Depression before and after cardiac surgery: Do all patients respond the same?

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Objective: To characterize the prevalence, incidence, and risk factors for depression before and after cardiac surgery.

Methods: Patients awaiting nonemergent surgery (N = 436), completed the Patient Health Questionnaire-9 for depression, as well as the International Physical Activity Questionnaire short version preoperatively (Q1, n = 436) and at hospital discharge (Q2, n = 374). At baseline patients were categorized depression “naïve,” “at risk,” or “depressed.” At each interval patients were identified as “not depressed” (Patient Health Questionnaire-9 score 0-3), “possibly depressed” (score 4-9), or “depressed” (score >9). Multivariate logistic regression analysis identified independent baseline and perioperative variables associated with depression.

Results: Depression prevalence at Q1 and Q2 was 23.6% and 37.7%, respectively ($P < .001$). The incidence of new depression at discharge was 29.2%. Multivariate logistic regression identified independent variables associated with depression: preoperative left ventricular ejection fraction 30% to 49% (Q1: odds ratio [OR], 1.81; 95% confidence interval [CI], 1.02-3.21; $P = .042$), left ventricular ejection fraction < 30% (Q1: OR, 2.81; 95% CI, 1.13-6.96; $P = .026$), physical inactivity (Q1: OR, 2.03; 95% CI, 1.26-3.28; $P = .002$), baseline at-risk group (Q2: OR, 2.16; 95% CI, 1.28-3.67; $P = .004$), baseline depressed group (Q2: OR, 7.46; 95% CI, 4.06-13.69; $P < .0001$), hospital length of stay >7 days (Q2: OR, 1.62; 95% CI, 1.03-2.55; $P = .039$).

Conclusions: Depression is prevalent in one-third of cardiac surgery patients at time of discharge. It is not associated with operative or postoperative risk factors, with the exception of prolonged hospital stay >7 days. Preoperative depression or being at risk for depression, is associated with the highest risk for postoperative depression. (J Thorac Cardiovasc Surg 2013;145:1400-6)

Depression after coronary artery bypass grafting (CABG) has been shown to be an independent risk factor for subsequent cardiac events¹⁻³ associated with increased risk of hospital re-admission⁴ and in patients with moderate to severe depression is associated with increased risk of death.^{3,5} Despite these assertions, there remains varied reporting on the prevalence of depression after cardiac surgery ranging from 15% to 47%.^{1,3,6} Recent publications have indicated that routine screening of depression should be introduced as standard practice in the preoperative assessment of patients undergoing cardiac procedures.^{3,7} McKann and colleagues⁶ reported the incidence of new onset depression to be 13%. The investigators of the Impact of

Physical Activity on Depression after Cardiac Surgery study sought to characterize depression in a large prospective cohort of patients undergoing cardiac surgery. Our objective was to delineate if different subsets of patients have a different response in mood after cardiac surgery. This was accomplished by determining (1) the prevalence of depression before and after cardiac surgery, (2) the incidence of new depression under patients at risk for depression, and (3) the risk factors associated with depression perioperatively, with an emphasis on self-reported physical activity.

METHODS

A prospective, observational study was undertaken of 436 consecutively enrolled patients undergoing elective or urgent (waiting in hospital for cardiac surgery) cardiac surgery requiring cardiopulmonary bypass (includes CABG, valve, and other cardiac surgical procedures) from May 2010 through August 2011 (Figure 1). Patients were subsequently followed for a 6-month period postoperatively to identify short-term depression and physical activity behavior. Inclusion criteria for enrolment were any patients older than age 18 years who could read, write, and understand English. Patients with cognitive impairment, or in-hospital stay of >3 months were excluded. The study was approved by the University of Manitoba Research Ethics Board, as well as the St. Boniface General Hospital Research Review Board. Written and informed consent was obtained from all patients before enrolment.

Patient baseline characteristics, cardiac risk factors, comorbidities, and previous history of depression, collected as part of our prospective analysis,

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting
 IPAQ = International Physical Activity Questionnaire
 LVEF = left ventricular ejection fraction
 PHQ-9 = Patient Health Questionnaire-9

are summarized in Table 1. Operative parameters and postoperative data are summarized in Table 2.

