

Review Article

Psychological Depression and Cardiac Surgery: A Comprehensive Review

Phillip J. Tully, PhD, MPsych (Clin)

Department of Surgery, Flinders Medical Centre and Flinders University of South Australia, Bedford Park, SA, Australia; The School of Psychology, The University of Adelaide, Adelaide, Australia; The Discipline of Psychiatry, The University of Adelaide, Adelaide, SA, Australia; and The Heart Failure Self Management Program, Ambulatory and Primary Healthcare Directorate, Hampstead Rehabilitation Centre, Northfield, Australia

Presented at the Perfusion Down Under Winter Meeting 2012, Queenstown, New Zealand, August 2–5, 2012.

Abstract: The psychological and neurological impact of cardiac surgery has been of keen empirical interest for more than two decades although reports showing the prognostic influence of depression on adverse outcomes lag behind the evidence documented in heart failure, myocardial infarction, and unstable angina. The paucity of research to date is surprising considering that some pathophysiological mechanisms through which depression is hypothesized to affect coronary heart disease (e.g., platelet activation, the inflammatory system, dysrhythmias) are known to be substantially influenced by the use of cardiopulmonary bypass. As such, cardiac surgery may provide a suitable exemplar to better understand the psychiatric mechanisms of

cardiopathogenesis. The extant literature is comprehensively reviewed with respect to the deleterious impact of depression on cardiac and neuropsychological morbidity and mortality. Research to date indicates that depression and major depressive episodes increase major cardiovascular morbidity risk after cardiac surgery. The association between depressive disorders and incident delirium is of particular relevance to cardiac surgery staff. Contemporary treatment intervention studies are also described along with suggestions for future cardiac surgery research. **Keywords:** depression, depressive disorder, coronary artery bypass, coronary artery disease, antidepressive agents. *JECT. 2012;44:224–232*

The impact of psychological depression in the etiology and prognosis of coronary heart disease (CHD) has been empirically described for more than two decades in myocardial infarction literature. Some of the earliest reports of cardiac surgery reported an association between cardiopulmonary bypass use and psychoses related to the stressors of surgery (1) and susceptibility to neurological insult and neurocognitive changes (2). Although the psychological side effects of cardiac surgery have long been of interest, the prevalence and influence of depression on patients undergoing cardiac surgery lag behind the evidence

documented in heart failure, myocardial infarction, and acute coronary syndromes (3). Rather, in cardiac surgery, an emphasis has been placed on preserving cognitive function but not mental health function per se. This is surprising considering that approximately 2–3% of patients undergoing cardiac surgery experience a form of psychological depression immediately leading up to and after surgery (4–8). Moreover, some pathophysiological mechanisms through which depression is hypothesized to affect CHD (platelet activation, the inflammatory system, dysrhythmias) are known to be substantially influenced by the use of cardiopulmonary bypass (9). Therefore, cardiac surgery may provide a suitable exemplar to better understand psychiatric mechanisms of cardiopathogenesis. An overview of research documenting a deleterious impact of depression on cardiac and neuropsychological morbidity and mortality is described. Part of the review describes the pathophysiological mechanisms as relevant. Finally, contemporary

Received for publication October 19, 2012; accepted November 15, 2012. Address correspondence to: Phillip J. Tully, PhD, MPsych (Clin), Cardiac and Thoracic Surgical Unit, Flinders Medical Centre, 3 Flinders Drive, Bedford Park, SA 5042, Australia. E-mail: phillip.tully@adelaide.edu.au The author has stated that the author has reported no material, financial, or other relationship with any healthcare-related business or other entity whose products or services are discussed in this paper.

Table 1. Coronary artery bypass graft studies reporting prevalence of depression with structured diagnostic interview.

Reference	Sample Characteristics	Diagnosis	Timing of Assessment	Major Depression (%)	Dysthymia (%)
Kazmierski (44)	563 open-heart surgery with CPB, Poland	MINI	Pre	6.2	—
Connerney (4)	309 CABG, US	NIMH	Pre	20.0	—
Kazmierski (36)	260 CABG, Poland	MINI	Pre	6.2	—
Tully (5,75)	158 CABG ± valve, Australia	MINI	Pre	17.1	—
Mitchell (8)	124 CABG, Canada	MINI	Pre	28.2	—
Fraguas (6)	50 CABG, Brazil	CIS	Pre	8.0	6.0
Rafanelli (7)	47 CABG, Italy	SCID	Post (1 month)	10.6	12.8
Rothenhauseler (76)	34 CABG, Germany	SCID	Pre	2.9	17.6*

*Minor depression and dysthymia.

CABG, coronary artery bypass graft; CPB, cardiopulmonary bypass; CIS, Clinical Interview Schedule; MINI, MINI International Neuropsychiatric Interview; NIMH, National Institute of Mental Health; Pre, preoperative period; Post, postoperative period; SCID, Structured Clinical Interview for DSM Disorders; US, United States.

treatment intervention studies are described along with suggestions for future cardiac surgery research.

