Original Investigation

Collaborative Care for Depression and Anxiety Disorders in Patients With Recent Cardiac Events
The Management of Sadness and Anxiety in Cardiology (MOSAIC) Randomized Clinical Trial

Jeff C. Huffman, MD; Carol A. Mastromauro, LICSW; Scott R. Beach, MD; Christopher M. Celano, MD; Christina M. DuBois, BA; Brian C. Healy, PhD; Laura Suarez, MD; Bruce L. Rollman, MD; James L. Januzzi, MD

IMPORTANCE Depression and anxiety are associated with adverse cardiovascular outcomes in patients with recent acute cardiac events. There has been minimal study of collaborative care (CC) management models for mental health disorders in high-risk cardiac inpatients, and no prior CC intervention has simultaneously managed depression and anxiety disorders.

OBJECTIVE To determine the impact of a low-intensity CC intervention for depression, generalized anxiety disorder, and panic disorder among patients hospitalized for an acute cardiac illness.

DESIGN, SETTING, AND PARTICIPANTS Single-blind randomized clinical trial, with study assessors blind to group assignment, from September 2010 through July 2013 of 183 patients admitted to inpatient cardiac units in an urban academic general hospital for acute coronary syndrome, arrhythmia, or heart failure and found to have clinical depression, generalized anxiety disorder, or panic disorder on structured assessment.

INTERVENTIONS Participants were randomized to 24 weeks of a low-intensity telephone-based multicomponent CC intervention targeting depression and anxiety disorders (n = 92) or to enhanced usual care (serial notification of primary medical providers; n = 91). The CC intervention used a social work care manager to coordinate assessment and stepped care of psychiatric conditions and to provide support and therapeutic interventions as appropriate.

MAIN OUTCOMES AND MEASURES Improvement in mental health–related quality of life (Short Form-12 Mental Component Score [SF-12 MCS]) at 24 weeks, compared between groups using a random-effects model in an intent-to-treat analysis.

RESULTS Patients randomized to CC had significantly greater estimated mean improvements in SF-12 MCS at 24 weeks (11.21 points [from 34.21 to 45.42] in the CC group vs 5.53 points [from 36.30 to 41.83] in the control group; estimated mean difference, 5.68 points [95% CI, 2.14-9.22]; P = .002; effect size, 0.61). Patients receiving CC also had significant improvements in depressive and general functioning, and higher rates of treatment of a mental health disorder; anxiety scores, rates of disorder response, and adherence did not differ between groups.

CONCLUSIONS AND RELEVANCE A novel telephone-based, low-intensity model to concurrently manage cardiac patients with depression and/or anxiety disorders was effective for improving mental health–related quality of life in a 24-week trial.

TRIAL REGISTRATION clinicaltrials.gov Identifier: NCT01201967

Published online April 14, 2014.

Author Affiliations: Harvard Medical School, Boston, Massachusetts (Huffman, Mastromauro, Beach, Celano, DuBois, Healy, Suarez, Januzzi); Department of Psychiatry, Massachusetts General Hospital, Boston (Huffman, Mastromauro, Beach, Celano, DuBois, Suarez); Biostatistics Center, Massachusetts General Hospital, Boston (Healy); Division of General Internal Medicine, Department of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania (Rollman); Division of Cardiology, Department of Medicine, Massachusetts General Hospital, Boston (Januzzi).

Corresponding Author: Jeff C. Huffman, MD, Massachusetts General Hospital/Blake 11, 55 Fruit St, Boston, MA 02114 (jhuffman@partners.org).
Depression following acute cardiac conditions is common and independently associated with mortality over the following year. Generalized anxiety disorder (GAD) and panic disorder (PD) also occur at higher rates in patients with heart conditions than in the general population and have been linked with adverse cardiac outcomes, often independent of depression. Furthermore, comorbid depression and anxiety in patients with heart conditions may magnify risk of adverse outcomes, compared with either condition alone.

Depression and anxiety are also important determinants of health-related quality of life (HRQoL), an important clinical outcome that encompasses pain, energy, well-being, psychological distress, and functional status. Depression is prospectively associated with lower HRQoL in patients with heart failure and following myocardial infarction, and anxiety has been linked to subsequent decline of HRQoL in patients with arrhythmias. Conversely, reduction of depressive symptoms in antidepressant trials has led to improvement of HRQoL in patients with acute and chronic heart conditions.

