, urgency of operation, and perioperative complications. Hospital LOS was best predicted by baseline unemployment, longer bypass time, and perioperative complications. Baseline unemployment and less optimism regarding surgery outcomes were predictive of postdischarge home care utilization. Lower baseline physical functioning predicted postdischarge emergency room visits. Sex and baseline mental status predicted quality of life/health satisfaction scores at 6 weeks and 6 months after discharge. The ability to predict patient outcomes has implications for program planning, patient education, and policy development. The findings of this study provide rationale for clinicians, educators, and administrators to consider a broader scope of physiological and psychosocial parameters to predict outcomes of CABG surgery. Although the sample size was relatively small, the broader perspective on risk and outcomes provides insight for strategies to optimize overall outcomes for the CABG surgery population. These findings also establish the cornerstone for ongoing CABG surgery outcomes evaluation and research.

KEY WORDS: cardiac surgery, coronary artery bypass graft, outcomes, quality of life

Introduction/Background

Cardiovascular disease (CVD) is the leading cause of mortality in Canada, accounting for approximately one-third of all deaths each year.[1] For the first 3 decades after its inception, the demand for coronary artery bypass graft (CABG) surgery grew exponentially; this demand still continues to increase at a modest rate.[2,3] Advances in surgical technology and expanding accessibility, combined with the increasing burden of coronary heart disease (CHD) and aging of the population, suggest that this escalating trend will continue in the years to come. Although CABG surgery is an established treatment for CHD, it is a costly, invasive procedure, which carries a discernible risk for adverse outcomes.

The research literature is replete with evidence related to the factors that increase the risk of cardiac surgery, but most of that evidence focuses on the physiological predictors of CABG surgery outcomes, such as the severity of the disease (eg, the number and percentage of coronary artery occlusions and ejection fractions) and comorbidities (eg, diabetes and chronic obstructive pulmonary disease). There is also considerable evidence regarding the significance of demographic factors such as age and sex; also, several studies have addressed the broader socioeconomic health determinants, including income, education, employment status, and social support. In addition, there is an emerging evidence on the significance of one's general health status (ie, quality of life [QOL]) as a predictor of postoperative outcomes. However, there is a paucity of data that encompass the broader perspective of risk and outcomes.

The purpose of this study was to explore the relationship between the physiological and psychosocial

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dimensions of preoperative status and postoperative morbidity and QOL outcomes in patients who underwent CABG surgery. Our goal is that these findings will facilitate the implementation of strategies to optimize overall outcomes and the standard of care for patients who have undergone CABG surgery.

Review of the Literature

Coronary artery bypass graft surgery is a frequently studied topic in healthcare outcomes research. The high utilization rates, enormous cost, and substantive risk for morbidity and mortality validate this research attention. However, despite the plethora of investigations in this area, many questions related to the CABG surgery trajectory remain unanswered.

Preoperative Status

Numerous investigators have established preoperative, summary risk factor scoring systems, which classify patients who underwent cardiac surgery into stratified risk subsets for morbidity and mortality, as well as the prediction of intensive care unit (ICU) and hospital length of stay (LOS).[4–11] Each of these risk scoring systems uses a different algorithm of demographics, risk factors, and pathology to predict adverse short-term (ie, in-hospital) outcomes. Various other predictors of postoperative outcomes have been tested on more extended outcomes; however, the evidence remains less than convincing. According to Weightman and associates, "[a]n accurate and objective estimate of perioperative risk would have important consequences for patients, clinicians, and administrators."[12(p408)] These estimates would be helpful for weighing the risks of surgical versus conservative treatment, advising individual patients of their perioperative risk, facilitating quality assurance by ensuring accurate comparisons of outcomes from year to year or before and after changes in practice, or aiding patient selection based on risk versus predicted cost.

