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Anxiety, depression, and healthcare utilization 1 year after cardiac surgery

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ABSTRACT

Background: While it is known that depression and anxiety influence cardiac surgery recovery, the mechanisms of such remain unclear. We examined the influence of anxiety and/or depression on health care utilization and quality of life (QOL) in the 12 months following cardiac surgery.

Methods: (N = 306) patients at two North Texas hospitals were assessed pre-operatively, at 30 days, and one year post-operatively using the Hospital Anxiety and Depression Scale and Kansas City Cardiomyopathy Quality of Life measures. Patient healthcare utilization metrics included length of stay, outpatient visits, hospital stays, emergency department (ED) visits, and home healthcare.

Results: At 12 months post-surgery, anxious patients sustained more outpatient visits ($p = 0.0129$) than those without anxiety. Depressed patients differed significantly from non-depressed patients with significantly lower QOL ($p < 0.01$), as well as more readmissions, ED visits, home healthcare use, and a longer length of stay (all $p < 0.05$).

Conclusions: Depressed patients utilized more expensive healthcare services and had lower QOL at 12 months follow up compared to non-depressed patients. Targeting depressed patients for intervention may foster a faster recovery and reduce excessive healthcare burden.

Introduction

Negative psychological factors such as depression and anxiety, along with positive psychological constructs like resilience have substantial effects on disease progression, maintenance, and outcomes in a variety of medical conditions and procedures.[1–3] In patients with cardiovascular disease, positive affect and optimism were found to be the strongest predictors of reduced all-cause readmission rates after 60 days when compared to other factors such as health status at discharge and length of inpatient stay.[4]

Research has also shown that 34% of cardiac patients report depressive symptoms and 55% report anxiety prior to surgery.[5] Although links between depression, anxiety, and cardiovascular surgical outcomes have been studied, the results are inconsistent.[5,6]

Tully et al. found no association between preoperative depressive symptoms and increased risk of mortality, yet found a significant association between preoperative anxiety and decreased survival following Coronary Artery Bypass Grafting (CABG) surgery.[7] Conversely, a study at Duke University found a strong link between depression and 6-month mortality following CABG surgery.[8] Another study showed that pre-operative generalized anxiety disorder, but not clinical depression, predicted major adverse cardiovascular and cerebrovascular events following CABG.[9]

Despite an increasing body of knowledge on health outcomes following cardiac surgery, very little is known about how cardiovascular surgery patients with depression and/or anxiety utilize available healthcare options. Understanding how these populations

Abbreviations: QOL, Quality of life; STS-ACSD, Society of Thoracic Surgeons Adult Cardiac Surgery Database; PROM, Predicted risk of mortality; HADS, Hospital Anxiety and Depression Scale; KCCQ, Kansas City Cardiomyopathy Questionnaire.

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behave following surgery will provide more insight into the differences observed in patient health outcomes. Researchers cite the need for continued research to further understand whether depression and anxiety play a role in the morbidity and mortality of patients undergoing cardiovascular surgery[5,6,10]. As depressed patients with medical conditions, such as diabetes and heart failure, have previously been shown to differ with respect to healthcare utilization from their non-depressed counterparts,[11,12] it is possible that these same differences exist is cardiovascular surgical patients. The same may be true for anxious patients. Identifying these correlations may allow for altered pre-surgical care to enhance recovery.

Despite an increasing body of knowledge on health outcomes following cardiac surgery, very little is known about how cardiovascular surgery patients with depression and/or anxiety utilize available healthcare options. Understanding how these populations behave following surgery will provide more insight into the differences observed in patient health outcomes. To this end, we sought to determine if patients with anxiety or depression differ in a variety of healthcare utilization behaviors as well as quality of life (QOL) ratings following cardiovascular surgery. Our hypothesis was that there may be factors associated with anxiety or depression which adversely influence healthcare utilization and QOL, and that by identifying these factors we may be able to modify the care plan to mitigate against their negative influence.

