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Cognitive Behavioral Therapy in Depressed Cardiac Surgery Patients: Role of Ejection Fraction

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Abstract

Aims—To evaluate the relationship of ejection fraction (EF) and depressive symptoms in cardiac surgery patients assigned to nurse-guided cognitive behavioral therapy (CBT) or usual care (UC)

Methods—Depressive symptoms were assessed using the Beck Depression Inventory (BDI). Seventy-seven patients (31% female, age 63.6±9.8 years) received 8 weeks of either CBT or UC. Using repeated measures ANOVA, changes in depressive symptoms over time were evaluated.

Results—There was a significant interaction among time, treatment group and EF status ($p = .019$). In patients with preserved EF ($\geq 40\%$), mean BDI scores in the UC group worsened by 1.9%, while those in the CBT group improved by 31.0%. In patients with low EF ($< 40\%$), mean BDI scores worsened by 26.8% and improved by 75.3% in the UC and CBT groups, respectively.

Conclusions—Nurse-guided CBT is effective in reducing depressive symptoms after cardiac surgery, particularly in patients with low EF.

Keywords

Cognitive behavioral therapy; depressive symptoms; cardiac surgery; ejection fraction

Background

Depression is common in patients who undergo cardiac surgery, with the reported prevalence ranging from 15% to 38%.¹⁻⁶ Moreover, depression has been reported to be an independent predictor of delayed recovery,² increased rehospitalization,^{4,5} and increased cardiac mortality²⁻⁵ after cardiac surgery. The detrimental effect of depression on mortality is long lasting, as shown in studies that followed patients for 5-10 years after cardiac surgery.^{1,6,7}

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Conflict of Interests: None declared.

Low ventricular ejection fraction (EF) (i.e., < 40–45%) indicates ventricular systolic dysfunction, the most common cause of heart failure.⁸ It has been found to be a strong predictor of short-term and long-term mortality after cardiac surgery.^{5,7,9} As both depression and low EF have been identified as predictors of poor outcomes, several researchers have examined the effect of depression on patient outcomes in relation to EF. Analyzing longitudinal data from 883 patients who underwent cardiac surgery, Kendel et al.¹⁰ reported that increased depressive symptoms predicted functional decline over 1 year after surgery. Furthermore, they found that the adverse effect of depression on postoperative physical functioning was significantly stronger in patients with low EF than in patients with preserved EF. Similar findings were reported in patients with heart failure. Following 510 patients with heart failure over a six-year period, Johansson, Dahlstrom, and Alehagen¹¹ reported that depressive symptoms were an independent predictor of cardiovascular mortality and all-cause mortality even after adjustment for age, gender, New York Heart Association class, EF and B-type natriuretic peptide. Moreover, they found that patients with low EF and depressive symptoms had the highest risk of cardiovascular mortality compared to patients with low EF without depressive symptoms and those who had preserved EF with and without depressive symptoms after adjustment. These findings suggest an additive adverse effect of low EF and depression on the outcomes of patients with heart disease.

The most recent guidelines from the American Heart Association and the American Psychiatric Association¹² recommend cognitive behavioral therapy (CBT) as a treatment option for depression in patients with heart disease. A recent Cochrane review¹³ concluded that psychological interventions, the majority of which included CBT strategies, resulted in small to moderate improvements in depression and fewer cardiac deaths among patients with heart disease. In addition, in a recent systematic review of psychological interventions for depression in patients with heart disease, Dickens et al.¹⁴ reported that CBT was the only psychological intervention that showed significant effects in high-quality trials and therefore recommended CBT for the treatment of depression in this population. Yet, there are only a few studies that examined the effect of CBT in cardiac surgery patients.¹⁵⁻¹⁷ These studies showed that 4 to 12 sessions of individual CBT resulted in greater improvements in depressive symptoms and quality of life compared to usual care or supportive stress management among patients who underwent cardiac surgery.

The efficacy of CBT has been established for depression among patients with heart disease.^{13,14} Despite the findings from previous studies demonstrating an additive adverse effect of low EF and depression on the outcomes of patients with heart disease,^{10,11} the effect of CBT on depressive symptoms has never been evaluated in relation to EF. Therefore, we conducted a secondary analysis of data from a clinical trial testing the effect of nurse-guided CBT compared with usual care on depressive symptoms among patients recovering from cardiac surgery.¹⁷ Specifically, the aim of the present study was to examine whether the effect of CBT on depressive symptoms is different between cardiac surgery patients with low EF (< 40%) and those with preserved EF (≥ 40%).