While the medical research literature tends to focus on physiological predictors, there is an increasing interest in the socioeconomic and psychosocial determinants of cardiac surgery outcomes. For example, several studies have reported a positive relationship between socioeconomic indicators and CABG surgery outcomes.[13–16] Research evidence to support the role of social support as a predictor of cardiac surgery outcomes has gained particular momentum over the past decade.[17–22]

Preoperative psychological status has been associated with subjective and objective surgical outcomes. For example, based on their prospective cohort study (N = 963), Mallik and associates[23] contend that depression is the most useful predictor of health status 6 months after CABG surgery. Similarly, others have found that depression is an important independent contributor to postoperative CABG surgery medical and psychosocial morbidity.[24–26] Perski et al[27] found that despite similar objective cardiac event outcomes, patients who exhibited a high degree of distress (ie, anxiety, depression, and fatigue) preoperatively were significantly less satisfied at the 1-year follow-up than their less distressed counterparts. The distressed group also reported significantly higher rates of cardiac events at the 3-year follow-up.

To date, most research has focused on either physical or psychosocial preoperative risk factors for surgery. There has been minimal published research that has explored the inter-relationship between these risk factors and the subsequent impact on the surgical outcome. Also, there has been a paucity of prospective research that explores the physiological predictors of QOL outcomes.

Surgery Outcomes

Most previous researchers have focused on short-term (in-hospital) outcomes of cardiac surgery. Although postoperative mortality is the typical outcome measure, nonfatal perioperative morbidity (ie, extended ICU and hospital LOS) is a more common and a much more costly issue after cardiac surgery.[28] Also, the factors that predict mortality are not necessarily the same as the predictors of postoperative morbidity.[7] In addition, many existing studies of extended/longer term outcomes culminated within 30 days after discharge. Although the most dramatic differences in physiological outcomes may be determined within the first month, the contention that the psychosocial outcomes, in particular, continue to improve after that time has not been resolved.

There has been a recent proliferation of interest in the psychological adaptation, as well as various aspects of QOL, after CABG surgery. The problem, however, is that QOL "is a complex multifaceted concept which continues to defy consensual definition."[29(p215)] Common elements of health-related QOL measures include the physical, social, and psychological domains. Although predominantly a subjective sense of well-being, including contentment, optimism, and satisfaction, objective functional status is also a critical attribute of QOL.[29] It follows that a diverse assortment of QOL measures has been used in CABG research. As well, although preoperative physiological factors may influence the psychological outcome, few QOL studies include these pivotal variables.[20]

