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The Effect of Rehospitalization and Emergency Department Visits on Subsequent Adherence to Weight Telemonitoring

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Better Effectiveness After Transition–Heart Failure (BEAT-HF) Research Group

Abstract

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The authors have no conflicts of interest to disclose.

Background: Weight telemonitoring may be an effective way to improve patients' ability to manage heart failure and prevent unnecessary utilization of health services. However, the effectiveness of such interventions is dependent upon patient adherence.

Objective: The purpose of this study was to determine how adherence to weight telemonitoring changes in response to 2 types of events: hospital readmissions and emergency department visits.

Methods: The Better Effectiveness After Transition–Heart Failure trial examined the effectiveness of a remote telemonitoring intervention compared with usual care for patients discharged to home after hospitalization for decompensated heart failure. Participants were followed for 180 days and were instructed to transmit weight readings daily. We used Poisson regression to determine the within-person effects of events on subsequent adherence.

Results: A total of 625 events took place during the study period. Most of these events were rehospitalizations (78.7%). After controlling for the number of previous events and discharge to a skilled nursing facility, the rate for adherence decreased by nearly 20% in the 2 weeks after a hospitalization compared with the 2 weeks before (adjusted rate ratio, 0.81; 95% confidence interval: 0.77–0.86; $P < .001$).

Conclusions: Experiencing a rehospitalization had the effect of diminishing adherence to daily weighing. Providers using telemonitoring to monitor decompensation and manage medications should take advantage of the potential “teachable moment” during hospitalization to reinforce the importance of adherence.

Keywords

adherence; compliance; heart failure; telemonitoring

Heart failure is the most common cause of hospital readmissions among adults older than 65 years, with as many as 50% of patients being readmitted in the first 6 months after initial discharge.[1] Hospitalizations for decompensated heart failure are often associated with increased body weight within the week before admission.[2-4] As a result, daily weighing is an important management strategy for patients with heart failure. The American Heart Association emphasizes the importance of daily weight checks for patients with heart failure, recommending that patients check in with a provider in the case of sudden weight gain.[5] Weight telemonitoring, in which patients transmit weight readings directly to a provider, has emerged as a tool to help patients and providers manage heart failure, reduce hospital readmissions, and improve patient satisfaction.[6-10] A 2015 Cochrane review on telemonitoring for heart failure found moderate-quality evidence for lowering all-cause mortality and heart failure–related hospitalizations and very-low-quality evidence for decreasing all-cause hospitalizations.[6] A 2019 systematic review found a significant decrease in mortality associated with home telemonitoring.[9]

The limited effectiveness of telemonitoring studies may be explained in part by low adherence to telemonitoring interventions. However, data on adherence to telemonitoring are not widely available and existing measures of adherence vary widely. Most previous telemonitoring studies for heart failure have not reported on adherence to the telemonitoring intervention. Of the previous interventions that included a home weighing component, only

11 reported some measure of adherence, ranging from 50% to 95% adherence to the study protocol.[11-20] However, these results should be interpreted with caution. First, 4 are small studies or pilot studies with fewer than 60 participants randomized to the intervention group.[14,17,19,20] Second, several studies describe extremely resource-intensive interventions that involved personalized treatment plans or parameters for each patient and a significant interaction component between patients and clinicians.[11,16] Third, 7 of these studies took place in Europe, where cultural and health delivery differences may account for differences in adherence.[13,15-20] Finally, because studies differ widely in the way adherence is defined and measured, it is impossible to compare studies.

To date, no studies have examined the way that events occurring during a period of home telemonitoring may change adherence over time. There are several theories that provide a rationale for how health or life events may change adherence. One of these is the sentinel event effect, which refers to the phenomenon of behavior change after a triggering event, or "close call." This pattern has been identified in numerous studies and has led to the concept of the "teachable moment," an opportunity for education or intervention at a point when patients have an increased motivation for behavior change.[21,22] Emergency department (ED) visits and hospital readmissions may act as a triggering event for patients with heart failure, which may encourage them to commit more fully to health management strategies, including improved adherence to the telemonitoring intervention. The health belief model, which has been widely used to predict adherence to self-care and preventive care regimens, refers to these types of triggers as "cues to action."[23-27] A rehospitalization or ED visit may serve as a cue to action by changing the way that the individual perceives both the severity of heart failure and his or her susceptibility to heart failure exacerbations.[23,28] Although cues to action have been less frequently studied than other health belief model variables,[29] there is evidence that both external and internal cues can predict health behaviors, including adherence.[30-34]

To better understand how adherence to daily weighing may change in response to health events, we performed a secondary analysis using data collected as part of a large randomized controlled trial on heart failure telemonitoring. The goal of this analysis was to understand the relationship of adherence to potentially triggering events, such as hospitalizations or ED visits, that may promote behavior change.