Methods

This was a secondary analysis of data from a randomized clinical trial of CBT compared to usual care (UC) in patients recovering from cardiac surgery. The study methods have been described in greater detail elsewhere.¹⁷ The primary study was conducted at five tertiary care centers in California, USA and was approved by the institutional review board.

Sample and Procedure

Patients who underwent cardiac surgery (coronary artery bypass grafting or valve replacement/repair) at the participating hospitals were screened for the primary study. Exclusion criteria included: age < 30 years, residing outside of the greater Los Angeles area, presence of cognitive impairment or major comorbid psychiatric condition (schizophrenia, bipolar disorder, substance abuse), and current autoimmune disorder or malignancy. Patients who met eligibility criteria and consented to participate were approached after surgery and before hospital discharge. Sociodemographic data were collected using a brief questionnaire. Depressive symptoms were assessed with the Beck Depression Inventory (BDI).¹⁸ Clinical data were collected from medical records. Within a month after hospital discharge, a trained research nurse called patients at home to reassess depressive symptoms. Patients with BDI scores >10 at either baseline or 1 month post-discharge, or those who had a history of depression were interviewed at home by a trained research nurse using the Structured Clinical Interview for DSM-IV (SCID-I).¹⁹

Based on the SCID-I interview and after confirmation of depression status by panel of mental health professional, 81 participants who met criterion for major or minor depression were randomized to receive either 8 weeks of nurse-guided CBT or UC. At 8 weeks, the presence of clinical depression was re-evaluated via the SCID-I by a trained research nurse, who was blinded to the treatment group.

The home-based nurse-guided CBT was conducted by four advanced practice nurses with expertise in cardiac and/or psychiatric care. All of them had completed standardized CBT training (Beck Institute, Philadelphia, PA). The intervention consisted of eight weekly sessions of therapy, each of which lasted 50 to 60 minutes. All sessions were conducted one-on-one in person without family members present. Details regarding the intervention and methods used to ensure fidelity and consistency of the intervention have been described elsewhere.¹⁷

Patients in the UC group received referrals to their primary care providers and mental health services. In addition, they received short biweekly follow-up phone calls from study staff over an 8-week period. Phone calls were aimed primarily at maintaining ongoing contact to facilitate patients' retention in the study and did not include assessment of depressive symptoms. A semi-scripted outline was used for these phone calls to ensure consistency.

Instruments

The Charlson Comorbidity Index (CCI) was used to assess the number and severity of medical comorbidities.²⁰ It is the most extensively studied comorbidity index available.²¹

Depressive symptoms were measured with the BDI, a 21-item self-report questionnaire with two subscales assessing cognitive-affective and somatic symptoms.¹⁸ In the current study, the alpha-coefficient of the BDI was 0.87. The cognitive-affective factor includes negative self-view, depressive mood, anhedonia, pessimism, irritability, suicidal ideation, and indecisiveness; the somatic factor includes somatic items (sleep disturbance, fatigability, change in appetite or weight, loss of libido), together with the items on social withdrawal and work inhibition.²²

The presence or absence of clinical depression was determined using the SCID-I. It is a semi-structured interview that is widely accepted and has been used as a criterion reference in studies evaluating other questionnaires for the identification of Axis 1 disorders.¹⁹ Criteria for major and minor depression in the SCID-I are consistent with the DSM-IV-R.

Analysis

Data were analyzed with IBM SPSS 21 (IBM, Armonk, NY 2012). Baseline characteristics between patients with low EF (< 40%) and preserved EF (≥ 40%) were compared using chi-square tests, Student's t-tests, and Mann-Whitney U tests, as appropriate. Changes in depressive symptoms over time by treatment group and EF status were evaluated using repeated measures analysis of variance controlling for baseline differences between patient with and without low EF. The models included a fixed time factor, two grouping factors (CBT vs. UC and low vs. preserved EF), the two-way interaction terms between time and two grouping factors, and the three-way interaction term of time, treatment group, and EF group. Analyses followed intention-to-treat (ITT) principles, in which baseline scores or last BDI scores were imputed for individuals who were excluded or did not finish 8 weeks of CBT. Similar models were evaluated for the BDI-cognitive/affective and BDI-somatic subscales. The statistical significance level was set at $p < .05$. For pairwise comparisons, the Bonferroni method was used to adjust for multiple comparisons.