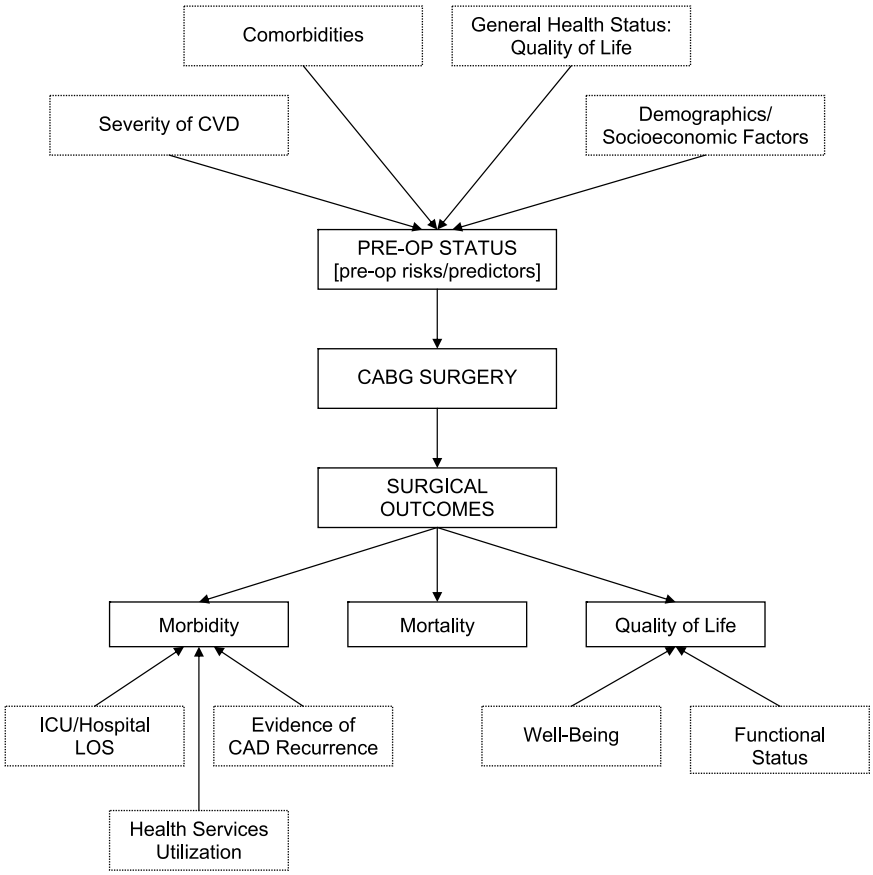

FIGURE 1. *Conceptual framework. CABG indicates coronary artery bypass graft; CAD, coronary artery disease; CVD, cardiovascular disease; ICU, intensive care unit; LOS, length of stay; preop, preoperative.*

Conceptual Framework

The conceptual framework for this study (see Figure 1) was derived from the work of Shroyer and associates[30] and Haas.[29] The Processes, Structures, and Outcomes of Care in Cardiac Surgery Study[30] involved data collection of more than 1,400 patient and provider variables at 14 medical centers and the subsequent development of a general conceptual model that defined the overall risk-process-structure-outcomes relationships. Within their model, the 4 dimensions of patient-related risk factors for cardiac surgery included severity of cardiac disease, comorbidity, general health status, and demographic/socioeconomic factors.

Haas[29] envisioned QOL as a broad concept with subjective and objective components. While the subjective component is referred to as well-being, the objective component is represented by functional status. Thus, in our study, the dimensions of the patient's preoperative status included severity of CHD, comorbidities, general health status (ie, QOL), and demographic/socioeconomic factors. The dimensions of the surgical outcomes included morbidity (ie, ICU/hospital LOS, evidence of CHD recurrence, and health services utilization) and QOL (well-being and functional status).

Methodology

Research Design

The research design was a prospective cohort study. Consecutive patients scheduled for CABG surgery were invited to participate in the study. Participants were followed from the time they are placed on the waiting list for surgery through the surgical event and for 6 months after the procedure.

Sample and Setting

Participants included patients referred for elective or urgent CABG surgery at 2 tertiary care institutions in a large urban center. To ensure a relatively homogeneous patient population, patients scheduled for "re-do" (ie, repeated) cardiac surgery or surgery combined with ventricular aneurysmectomy, valvular surgery, or other intracardiac procedures were excluded. Potential participants who were unable to read, write, and speak English and could not be contacted by telephone were also excluded.

Instrumentation

Data related to the patient's preoperative status included demographic, socioeconomic, and social support factors, as well as severity of CHD, comorbidities, and QOL. The demographic questionnaire included a 5-question measure of perceived social support.[31] Information related to CHD severity and comorbidities was derived from the routinely collected data in the Cardiac Surgery Wait-List Database. Surgical outcomes were operationally defined within the dimensions of QOL and morbidity and mortality.

Quality of Life

Psychological, social, and physical variables were included to operationalize the well-being and functional status dimensions of QOL. These variables were assessed with the following questionnaires.

Short Form-36 (SF-36)[32] was designed as a generic indicator of health status for population surveys and health policy evaluation. This 36-item scale measures 8 dimensions of health, which can also be combined to determine physical and mental component summary scores (ie, physical component summary score: physical functioning, physical role functioning, bodily pain, and general health; mental component summary score: vitality, social functioning, emotional role functioning, and mental health). The reliability and validity of the SF-36 have been well established (median Cronbach $\alpha > .80$); it has been widely used in general in cardiac populations.[33]

General Well-being Questionnaire is a 5-item scale developed specifically for this research. This questionnaire was based on research evidence that the concepts of life satisfaction (ie, 10-point scales regarding "How satisfied are you with your current health status?" and "How satisfied are you with your current quality of life?"), contentment (ie, a 5-point scale regarding "How happy are you that you had the heart surgery?"), and optimism (ie, a 4-point scale regarding "How optimistic are you about the success of your surgery?") may influence postoperative outcomes.