DEPRESSION AMONG PATIENTS UNDERGOING CARDIAC SURGERY

The term major depressive episode is used to refer to a psychiatric diagnosis of unipolar depression episode as distinct from bipolar depression, adjustment disorders, and other types of mood disorders. The cardinal symptoms of major depressive episode include depressed mood and/or loss of interest or pleasure among other cognitive and somatic symptoms described subsequently. The prevalence of major depressive episode is 15–20% among patients undergoing coronary artery bypass graft (CABG) surgery. Comparatively, prevalence estimates among the general population is 5–9% for females and 2–3% among males (10). Collectively, research to date indicates that the number of patients affected by any depression (i.e., major, minor or dysthymia) approximates between 20% and 30% of patients undergoing CABG surgery depending on concurrent comorbidity rates, and a summary is provided in Table 1. A notable limitation of these studies, however, is the low sample size, highlighting a need for further research.

Studies using self-report depression measures suggest up to 50% of patients experience depressive symptoms (9,11–13). Studies using self-report measures do not reflect a clinical diagnosis of depression but, rather, depression symptoms. Peterson and colleagues (14) explain that newly developed depressive symptoms result from the stressors of surgery that can produce an adjustment reaction or reactive-type depression. In any case, as described further subsequently, identifying depression in the patient undergoing CABG surgery is complicated by the somatic symptoms experienced in CHD and the physical stressors of surgery.

IDENTIFYING DEPRESSION

The American Heart Association (15) recommended the Patient Health Questionnaire (PHQ) (16) to screen

for depressive symptoms. In its expanded form, the PHQ-9 covers the full spectrum of symptoms reflective of a major depressive episode, depicted in Table 2. As Carney and Freedland point out (17), many different combinations of symptoms fulfill criteria for a major depressive episode. The American Heart Association and American College of Cardiology Foundation (18) stated that a reasonable level of evidence exists for depression screening, stating it is reasonable in instances in which patients have access to case management in collaboration with their primary care physician and a mental health specialist. As such, not every cardiac surgery unit or medical center could feasibly adopt a routine depression screening and follow-up protocol. Indeed, close monitoring and follow-up for patients describing thoughts of death or self-harm are strongly recommended. Shemesh et al. (19) reported that >12% of cardiovascular patients require immediate evaluation of suicidal thought and intent, reiterating the practical requirements for referral pathways after assessment.

It has been suggested that a positive response to either of the PHQ-2 questions should be followed up with

Table 2. Core depression symptoms assessed by the PHQ-9.

<i>Over the past 2 weeks, how often have you been bothered by any of the following problems?</i>
1. Little interest or pleasure in doing things
2. Feeling down, depressed, or hopeless
3. Trouble falling or staying asleep or sleeping too much
4. Feeling tired or having little energy
5. Poor appetite or overeating
6. Feeling bad about yourself or that you are a failure or have let yourself or your family down
7. Trouble concentrating on things such as reading the newspaper or watching television
8. Moving or speaking so slowly that other people could have noticed or the opposite—being so fidgety or restless that you have been moving around a lot more than usual
9. Thoughts that you would be better off dead or hurting yourself in some way

Questions are scored: not at all = 0; several days = 1; more than half the days = 2; nearly every day = 3. Refer to references (16,22). PHQ, Patient Health Questionnaire.

Table 3. Association between depression and mortality or cardiac outcome after cardiac surgery.

Reference	Sample	Age (% female)	Follow-up	Outcome, N (%)	Depression Measures	Prevalence Preoperative/ Postoperative	Adjustment	Critical Value HR/OR/RR (95% CI)
Baker (9)	158 CAG ± valve, AUS	64.6 (25.3)	Median 2 years	All-cause mortality, n = 6 (3.8)	DASS ≥ 10	1 day preoperative, 15.2%	—	Unadjusted OR 6.24; 95% CI = 1.18–32.98, p < .05
Blumenthal (24)	817 CAG, US	61 (27)	Mean 5.2 years	All-cause mortality, n = 122 (15)	CES-D 16–26 (mild)	1 day preoperative, 26.1% mild	Cigarette smoking, LVEF, sex, age, grafts 4 vs 2, DM, previous MI,	Moderate–severe adjusted HR 2.37 (1.40–4.00), p = .001;
Burg (33)	89 CAG, US	66.3 (0)	2 years	Cardiovascular mortality, n = 5 (5.6)	CES-D ≥ 27 (moderate to severe) BDI > 10	11.9% moderate to severe preoperative, <1 week preoperative 28.1%	Tu score (age, gender, LV function, urgency, redo) History of MI, chronic renal insufficiency	mild adjusted HR 1.08 (.70–1.67), p = .723 Adjusted OR = 23.16 (95% CI = 1.38–389.08, p = .03)
Burg (25)	89 CAG, US	65.9 (0)	6 months	Hospitalization for MI or unstable angina, n = 8 (9)	BDI ≥ 10	<1 week 28.1% preoperative		$\chi^2 = 4.24, p = .039$
Connerney (4)	309 CAG, US	63.1 (33)	12 months	MI, PCTA, redo, cardiac arrest, death resulting from cardiac causes, rehospitalization for angina, CHF, n = 42 (14)	BDI ≥ 10	4–10 days postoperative, 28%	MDD, LVEF, sex, living alone, LOS, NYHA class, CAG/valve, vessels	Adjusted RR = 1.62 (.83–3.16), p = NR
Connerney (4)	309 CAG, US	63.1 (33)	12 months	MI, PCTA, redo, cardiac arrest, death resulting from cardiac causes, rehospitalization for angina, CHF, n = 42 (14)	DIS	4–10 days postoperative, 20.4%	LVEF, sex, living alone, LOS, NYHA class, CAG/valve, vessels	Adjusted RR 2.31 (1.17–4.56) p = .01
Connerney (28)	309 CAG, US	63.1 (33)	Median 9.3 years	Cardiac mortality, n = 62 (20.1)	DIS	4–10 days postoperative, 20.4%	Female sex, age, LVEF, DM	Adjusted HR 1.78 (1.04–3.04), p = .04
Connerney (28)	309 CAG, US	63.1 (33)	Median 9.3 years	All-cause mortality, n = 117 (37.9)	DIS	4–10 days postoperative, 20.4%	Female sex, age, LVEF, DM	Adjusted HR 1.19 (.78–1.82), p = .42
Oxlad (26)	119 CAG ± valve, AUS	63.3 (16.0)	6 months	CHD or surgery related readmission, n = 21 (17.9)	DASS-D ≥ 10	5–6 days postoperative, 15.7%	CPB time	Adjusted preoperative HR 5.15 (1.45–18.28), p = .01 Adjusted postoperative HR = .97 (.25–3.79), p = .96