Collaborative care (CC) models for mental health conditions use nonphysician care managers (CMs) to systematically identify disorders, perform longitudinal assessments, and coordinate stepped treatment recommendations between mental health specialists and primary medical providers. Collaborative care and related care management interventions for depression have improved treatment and outcomes in a variety of populations, including patients with heart disease; these positive effects include significant improvements of mental HRQoL in prior CC depression trials among patients with recent cardiac surgery and acute cardiac illness.

Although these models are effective and cost-effective in research settings and have been successfully implemented clinically, such implementation can be a challenge. Clinical implementation of CC models typically requires the use of local resources and “champions,” substantial staff training, and intensive interventions, many of which occur in person. These models may be suboptimal when resources are scarce, staff availability is limited, or in-person interventions are less feasible (e.g., in older populations or rural areas). Evaluation of more streamlined, lower-resource, and more centralized interventions is therefore indicated.

Furthermore, there has been minimal use of CC interventions among patients hospitalized for heart conditions despite the fact that such patients appear to be at the highest risk of adverse cardiac events in the context of psychiatric symptoms. Finally, to our knowledge, CC models have never been used to simultaneously manage depression and anxiety disorders, despite their high comorbidity; such a model may be particularly useful in patients with heart disease given the independent (and possibly additive) association of depression and anxiety disorders with adverse cardiac events.

The Management of Sadness and Anxiety in Cardiology (MOSAIC) study was designed to evaluate the feasibility and efficacy of a 24-week telephone-based CC intervention that identified and managed depression, GAD, and PD among a broad cohort of patients hospitalized for cardiac illnesses. We hypothesized that this approach would lead to significantly greater improvement in mental HRQoL at 24 weeks, measured using the Medical Outcomes Study Short Form-12 Mental Component Score (SF-12 MCS), compared with enhanced usual care (UC). We also aimed to explore the CC intervention’s effects on psychiatric symptoms, adherence, general functioning, other aspects of HRQoL, and cardiac rehospitalizations.

Methods
Setting and Study Participants
Briefly, this was a pragmatic single-blind randomized clinical trial of a 24-week CC intervention for depression, PD, and GAD that enrolled patients admitted for acute cardiac illness between September 2010 and December 2012 (with follow-up until July 2013) to 1 of 3 cardiac units at an urban academic medical center. The enrollment goal was 180 patients. Approval was obtained from the Partners Healthcare institutional review board prior to commencement of study procedures. Written informed consent was obtained by a study investigator. Detailed information about study design, diagnostic criteria, and methods is described elsewhere.

Eligibility criteria for MOSAIC were as follows: (1) age at randomization of at least 18 years; (2) fluency in English; (3) hospitalization for a primary diagnosis of acute coronary syndrome, heart failure, or arrhythmia, confirmed using established criteria; and (4) diagnosis of clinical depression, GAD, and/or PD. To identify patients with depression or anxiety disorders, a study CM completed screening with a 5-item tool that combined the Patient Health Questionnaire-2 (PHQ-2), Generalized Anxiety Disorder-2 (GAD-2), and an item about panic attacks from the Depression and Anxiety Detector for primary care patients. Patients who answered affirmatively to 1 or more items were administered the Patient Health Questionnaire-9 (PHQ-9) for clinical depression and the Primary Care Evaluation of Mental Disorders anxiety modules for PD and GAD.

As in our prior trial in patients hospitalized for cardiac conditions, clinical depression was defined as a PHQ-9 score of at least 10, with 5 or more symptoms—including either depressed mood or anhedonia—present for more than half the days over the prior 2 weeks. This definition parallels the diagnostic criteria for major depression substantially more closely than a simple cutoff score that might be elevated solely through somatic symptoms; still, not all patients with clinical depression may have met full major depression criteria diagnosed through a structured clinical interview.

Patients were excluded if they (1) had a medical condition likely to be terminal within 24 weeks; (2) had cognitive disturbance that precluded informed consent or meaningful participation, assessed using a formal 6-item cognitive screen; or (3) met psychiatric exclusion criteria (bipolar disorder, psychotic symptoms, active suicidal ideation, or active and problematic substance use), measured via structured assessments.
For patients meeting study criteria, baseline study outcome measures were completed prior to randomization. Participants were randomized to CC or UC using a computerized random number generator with numbers placed in sealed envelopes into study binders.