Results

For the primary study, 45 patients were assigned to the CBT group, and 36 patients to the UC group. Three patients from the CBT group and one patient from the UC group had no EF data, and therefore, were excluded from this analysis. Sixty-four individuals (83%) had preserved EF; 13 (17%) had low EF. Eighty-eight percent of patients in the CBT group and 77% of patients in the UC group had preserved EF, respectively. There were no significant differences between patients with low EF and those with preserved EF in age, race/ethnicity, educational level, marital or employment status, type of cardiac surgery, or antidepressant use (Table 1). No significant differences were found between patients with and without low EF in their baseline BDI scores ($p = .46$), baseline cognitive-affective ($p = .16$) or somatic subscale scores ($p = .70$). However, patients with low EF had higher scores on the CCI, indicating that they had worse comorbidities, compared to patients with preserved EF ($p = .01$). Therefore, CCI scores were controlled for in the following analyses.

The results of the repeated measures analysis are displayed in Figure 1. For the total BDI, both patients with and without low EF benefited from CBT, compared to similar patients in the UC group (time by treatment group interaction, $F(1, 71) = 16.66, p < .001$). There was a

significant three-way interaction effect among time, treatment group, and EF status [$F(1, 71) = 5.78, p = .019$]. In patients with preserved EF, mean BDI scores in the UC group increased by 1.9% (indicating worsening symptoms; $p = .88$), while mean BDI scores in the CBT group decreased (indicating symptom improvement) by 31.0% ($p = .006$). In patients with low EF, mean BDI scores worsened by 26.8% ($p = .23$) and improved by 75.3% ($p = .001$) in the UC and CBT groups, respectively. Similar improvement for participants who received CBT with and without low EF was noted for the BDI subscales as well. Significant interactions of time by treatment by EF status were observed for the cognitive/affective symptoms [$F(1, 70) = 8.04, p = .006$] and for somatic symptoms [$F(1, 69) = 4.65, p = .034$].

Discussion

To our knowledge, this is the first study that examined the effect of CBT on depressive symptoms in relation to EF among cardiac surgery patients. After 8 weeks of home-based nurse-guided CBT, we found a greater effect of CBT on depressive symptoms in patients with low EF than in patients with preserved EF. In our sample, patients with low EF had more comorbidities than those with preserved EF, and therefore, comorbidities were controlled for in the analysis. The two groups of patients did not differ in terms of sociodemographic or other baseline clinical characteristics, including baseline depressive symptoms. Therefore, the greater effect of CBT in patients with low EF may not be explained by any of these characteristics of patients. Because physical symptoms that are common in cardiac patients, such as fatigue, loss of energy, changes in sleep patterns, and changes in appetite, overlap with somatic symptoms of depression,²³ we analyzed cognitive-affective and somatic symptoms of depression separately and found larger improvements for patients with low EF in both cognitive-affective and somatic symptoms compared to patients with preserved EF. Therefore, although we did not measure changes in physical symptoms after surgery, the greater effect of CBT in patients with low EF may not be explained by a potential difference in changes in physical symptoms after surgery between patients with and without low EF.

Although the mechanism of the greater effect of CBT in patients with low EF than in patients with preserved EF is yet to be determined in future research, this preliminary finding is particularly noteworthy in view of the results from previous studies, suggesting that cardiac patients with low EF and depressive symptoms are at particularly high risk of adverse outcomes.^{10,11} Following 883 cardiac surgery patients over one year, Kendel et al.¹⁰ found a moderating effect of EF on the relationship between depressive symptoms and physical functioning. While increased depressive symptoms predicted a decline in physical functioning after cardiac surgery, the effect of depression on postoperative physical functioning was greater in patients with low EF than in patients with preserved EF. In a study of 510 patients with heart failure, Johansson et al.¹¹ reported that patients with low EF and depressive symptoms had the highest risk for cardiovascular mortality compared to patients with low EF without depressive symptoms and patients with preserved EF and with and without depressive symptoms, controlling for other risk factors. Moreover, results from the study by Horne et al.²⁴ suggest that cardiac surgery patients with low EF are susceptible to persistent depression if proper treatment is not provided. In this study with 436 patients undergoing cardiac surgery, the investigators reported that among patients who were

depressed preoperatively, patients with low EF were more likely to remain depressed after surgery than patients with preserved EF. Based on these findings and our results demonstrating a greater effect of CBT on depressive symptoms in patients with low EF, treating depression with CBT may also contribute to preventing or minimizing adverse outcomes after cardiac surgery and may be especially beneficial for patients with low EF.

