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A Telehealth Protocol to Prevent Readmission among

High-Risk Patients with Congestive Heart Failure

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**Conflict of Interest Statement:** JM and BP have no conflicts of interest to report. DR has an equity stake in the company that was used to implement the intervention. Therefore, he was not involved in the collection or analysis of the data.

**Key Words:** telehealth; behavior change; congestive heart failure; chronic disease management; hospital admission; hospital readmission; video conferencing**ABSTRACT**

**Background.** Congestive heart failure (CHF) is the leading cause of hospital readmissions. We aimed to assess adherence to and effectiveness of a telehealth protocol designed to prevent hospital admissions for CHF.

**Methods.** We recruited a random sample of 50 patients with CHF (mean age 61). We developed a telehealth platform allowing for daily real-time reporting of health status and video conferencing. We defined adherence as the percentage of days on which the patient completed the intervention. To assess efficacy, we compared admission and readmission rates between the 6-month intervention period and the prior 6 months. Primary outcomes were admissions and readmissions due to CHF, and secondary outcomes were admissions and readmissions due to all causes.

**Results.** Forty-eight (96%) patients completed the protocol. About half (46%) were at high risk for readmission based on standardized measures. Median 120-day adherence was 96% (interquartile range=92-98%), and adherence did not significantly differ across sex, race, age, living situation, depression, cognitive ability, or risk for readmission. CHF-specific admissions were 53% lower during the intervention period compared with the control period (7 vs. 15, *P*=.007), and CHF-specific readmissions were 83% lower (1 vs. 6, *P*=.01). When comparing the intervention and control periods, all-cause admissions and readmissions were 25% and 57% lower (*P*=.01 and *P*=.006, respectively).

**Conclusion.** Adherence to this telehealth protocol was excellent and consistent, even among high-risk patients. The protocol was associated with a significant decrease in CHF-related and all-cause admissions and readmissions. Future research should test the protocol using a more rigorous randomized design.

**INTRODUCTION**

Congestive heart failure (CHF) affects nearly 6 million patients in the U.S. More than half of patients return to the hospital within 6 months of discharge,1 making it a leading cause of readmission.2 In 2011, CHF cost Medicare $7.6 billion and Medicaid nearly $1 billion.3

Half of hospital readmissions result from inadequate discharge teaching, nonadherence, or follow-up failure.4 These issues are even more problematic among high-risk patients, such as those with poor social support and cognitive impairment.4 Telehealth protocols may serve as effective strategies for addressing these problems.5 For example, technologies can be used to automate monitoring, integrate health coaching, and facilitate communication between patients and health care providers.6

Therefore, we developed a telehealth platform to reduce hospital admission among CHF patients. The purpose of this study was to assess protocol adherence in a high-risk sample, to compare adherence across a range of patient characteristics, and to assess intervention efficacy.

**METHODS**

**Participants**

CHF patients were identified through claims data provided by a regional Managed Care Organization. Eligible patients had a diagnosis of CHF and at least 1 emergency room visit or hospitalization in the past 3 years. A random sample of these patients received a recruitment letter, and interested patients were consented to be screened for the study. The enrollment phase closed once 50 patients had been recruited.

**Intervention Protocol**

We transformed a standardized CHF self-care protocol into a telehealth platform. All patients were provided with a touchscreen computer tablet with software designed for high-risk patients with poor health literacy. The software application allowed for real-time reporting of patient-supplied health status and HIPAA-compliant video conferencing. The application also included an interface engaging patients with educational information around CHF self-care. Patients also received a Bluetooth-enabled weight scale that synchronized with the tablet software. Daily, patients were prompted to report relevant information, such as difficulty breathing and medication compliance.

This patient-provided digital information was sent directly to social workers who were trained as CHF health coaches and provided with a protocol for interacting with patients over a video-conferencing application. The social workers also conducted weekly video sessions focused on education and behavior change. An initial in-home visit included equipment set-up in the patient’s home and collection of demographic and clinical information. De-identified data were presented to University researchers for analyses. This was deemed a Quality Improvement study by the University Institutional Review Board.