METHODS

Intervention

The Better Effectiveness After Transition–Heart Failure (BEAT-HF) trial examined the effectiveness of an intervention involving wireless remote telemonitoring, compared with usual care, for patients discharged to home after hospitalization for decompensated heart failure. The intervention included predischarge heart failure education, regularly scheduled calls with a study nurse, and a Bluetooth-enabled telemonitoring system that included a wireless transmission pod, weight scale, blood pressure cuff, heart rate monitor, and device that allowed for the display and response of selected symptoms. Participants were followed for 180 days and were instructed to transmit weight, blood pressure, heart rate, and responses to 3 symptom questions daily. Participants also completed surveys at

baseline, 7 days, 30 days, and 180 days. Survey questions collected data on demographic characteristics, social support, health literacy, self-care, quality of life, caregiving support, depression, and comorbidities. Calls with a study nurse were scheduled weekly during the first month of the intervention and monthly for the next 5 months. The original BEAT-HF study was approved by the University of California, Los Angeles institutional review board.

Participants

All participants were 50 years or older and had been hospitalized for decompensated heart failure at 1 of 6 participating academic medical centers between October 12, 2011, and September 30, 2013. Participants were excluded if they lacked the cognitive or physical ability to participate, were in a contact-intensive care environment such as a skilled nursing facility, or were expected to improve because of medical procedures during hospitalization. A total of 1437 patients were randomized either to the telemonitoring intervention (n = 722) or to usual care (n = 715). Complete details on the original study can be found in the study protocol and primary outcomes paper.[35,36] For this analysis, we focused on adherence to the daily weighing portion alone. To measure overall adherence, we removed days in which participants were hospitalized or seen in the ED from the denominator. Because we were interested in changes in adherence, we restricted the analysis to participants who transmitted at least 1 weight value during the study period; this also allowed us to exclude patients who were enrolled but who never set up the equipment or participated in the intervention.

Statistical Analysis

For each patient, we identified each triggering event (hospitalization or ED visit) and then created a pair of analysis records for that event, 1 a “pre-event” record describing adherence during what was typically a 14-day interval leading up to the event, the other a “postevent” record describing what was typically the 14-day posthospitalization interval immediately after that event. Intervals could be less than 14 days if truncated by another event or by the end of the study period. We then fit a conditional fixed-effects Poisson regression model for panel data, treating the pair of event records for each event as a panel, to determine the within-person effects of hospitalizations and ED visits on subsequent adherence. The dependent variable in these models was the total number of adherent days in the given interval, and the natural logarithm of the length of the interval was used as an offset term. Hence, we modeled adherence rates, and when the Poisson regression coefficients (and linear combinations of them) are exponentiated, they represent adjusted incidence rate ratios for adherence. For the first model, examining the effect of hospitalization on adherence, we controlled for discharge to a skilled nursing facility by including it as a covariate in the model; although patients were excluded from the study if they were discharged to skilled nursing facility after the enrollment visit, study participants could have been discharged to a skilled nursing facility after a rehospitalization. We formally tested effect modification using the Wald χ^2 test for interaction terms. To address concerns that discharge to a skilled nursing facility could modify the effects of the exposures on the outcomes, we performed a robustness analysis by modeling change in adherence excluding hospitalizations that ended in discharge to a skilled nursing facility. We fit a separate model for patients with ED visits. All statistical analyses were performed using Stata version 14.2.

RESULTS

Of the 722 participants assigned to the intervention arm of the BEAT-HF trial, 654 transmitted at least 1 weight value. Of these participants, 292 experienced at least 1 hospitalization or ED visit. Our sample includes only these 292 participants. Table 1 shows demographic characteristics of the sample. Most participants were male (52.7%) and unmarried (57.9%) and had less than a college education (65.1%). During the study period, 10.6% of participants died. The demographic characteristics of this subset of participants closely matches those of the intervention group reported in the primary outcomes paper.