Continued

Table 3. Continued.

Reference	Sample	Age (% female)	Follow-up	Outcome, N (%)	Depression Measures	Prevalence/ Postoperative	Adjustment	Critical Value HR/OR/RR (95% CI)
Oxman (77)	232 CAG, AVR, CAG ± AVR, US	¥(28)	6 months	In-hospital and postoperative all-cause mortality, n = 21 (9.1)	HAM-D ≥ 9	1-2 weeks preoperative 21.6%	—	$\chi^2, p = .07$
Phillips-Bute (78)	427 CAG, US	61 (30)	2 years	Repeat CAG, PCI, MI, cardiac arrest, all-cause mortality, n = not stated	CES-D > 16	1 day preoperative 36.8%	None	Unadjusted OR = 2.6; 95% CI = 1.6-4.3, p < .05
Szekley (79)	180 CAG/valve, HUN	57.9 (33.9)	4 years	All-cause mortality, n = 17 (9.4)	BDI > 10	1-5 days preoperative 44%	—	NS, not reported
Szekley (79)	180 CAG/valve, HUN	57.9 (33.9)	4 years	Cardiac death, hospitalization for angina, CHF, MI, PTCA, cardiac arrest, n = 48 (26.2)	BDI > 10	1-5 days preoperative 44%	DM, postoperative infection, ICU days, preoperative and post discharge 6th month STAI-T, 6 month BDI scores	Adjusted HR = .980 (95% CI = .917-1.047, p = .544)
Tully (61)	440 CAG ± valve, AUS	64 (20)	Median 5 years 10 months	All-cause mortality, n = 67 (15.2)	DASS-D ≥ 10	<1 week preoperative 20%	Age, renal disease, valve procedure, CVD, PVD	Adjusted HR = 1.61 (95% CI = .91-2.85), p = .10
Tully (11)	226 CAG, AUS	63 (17)	6 months	Cardiovascular/ surgery readmission, n = 72 (32)	DASS-D ≥ 10	<1 week preoperative 20.1% 4 days postoperative 23.5%	Anxiety, stress, age, sex, LVEF, urgency, lung disease, CHF, DM, PVD, renal disease, MI < 90 days, HTN, CCS, psychoactive medication use	Adjusted preoperative HR = .80 (.38-1.68), p = .56 Adjusted postoperative HR = 2.06 (.97-4.40), p = .06
Tully (32)	226 CAG, AUS	63 (17)	Median 4.9 years	MI, unstable angina, revascularization, CHF, sustained arrhythmia, stroke/CVA, LV failure, cardiac mortality, n = 65 (28.8)	BDI-II Cognitive factor	4 days postoperative	LVEF, age, respiratory disease, CHF, renal disease, DM	Adjusted HR = 1.36 (1.02-1.82), p = .04

AUS, Australia; BDI, Beck Depression Inventory; CAG, coronary artery graft; CCS, Canadian Cardiovascular Society; CES-D, Center for Epidemiological Studies-Depression; CHD, coronary heart disease; CHF, congestive heart failure; CI, confidence interval; CPB, cardiopulmonary bypass time; CVA, cerebrovascular accident; DASS, depression, anxiety and stress scales; DIS, diagnostic interview schedule; DM, diabetes mellitus; HAM-D, Hamilton Rating Scale for Depression; HR, hazard ratio; HUN, Hungary; HTN, hypertension; ICU, intensive care unit; LOS, length of stay; LV, left ventricular; LVEF, left ventricular ejection fraction; MDD, major depressive disorder; MI, myocardial infarction; NYHA, New York heart Association; OR, odds ratio; PCI, percutaneous coronary intervention; PCTA, percutaneous coronary transluminal angioplasty; PVD, peripheral vascular disease; RR, risk ratio; STAI-T, State Trait Anxiety Inventory-Trait; US, United States.

administration of the PHQ-9 with scores ≥ 10 on the PHQ-9 requiring an even more comprehensive assessment such as by a psychiatrist or psychologist (15). As previously mentioned, the somatic-laden depression diagnostic criteria overlap CHD symptoms. Specifically fatigue, loss of appetite, psychomotor retardation, insomnia, and difficulty concentrating can be the direct physiological response to a medical illness and hospitalization (20) and have been documented to significantly increase in the first month after CABG surgery (21). Important risk factors associated with a major depression episode among patients undergoing CABG surgery include female gender, younger age, a previous depression episode, and evidence of a family history of depression (8). Patients at high risk might warrant closer monitoring during the perioperative period with respect to depression and related psychiatric sequelae such as delirium, as described subsequently. Brief psychological reactions to the impending stressors of surgery and the postoperative recovery period may spontaneously remit over time, thus requiring no further intervention. Watchful waiting, monitoring, and brief support of suspected depressed cases might serve as a useful strategy before implementing psychological intervention. The developers of the PHQ-9 describe recommendations for what constitutes depression remission and treatment efficacy in primary care populations (22). With respect to identification of a major depressive episode, the only study to use receiver operating characteristics in patients undergoing CABG surgery showed that a self-report measure of depression yielded an area under the curve of .811 and 70.4% sensitivity and 77.1% specificity (23). Without more research, the use of self-report measures to identify depression in CABG populations remains largely unknown.