**Treatment Groups**

The CC intervention was delivered by a part-time social work CM (C.A.M.) in concert with team psychiatrists (J.C.H., S.R.B., C.M.C.). Ongoing CC cases were discussed at weekly treatment team meetings using data fed into an electronic database. On the basis of their preference, patients in the CC group received recommendations (conveyed to their medical providers) for pharmacotherapy or telephone-delivered manualized cognitive behavioral therapy (CBT) specific to their condition.

For newly enrolled patients in the CC group, the CM consulted with the study psychiatrist to discuss the patient’s disorder, prior treatment, and treatment preferences; on the basis of these factors, the CM and psychiatrist created treatment recommendations. The CM met with participants in the hospital to provide education about depression and anxiety disorders and to review the treatment recommendations. The CM next informed both inpatient and outpatient clinicians (physician or nurse practitioner) about the proposed treatment recommendations and placed them in the inpatient medical record. Finally, if the patient chose psychotherapy, the CM reviewed the first chapter of a condition-specific CBT workbook together with the participant in the hospital.

After discharge, the CM scheduled a 15- to 30-minute follow-up telephone call within 2 weeks of discharge to assess symptoms, maintain engagement, and monitor for adherence. Additional telephone sessions between the CM and the patients in the CC group were scheduled at varying intervals depending on the treatment plan (eg, weekly CBT) and whether there were substantial persistent symptoms. Given the single, half-time social work CM allotted for this project, contacts were otherwise infrequent in this low-intensity, low-resource treatment model.

In enhanced UC, at enrollment, the CM informed the primary inpatient treatment team that the patient had a diagnosis of clinical depression and/or GAD and/or PD and that treatment can provide benefit. At each 6-week follow-up assessment, for patients who had a PHQ-9 score of at least 10 or Hospital Anxiety and Depression Scale–Anxiety Subscale (HADS-A) score of at least 8, a letter was sent to the patient’s primary treatment provider outlining their ongoing symptoms, resulting in up to 5 total contacts. Participants were free to obtain any mental health treatment they desired.

**Treatments**

For all patients in the CC group, selective serotonin reuptake inhibitors (SSRIs) were recommended as first-line pharmacotherapy, given their prior study and relative safety in patients with cardiovascular disease and because they are established as effective for depression, GAD, and PD. On the basis of prior research in patients with heart conditions, citalopram hydrobromide (until an August 2011 US Food and Drug Administration warning regarding prolongation of the heart rate–corrected QT interval) and sertraline hydrochloride were the default SSRI choices for participants. For patients taking an antidepressant at enrollment, a clinical decision was made by the study psychiatrist to increase the dose, switch to another agent, or augment. For patients who had GAD alone, buspirone hydrochloride was considered if patients did not wish to take an SSRI. In patients who had PD alone, high-potency benzodiazepines (eg, clonazepam) were also considered.

Regarding telephone-based CBT, the CM underwent specific training and certification and was supervised by study psychiatrists who had experience in providing CBT. A minimum threshold of 6 sessions (50 minutes; weekly or every other week) was set for all patients choosing CBT, with additional sessions provided based on symptoms, patient choice, and study team consensus. The patient workbooks were selected because they used CBT principles and, in the case of the anxiety workbooks, were used in similar CC programs.

For patients with a PHQ-9 score of at least 10 or a HADS-A score of at least 8 at follow-up assessments, recommendations for adjustments in treatment were made serially until response was achieved. Such adjustments could include increase in medication dose, change of medication, addition of medication or therapy to the other modality, and/or continuation of CBT beyond 6 sessions. When the psychiatrist recommended medication changes, the CM discussed these with the primary medical provider and faxed a recommendation letter from the study psychiatrist. Patients could also be referred to an outside mental health specialist if they desired.

**Data Collection**

Baseline sociodemographic and medical data were collected from the electronic medical record by blinded study staff and from patients prior to randomization. To assess adequate treatment of disorders by discharge, blinded staff reviewed patient reports of psychiatric treatment and the electronic medical record (for therapy referrals and medications at admission and/or discharge). Longitudinal postdischarge outcome assessments were completed by telephone by staff blinded to study condition every 6 weeks for the 24-week study duration. Cardiac readmissions were assessed through patient report, contact with primary medical providers, and review of the health care system’s electronic medical records. Determination of cardiac (vs noncardiac) cause for readmission, when unclear, was adjudicated by the study cardiologist (J.L.J.), who was blinded to participants’ group assignment.