Duke Activity Status Index (DASI)[34] is a 12-item QOL scale of functional capacity. The DASI asks participants to rate the ease with which they are able to perform 12 major activities of daily living, such as personal care, ambulation, household tasks, yard work, sexual relations, and recreational activities. The reliability (Cronbach $\alpha > .80$) and validity of this scale have been established in the cardiovascular patient population.[34,35] The DASI has also been used in previous cardiac surgery research.[35–37]

Morbidity

In-hospital morbidity was assessed by chart review data. This concept was operationally defined by postoperative complications, as well as the ICU and hospital LOS.

Cardiac Status Questionnaire. Postdischarge morbidity was monitored with questions related to the recurrence of angina, heart failure, cardiac medications, and/or contact with the healthcare system (ie, doctor's appointment, emergency department/walk-in clinic visit).

The *Morbidity Questionnaire* was administered to study participants via telephone interview at approximately 2 weeks after discharge. During this interview, participants responded on a 4-point scale (ie, none, mild, moderate, severe) to a list of 23 potential postdischarge cardiac surgery issues/concerns.

Procedures

Following ethical approval from the Education and Nursing Research Ethics Board at the University of Manitoba, potential participants were informed about the study during initial contact with the Cardiac Surgery Waitlist Coordinator's office. Consenting patients were contacted by telephone and subsequently received the initial mail-out questionnaires. Information elicited at this initial point of contact included baseline demographic data and QOL measures. In-hospital outcomes data, including postoperative complications, ICU LOS, and hospital LOS were obtained from the patients' charts.

Approximately 2 weeks after discharge, participants were contacted via telephone interview to complete the Morbidity Questionnaire and a healthcare utilization survey. As well, QOL measures were collected at this time. Subsequent mail-out questionnaire packages were sent to all study participants approximately 6 weeks and 6 months after discharge. These packages included the questionnaires related to the various dimensions of QOL and cardiac status.

Data Analysis

Initially, the data were analyzed using basic descriptive analyses. Stepwise multivariate linear and logistic regression analyses were used to determine the preoperative risk profile that was significantly associated with perioperative and postoperative mortality, ICU LOS, and postoperative hospital LOS, as well as postoperative morbidity complications and QOL, thus establishing a useful predictive model for cardiac surgery procedures.

Results

Participant Profile

Two hundred fifty-seven patients were recruited to participate and completed the initial questionnaires.

During the course of the study, 121 participants were lost because of attrition; 136 participants completed the 6-month follow-up questionnaires. The final sample was primarily male (80%) and older than 60 years (66%), which was similar to the local CABG surgery population during this time period. At the time of recruitment, many of the participants were married (86%), were unemployed/retired (66%), had an education equivalent to grade 12 or less (64%), and had a self-reported family income between $25,000 and $64,000 per year (59%). Although more detailed data related to sex will be reported elsewhere, the male and female participants were similar in age, education, and mental health functioning. However, the female study participants were significantly more likely to be unemployed and poor. Also, females had lower baseline physical functioning ability and higher rates of angina (ie, topical nitrates), diabetes, CHF, and PVD. Although only 10% were reportedly current smokers, 66% had a history of smoking; 53% were sedentary.

TABLE 1 Regression Models

Series 1: Demographic/ SES Variables	Series 2: Baseline Risk Variables	Series 3: Surgical Profile Variables
Sex	Disease severity:	Perioperative complications
Age	NYHA class	No. of perioperative complications
Employment status	angina	Urgency of operation
Education	Comorbidities:	No. of CABGs
Marital status	Smoking Hx	Bypass time
Income level	Hypertension	
	Hyperlipidemia	
	Diabetes	
	Parsonnet risk score	
	QOL:	
	SF-36–PFS	
	SF-36–MFS	
	DASI score	
	Optimism	
	Satisfaction with QOL	
	Satisfaction with health status	

Abbreviations: DASI, Duke Activity Status Index; Hx, history; NYHA, New York Heart Association; QOL, quality of life; SES, socioeconomic status; SF-36–MFS, Short Form-36 Mental Function Scores; SF-36–PFS, Short Form-36 Physical Function Scores.