DEPRESSION AND MORBIDITY AFTER CORONARY ARTERY BYPASS GRAFT SURGERY

The recent depression research among patients undergoing CABG surgery is described in Table 3. The association between depressive symptoms at the time of CABG surgery and late mortality has been corroborated by several studies (4,9,24). In a study of 309 patients undergoing CABG surgery, Connerney et al. (4) reported that a major depressive episode, but not depressive symptoms, was associated with cardiac events at 1-year follow-up (risk ratio, 2.31; 95% confidence interval [CI], 1.17–4.56) adjusted for ejection fraction, female sex, extended length of hospital stay, New York Heart Association class, number of vessels revascularized, and living alone. Blumenthal et al. (24) reported a similar finding for person with moderate to severe depression symptoms and increased mortality risk (hazard ratio, 2.4; 95% CI, 1.2–4.2). Evidence

implicating depression in nonfatal morbidity outcomes has been reported for hospital readmissions (11,25–27), major cardiac events (4,28), and poorer quality of life (29). For example, patients reporting depressive symptoms 1 month after cardiac surgery were found to have a greater proportion of arrhythmias and return of angina symptoms at 5-year follow-up (12). Scheier et al. (30) reported that depressive symptoms were associated with surgery, CHD, and wound infection hospital readmissions among 309 patients at 6-month follow-up. In a study of 963 patients undergoing CABG, improvement in physical health at 6-month follow-up was lower among patients with depressive symptoms after adjustment for cardiac severity and baseline health (31). A systematic comparison of depression, anxiety, and stress suggested that only depression was consistently associated with quality-of-life measures of vitality, social role functioning, and physical and general health (29).

With respect to specific clusters of depression symptoms, two recent studies support a prognostic association between cognitive depression symptoms (e.g., pessimism, past-failure, self-criticalness, worthlessness) with nearly twofold greater risk of cardiac morbidity and mortality after CABG surgery (28,32). These findings suggest that the adverse effects of depression after CABG surgery are independent of any somatic depressive symptoms or medical comorbidity and diverge from findings with patients with myocardial infarction. However, Carney and Freedland's recent review (17) generally does not support that any particular subtype of depression confers greater CHD morbidity risk.

Studies to date are not without their limitations such as the low number of morbidity events experienced and lack of control for conventional risk factors (28). Unfortunately, these practices tend to bias the results in favor of rejecting the null hypothesis and the resultant wide CIs (e.g., 9,26,33) obscure the effect sizes and biological plausibility of an effect for depression.

DEPRESSION AND NEUROPSYCHOLOGICAL MORBIDITY AFTER CORONARY ARTERY BYPASS GRAFT SURGERY

The cognitive outcomes from cardiac surgery and the role for the perfusionist and cardiopulmonary bypass circuit continue to be of empirical interest. A major depressive episode also increases the risk for delirium among cardiac surgery populations (34), which is the most common psychiatric disorder observed on admission to healthcare settings (35). A fluctuating delirious state is characterized by disorientation to time, place, and persons; perceptual disturbances; and hallucinations. The incidence of delirium after cardiac surgery varies widely between 3.1% and 50% (36–42). McAvay and colleagues (43) showed that dysphoric mood and hopelessness depressive symptoms were

associated with incident delirium after hospitalization. Kazmierski et al. (44) screened patients undergoing open heart surgery for major depression episodes before surgery and found more than a fourfold greater risk for delirium after surgery (adjusted odds ratio [OR], 4.69; 95% CI, 1.84–11.93). Our prognostic study with 158 patients undergoing CABG (5) modified the diagnostic criteria for delirium to reduce potential bias from overlapping delirium–depression symptoms (e.g., concentration difficulties). Even with more stringent delirium criteria, preoperative major depression remained associated with incident delirium after CABG surgery (5) (adjusted OR, 3.86; 95% CI, 1.42–10.52). Surprisingly, parallel research concerning post-CABG neuropsychological function has produced predominantly null findings or weak correlations between depression and cognitive function in the short term (18,45) and long term (13,46,47). At 6-month and 5-year follow-up, depression, anxiety, and stress were not consistently associated with neuropsychological dysfunction in regression analysis among 75 patients undergoing CABG surgery and 36 control subjects (47). These results suggest that although depression poses a risk for delirium, there is not a consistent association with neuropsychological function.