**Study Outcomes**

**In-Hospital Outcome Measure: Adequate Treatment of Mental Health Disorder by Discharge**

Adequate treatment was defined as a prescription for a standard dose of an established first-line treatment for depression and/or GAD and/or PD or referral to evidence-based psychotherapy (either via outside mental health provider or CBT workbook in the CC arm). For patients admitted while already taking first-line pharmacotherapy at a stable dose (or in evidence-based psychotherapy) for at least 4 weeks but
who met the criteria for the disorder at hospital admission, adequate treatment required dose increase, augmentation, switch of agents, or addition of psychotherapy. At each follow-up time point, we also recorded rates of patients who had at least 1 adjustment (initiation or change) of treatment since enrollment.

Primary Study Outcome Measure: Mental HRQoL at 24 Weeks (Measured by SF-12 MCS)
We chose mental HRQoL as our primary outcome because it was the primary outcome for a major CC study of depression in patients with heart disease and because it incorporates multiple key clinical domains, including pain, energy, psychological distress, and function. Key secondary outcome measures included the PHQ-9 (main depression measure), HADS-A (main anxiety measure), and Duke Activity Status Index (DASI) (main functional measure).

Additional secondary measures included assessments of anxiety and/or depression treatment response (measured only in patients with those specific disorders), self-reported adherence to health behaviors (measured via Medical Outcomes Study Specific Adherence Scale items), physical HRQoL (SF-12 physical component score), overall HRQoL (EuroQol 5-Domain instrument [EQ5D] scores), and cardiac readmissions.

Statistical Analysis
We used an intent-to-treat model for all outcomes. For N = 180, the study was powered at greater than 80% to detect a clinically important difference (5 points) between groups in the primary study measure (change from baseline SF-12 MCS score) at 24 weeks.

For the in-hospital outcome (adequate treatment by discharge), we compared treatment rates in the CC and UC groups via χ² analysis. For longitudinal analyses, a random-effects regression model was used to examine between-group differences at 24 weeks. Sensitivity analyses (using random-effects models) were completed to examine the effect of the intervention on the primary outcome measure (SF-12 MCS) by sex; similar analyses were performed by psychiatric diagnosis (depression only, anxiety disorder only, or both) for all outcomes. Differences in the effect of treatment between sexes and across diagnostic groups were assessed using appropriate interaction terms in the random-effects model. Effect size on outcome measures was calculated by dividing the estimated mean difference (EMD) by the baseline standard deviation for the outcome measure.

A generalized estimating equations model with an exchangeable working covariance matrix was used to compare between-group differences in depression and/or anxiety response at 24 weeks among patients with those disorders using criteria for response (depression, 50% PHQ-9 reduction from baseline; anxiety, 40% HADS-A reduction) established in prior studies. Rates of cardiac readmissions over 24 weeks were compared via χ² tests. In exploratory analyses, time to readmission was compared using a log-rank test; for those who were readmitted, between-group differences in time to readmission were explored using a Wilcoxon rank sum test. All comparisons were 2-tailed, and P < .05 was considered statistically significant. With 10 secondary outcomes, a Bonferroni correction would result in using P < .005 to denote significance, so P values between .005 and .05 should be interpreted with caution. All analyses were performed using Stata software, version 11.0 (StataCorp).

Results
Study Participants
Among 223 patients who met all eligibility criteria, 183 (82%) enrolled (Figure 1). Overall, 133 patients met criteria for depression, 118 for GAD, and 19 for PD. Ninety-two participants were randomized to CC and 91 to UC. Baseline characteristics
and study outcome variables are listed in Table 1. Participants’ mean (SD) age was 60.5 (12.7) years, 53% were women, 90% were white, and admission diagnosis was evenly distributed across the 4 possible cardiac diagnoses. Follow-up data at 1 or more time points was available for 172 patients (94%).

**Intervention Implementation**

Among the 92 participants randomized to CC, during hospitalization 72 (78%) chose initiation or adjustment of psychiatric medication, 11 (12%) selected CBT, and 9 (10%) declined both. Over the 24-week intervention period, the median (maximum) number of contacts between the CM and the participant was 3 (14). After discharge, 32 patients had recommendations for additional pharmacotherapy adjustment, and 8 had addition of CBT or booster sessions. Three were referred to specialty mental health treatment.