Methods

Participants

In a protocol approved by the Institutional Review Board of Baylor Scott & White Research Institute (Dallas, Texas), 400 patients scheduled for cardiovascular surgery (including: CABG, Aortic Valve Replacement (AVR), and Mitral Valve Replacement (MVR)) at two hospitals in the Dallas area (Baylor University Medical Center at Dallas and The Heart Hospital Baylor Plano) were enrolled during a pre-surgical visit. Consenting patients completed five survey tools, along with a demographic and clinical questionnaire within 72 h prior to surgery. Using the Society for Thoracic Surgeons (STS) Adult Cardiac Surgery Database (ACSD), baseline demographics, pertinent medical history, procedural data including any complications were captured concurrently during the hospital stay and the one month post-op visit. The STS ACSD also allows for calculation of a Predicted Risk of Mortality (PROM) for the seven most common surgical procedures and it was calculated and recorded pre-operatively. For those patients for whom no PROM was available, the closest available score was calculated (e.g. MVR substituted for double valve replacement).

Prior to surgery, participants were asked to rate their health on a 5 point Likert scale (e.g. poor to very good) and provide information regarding their current insurance status (i.e. payor type). The Multidimensional Scale of Perceived Social Support (MSPSS) was administered to provide a gauge of their current level of social support with higher scores reflecting higher levels of support.[13] The MSPSS has previously shown to have good internal reliability as well as strong factorial and subscale validity.[14]

Patients completed one-month (±7 days) and one-year (±14 days) follow-up questionnaires via online survey collection tools (Snap Survey Software) or via telephone with a clinical research associate. A total of 306 patients completed the baseline, 1-month, and 12 month health care utilization questionnaires and were available for analysis. QOL analysis was available for 303 participants.

Assessment of anxiety and depression

The Hospital Anxiety and Depression Scale (HADS) is a self-report questionnaire consisting of 14 items scored on a 4-point Likert-type scale to ascertain the occurrence of anxiety (HADS-A), depression (HADS-D), and co-occurring anxiety with depression (HADS-A/D) over the preceding two weeks[15,16] The instrument and its subscales have good internal consistency and scale reliability, and have been validated in various populations[15,17,18] including cardiovascular patients.[19] The HADS was designed for use in a hospital setting, focuses on cognitive and psychological symptoms of anxiety and depression as opposed to somatic symptomology,[16] and has been previously used in cardiovascular patients.[20,21] The subscale structure of the HADS tool has been confirmed by a number of studies, and specifies that scores >8 on either the HADS-A subscale or the HADS-D subscale provide a balance between sensitivity and specificity for anxiety and depression, respectively.[15,16] Scores of 0–7 are considered Normal, 8–10 Borderline, and 11 or more as categorized as Clinical Caseness.

Assessment of healthcare utilization

At the 1-month and 12 month follow-up visits, study participants were asked to recall utilization of individual health services in the 30 days (±7 days) and one year (±14 days), respectively, since discharge from the hospital following their cardiovascular surgery. Post-operative length of stay was calculated as number of days from index cardiovascular surgery to the date of discharge from the hospital. Overnight visits, emergency visits, and home healthcare were considered “expensive” utilization as they consume healthcare dollars. Reasons for ED visits, as well as visit diagnoses, were not recorded. Outpatient visits were considered “inexpensive” as they are brief and often are included in the global surgical fee with no additional charges incurred. Fig. 1 (see appendix A) displays the questions patients were asked along with response options to ascertain usage of health care services.

Assessment of quality of life

The Kansas City Cardiomyopathy Questionnaire (KCCQ) was assessed at baseline and 1-year follow up. Its scale ranges from 0 to 100, with higher scores reflecting better QOL. In addition to an overall score, the KCCQ provides subscale scores for the domains of Physical Limitation, Symptom Stability, Self-Efficacy, QOL, Social Limitation, and Clinical Summary. Past research has demonstrated that the KCCQ is a reliable and valid self-report instrument for assessing chronic disease specific QOL associated with chronic heart failure (which encompasses the metric of “days alive and out of facility”).[22,23]

Data analysis

The results were summarized using basic descriptive statistics (mean and standard deviation or median and interquartile range for continuous variables, and counts and percentages for categorical variables). Each utilization outcome was summarized as a binary indicator for at least one occurrence during the follow-up period. Additionally, outpatient visits were also summarized using the frequency of visits and a binary indicator for more than one visit. This was not done for other utilization outcomes due to the majority of participants having no utilization of the given service.