The Patient Health Questionnaire-9 (PHQ-9)⁸ was used to assess depressive symptoms at each time point described below. The PHQ-9 consists of 9 items pertaining to the key symptoms of major depressive disorder according to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*⁹ and investigates the frequency patients experience these symptoms over a 2-week period (not at all = 0, several days = 1, more than half the days = 2, or nearly every day = 3). Table 3 explains how patients were classified at baseline. At each interval patients were labeled as depressed (including severity) or not depressed (no depression or possible depression) according to Table 3. An increase in antidepressant dose or initiation of antidepressants was considered deterioration in mood, and subsequently the patient would be reclassified as depressed at that time point if their PHQ-9 score was <10. Their PHQ-9 score would also be adjusted to 10.

Assessment for depression and physical activity was performed preoperatively (Q1), whereas depression only was evaluated on day of discharge from the hospital after cardiac surgery (Q2). Operative and postoperative data were collected after Q2 (Table 2). Further follow-up (with the same assessment tools) in the Impact of Physical Activity on Depression after Cardiac Surgery study was done at 3 months (Q3) and 6 months (Q4) (data not reported).

Physical activity behavior, assessed with the short form International Physical Activity Questionnaire (IPAQ),¹⁰ utilizes a patient's recall of the amount of physical activity performed during the preceding week to determine the relationship with depression at baseline (Q1) and at discharge (Q2). Activity was reported in terms of minutes per week of vigorous, moderate, walking, sedentary, and total physical activity. Patients were categorized as being inactive, moderately active, or physically active in accordance with the official IPAQ scoring protocol (www.ipaq.ki.se). We combined moderately and physically active into 1 active category. See Table 4 for physical activity scoring classification of IPAQ scores.

Statistical Analysis

No formal power analysis was conducted. In view of published literature we expected a 20% to 40%^{3,11} prevalence of depression before and after cardiac surgery. The expected number of outcomes from a sample size of 400 to 500 would thus exceed 10 times the number of predictors in a multivariable logistic regression model. Once we categorized >100 depressed patients at baseline, we believed that the sample size was large enough to allow for high statistical power. Logistic regression modeling was utilized to determine the characteristics of individuals with depression before and after cardiac surgery. Dependent variables for baseline depression were explored by performing univariate logistic regression models for various preoperative characteristics. Operative and postoperative characteristics, along with a preoperative classification of an individual's depression risk group were considered among variables associated with depression at hospital discharge. Stepwise logistic regression was utilized to develop multivariate logistic regression models for independent variables associated with depression at baseline and discharge. Variables with a *P* value < .2 in the univariate analysis were considered among the potential variables for the stepwise logistic

regression. Variables for developing new depression at discharge were identified by performing similar univariate and multivariate logistic regression models for patients classified as naïve or at risk at baseline. Univariate and multivariate logistic regression models were also performed for those classified as depressed at baseline to characterize patients who no longer had depression at discharge.

RESULTS

Prevalence of any depression increased from 23.9% (104 of 436) preoperatively to 37.7% (141 of 374) postoperatively (*P* < .001). Table 1 summarizes baseline variables collected and indicates significant preoperative univariate parameters for preoperative depression. Table 2 summarizes operative and postoperative parameters collected at discharge, as well as the significant preoperative univariate parameters associated with depression at discharge. There were no significant differences between depressed or non-depressed patients for operative or postoperative parameters by univariate analyses. Significant independent variables associated with depression at baseline as well as discharge, are summarized in Table 5 (multivariate analysis results).

The increase in prevalence at discharge was due to a 29.2% (84 of 288) incidence of new depression under patients previously classified as naïve or at risk for depression. There was a 24% incidence for mild depression, 4.2% for moderate depression, and only 1% had severe depression. Significant univariate variables for new depression (same variables as collected in Table 1) were New York Heart Association functional class III or IV (*P* = .007; odds ratio [OR], 2.24; 95% confidence interval [CI] 1.24-4.05), being at risk for depression preoperatively (*P* = .007; OR, 2.04; 95% CI, 1.21-3.44), and hospital length of stay >7 days (*P* = .011; OR, 1.97; 95% CI, 1.16-3.34). The same variables were significant in the multivariate logistic model (Table 5).

In contrast, 33.7% of patients (29 of 86) classified as depressed before cardiac surgery were not depressed at the time of discharge from hospital. These patients had significantly lower Canadian Cardiovascular Society angina scores preoperatively (*P* = .007) and fewer had isolated CABG (*P* = .02) by univariate analyses. There were also more patients with preoperative ejection fraction (LVEF) <30% under patients who remained depressed (Table 5). There were no significant differences in change of LVEF from pre- to postoperatively between patients who remained depressed and those whose depressive symptoms improved.