**Primary Study Outcome**

Patients randomized to CC had significantly greater improvement in estimated mean SF-12 MCS score (11.21 [from 34.21 to 45.42]) in the CC group and 5.53 [from 36.30 to 41.83] in the UC group; EMD, 5.68 [95% CI, 2.14–9.22]; \( P = .002 \); effect size, 0.61 (Table 2). There was no significant difference of SF-12 MCS effect (\( P = .72 \)) between men (\( n = 86 \); EMD, 4.94 [95% CI, −0.42–9.82]) and women (\( n = 86 \); EMD, 5.90 [95% CI, 1.18–9.62]).

### Table 1. Baseline Sociodemographic and Clinical Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Usual Care (( n = 91 ))</th>
<th>Collaborative Care (( n = 92 ))</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic and psychosocial characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>60.1 (12.8)</td>
<td>60.9 (12.7)</td>
<td>60.5 (12.7)</td>
</tr>
<tr>
<td>Male sex</td>
<td>43 (47)</td>
<td>43 (47)</td>
<td>86 (47)</td>
</tr>
<tr>
<td>Married</td>
<td>39 (43)</td>
<td>50 (54)</td>
<td>89 (49)</td>
</tr>
<tr>
<td>White race</td>
<td>81 (89)</td>
<td>83 (90)</td>
<td>164 (90)</td>
</tr>
<tr>
<td>Employed</td>
<td>29 (32)</td>
<td>32 (35)</td>
<td>61 (33)</td>
</tr>
<tr>
<td>Living alone</td>
<td>29 (32)</td>
<td>24 (26)</td>
<td>53 (29)</td>
</tr>
<tr>
<td><strong>Medical history</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertension</td>
<td>63 (69)</td>
<td>61 (66)</td>
<td>124 (68)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>31 (34)</td>
<td>32 (35)</td>
<td>63 (34)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>62 (68)</td>
<td>58 (63)</td>
<td>120 (66)</td>
</tr>
<tr>
<td>Current smoking</td>
<td>17 (19)</td>
<td>25 (27)</td>
<td>42 (23)</td>
</tr>
<tr>
<td>Prior MI</td>
<td>21 (23)</td>
<td>18 (20)</td>
<td>39 (21)</td>
</tr>
<tr>
<td>Peripheral arterial disease</td>
<td>4 (4)</td>
<td>6 (7)</td>
<td>10 (5)</td>
</tr>
<tr>
<td>Prior depression</td>
<td>44 (48)</td>
<td>35 (38)</td>
<td>79 (43)</td>
</tr>
<tr>
<td>Depression symptoms &gt; 1 mo(^b)</td>
<td>59 (94)</td>
<td>65 (93)</td>
<td>124 (93)</td>
</tr>
<tr>
<td>GAD symptoms &gt; 1 y(^c)</td>
<td>28 (45)</td>
<td>34 (61)</td>
<td>62 (53)</td>
</tr>
<tr>
<td>Antidepressant use at admission</td>
<td>38 (42)</td>
<td>42 (46)</td>
<td>80 (44)</td>
</tr>
<tr>
<td>Anxiolytic use at admission</td>
<td>35 (39)</td>
<td>31 (34)</td>
<td>66 (36)</td>
</tr>
<tr>
<td>Duration of hospitalization, mean (SD), d</td>
<td>6.1 (5.6)</td>
<td>7.9 (8.6)</td>
<td>7.0 (7.3)</td>
</tr>
<tr>
<td><strong>Admission diagnosis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>30 (33)</td>
<td>23 (25)</td>
<td>53 (29)</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>18 (20)</td>
<td>22 (24)</td>
<td>40 (22)</td>
</tr>
<tr>
<td>MI</td>
<td>18 (20)</td>
<td>25 (27)</td>
<td>43 (24)</td>
</tr>
<tr>
<td>Unstable angina</td>
<td>25 (28)</td>
<td>22 (24)</td>
<td>47 (26)</td>
</tr>
<tr>
<td><strong>Medications at discharge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\beta)-Blocker</td>
<td>72 (79)</td>
<td>77 (84)</td>
<td>149 (81)</td>
</tr>
<tr>
<td>ACE inhibitor</td>
<td>45 (50)</td>
<td>46 (50)</td>
<td>91 (50)</td>
</tr>
<tr>
<td>Lipid-lowering agent and/or statin</td>
<td>66 (73)</td>
<td>73 (79)</td>
<td>139 (76)</td>
</tr>
<tr>
<td>Aspirin</td>
<td>73 (80)</td>
<td>69 (75)</td>
<td>142 (78)</td>
</tr>
<tr>
<td>Clopidogrel bisulfate</td>
<td>26 (29)</td>
<td>26 (28)</td>
<td>52 (28)</td>
</tr>
<tr>
<td>Diuretic</td>
<td>36 (40)</td>
<td>39 (42)</td>
<td>75 (41)</td>
</tr>
<tr>
<td><strong>Baseline symptoms and functional measures, mean (SD)</strong></td>
<td>15.6 (5.0)</td>
<td>15.9 (4.2)</td>
<td>15.8 (4.6)</td>
</tr>
<tr>
<td>Patient Health Questionnaire-9</td>
<td>11.5 (13.9)</td>
<td>10.9 (4.0)</td>
<td>11.2 (13.9)</td>
</tr>
<tr>
<td>Hospital Anxiety and Depression-Anxiety Subscale</td>
<td>21.4 (16.9)</td>
<td>19.7 (15.8)</td>
<td>20.5 (16.3)</td>
</tr>
<tr>
<td>MOS SAS itemsd</td>
<td>14.2 (3.1)</td>
<td>13.0 (3.5)</td>
<td>13.6 (3.3)</td>
</tr>
<tr>
<td>SF-12 mental component score</td>
<td>36.3 (8.9)</td>
<td>34.2 (9.7)</td>
<td>35.2 (9.3)</td>
</tr>
<tr>
<td>SF-12 physical component score</td>
<td>33.8 (11.0)</td>
<td>32.9 (10.8)</td>
<td>32.9 (10.5)</td>
</tr>
<tr>
<td>EuroQol-5 Domain</td>
<td>0.44 (0.33)</td>
<td>0.40 (0.34)</td>
<td>0.42 (0.34)</td>
</tr>
</tbody>
</table>