Multivariable regression was used to analyze the association of anxiety and depression with each outcome. Models were run for each outcome individually and with HADS results. First, only the anxiety scale was considered and patients with a score of eight or

higher were compared to patients with a score of less than eight. Similarly, the second set of analyses only considered the depression scale, using the same cutoff. For length of stay, generalized linear models with a negative binomial distribution and log link function were used for analysis. For count of outpatient visits, generalized linear models with a Poisson distribution and log link function were used, and for all other binary outcomes logistic regression was used. General linear models were used for each domain of the KCCQ at baseline, 1 month, and at 12 month follow-up. KCCQ models at 12 months were additionally adjusted for the corresponding scores at baseline. All models were adjusted for age, gender, race, marital status, education, insurance status, perceived social support, STS ACSD PROM, self-rated health, and type of surgery. Analyses were completed using SAS 9.4.[24] The significance level was set at 0.05.

Table 2
Hospital anxiety depression scale (pre-operative).

Results	Mean (SD) or Frequency (%)
Anxiety Scale	5.8 (4.3)
Normal	213 (69.6%)
Borderline	51 (16.7%)
Clinical Caseness	42 (13.7%)
Depression Scale	3.7 (3.1)
Normal	264 (86.3%)
Borderline	33 (10.8%)
Clinical Caseness	9 (2.9%)
Combined	
Normal	196 (64.1%)
Anxiety Only	68 (22.2%)
Depression Only	17 (5.6%)
Anxiety and Depression	25 (8.2%)

Results

Baseline summary

Patient characteristics are summarized in Table 1. The average age of study participants was 66 years with the majority being male (65%) and of white race (90%). Sixty-one percent rated their health as either good or very good. The most commonly performed procedure was isolated CABG (33%) followed by AVR with or without additional procedure (21%). Sixty-four percent of participants showed normal level of hospital anxiety and depression. 30% showed elevated levels (borderline or worse) of anxiety, and 14% showed elevated levels of depression (Table 2). 8% of participants showed higher than normal levels for both anxiety and depression. In patients who reported postoperative depression, depression rates decreased with about 71% having no depressive symptoms one month postoperatively and 74% having no depressive symptoms one year postoperatively. 97% of patients with no depressive symptoms at baseline continued to have no symptoms at 12 months. Similarly, 91% of patients with no anxiety symptoms at baseline continued to display no symptoms at 12 months.

Healthcare utilization summary

The median length of postoperative stay was 7 days with an interquartile range of 6–9 days. The median number of outpatient visits was 5 with an interquartile range of 3–8 visits. 281 participants (82%) had at least 1 visit and 148 (46%) had more than 1 visit. At least 1 overnight hospital stay was reported by 66 (22%)

Table 1
Demographics and clinical information.

Characteristic	Mean (SD) or Frequency (%)
Age	65.5 (11.2)
Sex:	
Male	201 (65.7%)
Female	105 (34.3%)
Race:	
White	275 (89.9%)
Black/African American	19 (6.2%)
Other/Unknown	12 (3.9%)
Marital Status	
Married/Living with Partner	237 (77.5%)
Single	69 (22.5%)
Education:	
No High School Diploma/GED	22 (7.24%)
High School Diploma/GED	62 (20.3%)
Some College/Associate's Degree	111 (36.3%)
Bachelor's Degree	61 (19.9%)
Graduate Degree	50 (16.3%)
Insurance:	
Public Insurance: Medicare, Medicaid, Champus	117 (38.2%)
Private/Employer Sponsored	173 (56.5%)
Self-Pay/Other/Unknown	16 (5.2%)
Self-rated health:	
Very Good	55 (18.0%)
Good	131 (42.8%)
Average	41 (13.4%)
Fair	35 (11.4%)
Poor	44 (14.4%)
Perceived Social Support Assessment	77.3 (7.8)
STS Score (n = 282)	1.8 (1.7)
Surgery Type	
AVR ± Other Procedure	65 (21.2%)
Isolated CABG	100 (32.7%)
CABG/Valve ± Maze	37 (12.1%)
MVR, MVRp, +/-Maze, +/− any revision	71 (23.2%)
Other/Not Listed	33 (10.8%)

Table 3
Health Care Utilization by Anxiety Symptoms within 12 months post cardiovascular surgery.