Surgery Profile

Information obtained from the cardiac surgery waitlist database and patients' charts during the hospitalization forCABG surgery revealed the following: participants waited an average (SD) of 72 (62) days for their surgery. Most participants had "routine" (80%) versus "urgent" (20%) surgery. The average (SD) time on cardiopulmonary bypass was 88 (42) minutes. Average (SD) ICU and hospital LOS were 15.5 (22.7) hours and 6.3 (3.4) days respectively. This surgery profile was similar to the overall CABG surgery population during the time period of the study.

Study Outcomes

Based on the conceptual framework, the predictor variables were entered into the stepwise regression models in clusters or series (see Table 1). Although there were numerous predictor variables, small cell sizes dictated the factors that were included in the regression modeling. Each series was included in the outcomes analyses for morbidity, patient satisfaction, and QOL.

Morbidity was operationally defined as ICU LOS, hospital LOS, and the 2-week postdischarge concerns and reported healthcare resource utilization. While controlling for other factors, the bivariate and multiple regression analyses revealed several significant predictors of ICU LOS (see Table 2). Older patients experienced significantly longer ICU stays; patients requiring urgent surgery spent more than 13 hours longer in ICU; patients experiencing any perioperative complications as compared with those not experiencing complications were in ICU more than 15 hours longer.

Predictors of hospital LOS (see Table 2) included employment status, with participants who were unemployed at baseline staying in hospital almost 2 days longer than did those who were employed. Patients who were on bypass 30 minutes longer remained in hospital almost a half day longer, and patients experiencing any perioperative complications, as compared with those not experiencing any complications, stayed in hospital more than 2 days longer. Age, as well as marital status, diabetes, and number of perioperative complications, was significant in the univariate analyses. Age, in particular, may have been explained by proxy of the employment variable in the multivariate analyses because increasing age tends to correspond with unemployment/retirement. Of note as well was a significant difference in the hospital LOS for men versus women (ie, 6.41 vs 7.46 days, respectively) in the bivariate analysis; the lack of significance in the regression model may be explained by the small sample size and/or proxy (ie, women are more likely to be unemployed).

Logistic regression analyses of the health resource utilization at 2 weeks after CABG surgery discharge (see Table 2) revealed that participants who were unemployed at baseline had a 7-fold higher odds of requiring at least 1 home care visit within 2 weeks after surgery compared with patients who were employed at baseline. In addition, patients lacking

TABLE 2 Multiple/Logistic Regression Models: Morbidity

	Postoperation		2 wk Postdischarge	
	ICU LOS	Hosp LOS	Home Care	ED Visits
Predictors	**β (P)**	**β (P)**	**OR (CI)**	**OR (CI)**
Sex		…[a]	…[a]	
Age	0.29 (.03)	…[a]		
Employment status		1.96 (.001)	7.06 (1.46, 34.16)	
Marital status		…[a]		
Income level			…[a]	
HTN				…[a]
Diabetes		…[a]		
NYHA class angina				…[a]
Baseline SF-36–MCS				…[a]
Baseline DASI				1.02 (1.01, 1.03)
Baseline Optimism			0.06 (0.004, 0.97)	
Perioperative complications	15.2 (.003)	2.11 (.008)		
No. of perioperative complications		[a]		
Urgency of OR	13.5 (.005)			…[a]
Bypass time		0.015 (.03)		

Abbreviations: CI, confidence interval; DASI, Duke Activity Status Index; ED, emergency department; ICU, intensive care unit; LOS, length of stay; NYHA, New York Heart Association; OR, odds ratio.
[a]Significant in the bivariate analyses.

optimism before surgery had more than a 16-fold greater odds of requiring at least one home care visit than optimistic patients during this time period. Specific to emergency department visits, patients with DASI scores 10 points higher (ie, lower functional ability) had a 1.2 times greater odds of requiring a visit to the emergency department within the initial 2 weeks after discharge.