**Abbreviations:** ACE, angiotensin-converting enzyme; GAD, generalized anxiety disorder; MI, myocardial infarction; MOSAIC, Medical Outcomes Study Specific Adherence Scale; SF-12, Medical Outcomes Study Short Form-12.

\(^{a}\) All data are No. (%) unless otherwise specified.

\(^{b}\) Calculation of percentage includes only patients with depression.

\(^{c}\) Calculation of percentage includes only patients with GAD.

\(^{d}\) Out of 24 items; \( P = .04 \).
Figure 2, B, C, and D.

The 24-week trajectory for these outcomes is displayed in the trajectory of SF-12 MCS improvement differences over 24 weeks (eFigure 1 in Supplement).

Additional mental health and functional outcomes, mean

DASI, main function variable 19.67 31.84 12.17 21.40 27.99 6.59 5.59 (1.71 to 9.46) 0.34 .005

HADS-A, main anxiety variable 10.88 6.60 −4.28 11.55 7.68 −3.87 −0.41 (−0.93 to 1.76) 0.10 .55

PHQ-9, main depression variable 15.90 7.84 −8.06 21.40 9.64 −12.04 −2.05 (−4.06 to −0.05) 0.45 .045

Primary outcome variable

SF-12 MCS, mean 34.21 45.42 11.21 36.30 41.83 5.53 5.68 (2.14 to 9.22) 0.61 .002

In-hospital outcome

Adequate treatment by discharge, No. (%) 69 (75) 6 (7) 11.4 (5.20 to 24.9) <.001

PHQ-9, main depression variable 15.90 7.84 −8.06 15.65 9.64 −6.01 −2.05 (−4.06 to −0.05) 0.45 .045

HADS-A, main anxiety variable 10.88 6.60 −4.28 11.55 7.68 −3.87 −0.41 (−0.93 to 1.76) 0.10 .55

DASI, main function variable 19.67 31.84 12.17 21.40 27.99 6.59 5.59 (1.71 to 9.46) 0.34 .005

Secondary outcomes

MOS SAS, self-reported adherence, mean 13.04 15.26 2.22 14.18 15.77 1.59 0.63 (−0.51 to 1.76) 0.19 .28

Additional mental health and functional outcomes, mean

PHQ-9, main depression variable 15.90 7.84 −8.06 21.40 9.64 −12.04 −2.05 (−4.06 to −0.05) 0.45 .045

HADS-A, main anxiety variable 10.88 6.60 −4.28 11.55 7.68 −3.87 −0.41 (−0.93 to 1.76) 0.10 .55

DASI, main function variable 19.67 31.84 12.17 21.40 27.99 6.59 5.59 (1.71 to 9.46) 0.34 .005

In-Hospital Outcome

Patients receiving CC were more likely to have adequate treatment of 1 of their psychiatric disorders by discharge (75% in the CC group vs 7% in the UC group; P < .001; Table 2). The proportion of patients in the CC group who had at least 1 treatment adjustment during the study and continued receiving this adjusted treatment remained relatively stable over the 24 weeks (70%-76%), whereas rates of adjusted treatment in the UC group rose steadily to 47% by 24 weeks (eFigure 1 in Supplement).