**Measures**

*Dependent Variables*. Adherence was defined as the percentage of days on which patients successfully completed the protocol. Primary efficacy variables were CHF-specific admissions and CHF-specific readmissions. Secondary efficacy variables were admissions and readmissions due to all causes. Admission was defined as a hospital stay beyond the emergency department of any length (including 1 day). Readmission was defined as an additional admission 30 days or fewer from discharge.1 A CHF-specific admission was one in which CHF was the primary admitting diagnosis. When a patient was released but readmitted on the same day, this was defined as a continuation of the original admission.

*Covariates*. Demographic variables included sex, race, age, living alone, and insurance type. We assessed depression with the PHQ-27 and cognitive impairment with the Mini-Cognitive Battery.8 We also used standardized measures to assess each patient’s risk for readmission9 and fall risk.10

**Analysis**

We used Mann-Whitney *U*-tests to determine if adherence scores were significantly different across each of the patient characteristics. Non-parametric testing was used due to non-normality of the dependent variable. Adherence rates were divided into 30-day increments to examine differences over time.

For efficacy-related dependent variables, we used binomial tests to determine whether there were significant differences in numbers of admissions when comparing the intervention and comparison periods. The intervention period was defined as the 6 months during which each participant received the intervention, and the control period was defined as the 6 months immediately prior to enrollment. We used a two-tailed alpha of 0.05 to define significance.

**RESULTS**

During the first month, two patients withdrew for medical reasons. The remaining 48 (96%) patients completed the study. The mean age of participants was 61 (standard deviation=12). One-third of participants were Medicaid eligible (33%, N=16) and two-thirds were dually-eligible (Medicaid and Medicare) (67%, N=32). Almost a quarter (23%, N=11) of patients were depressed, nearly half (40%, N=19) lived alone, and nearly half (46%, N=22) were at risk for readmission based on LACE scores (Table 1).

Median adherence for the complete period was 96% (IQR=92-98%). Adherence was not significantly different across sex, race, age, living situation, depression, cognitive ability, or risk for readmission. Adherence also did not change across each 30-day increment over the 120-day period (Table 1).

All four readmission rates were significantly decreased in the intervention period compared with the control period. Compared with the control period, during the intervention period there were 53% fewer CHF-specific admissions, 83% fewer CHF-specific readmissions, 25% fewer all-cause admissions, and 57% fewer all-cause readmissions (Table 2).

**DISCUSSION**

First, we found that adherence to this telehealth protocol was excellent despite the relatively intensive daily attention required. Second, there were no significant differences in adherence by patient characteristics. Finally, compared with the 6 months prior to the intervention, the number of admissions and readmissions—both for CHF and for all causes—was significantly lower during the 6-month intervention period.

It is notable that this cohort adhered to the protocol well, because morbidity from CHF tends to be higher among patients with certain risk factors.11 This strong adherence may be due to the fact that the intervention was tailored to those with low health literacy and was very easy to use. It may have also been valuable that we employed as health coaches social workers, who have specialized training around factors such as (1) addressing psychosocial and environmental barriers to behavior change and (2) identifying particularly impactful educational opportunities.

The protocol involved providing technology to patients who historically have not had equal access to technology.12 While this technology was not extremely expensive, future cost-effectiveness research may be valuable to assess whether this investment of machinery and personnel resulted in sufficient cost savings.

Similar protocols could be developed for other high-cost chronic health issues with frequent hospital admissions, such as chronic obstructive pulmonary disease or rheumatoid arthritis. While specific target symptoms would be different, the overall strategy of providing tailored education and surveillance based on the biopsychosocial model would remain the same.

**Limitations**

This study used a comparison period instead of a randomized clinical trial or a randomized crossover trial. Future research could use a more rigorous design. This study also focused on outcomes of adherence and readmission rates. While these are useful outcomes to examine at this stage of research, future research could focus on more distal outcomes such as admission rates after the intervention period has ended in order to assess retention of self-care skills.

