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Personalized Postacute Hospitalization Recovery: A Novel Intervention to Improve Patient Experience and Reduce Cost

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SUMMARY

Goal: Readmissions are a significant financial burden for payers. Cardiovascular-related discharges are particularly prone to readmission. Posthospital discharge support can impact patient recovery and probably reduce patient readmissions. This study aimed to address the underlying behavioral and psychosocial factors that can negatively affect patients after discharge.

Methods: The study population was adult patients admitted to the hospital with a cardiovascular diagnosis who had a plan to discharge home. Those who consented to participate were randomized to intervention or control groups on a 1:1 basis. The intervention group received behavioral and emotional support, whereas the control group received usual care. Interventions included motivational interviewing, patient activation, empathetic communication, addressing mental health and substance use, and mindfulness.

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Principal Findings: Observed total readmission costs were significantly lower in the intervention group than in the control group ($1.1 million vs. $2.0 million) as was the observed mean cost per readmitted patient ($44,052 vs. $91,278). The mean expected cost of readmission after adjustment for confounding variables was lower in the intervention group than in the control group ($8,094 vs. $9,882, $p = .011$).

Practical Applications: Readmissions are a costly spend category. In this study, posthospital discharge support addressing the psychosocial factors contributing to patients' readmissions resulted in a lower total cost of care for those with a cardiovascular diagnosis. We describe an intervention that is reproducible and can be scaled broadly through technology to reduce readmission costs.

INTRODUCTION

In the United States, more than $1 in every $6 of the gross domestic product (GDP) goes to healthcare. This reflects an increase from $1.4 trillion (3.3% of GDP) to $3.1 trillion (17.9% of GDP) from 1996 to 2016 (Dieleman et al., 2020). Porter and Olmsted (2006) suggested that this unsustainable cost is due to misapplied incentives in the health system that do not promote competition based on value. Thus, the need for innovation in strategies and technology integrations that promote value initiatives is anchored in higher-quality care with scalable cost.

Preventable patient readmissions are a particular concern. The Northeast Business Group on Health Hospital Readmission Reduction Project of 2012 noted that preventable readmissions cost approximately $25 billion per year (Duncan et al., 2021; Nowicki et al., 2012). According to the 2010–2016 estimates from the Nationwide Readmissions Database, circulatory disease readmissions are more common (16.4%) than readmissions overall (13.9%; Bailey et al., 2019). In addition, patients with heart failure had a 30-day rehospitalization rate of 21% (Panagiotou et al., 2019). Nearly 20% of 30-day readmissions are likely preventable (van Walraven et al., 2011). Hospital readmission rates are influenced, in large part, by factors outside of the hospital domain, including poor social support, poverty, and lack of access to outpatient care (Joynt & Jha, 2012; Joynt et al., 2011; Philbin et al., 2001). Although tactics to improve care for patients hospitalized with cardiovascular disease have been disseminated and implemented, access to care remains a barrier associated with readmission and higher costs (Ferro et al., 2019). The results of a nationwide survey of 478 hospitals showed that facilitated follow-up appointments were key to reducing readmissions (Bradley et al., 2015).

Behavioral health is of vital importance in understanding readmissions. If contextual or emotional/behavioral factors lead to reduced compliance by patients, outcomes will be significantly hampered, regardless of the excellence of the medical treatment. Hibbard and Greene (2013) developed a concept called *patient activation*, which refers to knowledge, skills, confidence,

and inclination to assume responsibility for managing one's health and healthcare needs. Similar in concept, *motivational interviewing* is a patient-centered approach that enables patients to identify and overcome unhealthy or problematic behaviors that prevent them from engaging in proper self-care. Riegel and colleagues (2016) demonstrated the effectiveness of motivational interviewing; patients receiving this intervention had a readmission rate of 7.1% compared with 30% for those in the control group ($p = .003$). In a randomized clinical trial of patients with chronic obstructive pulmonary disease, a population with a high readmission risk, Benzo and colleagues (2016) reported that health coaching resulted in significant reductions in readmissions. Also, a systematic review and meta-analysis showed that motivational interviewing improved the transition to outpatient care and medication adherence in patients after hospital discharge (Palacio et al., 2016).