MECHANISMS OF CARDIOPATHOGENESIS

An increased risk in CHD morbidity attributable to emotional distress is explained by behavioral and biological mechanisms. Epidemiological surveys suggest that affective disorders are associated with larger body mass index, hypertension, hypercholesterolemia, diabetes (48), physical inactivity (49), and regular smoking and nicotine dependence (50,51). Psychological distress has also been associated with less concordance to exercise regimens and smoking cessation 4 months after myocardial infarction (52). The biological mechanisms of cardiopathogenesis attributable to depression are multifactorial and include the dysregulation of the hypothalamic–pituitary–adrenal axis (53–55), reduced heart rate variability (56–58), altered serotonergic pathways, inflammatory response (59), and altered platelet aggregability (60). Reports among patients undergoing CABG show that depression symptoms are associated with peripheral vascular disease and diabetes (14), impairment in left ventricular function (61), and lower use of the left internal mammary artery (9).

INTERVENTION AND TREATMENT

With respect to pharmacological management, clinicians should be aware of the possible proarrhythmic and cardiotoxic effects of tricyclic antidepressants in cardiac patients and the common use of tricyclics such as amitriptyline for pain management (62,63). Selective serotonin

reuptake inhibitors (SSRIs) on the other hand have been hypothesized as safe among cardiac patients as a result of the serotonin transporter affinity and attenuation of platelet functioning. Safety, tolerability and efficacy of SSRIs among cardiac patients have been reported in some studies (45,64) but not others (65–67). Possible risks for patients undergoing CABG surgery specifically include increased bleeding attributable to SSRIs; however, this has not been consistently supported (68–70). One study suggested an increased mortality and readmission risk after CABG surgery attributable to SSRIs (71) and others have indicated greater morbidity but not mortality risk (70). The largest study from a Swedish registry of 10,884 CABG procedures reported a 40–45% increased hazard ratio in adjusted analyses for rehospitalization and death respectively (72). Two recent systematic reviews of randomized, controlled trials (RCTs) in patients with CHD both corroborated SSRI and placebo were not associated with reductions, or increased risk, in mortality (50,51).

A diverse range of behavioral and psychological RCT interventions have been reported and cognitive–behavioral therapy or collaborative care constitutes Class IIa evidence (i.e., additional studies with focused objectives are needed, and it is reasonable to administer treatment) (73). Freedland et al. (74) compared cognitive behavior ($n = 41$) or supportive stress management ($n = 42$) vs. usual care ($n = 40$) and found significant 3-month depression remission rates in the treatment arms (71%, 57%, and 33%, respectively; $p = .002$). Group differences were sustained at 9-month follow-up, whereas cognitive–behavioral therapy intervention was found to be superior with respect to measures of anxiety, hopelessness, stress, and quality of life. Four sessions of psychoeducation and skills training in a RCT treatment group ($n = 48$) were associated with reduced depressive symptoms 4 weeks after surgery by comparison to a usual care group ($n = 48$) (53). A biweekly, nurse-led telephone-delivered intervention for depressed patients over 8 months reported modest effect sizes (.30; 95% CI, .17–.52) for mental health quality of life (54), and a trend toward favorable cardiac hospital readmission rates. One disconcerting finding for mental health professionals was the low mental health service visits (4% intervention vs. 6% usual care), suggesting that patients undergoing CABG surgery may not be suited to this particular form of psychological support (55). Together with the findings of lower cardiac events in patients randomized to a stress intervention over 12 months in Finland (56), these studies suggest that sustained depression remission can be achieved with a diverse range of interventions. However, more comprehensive psychological interventions appear to be required for clinically significant reductions in cardiovascular complications. Also, as the developers of the PHQ-9 point out (22), severe depression episodes require combinations of antidepressants and psychotherapy; thus, neither treatment modality can be recommended over the other.

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

Although a concerted effort has been made to improve patient cognitive outcomes after cardiac surgery, far less intervention has been invested in improving the mental health outcomes of patients undergoing cardiac surgery. Indeed, the interaction between depression pathophysiology and effects of cardiopulmonary bypass is a potentially fruitful avenue of research in cardiac surgery to better understand mechanisms of psychiatric cardiopathogenesis. Naturally, the rates of depression after cardiac surgery highlight a requirement for appropriate identification, support, and intervention efforts. One suggestion for future depression focused research in CABG surgery would be to investigate the impact of closely related psychological constructs, particularly anxiety (57,58). Collaboration between psychologists and psychiatrist specialists with cardiac surgeons, cardiologists, and cardiac nurses may enhance the research basis for improved patient outcomes. It is commonly hoped that intervention might mitigate the deleterious impact of depression on subsequent morbidity and mortality.