Median PHQ-9 score decreased under preoperative depressed patients (Figure 2) due to 33% of these patients whose mean scores improved from 10.1 to 4.1. Both naïve and at-risk sub-groups had an increase in median PHQ-9-scores (Figure 2) due to new onset depression in both sub-groups. For patients with new onset depression, median PHQ-9 score increased from 3.03 to 10.48 (Figure 3), whereas patients who remained not depressed had no

FIGURE 1. Study population flow diagram.

significant change in PHQ-9 score (Figures 3 and 4). Median PHQ-9 scores were similar between patients who remained depressed compared with those with new depression (11.6 vs 10.5, respectively; $P = .31$).

Patients reported accumulating a median 300 (interquartile ratio, 70-840) total minutes of physical activity/week at Q1 (not depressed 325 minutes [range, 105-870 minutes] vs depressed group 200 minutes [range, 20-598 minutes]; $P = .02$). Self-reported physical inactivity was significantly associated with depression at baseline by both univariate (OR, 2.11; 95% CI, 1.35-3.31; $P = .001$) as well as multivariate (OR, 2.05; 95% CI, 1.30-3.23; $P = .002$) analysis.

DISCUSSION

The investigators of the Impact of Physical Activity on Depression after Cardiac Surgery study report data describing depression before and after cardiac surgery in a large, prospective cohort of patients. Analysis of pre- and postoperative data indicate an increase in depression prevalence after cardiac surgery is unrelated to any particular operative parameters and importantly is not restricted to patients undergoing an isolated CABG procedure. Physical inactivity and preoperative LVEF <50% independently increased the risk of being depressed preoperatively by 2.0-fold and 2.8-fold, respectively. The strongest independent parameters associated with postoperative depression were being depressed or at risk for depression preoperatively. Hospital length of stay >7 days was the only independent postoperative variable associated with increased rates of depression at time of discharge. Other independent variables for new onset depression at discharge were preoperative New York Heart Association functional class III or IV (consistent with previous publications¹²), being at risk for depression and hospital length of stay >7 days.

Length of hospital stay being significantly associated with depression at discharge reflects how medical complications following surgery can be an additional stressor

TABLE 1. Baseline characteristics comparing patients in the depressed subgroup to patients who were not depressed (depression naïve + at risk subgroup) preoperatively

Baseline	Depressed (n = 104)		Not depressed (n = 332)		P value
Preoperative					
Age	64	58-72	67	58-74	.1405
Sex (woman)	36	34.6%	68	27.4%	.1581
Operative status					.7435
Elective	72	69.2%	234	70.9%	
Urgent	32	30.8%	96	29.1%	
Winnipeg residence	51	49.0%	183	55.5%	.2524
Preoperative ejection fraction severity					.0216
≥50	61	65.6%	245	78.5%	
≤30 to <50	23	24.7%	54	17.3%	
<30	9	9.7%	13	4.2%	
CCS class (III or IV)	62	59.6%	174	52.4%	.1981
NYHA class (III or IV)	33	31.7%	68	20.5%	.0177
Preoperative creatinine	75.5	62-93.5	76.5	64.5-92	.5075
Smoker	27	26.2%	86	26.2%	.9990
Dyslipidemia	77	74.0%	257	77.6%	.4475
Hypertension	85	81.7%	251	75.8%	.2106
Diabetes mellitus	36	34.6%	106	32.0%	.6230
Peripheral vascular disease	16	15.5%	39	11.9%	.3336
CVA or TIA	13	12.8%	40	12.2%	.8747
≥2 Risk factors*	83	81.4%	248	75.8%	.2453
≥3 Risk factors*	52	51.0%	163	49.9%	.8416
≥4 Risk factors*	21	20.6%	66	20.2%	.9293
Physical activity					.0010
Inactive	51	49.5%	105	31.7%	
Active†	52	50.5%	226	68.3%	
IPAQ minutes	664.5	65.5-2617	1188	347-3672	.0111
Time spent on waitlist (d)	46.5	19-96	57	26-110	.2371
Operative					
Procedure					.5640
Isolated CABG	63	60.6%	185	55.7%	
Isolated valve	19	18.3%	54	16.3%	
CABG + valve	7	6.7%	26	7.8%	
Other	15	14.4%	67	20.2%	
All CABG procedures (C + V or ISO C)	70	67.3%	211	63.6%	.4853