Although these initiatives have shown promise, they do not adequately address behavioral health and life context after hospitalization. Hospitalization for severe illness leads to postdischarge anxiety that often demands patient activation, involving knowledge, skills, confidence, and inclination to assume responsibility for managing one's health and healthcare needs (Hibbard & Greene, 2013), or motivational interviewing to improve the transition to outpatient care and medication adherence (Mitchell et al., 2014; Riegel et al., 2016).

Life context information has also been found to be critical for quality patient care. Two decades of research have shown that "inattention to contextual information, such as a patient's transportation needs, economic situation, or caretaker responsibilities, can lead to contextual error . . . ." (Weiner et al., 2010).

Therefore, our study aimed to measure the efficacy of a virtual platform anchored on behavioral health and ease of postdischarge access in decreasing readmissions and costs incurred in the postdischarge cycle of care among patients admitted to the hospital with a cardiovascular disease diagnosis.

METHODS

Study Design

This study was a single-center, unblinded, randomized controlled, adaptive design trial comparing behavioral and contextualized support (intervention group) versus a conventional postdischarge approach (control group) in patients discharged following hospitalization for cardiovascular conditions. Patients who consented to participate were assigned to an intervention or a control group using a randomization algorithm with a 50% chance to be assigned to intervention or control.

Study Oversight

The NorthShore University HealthSystem Cardiovascular Research Institute was the academic coordinating center. The study was designed and led by a NorthShore steering committee (including authors M.L., A.T., J.S., I.M., and S.B.). The study and all amendments were approved by the NorthShore Institutional Review Board committee. Data management and statistical analyses were performed

independently by the Institute for Practice and Provider Performance. The trial was supported by Laguna Health and institutional research funds. The steering committee retained independent rights to final manuscript review. Laguna Health played no role in the design or conduct of the trial or the collection or analysis of the data. The authors vouch for the accuracy of the data and the adherence to the trial protocol.

Population

Patients who met all the following inclusion criteria were eligible: 18 years of age or older, hospital admission with a diagnosis of a cardiovascular disorder as defined by the coded diagnosis-related groups and *ICD-10* (*International Classification of Diseases, Tenth Revision*) codes (see Supplemental Digital Content Table 1, provided as Appendix A to this article, available at http://links.lww.com/JHM/A98), for whom consultation had been requested by the attending physician from the general cardiology, advanced heart failure, or vascular medicine services. Study inclusion required fluency in English or Spanish and a plan for discharge to home with or without home health services. Patients who had cognitive impairment limiting their ability to actively engage in the study based on the primary attending physician's judgment were excluded. Those discharged to a skilled nursing facility, inpatient rehabilitation center, or hospice were also excluded.

Intervention

The intervention was provided by healthcare staff and virtual coaches, including registered nurses, clinical social workers, and psychologists. Structured patient interactions included four weekly engagements initiated by the virtual coach, along with the ability of the patient to send text messages or request additional time. Scheduling and documentation were cataloged in Harmony (version 1) virtual case management software.

Intervention engagement was defined as the completion of an initial 5-min patient interaction via telephone, video, or web chat conversation with the healthcare staff at any point between enrollment and 30 days after hospital discharge. Patients in the intervention group who did not meet this criterion were classified as nonengaged.

Participants in the intervention group underwent an assessment of their emotional state, which included the use of the Patient Health Questionnaire (PHQ-9) and the Generalized Anxiety Disorder (GAD-7) survey tools. An assessment of life context and social issues was also performed on the basis of life context domains initially developed by Saul Weiner and Alan Schwartz and then modified by Alan Spiro and Jeff Rubin at Laguna Health to best address the most prevalent issues found during the transition from hospital to home (Weiner et al., 2020). All coaches underwent a training program that included life context analysis, and they were required to pass a case-based proficiency test to become certified to interact with patients.