Table 2. Study Outcomes for All Comparisons in 183 Patientsa

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Collaborative Care</th>
<th>Usual Care</th>
<th>Between-Group Difference (95% CI)b</th>
<th>Effect Size</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary outcome variable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF-12 MCS, mean</td>
<td>34.21 (75)</td>
<td>36.30</td>
<td>2.14 (1.71 to 9.46)</td>
<td>0.61</td>
<td>.002</td>
</tr>
<tr>
<td>In-hospital outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate treatment by discharge, No. (%)</td>
<td>69 (75)</td>
<td>6 (7)</td>
<td>5.20 to 24.9</td>
<td>.19</td>
<td>.28</td>
</tr>
<tr>
<td>Additional mental health and functional outcomes,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASI, main function variable</td>
<td>19.67 (75)</td>
<td>21.40</td>
<td>5.20 to 24.9</td>
<td>.34</td>
<td>.005</td>
</tr>
<tr>
<td>HADS-A, main anxiety variable</td>
<td>10.88 (75)</td>
<td>11.55</td>
<td>−1.50 to 12.24</td>
<td>.10</td>
<td>.55</td>
</tr>
<tr>
<td>PHQ-9, main depression variable</td>
<td>15.90 (75)</td>
<td>15.65</td>
<td>−4.06 to −0.05</td>
<td>.45</td>
<td>.045</td>
</tr>
<tr>
<td>In-hospital outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate treatment by discharge, No. (%)</td>
<td>69 (75)</td>
<td>6 (7)</td>
<td>5.20 to 24.9</td>
<td>.19</td>
<td>.28</td>
</tr>
<tr>
<td>Additional mental health and functional outcomes,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DASI, main function variable</td>
<td>19.67 (75)</td>
<td>21.40</td>
<td>5.20 to 24.9</td>
<td>.34</td>
<td>.005</td>
</tr>
<tr>
<td>HADS-A, main anxiety variable</td>
<td>10.88 (75)</td>
<td>11.55</td>
<td>−1.50 to 12.24</td>
<td>.10</td>
<td>.55</td>
</tr>
<tr>
<td>PHQ-9, main depression variable</td>
<td>15.90 (75)</td>
<td>15.65</td>
<td>−4.06 to −0.05</td>
<td>.45</td>
<td>.045</td>
</tr>
</tbody>
</table>

Abbreviations: DASI, Duke Activity Status Index; EQ5D, EuroQol-5 Domain Measure; HADS-A, Hospital Anxiety and Depression Scale-Anxiety Subscale; HRQoL, Health-Related Quality of Life; MOS SAS, Medical Outcomes Study Short Form-12 Sensitivity to Change Scale; SF-12 MCS, Medical Outcomes Study Short Form-12 Mental Component Score.

*Mean baseline scores, final scores, changes, and between-group differences were estimated from the random-effects model.

Discussion

Collaborative care was associated with greater rates of adequate treatment and significant improvements in mental HRQoL, depressive symptoms, overall HRQoL, and general functioning at 24 weeks. These improvements occurred despite the low intensity of the intervention, the potential for spontaneous remission after discharge, and high rates of treatment in the UC condition.

The internal and external validity of these findings is strengthened by concurrent identification and management of multiple psychiatric conditions, inclusion of patients with multiple cardiac diagnoses to include a substantial proportion of patients admitted to a typical cardiac unit, use of pa-
tient preference in treatment, inclusion of patients (10%) who declined treatment as part of the intent-to-treat design, and centralized postdischarge care management by telephone. We also used a social worker as a CM; social workers are trained in psychiatric evaluation as part of their education, are present on most cardiac units, and typically come at a substantially lower cost than nurses.

Furthermore, this study included patients with personality disorders and those with serious medical issues (eg, cardiac transplantation); we enrolled these participants because “real-world” implementation of this program would likely include patients with such complex conditions. This work also differs from other CC trials in its combined treatment of mood and anxiety disorders and its focus on anxiety disorders specifically in patients with heart conditions.