Utilization	No Anxiety (n = 213)	Anxiety Symptoms (n = 93)	Adjusted Risk/Odds Ratio (95% CI)*	Adjusted p-value**
Length of Stay at baseline (days)	7 (6, 8)	8 (6, 9)	1.09 (0.96, 1.24)	0.1689
Outpatient visit count (Median, Q1,Q3)	4 (3, 7)	5 (3, 9)	1.14 (1.03, 1.27)	**0.0136**
Overnight Hospital stay (n, %)	42 (19.7%)	24 (25.8%)	1.24 (0.65, 2.36)	0.5056
Emergency department visit (n, %)	61 (28.6%)	32 (34.4%)	1.29 (0.73, 2.30)	0.3841
Home healthcare (n, %)	39 (18.3%)	20 (21.5%)	1.31 (0.64, 2.72)	0.4617

*Risk ratios are calculated as the risk of one more day/visit count given anxiety relative to those without; Odds Ratios are calculated as the odds of the given outcome occurring given anxiety vs. no anxiety.
**All models adjusted for age, gender, race, marital status, education, insurance, perceived social support, STS score, self-rated health, and type of surgery.

Table 4
Health Care Utilization by Depression Symptoms within 12 months post cardiovascular surgery.

Utilization	No Depression (n = 264)	Depression Symptoms (n = 42)	Adjusted Risk/Odds Ratio (95% CI)*	Adjusted p-value*
Length of Stay at baseline (days)	7 (6, 8)	8 (7, 9)	1.35 (1.15, 1.59)	**0.0003**
Outpatient visit count (Median, Q1,Q3)	5 (3, 8)	5 (3, 8)	0.87 (0.75, 1.00)	0.0538
Overnight Hospital stay (n, %)	51 (19.3%)	15 (35.7%)	2.41 (1.06, 5.46)	**0.0350**
Emergency department visit (n, %)	73 (27.7%)	20 (47.6%)	3.05 (1.42, 6.53)	**0.0041**
Home healthcare (n, %)	46 (17.4%)	13 (31%)	2.67 (1.11, 6.46)	**0.0289**

*Risk ratios are calculated as the risk of one more day/visit count given depression relative to those without; Odds Ratios are calculated as the odds of the given outcome occurring given depression vs. no depression.
**All models adjusted for age, gender, race, marital status, education, insurance, perceived social support, STS score, self-rated health, and type of surgery.

participants, 93 (30%) reported at least one emergency department (ED) visit, and 59 (19%) reported using home healthcare.

Association of anxiety and depression with healthcare utilization

At one month post-surgery, anxious patients were not found to differ significantly from their non anxious counterparts with respect to any healthcare utilization habits. The same was true for depressed patients vs. non depressed patients.

At 12 months post-surgery, patients with anxiety symptoms had significantly more outpatient visits (OR = 1.14, $p = 0.0136$). There were no statistically significant associations with: length of stay, number of overnight hospital stays, ED visits, or home healthcare visits, all $p > 0.05$ (Table 3). However, elevated depressive symptoms were significantly associated with more ED visits (OR = 3.05), higher odds of home healthcare usage (OR = 2.67), readmissions (OR = 2.41), and a longer length of stay at baseline (OR = 1.35), all $p < 0.05$ (Table 4).

Quality of life

Changes in QOL scores for all patients from baseline to 12 months following surgery are reported in Table 5. Three patients were missing KCCQ scores at 12 month follow-up, so analysis only included n = 303. At baseline, anxious patients differed significantly from non-anxious patients in ratings of Physical Limitation, Total symptoms, QOL, Clinical Summary, as well as the Overall summary score, all *ps* < .05 (See Table 6). However, at 12 months, anxious patients differed from their non-anxious counterparts only on the physical limitation and clinical summary scores *ps* < .05. While anxiety was associated with a significant difference in QOL pre-op, this association was not present at 12 months.

At baseline, depressed patients showed significantly lower scores in the following subsections; Physical limitations, Total symptoms, QOL, Social Limitation, Clinical Summary, and Overall Summary *ps* < .05. In contrast to the improvement seen in anxious patients, at 12 months, depressed patients demonstrated lower scores in each of the aforementioned subsections *ps* < .05, indicating no improvement in QOL (See Table 7).