Table 2 shows event characteristics for the sample. We define “events” as a hospitalization or ED visit occurring after discharge from the index hospitalization during which the participant was recruited into the trial. A total of 625 events took place during the study period. Most of these events were rehospitalizations (78.7%). The number of events experienced by participants ranged from 1 to 10, with a median of 2. The day of the first event varied widely, ranging from the first day after discharge to 180 days after discharge. Overall, 16.2% of events were followed by no additional transmissions during the study period. Of the 164 hospitalizations that resulted in a discharge to a skilled nursing facility, 39 (23.8%) were not followed by any subsequent weight transmissions. For the 300 hospitalizations and 112 ED visits that resulted in a discharge to home, 39 (13.0%) and 18 (16.1%), respectively, did not transmit again. Mean total adherence, which was defined as the proportion of at-home days in which a weight value was transmitted, was 49%. Crude measures of adherence for hospitalizations and ED visits are shown in Table 3.

Table 4 shows incidence rate ratios for postevent adherence. After controlling for the number of previous events and discharge to a skilled nursing facility, the rate for adherence decreased by nearly 20% in the 2 weeks after a hospitalization compared with the 2 weeks before (adjusted rate ratio, 0.81; 95% confidence interval, 0.77–0.86; $P < .001$). Wald tests showed that there was no statistically significant evidence for effect modification from discharge to a skilled nursing facility on event number ($P = .904$) or posthospitalization period ($P = .935$). Results of the robustness analysis are also included in Table 4. When excluding hospitalizations that ended with discharge to a skilled nursing facility, adherence rates were still significant, decreasing by 13% (adjusted rate ratio, 0.87; 95% confidence interval, 0.81–0.93, $P < .001$). Emergency department visits alone were not associated with a change in adherence rates.

DISCUSSION

Interpretation of Results and Comparison to Previous Studies

Although previous studies have explored how management behaviors, self-efficacy, attitudes, and other factors may act as predictors of hospitalization, we did not find any studies that explored the converse relationship, that is, the effect of hospitalization on management behaviors, attitudes, and other factors that may contribute to health and mortality. In this study, it was attempted to fill that gap by examining how hospitalization and ED visits may affect adherence to daily weighing for patients with heart failure.

Our findings indicate that experiencing a rehospitalization did not have the expected effect of triggering an increase in adherence. Rather, rehospitalization had the effect of diminishing adherence to daily weighing. There are several possible explanations for this result. First, a rehospitalization may undermine a patient's perception of the usefulness of daily weighing. If previous adherence to the telemonitoring intervention was not successful at avoiding a readmission, the patient may be less likely to continue with the intervention. Second, it is likely that some patients may have felt unwell or depressed after the hospitalization, which may have decreased their ability or willingness to step on the scale. This may be a result of "posthospital syndrome," which describes increased vulnerability of patients after a hospitalization owing to psychologic and physiologic stress.[37,38] Previous studies have found that depression and anxiety are associated with lower adherence to self-management behaviors and increased rates of readmission within 30 days.[37,39-42] If a rehospitalization increases stress and exacerbates comorbidities, this could contribute to a decrease in adherence to daily weighing and other management behaviors essential to managing heart failure. That each subsequent hospitalization results in a lower level of postevent adherence supports this idea. Finally, because patients may be more closely monitored in the period after a rehospitalization, it is possible that the telemonitoring intervention is redundant and therefore unnecessary. This may partially explain the finding of decreased adherence after discharge to a skilled nursing facility. This effect is also likely explained by the fact that some patients may not have access to the Bluetooth-enabled scale during their stay in the facility. Facilities may also inhibit telemonitoring because of policy or liability concerns. However, many patients (n = 54) resumed daily weighing 1, 2, and 3 days after a discharge to a skilled nursing facility, demonstrating that this type of discharge does not necessarily impede adherence to telemonitoring.

Our findings showed that ED visits did not have the same diminishing effect on postevent adherence as rehospitalization. This difference may be explained by the fact that ED visits occur only for 1 day and a discharge home implies a better health status than does a hospital admission. Neither event acted as a "trigger" for patients to increase adherence to the telemonitoring intervention. This may represent a missed opportunity for providers to reengage patients to improve self-management. Hospitalizations have been found to be effective teaching moments for patients managing chronic disease. Fonarow et al[43] found that adherence to a medication protocol was significantly improved when therapy began during the hospital visit, compared with therapy that began after discharge. Other studies have found hospital settings to be effective for reducing alcohol and tobacco consumption.[44-46] Patient discharge education commonly includes counseling on daily weighing and monitoring of symptoms, salt and fluid intake, and medication adherence. An approach more focused on the purpose of telemonitoring and the importance of adherence during the hospital stay may have improved adherence.