CCS, Canadian Cardiovascular Society; NYHA, New York Heart Association; CVA, cerebro-vascular accident; TIA, transient ischemic attack; IPAQ, International Physical Activity Questionnaire; CABG, coronary artery bypass grafting; C + V or ISO C, CABG plus valve procedure or isolated CABG. *Risk factors included coronary artery risk factors of chronic renal insufficiency (creatinine ≥110 μmol/L), hyperlipidemia, hypertension, smoking, diabetes, peripheral vascular disease, and CVA/TIA. †Physically active refers to patients identified as moderately and very physically active preoperatively.

that overwhelms the already taxed coping resources of many patients and precipitates or exacerbates depressive symptomatology.¹¹

TABLE 2. Summary of preoperative (only significant parameters), operative, and postoperative variables comparing depressed patients (includes newly depressed patients previously naïve or at risk, plus previously depressed patients who remained depressed) with patients not depressed at discharge from hospital

Postoperative	Depressed (n = 141)		Not depressed (n = 233)		P value
Preoperative					
NYHA class (III or IV)	43	30.5%	47	20.2%	.0236
Physical activity					.0241
Inactive	57	40.7%	68	29.3%	
Active	83	59.3%	164	70.7%	
Baseline classification					<.0001
Naïve	31	22.0%	111	47.6%	
At risk	53	37.6%	93	39.9%	
Depressed	57	40.4%	29	12.5%	
Operative					
Procedure					.6598
Isolated CABG	79	56.0%	133	58.1%	
Isolated valve	20	14.2%	42	18.3%	
CABG + valve	12	8.5%	12	5.2%	
Other	30	21.3%	42	18.3%	
All CABG procedures (C + V or ISO C)	91	64.5%	149	64.0%	.9081
Pump time >180	13	9.9%	28	12.7%	.4150
Pump time >120	44	33.3%	76	34.6%	.8163
Pump time (continuous)	100.5	77.5-144	96.5	76-138	.8460
Postoperative					
ICU length of stay >72 h	25	17.7%	33	14.2%	.3557
Hospital stay >7 d	83	58.9%	117	50.2%	.1041
Postoperative creatinine	88	(72-114)	89	(74-110)	.7960
Postoperative ejection fraction severity					.9316
≥50	103	78.6%	180	78.2%	
≤30 to <50	22	16.8%	41	17.8%	
<30	6	4.6%	9	3.9%	
Ejection fraction improve by ≥5	16	12.7%	21	9.4%	.3389
Ejection fraction worsen by ≥5	10	7.9%	20	9.0%	.7411

NYHA, New York Heart Association; CABG, coronary artery bypass grafting; C + V or ISO C, CABG plus valve procedure or isolated CABG; ICU, intensive care unit.

Heterogeneity of Depressive Symptoms in Different Subgroups

Approximately 30% of patients had PHQ-9 scores consistent with depression, thus highlighting depression as a common postprocedural problem.^{3-6,12} Rudisch and colleagues¹³ reported a 17% to 27% prevalence of depression in nonoperative cardiovascular patients, which is in keeping with our observed prevalence of preoperative

TABLE 3. Depression scoring classification

PHQ-9 score	No. of responses on PHQ-9	Risk factors*	Degree of depression	Baseline classification
0-4	Any	No	Not	Naïve
0-4	Any	Yes	Not	At risk
5-9	<3	n/a	Possibly	At risk
5-9	>3	n/a	Mild	Depressed
10-14	Any	n/a	Mild	Depressed
15-20	Any	n/a	Moderate	Depressed
20-27	Any	n/a	Severe	Depressed

PHQ-9, Patient Hospital Questionnaire-9; n/a, not applicable. *Risk factors included family history of depression, previous diagnosis of depression, currently controlled using antidepressants, living alone, and recent stressful event.

depression of 23.9%. The overall increased prevalence of any depression at discharge (37.7%) observed in this study appears to be in contrast to improvement in symptoms noted in a review by McKenzie and colleagues.¹² Murphy and colleagues¹⁴ indicated there are subgroups of patients who show marked heterogeneity in depressive symptoms over time with some showing no improvement or worsening of their symptoms following surgery. Indeed, we identified 2 patterns of depressed mood after cardiac surgery. The preoperative depressed patients had a generalized improvement in depression, whereas an increase in depression, primarily in at-risk patients, was observed. This stresses the importance of identifying these subgroups because this potentially carries implications for psychological interventions as well as the long-term medical outcomes for these groups.