Discussion

Symptomatic anxiety and depression have been shown to influence healthcare utilization following cardiovascular surgery, albeit in different ways. The reason for these observed effects remains unclear. In this study, patients with anxiety were observed to have more outpatient visits compared to their non-anxious counterparts, perhaps to quell concern regarding their surgery recovery or resulting somatic complaints. Compared to patients without anxiety, anxious patients' utilization of expensive healthcare services (i.e. ED visits, overnight stays, and home health visits) was not significantly higher. Additionally, anxious patients did not have significantly lower QOL scores at 12 months compared to patients without anxiety.

In contrast, depressed patients displayed longer length of stay, 2.41 times greater odds of readmission, 3.05 greater odds of an ED

Table 5
KCCQ summary.

KCCQ Summary	Baseline Mean (StdDev)	12 Months Mean (StdDev)	Change Mean (StdDev)
Physical Limitation Score	72.2 (24.6)	84.7 (20.9)	12.6 (26.4)
Symptom Stability Score	44.4 (22.3)	54.6 (17.1)	10.2 (26.7)
Total Symptom Score	64.7 (22.7)	82.5 (18.3)	18.1 (21.5)
Self-Efficacy Score	86.6 (18.6)	91.5 (13.5)	5.1 (20.1)
Quality of Life Score	56.7 (25.8)	84.6 (20.8)	28.1 (25.6)
Social Limitation Score	68.7 (28.2)	86.5 (21.3)	18.1 (29.3)
Clinical Summary Score	68.2 (21.5)	83.5 (18)	15.5 (20.5)
Overall Summary Score	65.3 (21.5)	84.6 (17.7)	19.4 (20.5)

Table 6
KCCQ at 12 months by Anxiety Symptoms.

KCCQ at Baseline	No Anxiety (n = 210)	Anxiety Symptoms (n = 93)	Adjusted Beta (standard error)*	Adjusted p-value**
Physical Limitation Score	76 (23.5)	63.4 (25.1)	−7.0 (3.1)	**0.0238**
Symptom Stability Score	44.4 (22.7)	44.6 (21.4)	2.2 (3.1)	0.4652
Total Symptom Score	68.2 (22.3)	56.7 (21.6)	−5.6 (2.8)	**0.0404**
Self-Efficacy Score	88.4 (18.1)	82.2 (18.9)	−4.3 (2.4)	0.0785
Quality of Life Score	62.6 (23.2)	42.9 (26.4)	−13.5 (3.1)	< **.0001**
Social Limitation Score	71.7 (27.4)	61.2 (28.8)	−3.9 (3.6)	0.2744
Clinical Summary Score	71.9 (20.8)	59.6 (20.6)	−6.3 (2.5)	**0.0125**
Overall Summary Score	69.6 (20.2)	55.3 (21.1)	−7.9 (2.5)	**0.0014**
KCCQ at 12 Months				
Physical Limitation Score	88.2 (17.8)	77 (25)	−6.2 (2.7)	**0.0234**
Symptom Stability Score	54.9 (16.3)	53.8 (18.8)	−3.5 (2.4)	0.1414
Total Symptom Score	85.1 (16.2)	76.7 (21.4)	−3.6 (2.2)	0.1051
Self-Efficacy Score	92.9 (11.5)	88.6 (16.9)	−1.0 (1.7)	0.5843
Quality of Life Score	88.1 (17.5)	76.6 (25.2)	−2.9 (2.6)	0.2692
Social Limitation Score	89.6 (18.7)	79.3 (24.8)	−4.5 (2.8)	0.1083
Clinical Summary Score	86.4 (15.7)	76.9 (21.1)	−4.5 (2.2)	**0.0402**
Overall Summary Score	87.6 (14.9)	77.6 (21.3)	−3.6 (2.2)	0.0971

*Beta coefficients are calculated as the average difference in KCCQ score at 12 months for patients with anxiety relative to those without.
**All models adjusted age, gender, race, marital status, education, insurance, perceived social support, STS score, self-rated health, and type of surgery. Models at 12 months also adjusted for KCCQ score at baseline.

visit, and 2.67 times greater odds of home health utilization as their non-depressed counterparts. A nearly significant result was observed regarding depressed patients attending less outpatient visits, $p = .0538$. Such expensive services will likely result in hospitals sustaining monetary penalties under increasingly prevalent bundled care payment plans. Further, at 12 months, depressed patients reported lower QOL than patients who were not depressed. Thus, the presence of depression in cardiac surgery patients presents a very serious finding for clinicians. In sum, depressed patients use more services, potentially cause reimbursement penalties, and have a lower QOL at 12 months post-surgery.