Based on those assessments, coaching and support were individualized to best meet each patient's needs. Standard methods, including motivational interviewing, education, and

empowerment, were used in a program specifically designed for the postacute population (Begum et al., 2011; Mitchell et al., 2014; Prochaska & Velicer, 1997). In addition, specific techniques were used to address contextual barriers such as arranging transportation, sending reminders to patients, and helping arrange needed durable medical equipment.

Patients were encouraged to participate in weekly sessions but had the opportunity to opt out at any time. The coach informed the coprincipal investigator if the participant required immediate medical or mental health attention.

Study Regimen

After receiving an explanation of the study protocol, patients who agreed to participate provided consent electronically via REDCap. Randomization was performed at the time of online registration using an automated 1:1 randomization algorithm. Patients randomized to the intervention arm received a text message on their smartphone to schedule their initial engagement. Those in the control group did not receive any further communication from the team until 30 days after discharge when they were offered questionnaires to complete. On Day 30, all patients in both groups received an automated text message and/or e-mail with a link to complete the PHQ-9 and GAD-7 assessments in their primary language (English or Spanish). If the participant did not respond within 2 days, staff trained in PHQ-9 and GAD-7 reached out by phone on two occasions over the following week.

Outcomes and Measures

All patients who underwent randomization were to be followed up to 30 days after discharge. The planned primary outcome was the 30-day readmission rate. Secondary outcomes included 30-day readmission costs and engagement (in the intervention group). Readmission rates were defined as all-cause rehospitalization within a 30-day postdischarge period. Study participants' postadmission clinical outcomes data were collected from a clinical analytics report. If a patient was readmitted, the readmission summary and reasons, including whether it was avoidable, were evaluated. We measured the cost of readmission as the hospital charges and did not include professional billing. The patient's insurance information was also collected. The expected cost of readmission was calculated on the basis of insurance charge data from patients readmitted to the hospital. Other end points and variables included 30-day emergency department visits; this information was obtained from reported all-cause emergency department check-ins. The net promoter score was collected from patients in the intervention group to assess their satisfaction, and GAD-7 and PHQ-9 scores were obtained as part of mental health assessments.

Statistical Analysis

The study was initially powered to demonstrate at least a 30% reduction in 30-day readmission in the intervention group based on an expected readmission rate of 20% in the control group. Because it was implausible that the intervention would increase readmission, we used

one-tailed tests or treated results as significant if and only if the direction of the effect was a reduction in admissions significant at an α level of .1. Under these assumptions, 367 intervention participants and 367 control participants were needed to achieve 80% power for a χ^2 test. Following an interim review of readmission rates and costs, however, it became clear that overall readmission rates were lower than expected and we would be unable to detect the expected difference in rates, taking into account the variations in readmission costs among the groups, which could provide a more sensitive reflection of the impact on care.

Thus, we evaluated the following hypotheses:

Hypothesis 1 (H1): The intervention group would have lower readmission costs per enrolled patient compared with the control group.

Hypothesis 2 (H2): The intervention group would have lower readmission rates compared with the control group. The intention-to-treat population included all patients who had undergone randomization.

We tested H1 by fitting a two-part model to the data, modeling for each individual the probability of readmission (using logistic regression fitted to all patients) and the expected cost of readmission if one occurred (using a log-linked gamma model fitted to readmitted patients). Study arm and available patient demographics (age, gender, White vs. non-White race, median income for the patient's zip code, length of stay [LOS], and body mass index [BMI]) were predictors in each model. We calculated the expected cost of readmission for each patient as the product of their predicted probability of readmission and the predicted cost of readmission if one occurred. We compared the mean expected costs for the study arms using a t test. We tested H2 by testing the coefficient associated with the study arm in the two-part readmission model (Mood, 1954). We treated all tests as one-tailed and considered $p < .1$ to be significant if it was in the predicted direction and no p value to be significant if it was in the other direction. We conducted data analysis using R 3.6 (R Core). The study was concluded after 215 control and 193 intervention patients were enrolled.