Morbidity was also operationally defined by participants' health issues/concerns 2 weeks after discharge (see Figure 2). In this telephone interview, a relatively high percentage of the study sample (≥20%) reported the symptoms of fatigue (31%), depression (28%), sleep problems (26%), shortness of breath (23%), and chest incisional pain (20%).

Self-rated outcomes across the perioperative trajectory were also explored. For example, self-rated health status was measured preoperatively and at 6 weeks and 6 months after surgery, with a fairly dramatic overall improvement in self-rated health status by 6 months postsurgery time interval (see Figure 3). Preoperative predictors of higher satisfaction with health status at 6 months included the following: satisfaction with QOL at baseline (odds ratio [OR] = 4.93; confidence interval [CI] = 1.38–17.6) and being male (OR = 0.22; CI = 0.07–0.67).

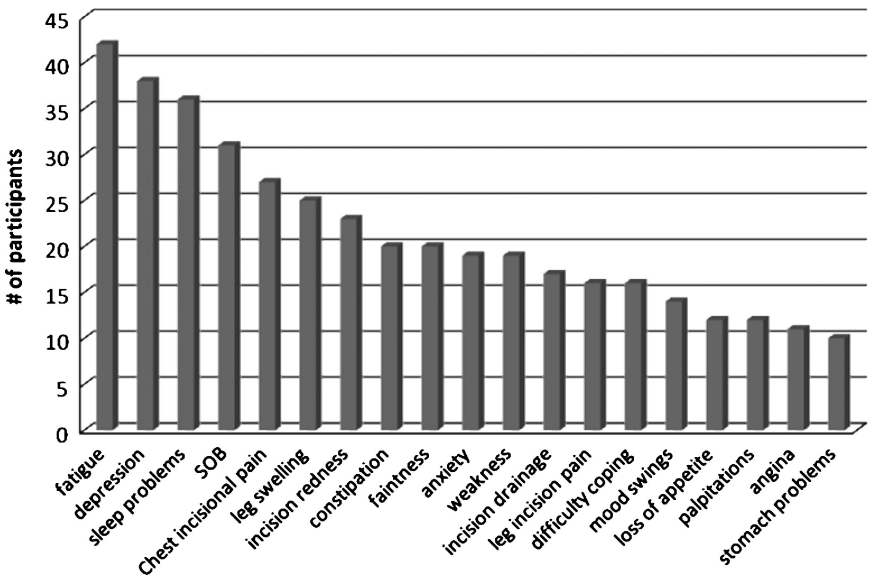

FIGURE 2. *Participant's 2-week postdischarge complaints. SOB indicates shortness of breath.*

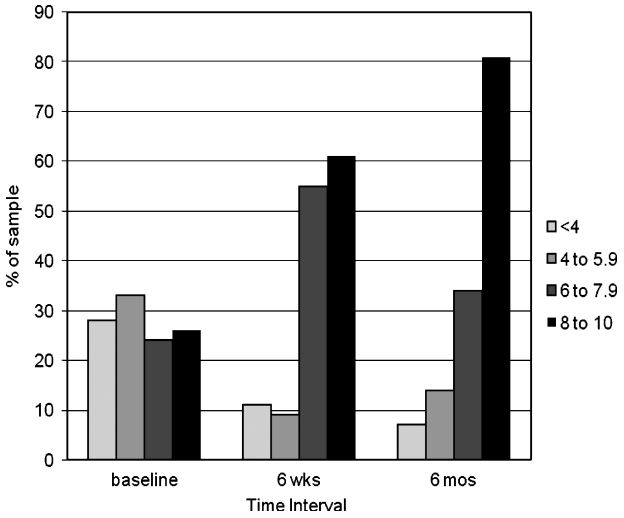

FIGURE 3. *Self-rated health status scores. 0 = Not satisfied at all, 10 = very satisfied. Note: Scores of 8 to 10: 26% of sample at baseline; 81%, at 6 months.*