Depressed patients may be less likely to seek healthcare if they experience impairing symptoms, such as psychomotor retardation or avolition. Depressed patients who hold their health, and more broadly, themselves, in lower regard may be less likely to initiate or adhere to follow-up appointments. The extra days spent in the hospital could possibly contribute in some manner to the lower QOL in depressed patients, or it may be that the depression itself causes decreased QOL.

Regardless of whether patients' anxiety and depressive symptom ratings were longstanding or were in anticipation of the upcoming surgery, the association between elevated symptom ratings and healthcare utilization habits raises genuine concerns. Prior research has demonstrated that greater psychological distress is associated with increased risk of stroke and myocardial infarction[25] whereas preoperative anxiety is associated with a more complicated and prolonged postoperative recovery.[26] Doering and colleagues have also shown that depressive symptoms in patients following CABG surgery were associated with negative health outcomes such as infections, impaired wound healing, and poor emotional and physical recovery.[27] Additionally, past research indicates that pre-operative depression, but not anxiety, predicts poor health-related quality of life (QOL) at 6-months following cardiovascular surgery[28] and has been linked with increased length of stay.[29] Our study builds upon this research, with the added component of demonstrating poorer QOL findings even at 12 months following surgery.

The findings of the present study highlight the need to identify and treat depressed patients following cardiovascular surgery. We

Table 7
KCCQ by depression symptoms.

KCCQ at Baseline	No Depression (n = 261)	Depression Symptoms (n = 42)	Adjusted Beta (standard error)*	Adjusted p-value*
Physical Limitation Score	74.5 (22.5)	56.8 (32.1)	−11.2 (4.1)	**0.0064**
Symptom Stability Score	44.9 (21.3)	41.7 (28)	−3.3 (4)	0.4126
Total Symptom Score	66.9 (21.7)	50.5 (24.2)	−7.1 (3.6)	**0.0487**
Self-Efficacy Score	87.3 (18.2)	81.7 (20.4)	−2.7 (3.2)	0.3930
Quality of Life Score	59.8 (24.3)	36.8 (27)	−12.9 (4.2)	**0.0019**
Social Limitation Score	71.6 (25.7)	49.8 (35.6)	−12.5 (4.6)	**0.0065**
Clinical Summary Score	70.6 (20.1)	53 (23.5)	−9.6 (3.3)	**0.0036**
Overall Summary Score	68.1 (19.7)	47.7 (24.1)	−11.5 (3.2)	**0.0003**
KCCQ at 12 months				
Physical Limitation Score	87.6 (17.7)	66.9 (28.7)	−14.1 (3.5)	< **0.0001**
Symptom Stability Score	54.3 (17.1)	56 (17.3)	−1.0 (3.1)	0.7406
Total Symptom Score	84.7 (16.5)	68.9 (22.8)	−11.3 (2.8)	< **0.0001**
Self-Efficacy Score	92.5 (11.7)	85.4 (20.6)	−1.9 (2.3)	0.4113
Quality of Life Score	87.7 (17.5)	64.9 (28)	−13.2 (3.3)	< **0.0001**
Social Limitation Score	89.8 (17.9)	66.8 (28.4)	−13.7 (3.6)	**0.0001**
Clinical Summary Score	86 (15.6)	67.9 (23.5)	−12.4 (2.8)	< **0.0001**
Overall Summary Score	87.4 (14.8)	67 (23.3)	−13.3 (2.8)	< **0.0001**

*Beta coefficients are calculated as the average difference in KCCQ score at 12 months for patients with depression relative to those without.
**All models adjusted for age, gender, race, marital status, education, insurance, perceived social support, STS score, self-rated health, and type of surgery. Models at 12 months also adjusted for KCCQ score at baseline.

do not recommend that surgeries be denied or delayed based on anxiety or depression status. Rather, we recommend efforts geared towards identification and implementation of brief interventions for vulnerable patients. Recent efforts by Howe-Martin and colleagues have established the feasibility of identifying depressed patients in primary care settings and initiating targeted care.[30] Regarding interventions, Behavioral Activation is a first-line treatment for depression[31] that is uncomplicated and brief enough to be delivered in hospitals or via the internet.[32] Prior efforts have also identified that a brief cognitive behavioral intervention for patients undergoing CABG surgery led to improved depressive and anxiety symptoms, as well as improved QOL.[33] Clinicians and researchers alike could extend these models to identify vulnerable pre-operative patients and tailor effective treatments to facilitate reductions in symptomatic distress, facilitate recovery, and improve QOL.