REFERENCES

1. Fox H, Rizzon N, Gifford S. Psychological observations of patients undergoing mitral surgery: A study of stress. *Am Heart J*. 1954;48:645-70.
2. Gilman S. Cerebral disorders after open-heart operations. *N Engl J Med*. 1965;272:489-98.
3. Tully PJ, Baker RA. Depression and anxiety and morbidity outcomes after coronary artery bypass graft surgery patients: A practical and contemporary review. *J Geriatr Cardiol*. 2012;9:197-208.
4. Connerney I, Shapiro PA, McLaughlin JS, Bagiella E, Sloan RP. Relation between depression after coronary artery bypass surgery and 12-month outcome: A prospective study. *Lancet*. 2001;358:1766-71.
5. Tully PJ, Baker RA, Winefield HR, Turnbull DA. Depression, anxiety disorders and Type D personality as risk factors for delirium after cardiac surgery. *Aust N Z J Psychiatry*. 2010;44:1005-11.
6. Fraguas Junior R, Ramadan ZB, Pereira AN, Wajngarten M. Depression with irritability in patients undergoing coronary artery bypass graft surgery: The cardiologist's role. *Gen Hosp Psychiatry*. 2000;22:365-74.
7. Rafanelli C, Roncuzzi R, Milanesechi Y. Minor depression as a cardiac risk factor after coronary artery bypass surgery. *Psychosomatics*. 2006;47:289-95.
8. Mitchell RH, Robertson E, Harvey PJ, et al. Sex differences in depression after coronary artery bypass graft surgery. *Am Heart J*. 2005;150:1017-25.
9. Baker RA, Andrew MJ, Schrader G, Knight JL. Preoperative depression and mortality in coronary artery bypass surgery: Preliminary findings. *Aust N Z J Surg*. 2001;71:139-42.
10. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders: DSM-IV-TR. Washington, DC: American Psychiatric Association; 2000.
11. Tully PJ, Baker RA, Turnbull D, Winefield H. The role of depression and anxiety symptoms and hospital readmissions after cardiac surgery. *J Behav Med*. 2008;31:281-90.
12. Borowicz L Jr, Royall R, Grega M, Selnes O, Lyketso C, McKhann G. Depression and cardiac morbidity 5 years after coronary artery bypass surgery. *Psychosomatics*. 2002;43:464-71.
13. McKhann GM, Borowicz LM, Goldsborough MA, Enger C, Selnes OA. Depression and cognitive decline after coronary artery bypass grafting. *Lancet*. 1997;349:1282-4.
14. Peterson JC, Charlson ME, Williams-Russo P, et al. New postoperative depressive symptoms and long-term cardiac outcomes after coronary artery bypass surgery. *Am J Geriatr Psychiatry*. 2002;10:192-8.
15. Lichtman JH, Bigger JT Jr, Blumenthal JA, et al. Depression and coronary heart disease: recommendations for screening, referral, and treatment: A science advisory from the American Heart Association Prevention Committee of the Council on Cardiovascular Nursing, Council on Clinical Cardiology, Council on Epidemiology and Prevention, and Interdisciplinary Council on Quality of Care and Outcomes Research: Endorsed by the American Psychiatric Association. *Circulation*. 2008;118:1768-75.
16. Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: The PHQ primary care study. *Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire*. *JAMA*. 1999;282:1737-44.
17. Carney R, Freedland K. Is there a high-risk subtype of depression in patients with coronary heart disease? *Curr Psychiatry Rep*. 2012;14:1-7.
18. Smith SC Jr, Benjamin EJ, Bonow RO, et al. AHA/ACC secondary prevention and risk reduction therapy for patients with coronary and other atherosclerotic vascular disease: 2011 update: A guideline from the American Heart Association and American College of Cardiology Foundation endorsed by the World Heart Federation and the Preventive Cardiovascular Nurses Association. *J Am Coll Cardiol*. 2011;58:2432-46.
19. Shemesh E, Annunziato RA, Rubinstein D, et al. Screening for depression and suicidality in patients with cardiovascular illnesses. *Am J Cardiol*. 2009;104:1194-7.
20. Koenig HG, George LK, Peterson BL, Pieper CF. Depression in medically ill hospitalized older adults: Prevalence, characteristics, and course of symptoms according to six diagnostic schemes. *Am J Psychiatry*. 1997;154:1376-83.
21. Contrada RJ, Boulifard DA, Idler EL, Krause TJ, Labouvie EW. Course of depressive symptoms in patients undergoing heart surgery: Confirmatory analysis of the factor pattern and latent mean structure of the Center for Epidemiologic Studies Depression Scale. *Psychosom Med*. 2006;68:922-30.
22. The MacArthur Initiative on Depression in Primary Care. Use of the PHQ-9 to make a tentative diagnosis (symptomatology and functional impairment). 2011. Available at: <http://www.depressionprimarycare.org/clinicians/toolkits/materials/forms/phq9/>. Accessed May 28, 2012.
23. Tully PJ, Penninx BW. Depression and anxiety among coronary heart disease patients: Can affect dimensions and theory inform diagnostic disorder based screening? *J Clin Psychol*. 2012;68:448-61.
24. Blumenthal JA, Lett HS, Babyak MA, et al. Depression as a risk factor for mortality after coronary artery bypass surgery. *Lancet*. 2003;362:604-9.
25. Burg MM, Benedetto MC, Rosenberg R, Soufer R. Presurgical depression predicts medical morbidity 6 months after coronary artery bypass graft surgery. *Psychosom Med*. 2003;65:111-8.
26. Oxlad M, Stubberfield J, Stuklis R, Edwards J, Wade TD. Psychological risk factors for cardiac-related hospital readmission within 6 months of coronary artery bypass graft surgery. *J Psychosom Res*. 2006;61:775-81.
27. Saur CD, Granger BB, Muhlbaier LH, et al. Depressive symptoms and outcome of coronary artery bypass grafting. *Am J Crit Care*. 2001;10:4-10.
28. Connerney I, Sloan RP, Shapiro PA, Bagiella E, Seckman C. Depression is associated with increased mortality 10 years after coronary artery bypass surgery. *Psychosom Med*. 2010;72:874-81.
29. Tully PJ, Baker RA, Turnbull DA, Winefield HR, Knight JL. Negative emotions and quality of life six months after cardiac surgery: The dominant role of depression not anxiety symptoms. *J Behav Med*. 2009;32:510-22.
30. Scheier MF, Matthews KA, Owens JF, et al. Optimism and rehospitalization after coronary artery bypass graft surgery. *Arch Intern Med*. 1999;159:829-35.
31. Mallik S, Krumholz HM, Lin ZQ, et al. Patients with depressive symptoms have lower health status benefits after coronary artery bypass surgery. *Circulation*. 2005;111:271-7.
32. Tully PJ, Winefield HR, Baker RA, Turnbull DA, de Jonge P. Confirmatory factor analysis of the Beck Depression Inventory-II and the association with cardiac morbidity and mortality after coronary revascularization. *J Health Psychol*. 2011;16:584-95.