Compared to the female participants, the males were also 4 times more likely to report being happy that they had the surgery at the 6-month mark (OR = 0.26; CI = 0.07–0.99). Also, changes in self-rated QOL scores corresponded with scores for self-rated health status. Once again, a significant predictor of higher self-rated QOL after CABG surgery was being male, with the male participants having 3 times the odds of reporting that their QOL was high at 6 weeks (OR = 0.33; CI = 0.12–0.90). In addition, a more favorable baseline SF-36–MCS (mental component summary score), that is, the participants who felt better about their QOL before surgery, had twice the odds of feeling that their QOL was high at 6 weeks and also at 6 months after surgery (OR = 1.08; CI = 1.03–1.13).

Discussion

The findings of this study provide substantive support for the hypothesis of a significant relationship between the physiological and psychosocial dimensions of preoperative status and postoperative morbidity and QOL outcomes in patients who have undergone CABG surgery. Consistent with previous research evidence, the preoperative predictors of postoperative outcomes were encompassed within the constructs of the study's framework to include demographic/socioeconomic factors (ie, age, sex, employment status, income), QOL (ie, baseline SF-36–MCS, DASI, and optimism), comorbidities (ie, hypertension, diabetes, New York Heart Association class angina), and the CABG surgery (ie, urgency of the surgery, duration of surgery, bypass time, perioperative complications). Overall, the morbidity and QOL surgery outcomes were favorable in our study sample. In summary, this study builds on previous evidence regarding predictors and outcomes related to life satisfaction and QOL—in particular, the apparent advantage of being male, optimistic, and employed.

While more detailed findings related to the gender differences will be reported elsewhere, our findings were generally consistent with the cardiac surgery research literature. Although there were no significant differences in age between the male and female cohorts, the women were more likely to be unemployed and poor. Thus, the employment variable may have masked gender differences in the regression analyses. Based on the tradition of the time, aging females are more likely to be unemployed than their male counterparts; however, severity of illness may also explain their higher level of unemployment. Finally, given the evidence related to the significance of preoperative optimism, further research is needed to explore the role of this variable on CABG surgery outcomes.

While this study was not without limitations, including convenience sampling, the sample was similar to the study population. Unfortunately, the sample size was inadequate to complete several of the more sophisticated data analyses originally proposed; however, there was sufficient power to obtain important evidence from these findings.

The findings of this research are relevant to clinicians, educators, and researchers. Specific to clinical implications, this study highlights the importance of considering the preoperative physiological and psychosocial status of patients who have undergone CABG surgery. In some cases, the psychosocial status may be as relevant or perhaps even more relevant in predicting patient outcomes. Therefore, the preoperative assessment should encompass the physiological and psychosocial dimensions of risk. Preoperative patient education should include the potential for sustained postoperative symptoms such as fatigue and depression. Also, it is important for patients to realize that the recovery period will likely extend beyond 6 weeks, 6 months, and perhaps even longer. Finally, and perhaps most importantly, our findings reinforce the importance of postoperative follow-up of the patients who underwent CABG surgery, particularly within the first several weeks after hospital discharge.

There is a need for larger, prospective cohort studies, which include physical and psychosocial predictors of surgery outcomes. Our study also highlighted several unique gender differences; therefore, more research, with larger cohorts of women, is desperately needed.

Conclusion

This research highlights the importance of considering a broader scope of CABG surgery risks and outcomes,

Clinical Pearl

- Physiological and psychosocial factors must be considered in the patient's preoperative risk assessment.
- Patient education should include the potential for sustained post-operative symptoms, such as fatigue and depression.
- Patients should be informed that the recovery period following CABG surgery will likely extend beyond 6 weeks and that there may be recovery issues for up to 6 months.

to include both physiological and psychosocial parameters. This broader perspective provides insight for strategies to optimize the overall outcomes for patients who underwent CABG surgery. Finally, these findings establish the cornerstone for ongoing cardiac surgery outcomes evaluation and research.

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