Despite their psychological distress, anxious patients did not have an increased length of stay or increased utilization of expensive healthcare services. They did have more outpatient visits and perhaps this mitigated against increased utilization of expensive services. Perhaps there is a lesson here for the treatment of depressed patients. Increased and earlier contact with healthcare providers via more outpatient visits might mitigate against depressed patients' increased ED visits, readmissions, and home health usage despite the burden of their adverse psychological state. Given the tremendous cost society faces with regards to excessive healthcare utilization, identifying depressed patients and initiating treatment prior to surgery may lead to a facilitated recovery, lessened demand for expensive healthcare services, and improve QOL.

Our study has limitations including potential for selection bias in those who 1) chose to participate in our study and 2) completed our follow-up questionnaires (loss to follow-up rate = 94/400; 23.5%). Since we do not have information on those who declined study participation, we are unable to ascertain if there are differential effects of those who chose to enroll versus those who did not. Second, the sample used was predominantly white and male, while this study was conducted at two urban hospitals which were nested inside communities that have largely different demographic make-ups. As such, an imbalance was observed between both samples with respect to race and SES which may influence these results' generalizability. Finally, anxiety and depression symptom ratings were collected just prior to surgery (e.g. 72 h) and may not accurately reflect trait anxiety or depression. Measures of mood, including anxiety and depression, may be influenced by acute feelings of anticipation leading up to a surgical procedure. Patients may have overestimated pre-operative anxiety, depression, and co-occurring anxiety with depression. Information on pre-existing anxiety and depression, including use of psychiatric medications, was not gathered, and thus future research could benefit from examining psychiatric histories to gauge differences between longstanding and acute distress.

Conclusions

The presence of both pre-surgical anxiety and depression was found to influence patients' healthcare utilization habits following cardiac surgery, however depressed patients utilized more expensive healthcare services and had lower QOL at 12 months follow up compared to non-depressed patients. These results hold important lessons for clinicians both is patient selection and in pre-operative intervention. Our findings suggest the importance of identifying depressed patients pre-operatively and initiating treatment, as such efforts may result in both increased QOL and decreased healthcare utilization. For researchers, further work needs to be done to validate that such interventions are efficacious as well as investigate such interventions in different surgical populations. Finally, we show that those patients who are achieving the less than desired results are doing so at the greatest expenditure of post-discharge resources. This holds implications for healthcare financing and further efforts to arrive at the most efficacious treatment strategies are needed.

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Appendix A

Fig. 1
Healthcare Utilization Service Questionnaire

Healthcare Utilization Metric	Questions and response options
Outpatient visits:	"Since you left the hospital following your surgical procedure, have you seen a doctor or other health care professional about your own health at **a doctor's office, a clinic, or some other place**?" (Yes/No/Unsure) "If yes, how many times have you seen a doctor or other health care professional about your own health at **a doctor's office, a clinic, or some other place?** *Do not include times you were hospitalized overnight, visits to hospital emergency rooms, home visits, or telephone calls.*" (number of visits)
Overnight hospital stays:	"Since you left the hospital following your surgical procedure, have you **stayed overnight in a hospital** due to your own health?" (Yes/No/Unsure) "If yes, how many times have you **stayed overnight in a hospital** due to your own health?" (number of overnight stays)
Emergency visits:	"Since you left the hospital following your surgical procedure, have you gone to **an emergency department/room** about your own health?" (Yes/No/Unsure) "If yes, how many times have you gone to **an emergency department/room** about your own health?" (number of visits)
Home healthcare:	"Since you left the hospital following your surgical procedure, have you had any **home visits** by a health care professional (physician, nurse, medical assistant)? (Yes/No/Unsure)

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