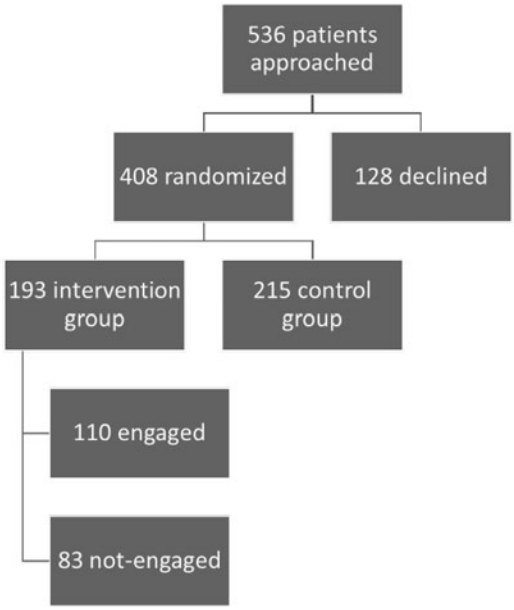
RESULTS

Population Characteristics

A total of 408 patients were included in the study, with 193 patients randomized to the intervention group and 215 to the control group (Figure 1). The first participant was enrolled on February 18, 2021, and the last participant finished the study on February 24, 2022. Eighty-four percent of patients in the trial received the top admitting diagnoses (congestive heart failure, chest pain, atrial fibrillation, acute myocardial infarction, chronic ischemic heart disease, shortness of breath, uncontrolled hypertension, peripheral vascular disease, and aortic aneurysm). Among those in the intervention group, 110 (57%) engaged in the intervention and 83 (43%) did not engage. Among the engaged participants, the mean time of intervention was 17 days ($SD = 10.9$ days; Table 1). There was no difference in GAD-7 ($p = .72$) and PHQ-9 ($p = .64$)

FIGURE 1

Breakdown of Study Participants and Study Groups



scores between engaged and nonengaged participants. In addition, there was no difference in GAD-7 ($p = .25$) or PHQ-9 ($p = .15$) scores between readmitted and nonreadmitted patients.

There were no differences between the engaged and nonengaged participants in the intervention group with respect to age, gender, race, LOS, depression scores, or BMI. The mean age of all participants was 67 years ($SD = 15.2$ years); 59.6% were male; the mean BMI was 30.3 ($SD = 8.0$); and 64.7% were White. The mean LOS was 5.1 days ($SD = 4.5$ days). Readmission LOS did not differ between the two groups after adjusting for demographics (race, gender, age, income, BMI, and LOS at original admission). The marginal mean LOS in the control group was 5.5 days, 95% CI (3.7–81), and the marginal mean LOS in the intervention

TABLE 1

Participant Characteristics in the Control and Intervention Groups

Characteristic	Control ($n = 215$)	Intervention ($n = 193$)	Total ($N = 408$)	p
Age, median (IQR), years	70 (59–79)	69 (59–78)	69.5 (59–78)	.93
Female, *n* (%)	82 (38.1)	83 (43.0)	165 (40.4)	.32
White race, *n* (%)	138 (64.2)	126 (65.3)	264 (64.7)	.82
Insurance, *n* (%)				.31
Commercial	50 (23.3)	51 (26.4)	101 (24.8)	
Medicare	109 (50.7)	99 (51.3)	208 (51.0)	
Public/self-pay	30 (14.0)	16 (8.3)	46 (11.3)	
Unknown	26 (12.1)	27 (14.0)	53 (13.0)	
Income, $, mean (*SD*)	93,381 (37,480)	94,363 (36,107)	93,846 (36,795)	.79
Length of stay, mean (*SD*), days	5.0 (4.2)	5.2 (4.8)	5.1 (4.5)	.68
Body mass index, mean (*SD*)	29.8 (8.3)	30.9 (7.7)	30.3 (8.0)	.19
PHQ-9, mean (*SD, n*)	4.6 (4.4, 82)	4.1 (4.4, 81)	4.3 (4.4, 163)	.46
GAD-7, mean (*SD, n*)	3.0 (3.9, 82)	2.6 (3.2, 81)	2.8 (3.6, 163)	.54