33. Burg MM, Benedetto MC, Soufer R. Depressive symptoms and mortality two years after coronary artery bypass graft surgery (CABG) in men. *Psychosom Med.* 2003;65:508–10.
34. Sockalingam S, Parekh N, Bogoch II, et al. Delirium in the postoperative cardiac patient: A review. *J Card Surg.* 2005;20:560–7.
35. Leentjens AF, MacLulich AM, Meagher DJ. Delirium, Cinderella no more...? *J Psychosom Res.* 2008;65:205.
36. Kazmierski J, Kowman M, Banach M, et al. Preoperative predictors of delirium after cardiac surgery: A preliminary study. *Gen Hosp Psychiatry.* 2006;28:536–8.
37. Norkiene I, Ringaitiene D, Misiuriene I, et al. Incidence and precipitating factors of delirium after coronary artery bypass grafting. *Scand Cardiovasc J.* 2007;41:180–5.
38. Rolfson DB, McElhaney JE, Rockwood K, et al. Incidence and risk factors for delirium and other adverse outcomes in older adults after coronary artery bypass graft surgery. *Can J Cardiol.* 1999;15:771–6.
39. Rudolph JL, Babikian VL, Birjiniuk V, et al. Atherosclerosis is associated with delirium after coronary artery bypass graft surgery. *J Am Geriatr Soc.* 2005;53:462–6.
40. Rudolph JL, Jones RN, Grande LJ, et al. Impaired executive function is associated with delirium after coronary artery bypass graft surgery. *J Am Geriatr Soc.* 2006;54:937–41.
41. Santos FS, Velasco IT, Fraguas R Jr. Risk factors for delirium in the elderly after coronary artery bypass graft surgery. *Int Psychogeriatr.* 2004;16:175–93.
42. Yoon BW, Bae HJ, Kang DW, et al. Intracranial cerebral artery disease as a risk factor for central nervous system complications of coronary artery bypass graft surgery. *Stroke.* 2001;32:94–9.
43. McAvay GJ, Van Ness PH, Bogardus ST Jr, et al. Depressive symptoms and the risk of incident delirium in older hospitalized adults. *J Am Geriatr Soc.* 2007;55:684–91.
44. Kazmierski J, Kowman M, Banach M, et al. Incidence and predictors of delirium after cardiac surgery: Results from The IPDACS Study. *J Psychosom Res.* 2010;69:179–85.
45. Dowlati Y, Herrmann N, Swardfager WL, Reim EK, Lanctot KL. Efficacy and tolerability of antidepressants for treatment of depression in coronary artery disease: A meta-analysis. *Can J Psychiatry.* 2010;55:91–9.
46. Tully PJ, Baker RA, Knight JL, Turnbull DA, Winefield HR. Neuropsychological function five years after cardiac surgery and the effect of psychological distress. *Arch Clin Neuropsychol.* 2009;24:741–51.
47. Stroobant N, Vingerhoets G. Depression, anxiety, and neuropsychological performance in coronary artery bypass graft patients: A follow-up study. *Psychosomatics.* 2008;49:326–31.
48. Barger SD, Sydeman SJ. Does generalized anxiety disorder predict coronary heart disease risk factors independently of major depressive disorder? *J Affect Disord.* 2005;88:87–91.
49. Goodwin RD. Association between physical activity and mental disorders among adults in the United States. *Prev Med.* 2003;36:698–703.
50. Baumeister H, Hutter N, Bengel J. Psychological and pharmacological interventions for depression in patients with coronary artery disease. *Cochrane Database Syst Rev.* 2011;9:CD008012.
51. Pizzi C, Rutjes AW, Costa GM, Fontana F, Mezzetti A, Manzoli L. Meta-analysis of selective serotonin reuptake inhibitors in patients with depression and coronary heart disease. *Am J Cardiol.* 2011;107:972–9.
52. Kuhl EA, Fauerbach JA, Bush DE, Ziegelstein RC. Relation of anxiety and adherence to risk-reducing recommendations following myocardial infarction. *Am J Cardiol.* 2009;103:1629–34.
53. Dao TK, Youssef NA, Armsworth M, Wear E, Papatopoulos KN, Gopaldas R. Randomized controlled trial of brief cognitive behavioral intervention for depression and anxiety symptoms preoperatively in patients undergoing coronary artery bypass graft surgery. *J Thorac Cardiovasc Surg.* 2011;142:e109–15.
54. Rollman BL, Belnap BH, LeMenager MS, et al. Telephone-delivered collaborative care for treating post-CABG depression: A randomized controlled trial. *JAMA.* 2009;302:2095–103.
55. Tully PJ. Randomised controlled trial: telephone-delivered collaborative care for post-CABG depression is more effective than usual care for improving mental-health-related quality of life. *Evid Based Med.* 2010;15:57–8.
56. Gulliksson M, Burell G, Vessby B, Lundin L, Toss H, Svardsudd K. Randomized controlled trial of cognitive behavioral therapy vs standard treatment to prevent recurrent cardiovascular events in patients with coronary heart disease: Secondary Prevention in Uppsala Primary Health Care project (SUPRIM). *Arch Intern Med.* 2011;171:134–40.