The incidence of new depression (29%) from the at-risk and naïve subgroups (58% vs 28%, respectively) highlights how even minor levels of depressive symptoms, or having risk factors for depression, can accentuate individuals' reactions to acute stressors. These individuals could be viewed as being more physically and emotionally vulnerable to the stresses of the surgical intervention than the cohort who did not become depressed. Moreover, it is a possibility that they were faced with the additional stress of a prolonged and probably more complicated inpatient admission (ie, greater length of stay) that further taxed their coping skills. This supports the practice of psychological screening of cardiac patients for

TABLE 4. Physical activity scoring classification

MET min/wk score*	IPAQ categorical score	IPAD-CS classification
<600	Inactive	Inactive
>600	Moderately active	Active
>1500 of vigorous activity	Physically active	Active
>3000 of any activity	Physically active	Active

MET, Metabolic equivalent of task; IPAQ, International Physical Activity Questionnaire; IPAD-CS, Impact of Physical Activity on Depression after Cardiac Surgery Study. *MET minutes per week were calculated for each patient (MET level × minutes of activity × events per week). Each category of activity was assigned a MET level (vigorous activity = 8 METs, moderate activity = 4 METs, and walking activity = 3.3 METs).

TABLE 5. Summary of independent preoperative (Q1) and postoperative (Q2) variables placing patients at risk of developing depression, after multivariate logistic regression

Multivariable logistic model risk factor	Odds ratio	95% Confidence interval	P value
Q1: Depression			
Moderate preoperative ejection fraction ≤ 30 to <50	1.81	(1.02-3.21)	.041
Severe preoperative ejection fraction (<30)	2.81	(1.13-6.96)	.0261
Physically inactive	2.05	(1.30-3.23)	.0019
Q2: Depression			
At-risk group (baseline)	2.16	(1.28-3.67)	.0042
Depressed group (baseline)	7.46	(4.06-13.69)	<.0001
Hospital stay >7 d	1.62	(1.03-2.55)	.0387
Q2: New depression (at risk and naïve patients only)			
NYHA class III or IV	2.06	(1.1-3.81)	.0212
At-risk group	2.02	(1.17-3.48)	.0119
Hospital stay >7 d	2.16	(1.25-3.75)	.0039
Q2: Remained depressed (depressed at Q1 patients only)			
CCS class III or IV	4.22	(1.47-12.08)	.0073
Severe preoperative ejection fraction (<30)	10.53	(1.72-66.67)	.0110

NYHA, New York Heart Association; CCS, Canadian Cardiovascular Society.

depressive risk factors and negative emotions at several points during the pre- and postoperative recovery period.

One-third of preoperatively depressed patients were found to have normal mood at discharge, highlighting another different pattern of depression in cardiac surgery patients. Notably an improvement in the median PHQ-9 score for the depressed subgroup postoperatively was observed. A possible explanation for the remission of depression in some of the depressed patients is the link between depression and ruminative and catastrophic thinking.¹⁵ These thought processes could have heightened depressive symptoms before surgery due to the uncertainty

FIGURE 2. Median Patient Health Questionnaire-9 (PHQ-9) scores by depression category. IQR, Interquartile range. **FIGURE 3.** Median Patient Health Questionnaire-9 (PHQ-9) scores of patients without depression. IQR, Interquartile range. * $P < .001$.

surrounding outcomes (ie, survival vs death).¹⁵ They would become less relevant following an immediate positive surgical outcome and hence accompanied by a decrease in depressive mood and negative processes. McKann and colleagues⁶ reported a similar finding in that about half of the patients in their study who were depressed before surgery were no longer depressed at 1-month follow-up. They speculated that improvement in physical functioning seen in many patients following CABG may have the added effect of elevating mood. Sansone and colleagues¹⁵ believed that the greater amounts of pain experienced by the unremitted depressed patients provided constant fuel for their negative expectations being realized and consequently the persistence of their depression.¹⁵

Influence of Physical Activity

Pre- and postoperative Cognitive Behavior Therapy (including exercise components) are beginning to show

FIGURE 4. Change in median Patient Health Questionnaire-9 (PHQ-9) scores of patients without depression (discharge - baseline score). IQR, Interquartile range.