Note. GAD = Generalized Anxiety Disorder; IQR = first and third interquartile range; PHQ = Patient Health Questionnaire.

group was 4.6 days (3.3–6.5; $p = .52$). There were no significant differences in baseline characteristics between the two groups (Table 1).

OUTCOMES

Readmission Costs

The total cost of readmissions was $2,008,107 in the control group and $1,145,348 in the intervention group. In the control group, there were 23 readmissions for which cost data were available (two patients were admitted to other institutions). The mean observed cost was $91,278 per readmitted patient ($SD = $152,320). In the intervention group, there were 26 readmissions for which cost data were available (two patients were admitted to other institutions). The mean observed cost was $44,052 per readmitted patient ($SD = $38,239; $p = .17$). The mean predicted cost of readmission per readmitted patient, adjusted for age, gender, White race, income, LOS, and BMI, was lower in the intervention group ($52,301, $SD = $33,466) than in the control group ($81,519, $SD = $52,583; $p = .011$).

The mean expected cost of readmission per enrolled patient (i.e., the predicted probability of readmission multiplied by the predicted cost if readmitted), adjusted for age, gender, White race, income, LOS, and BMI, was $9,892 (95% CI [$9,749 to $10,034]) in the control group and $8,094 (95% CI [$7,959 to $8,229]) in the intervention group ($p = .01$). This difference in expected costs was more pronounced in the per-protocol analysis ($10,565 for control patients vs. $6,921 for engaged intervention patients, $p = .01$). The cost comparisons are summarized in Table 2 and Figures 2 and 3.

Readmission Rates

Readmission rates did not differ significantly by study arm. Overall, 25 of 215 control patients (11.6%) were readmitted and 28 of 193 intervention patients (14.5%) were readmitted ($p = .38$). Across arms, readmission

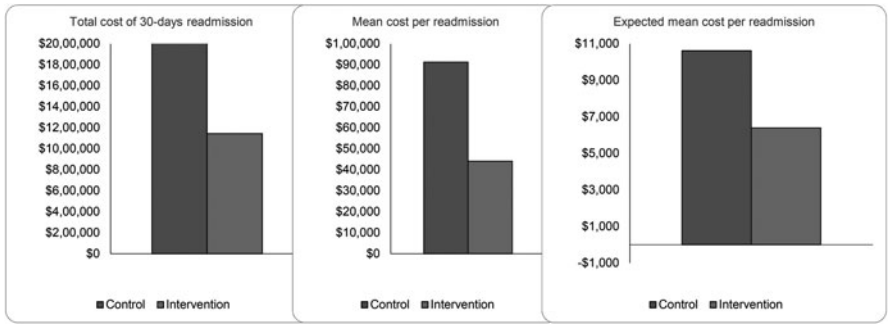
TABLE 2

Comparisons of Costs Under Intention to Treat

Variable	Control	Intervention	*p*
Total cost, $, of readmissions	2,008,107	1,145,348	
Observed mean (*SD*) cost, $, per readmitted patient	91,278 (152,320)	44,052 (38,239)	.17
Expected mean cost, $, of readmission per enrolled patient	10,614	6,391	No variance within group
Expected mean (*SD*) cost, $, of readmission per enrolled patient, adjusted for demographics	9,892 (7,500)	8,094 (6,697)	.01