57. Tully PJ, Cosh SM. Generalized anxiety disorder prevalence and comorbidity with depression in coronary heart disease: A meta-analysis. *J Health Psychol.* (in press).
58. Tully PJ, Bennetts JS, Baker RA, McGavigan AD, Turnbull DA, Winefield HR. Anxiety, depression, and stress as risk factors for atrial fibrillation after cardiac surgery. *Heart Lung.* 2011;40:4–11.
59. Frasure-Smith N, Lesperance F, Irwin MR, Sauve C, Lesperance J, Theroux P. Depression, C-reactive protein and two-year major adverse cardiac events in men after acute coronary syndromes. *Biol Psychiatry.* 2007;62:302–8.
60. Soufer R, Arrighi JA, Burg MM. Brain, behavior, mental stress, and the neurocardiac interaction. *J Nucl Cardiol.* 2002;9:650–62.
61. Tully PJ, Baker RA, Knight JL. Anxiety and depression as risk factors for mortality after coronary artery bypass surgery. *J Psychosom Res.* 2008;64:285–90.
62. Cohen HW, Gibson G, Alderman MH. Excess risk of myocardial infarction in patients treated with antidepressant medications: Association with use of tricyclic agents. *Am J Med.* 2000;108:2–8.
63. Jeong-Hoon Ha, Wong C-K. Pharmacologic treatment of depression in patients with myocardial infarction. *J Geriatr Cardiol.* 2011;8:121–6.
64. Glassman AH, O'Connor CM, Califf RM, et al. Sertraline treatment of major depression in patients with acute MI or unstable angina. *JAMA.* 2002;288:701–9.
65. Veien KT, Videbaek L, Schou M, Gustafsson F, Hald-Steffensen F, Hildebrandt PR. High mortality among heart failure patients treated with antidepressants. *Int J Cardiol.* 2011;146:64–7.
66. Von Ruden AE, Adson DE, Kotlyar M. Effect of selective serotonin reuptake inhibitors on cardiovascular morbidity and mortality. *J Cardiovasc Pharmacol Ther.* 2008;13:32–40.
67. Tata LJ, West J, Smith C, et al. General population based study of the impact of tricyclic and selective serotonin reuptake inhibitor antidepressants on the risk of acute myocardial infarction. *Heart.* 2005;91:465–71.
68. Kim DH, Daskalakis C, Whellan DJ, et al. Safety of selective serotonin reuptake inhibitor in adults undergoing coronary artery bypass grafting. *Am J Cardiol.* 2009;103:1391–5.
69. Andreasen JJ, Riis A, Hjortdal VE, Jorgensen J, Sorensen HT, Johnsen SP. Effect of selective serotonin reuptake inhibitors on requirement for allogeneic red blood cell transfusion following coronary artery bypass surgery. *Am J Cardiovasc Drugs.* 2006;6:243–50.
70. Tully PJ, Cardinal T, Bennetts JS, Baker RA. Selective serotonin reuptake inhibitors, venlafaxine and duloxetine are associated with in hospital morbidity but not bleeding or late mortality after coronary artery bypass graft surgery. *Heart Lung Circ.* 2012;21:206–14.
71. Xiong GL, Jiang W, Clare R, et al. Prognosis of patients taking selective serotonin reuptake inhibitors before coronary artery bypass grafting. *Am J Cardiol.* 2006;98:42–7.
72. Stenman M, Holzmann MJ, Sartipy U. Antidepressant use before coronary artery bypass surgery is associated with long-term mortality. *Int J Cardiol.* 2012 Sep 5 [Epub ahead of print].
73. Hillis LD, Smith PK, Anderson JL, et al. 2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery: Executive summary. A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines developed in collaboration with the American Association for Thoracic Surgery, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons. *J Am Coll Cardiol.* 2011;58:2584–614.
74. Freedland KE, Skala JA, Carney RM, et al. Treatment of depression after coronary artery bypass surgery: A randomized controlled trial. *Arch Gen Psychiatry.* 2009;66:387–96.
75. Tully PJ, Pedersen SS, Winefield HR, Baker RA, Turnbull DA, Denollet J. Cardiac morbidity risk and depression and anxiety: A disorder, symptom and trait analysis among cardiac surgery patients. *Psychol Health Med.* 2011;16:333–45.

76. Rothenhausler HB, Grieser B, Nollert G, Reichart B, Schelling G, Kapfhammer HP. Psychiatric and psychosocial outcome of cardiac surgery with cardiopulmonary bypass: A prospective 12-month follow-up study. *Gen Hosp Psychiatry*. 2005;27:18–28.
77. Oxman TE, Barrett JE, Freeman DH, Manheimer E. Frequency and correlates of adjustment disorder related to cardiac surgery in older patients. *Psychosomatics*. 1994;35:557–68.
78. Phillips-Bute B, Mathew JP, Blumenthal JA, et al. Relationship of genetic variability and depressive symptoms to adverse events after coronary artery bypass graft surgery. *Psychosom Med*. 2008;70:953–9.
79. Szekeley A, Balog P, Benko E, et al. Anxiety predicts mortality and morbidity after coronary artery and valve surgery—A 4-year follow-up study. *Psychosom Med*. 2007;69:625–31.