some promise in treating anxiety and depression in patients undergoing cardiac surgery.¹⁶ These are best implemented early following their surgery to allow for a normative adjustment reaction to take place.¹⁷ The relationship between physical activity and depressive symptoms are not fully understood. There is a growing body of evidence indicating a beneficial association between physical activity and depression amongst people with cardiovascular disease.¹⁸ Whether withdrawal from physical activity leads to depressive¹⁹ symptoms or if depression leads to a sedentary lifestyle²⁰ still remains to be elucidated. To our knowledge, this is the first study to provide evidence indicating an association between preoperative self-reported cardiac surgery patient physical activity levels and depressive symptoms perioperatively.

Limitations

One of the limitations in our study is that being categorized as depressed by the PHQ-9 does not imply having a major depressive disorder as this can only be diagnosed with a clinical interview using *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*⁹ criteria. The PHQ-9 has been shown to be an effective depression screening tool for cardiac populations^{7,21-23} with good psychometric properties and clinical utility.^{8,24} In addition, discrete cutoff scores for caseness^{7,22,23} (numerical value on a test indicator at or above which a respondent is considered to be a positive case) have been ascertained that show good sensitivity (81.5%), specificity (80.6%), positive predictive value (62%), and negative predictive value (91.8%) for any depressive disorder.²² In addition, some of the symptoms of depression overlap with anxiety or acute stress reactions (both of which are evident after cardiac surgery), and somatic symptoms like lack of energy, sleep disturbances, loss of appetite, and moving slowly are commonly seen immediately after cardiac surgery. In lieu of this potential overlap, an adjustment to the mild category (PHQ-9 score 5-14) of depression to also include a possibly depressed category (PHQ-9 score 5-9) was made to minimize a high false positive identification of mild depression.⁷ Possibly depressed patients that answered positive to more than 3 different questions (thus meet the criteria for minor depressive episode according to the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*⁹ criteria), were changed to being mildly depressed. Because interviewing patients identified to be depressed was outside the scope of this project, sensitivity and specificity of the PHQ-9 in our population could not be confirmed. Unlike other depression screening tools, the PHQ-9 is a free questionnaire that does not add additional cost as a screening tool to cardiac surgery programs.

A further limitation is the high likelihood of over self-reporting physical activity with the short form IPAQ.²⁵ Patients in our study reported accumulating on average 224 minutes (3.7 hours) of moderate to vigorous physical activity

weekly at their baseline assessment preoperatively (Q1). This is well above the recommended weekly 150 minutes of moderate to vigorous physical activity for optimal health. Even so, these data are consistent with previous literature indicating that people tend to over-report their physical activity when using self-reporting methods.^{10,25} The IPAQ has been shown though, to have a correlation of $\rho = 0.3$ with objective measures of physical activity (ie, accelerometry).¹⁰

Thirdly, the absence of testing for postoperative anxiety and neurocognitive dysfunction is another limitation because patients with an acute stress response could experience a mixture of depressive and anxiety symptoms postoperatively. Our intention was to evaluate depression as a single entity and not postoperative stress responses. McKann and colleagues⁶ found no relation between depression and neurocognitive disorders.

A total of 62 patients enrolled did not complete the questionnaires at discharge (Figure 1); however, there was no difference in results when analysis was performed with only patients who completed Q1 and Q2, compared with analysis including all 436 Q1 and 374 Q2 questionnaires.

CONCLUSIONS

Depression is prevalent in approximately one-third of patients undergoing cardiac surgery at the time of discharge. Preoperatively depressed patients tend to have an improvement in depression scores, whereas other patients have worsening of depressive symptoms. Our study demonstrates that depression following cardiac surgery is not associated with any operative or postoperative risk factors with the exception of prolonged hospital stay >7 days. Preoperative depression or being at risk for depression adds a 7-fold and 2-fold risk for postoperative depression, respectively. Preoperative physical inactivity independently adds a 2-fold risk for preoperative depression. Questions remaining, such as how many of these patients remain depressed, how physical activity influences depression postoperatively, and the influence of depression and physical activity on medium or long-term morbidity and mortality after cardiac surgery remain to be answered in the follow-up reporting from the Impact of Physical Activity on Depression after Cardiac Surgery study. Future studies are necessary to develop effective, timely treatment strategies for the different subgroups of depressed patients before and after cardiac surgery.

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