FIGURE 2

Comparison of Costs Between the Two Groups



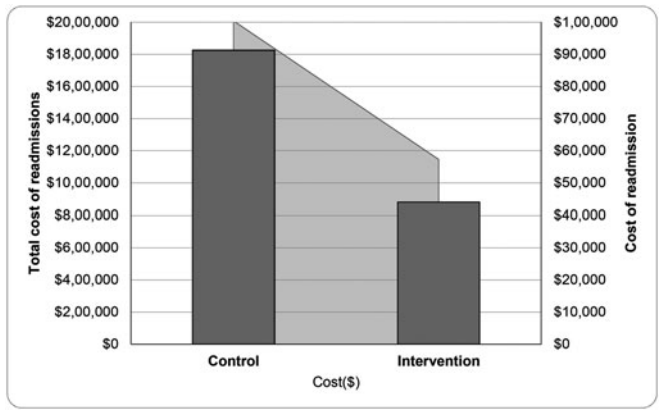
Note. Comparison on left shows the total cost per 30-day readmission in the control ($2,008,107) and intervention ($1,145,348) groups. Center comparison shows the observed mean cost per readmission in the control ($91,278) and intervention ($44,052) groups ($p = .17$). Comparison on right shows the expected mean cost per readmission in the control ($10,614) and intervention ($6,391) groups.

rates did not differ by age, gender, White race, income, LOS, or BMI. Yet, in the intervention group, nonengaged patients were more likely to be readmitted (21.7%) than engaged patients (9.1%, $p = .02$) or control patients (11.6%, $p = .04$).

The difference in readmission rates between engaged and nonengaged intervention patients persisted after adjustment for age, gender, White race, income, LOS, and BMI, none of which were significant predictors (adjusted odds

FIGURE 3

Expected Mean Cost of Readmission Adjusted for Baseline Characteristics in the Control ($9,892) and Intervention ($8,094) Groups (p = .01)



ratio for engagement = 0.38, 95% CI [0.16–0.88], $p = .02$; see Supplemental Digital Content Table 2, provided as Appendix B to this article, available at http://links.lww.com/JHM/A98).

DISCUSSION

Our study demonstrated that behavioral and contextualized support after hospitalization was associated with a reduced total cost of readmissions. This strategy also resulted in a reduction in the observed per-patient readmission cost and the mean per-patient predicted cost of readmission after adjusting for confounding variables, including age, gender, White race, income, LOS, and BMI. These results align with H1, which stated that the intervention group would have lower readmission costs per enrolled patient compared with the control group; therefore, the null hypothesis was rejected. Our interim analysis demonstrated that the difference in readmission costs better reflected the impact of the intervention on the cost of care than the rate of readmission. Readmission rates were not significantly different between the two groups in our study (H2); thus, the null hypothesis cannot be rejected on the basis of these results.

The lower cost of readmission in patients who were engaged in the intervention group may be explained by their presentation at an earlier, and hence less decompensated, stage of illness. Patients may have been advised by medically trained coaches to seek medical attention early in the course of their setback, rather than attempting to wait for their next doctor's appointment or presenting to the emergency department in extremis. Therefore, it is plausible that having sought medical attention at an earlier stage in the disease process could have affected readmission LOS, acuity of illness, and overall readmission cost. Our sample size was too small to support this hypothesis, but we seek to perform future studies with more participants to explore this hypothesis further.

Our study is unique in that it was designed on the basis of existing evidence while implementing behavioral and contextualized support immediately after discharge in a high-risk patient population with cardiovascular diseases. This study bridges the gap in the literature by simultaneously bundling multiple interventions such as motivational interviewing, health coaching, patient activation, and addressing the underlying behavioral, social, and life context issues. During this vulnerable period in the lives of intervention group participants, trained health coaches provided individualized care using virtual platforms, which proved to significantly reduce costs associated with hospital readmissions.