**Conclusion**

Telehealth programs combining useful technologies with best practices for at-risk populations can maintain excellent adherence, even for individuals at high risk for readmission. These programs can be associated with significant reductions in admissions, not only for CHF-specific admissions, but also for all-cause admissions. It may be valuable for future work in this area to examine cost-effectiveness and to use more rigorous randomized designs.

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**Table 1.** Patient Engagement with Intervention Protocol by Demographic and Personal Characteristics.

Characteristic N (%) Engagementa 30 days Engagementa 60 days Engagementa 90 days Engagementa 120 days

Median (IQR) Median (IQR) Median (IQR) Median (IQR)

Sex

Male 14 (29) 97 (93, 100) 97 (95, 98) 96 (91, 98) 96 (93, 98)

Female 34 (71) 97 (93, 100) 95 (88, 98) 97 (88, 99) 96 (89, 98)

Race

White 22 (46) 95 (90, 100) 95 (88, 98) 94 (88, 99) 95 (86, 98)

Black 26 (54) 97 (93, 100) 97 (93, 98) 97 (92, 98) 96 (93, 98)

Age

<65 30 (63) 95 (93, 100) 97 (90, 98) 97 (90, 98) 96 (92, 98)

65 and up 18 (38) 98 (93, 100) 96 (88, 100) 96 (92, 99) 95 (93, 98)

Lives Alone

No 29 (60) 93 (93, 100) 97 (90, 98) 94 (90, 98) 95 (92, 98)

Yes 19 (40) 100 (93, 100) 97 (90, 100) 97 (92, 99) 96 (93, 98)

Dual Eligible

No 16 (33) 95 (92, 100) 95 (92, 97) 95 (91, 97) 96 (89, 98)

Yes 32 (67) 98 (93, 100) 97 (89, 98) 97 (91, 99) 96 (92, 98)

PHQ-2

Negative 37 (77) 100 (93, 100) 97 (90, 98) 97 (91, 99) 96 (93, 98)

Positive 11 (23) 93 (90, 97) 95 (83, 97) 97 (88, 98) 96 (86, 97)

Mini-Cognitive Battery

Negative 38 (79) 97 (93, 100) 97 (92, 98) 97 (92, 99) 96 (93, 98)

Positive 10 (21) 93 (93, 100) 94 (90, 98) 93 (90, 96) 93 (86, 95)

LACEb

0-10 26 (54) 97 (93, 100) 97 (83, 98) 97 (86, 99) 97 (86, 98)

11 or more 22 (46) 97 (93, 100) 96 (92, 98) 95 (92, 98) 95 (93, 98)

Fall Risk

No 29 (60) 100 (93, 100) 97 (93, 98) 97 (93, 99) 97 (93, 98)

Yes 19 (40) 97 (93, 100) 95 (83, 98) 94 (88, 98) 94 (86, 98)

*Abbreviations: PHQ-2, patient health questionnaire screening instrument; Dual Eligible (NO, Medicaid & YES, both Medicaid and Medicare); LACE, Length of stay / Acute admission / Comorbidities / Emergency department visits in the past month.*

*Note: P-Values were computed using Mann-Whitney U tests comparing engagement scores by each characteristic. Non-parametric testing was indicated because of non-normality of the dependent variable (adherence).*

*a Engagement was defined as the percentage of days since discharge on which the patient successfully completed the intervention protocol.*

*b Higher LACE scores indicate greater likelihood of readmission.*

**Table 2.** Comparison of CHF-Specific and All-Cause Admissions and Readmissions during the Intervention and Comparison Periods.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Comparison Period | Intervention Period | *P* a | Percent Change |
| CHF-Specific Admissions | 15 | 7 | .007 | -53% |
| CHF-Specific Readmissions | 6 | 1 | .01 | -83% |
| All-Cause Admissions | 32 | 24 | .01 | -25% |
| All-Cause Readmissions | 14 | 6 | .006 | -57% |

a Computed using binomial tests comparing intervention admission rate with expected admission rate from the comparison period.