CBT is one of the frequently used psychological interventions to treat depressive symptoms in patients with heart disease.¹⁴ Although there are only a limited number of studies on the effect of CBT in cardiac surgery patients,¹⁵⁻¹⁷ CBT has been reported to be safe and equally effective to antidepressants in reducing depressive symptoms in medical patients.^{25,26} CBT has also been shown to produce longer-lasting improvement with low relapse rates than antidepressants and to enhance the efficacy of antidepressants in combination treatment.²⁷ Given the substantial evidence supporting the adverse effect of depression on short-term and long-term outcomes of cardiac surgery patients, such as recovery and survival after surgery,¹⁻⁷ patients undergoing cardiac surgery need screening and treatment for depression. While further research is needed to replicate these results, our findings provide preliminary evidence that nurse-led CBT may be an efficacious treatment for depressed patients after cardiac surgery, especially for those with low EF.

A few limitations of the present study should be noted. First, due to its small sample size, the generalizability of findings from this study is limited. Therefore, larger clinical trials of CBT in cardiac surgery patients are needed to confirm these findings. Especially, the findings need to be replicated in studies with a larger number of patients with low EF to establish the clinical significance of the observed greater effect of CBT in patients with low EF. Second, we measured depressive symptoms at baseline and the end of 8-weeks. Therefore, the long-term effect of CBT on depressive symptoms in patients with and without low EF needs to be determined in future research with a longer period of follow-up. Also, additional outcomes, including physical functioning and mortality, need to be assessed to determine whether the greater improvement in depressive symptoms among patients with low EF after CBT leads to improvement in these outcomes.

Conclusions

The present study provides evidence that nurse-guided CBT is effective in reducing depressive symptoms after cardiac surgery and is particularly effective in patients with low EF. While larger clinical trials are needed to confirm our findings, we suggest that patients undergoing cardiac surgery should be screened and treated for depression and that nurse-led CBT may be considered as a treatment option for depressed patients, particularly those with low EF, after cardiac surgery.

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Figure 1. Differences in the Beck Depression Inventory and subscale scores by treatment group and ejection fraction status, controlling for comorbidities

Table1

Demographics by Ejection Fraction Group

	Ejection Fraction		P-value
	Preserved EF ($\geq 40\%$) (n=64)	Low EF ($< 40\%$) (n=13)	
	<u>N (%)</u>	<u>N (%)</u>	
Female	20 (31.3%)	5 (38.5%)	.62
Non-Hispanic white	44 (68.8%)	8 (61.5%)	.61
> high school education	47 (74.6%)	11 (84.6%)	.44
Married or cohabitating	47 (73.4%)	7 (53.8%)	.16
Employed	23 (35.9%)	4 (30.8%)	.72
Non-elective surgery *	25 (39.7%)	9 (69.2%)	.05
Type of Surgery			
CABG	41 (64.1%)	11 (84.6%)	.49
AVR	11 (17.2%)	1 (7.7%)	
MVR	5 (7.8%)	0	
CABG & AVR/MVR	7 (10.9%)	1 (7.7%)	
Post-operative complications (yes)	33 (53.2%)	7 (58.3%)	.75
Type of depression – baseline			
Major	50 (78.1%)	10 (76.9%)	.92
Minor	14 (21.9%)	3 (23.1%)	
History of depression	21 (32.8%)	5 (38.5%)	.70
On antidepressants	24 (37.5%)	4 (30.8%)	.65
Past smoker	34 (54.0%)	9 (69.2%)	.31
	<u>Mean (SD)</u>	<u>Mean (SD)</u>	P-value
Age (years)	63.0 (9.8)	61.8 (10.3)	.47
Body Mass Index (kg/m ²)	31.0 (9.6)	29.4 (6.3)	.57
Charlson Comorbidity Index total score	3.6 (1.9)	5.3 (3.0)	.01
Hospital length of stay (days)	9.1 (5.5)	10.9 (5.9)	.29
Mini Mental Exam total score	27.5 (0.8)	27.5 (1.0)	.93
Number of grafts	2.2 (1.4)	2.4 (1.2)	.70
Pump time (min)	100.4 (56.3)	97.7 (54.7)	.87

	Ejection Fraction		
	Preserved EF ($\geq 40\%$) (n=64)	Low EF ($< 40\%$) (n=13)	
Cross clamp time (min)	76.9 (55.8)	71.5 (40.3)	.75
Baseline total BDI score	15.8 (9.2)	17.8 (9.1)	.46
Cognitive-affective subscale score	6.6 (6.0)	9.2 (6.4)	.16
Somatic subscale score	8.1 (4.1)	8.6 (4.6)	.70

* Non-elective surgery = urgent (≤ 48 hours of catheterization) or emergent (≤ 24 hours of catheterization)

EF = ejection fraction; CABG = coronary artery bypass grafting; AVR = aortic valve replacement/repair; MVR = mitral valve replacement/repair;
BDI = Beck Depression Inventory