Behavioral comorbidities, particularly depression and anxiety, increase the risk of readmission (Bruce et al., 2016; Ogunmoroti et al., 2022). In fact, at the time of readmission, approximately 50% of patients have secondary behavioral health diagnoses. Freedland and colleagues (2015) found that in a population of patients with heart failure, depressive symptoms greatly predicted multiple readmissions (adjusted hazard ratio [HR], 1.08; 95% CI [1.03–1.13]; $p = .0008$). Reese and colleagues (2011)

reported similar findings in patients who experienced acute myocardial infarction; their results showed that patients with depression were at an increased risk of cardiac rehospitalization compared with those with no depression (major depression unadjusted HR, 2.69; 95% CI [1.95–3.70]; $p < .001$, minor depression unadjusted HR, 1.99; 95%, CI [1.44–2.76]; $p < .001$).

Life context, when not addressed in care delivery, has been found to be associated with poor-quality care and a higher cost of care, with contextual errors estimated to be seven times the cost of biomedical errors (Schwartz et al., 2012; Weiner & Schwartz, 2016). More recent studies have shown that this lack of attention-to-life context can be improved. When addressed with physicians or case managers, care improves and costs are reduced. In a study of 666 clinicians and 4,496 patient visits, contextualized care planning was associated with a greater likelihood of improved outcomes and an estimated cost savings of $25.2 million from avoided hospitalizations (Weiner et al., 2020). Schwartz and colleagues (2016) observed that care managers are better able to produce contextualized care plans than health professionals delivering direct patient care. The results of our study add credibility to the available evidence in the literature; by providing behavioral and contextualized support immediately after discharge, one can significantly reduce costs associated with hospital readmissions.

Study Strengths and Limitations

This study was a randomized controlled trial with an intention-to-treat analysis, which limited the introduction of bias. Our study findings highlight the reduction in the total cost of 30-day readmissions as a primary outcome and in rates of readmission as a secondary outcome among patients in the intervention group compared with those in the control group. There is a paucity of data on readmission costs in patient populations discharged with complex cardiovascular problems, which constituted the majority of the readmissions. Most patients in this study were Medicare recipients (51%) and one fourth were commercially insured, and our study interventions are widely available to those populations.

Our study was unique in that we used a virtual platform, used a comprehensive range of behavioral tactics among a broadly trained group of coaches with clinical expertise, and measured cost data across a diverse population of patients with cardiovascular diseases. We hope that our contribution to the literature will stimulate further investigation into the use of these techniques to enhance the current methods of transitional care.

This nonblinded study could have introduced observer bias. However, data management and statistical analysis were performed independently by a separate team not directly involved with patient recruitment and treatment, thus mitigating this bias. Multiple scores such as GAD-7 and PHQ-9 were collected as part of mental health assessments, but the study is not powered to analyze the association and effect (GAD-7 and PHQ-9) score. This is a single-center study, and external validity needs reevaluation.

We acknowledge that the lack of a precise measurement tool for clinical

severity of illness is a limitation of our study. Future investigations would be strengthened by having a more precise measurement tool.

CONCLUSION

Our study highlights the important role of postdischarge behavioral and contextualized intervention to reduce readmission costs. This metric, which is not commonly tracked, may be beneficial for the measurement of overall healthcare spending as not all readmissions are equal in terms of the cost to the system.

Behavioral and emotional support that is tailored to the patient's individual needs can help reduce 30-day readmission costs in patients with cardiovascular diseases compared with the conventional postdischarge approach. Future studies could investigate similar interventions in patients with other high-risk medical conditions, as well as expand the postdischarge observation period.

NOTE

Drs. Schwartz and Lampert are advisers to Laguna Health. The Institute for Practice and Provider Performance Improvement received consulting fees for Dr. Schwartz's participation in this manuscript. Dr. Spriro is a board member of the Institute for Practice and Provider Performance Improvement. Dr. Tafur has received research support from Janssen, Doasense, Idorsia, Bristol Myers Squibb, and Biotap, and an education grant from Janssen. He is a consultant for Recovery Force.

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