The effect sizes of the intervention on mental HRQoL, depression, and function were moderate (0.34 to 0.61), and the effect size on depression (0.45) is at the upper end of the range seen in typical CC depression interventions. The intervention did not show significant associations, however, between the CC intervention and improvements in anxiety or secondary medical outcome measures, including read-

---

**Figure 2. Trajectory of Improvement in Outcome Measures Over 24 Weeks**

A. Short Form-12 Mental Component Score

B. Patient Health Questionnaire-9

C. Hospital Anxiety and Depression Scale—Anxiety Subscale

D. Duke Activity Status Index

A-D. The left-hand graph shows mean scores in each treatment group, and the right-hand graph, between-group difference in change from baseline.
mission rates; there were also no significant differences in rates of depression and anxiety response. Furthermore, given the multiple secondary outcome measures, P values between .005 and .05 should be interpreted more cautiously.

Lack of some between-group differences may have been related to the inclusion of patients with complex conditions and the nearly 50% rate of treatment adjustment in the UC group by 24 weeks, likely caused by our recurrent notification (of both participants and clinicians) of ongoing symptoms in the “enhanced” control condition; this rate is far greater than the treatment rate for depression (18.2%) seen in a lower-intensity physician notification model.20 Furthermore, the CM in this low-intensity treatment had a median of 3 contacts with participants, compared with 10 to 21 contacts (in 8-12 months) in other CC trials in patients with heart disease.19,20 Finally, we did not use a “blended” care management model actively intervening on both medical and psychiatric targets; prior study of this model found improvements in medical and mental health outcomes.19

Despite these caveats, this intervention seems to have substantial promise as an adjunct or alternative to standard CC paradigms. We found that a single CM was able to coordinate care of 3 psychiatric conditions in patients with a wide range of cardiac diagnoses living within and outside the metropolitan area of the hospital. Next-step studies may consider more intensive interventions (while maintaining the core model) to increase the number of patients getting truly stepped care for their mental health disorder, or use a blended care model.19

There were several limitations to this work. First, it occurred in an academic medical center among mostly white patients. Second, the intervention was delivered by research clinicians who have experience with the population and CC programs; however, in clinical implementation of other CC programs, the magnitude of improvement on clinical outcomes has mirrored that in research trials.53-54 Third, there was a single CM, and our results may have been primarily due to the proficiency of this clinician, although relatively few patients received CBT and the overall number of CM-patient contacts was low. Fourth, psychiatric diagnoses were not made using formal structured clinical interviews. Finally, the intervention did not have effects on medical outcomes such as adherence or readmissions; of note, our prior trial of this model found that improvements in adherence and physical symptoms occurred in a lagged sequence, only after the intervention period was complete.21

Conclusions

Adequately powered and randomized trials remain necessary to determine whether refinements to this model (such as adding slightly more postdischarge contact or using a blended care model) can lead to even greater improvements in mental health and function. Given the relatively low-burden and low-resource nature of this intervention—with telephone delivery of all postdischarge interventions and use of a single social worker as the CM for 3 psychiatric illnesses—such a program may be easily implemented and effective in real-world settings.

ARTICLE INFORMATION

Accepted for Publication: February 18, 2014.

Published Online: April 14, 2014.

Author Contributions: Dr Huffman had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Huffman, Healy, Rollman, Januzzi.

Acquisition, analysis, or interpretation of data: All authors.

Drafting of the manuscript: Huffman.

Critical revision of the manuscript for important intellectual content: Mastromauro, Beach, Celano, Dubois, Healy, Suarez, Rollman, Januzzi.

Statistical analysis: Huffman, Healy, Suarez.

Obtained funding: Huffman.

Administrative, technical, or material support: Mastromauro.

Study supervision: Huffman, Beach, Celano, Januzzi.

Conflict of Interest Disclosures: Dr Huffman received an honorarium for a presentation on depression in patients with heart conditions from the American Physician Institute for Advanced Professional Studies. No other disclosures are reported.

Funding/Sponsor: This research was funded by the American Heart Association Grant-in-Aid 10GRNT3450015 (to Dr Huffman).

Role of the Sponsor: The funder had no role in the design and conduct of the study; collection, management, analysis, or interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Correction: This article was corrected on June 17, 2014, to fix an erroneous follow-up period in the Results section.

REFERENCES

The MOSAIC Randomized Controlled Trial