Limitations

This study had several limitations. First, we did not have data on how long patients stayed in a skilled nursing facility before returning home. This may have limited our ability to calculate a posthospitalization interval after patients returned to their home, which may have limited our ability to accurately calculate a postevent interval for these events. Providers

should take into account discharge to skilled nursing facilities when planning telemonitoring programs; intervention during this vulnerable period may have the ability to improve adherence upon returning home. Second, we were not able to account for heterogeneity in the reason for readmission; it is possible that certain reasons for readmission could be related to a loss of functional status, which may drive lower adherence. We also did not have data on how many patients may have transitioned to hospice care during the study period, which would likely have diminished adherence to the intervention. Third, we did not have data on how study personnel communicated with participants after a hospitalization. If study personnel followed up with patients immediately after a hospitalization and counseled them on daily weighing, this may have increased postevent adherence. Fourth, we were unable to account for other factors that may have accounted for changes in adherence prehospitalization and posthospitalization, such as scheduled hospital visits, scheduled calls with study staff, and technical problems. However, because we have no reason to believe that these factors would preferentially affect the period before or after the event, these factors are unlikely to explain our results. Fifth, scale transmission error could have affected the results. For example, participants may have experienced technical issues with the device that prevented participant from adhering as intended. Data on frequency and timing of technical issues would allow for a better understanding of how these types of problems may affect adherence. Finally, it is important to acknowledge that this study relied on data from a telemonitoring intervention that took place in 2011–2013; improved modern technology may improve both the effectiveness of telemonitoring for heart failure and patient adherence.

CONCLUSIONS

Weight telemonitoring may have the ability to improve patient outcomes and decrease hospital readmissions. However, adherence to daily weighing is essential for the success of this type of regimen. This study contributes to the literature by providing a deeper understanding of how hospitalizations and ED visits can affect a patient's subsequent adherence to daily weighing. Further research will show how providers using telemonitoring to monitor decompensation and manage medications can take advantage of the potential “teachable moment” during hospitalization to reinforce the importance of adherence to daily weighing.

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What's New and Important

- Adherence to weight telemonitoring for patients with heart failure is likely to decrease after a rehospitalization
- Rehospitalizations and ED visits present a potential "teachable moment" where the importance of adherence to daily weighing, medications, and other management behaviors could be reinforced

Table 1

Demographic Characteristics of Participants (N = 292)

	n (%)
Gender	
Male	154 (52.7)
Female	134 (45.9)
Race	
White	132 (45.2)
Black	78 (26.7)
Hispanic	38 (13.0)
Asian	18 (6.2)
Other	21 (7.2)
Education	
<High school	51 (17.5)
High school graduate	139 (47.6)
College graduate	67 (23.0)
Advanced	29 (9.9)
Marital status	
Not married	169 (57.9)
Married	116 (39.7)
Annual household income	
<$25 000	97 (33.2)
$25 001–$50 000	58 (19.9)
$50 001–$75 000	31 (10.6)
>$75 000	43 (14.7)
Died in study	
Died during study	31 (10.6)
Did not die during study	261 (89.4)
Age, median (interquartile range), y	72 (61–83)

TABLE 2

Events During the Study Period for Participants Experiencing at Least 1 Hospitalization or Emergency Department Visit

	Mean (SD)	Median (Range)	N
Total number of events (hospitalization or ED visit)	2.18 (1.56)	2 (1,10)	625
Total hospitalizations	1.73 (1.39)	1 (0,8)	492
Total ED visits	0.46 (0.83)	0 (0, 6)	133
Day of first event after index hospitalization	57.44 (50.00)	40 (2,180)	625
First transmission after rehospitalization (discharge to home)	9.28 (16.17)	4 (1,105)	261
First transmission after rehospitalization (discharge to SNF)	11.55 (14.02)	6 (1,74)	125
First transmission after ED visit	5.86 (9.88)	2 (1,53)	112

Abbreviations: ED, emergency department; SNF, skilled nursing facility.

TABLE 3

Crude Study Adherence for Participants Experiencing at Least 1 Hospitalization or Emergency Department Visit

	Pre-Event	Postevent
Hospitalizations (n = 492)		
Number of adherent days	2624	1993
Number of days at risk	5916	5414
Crude adherence rate	0.44	0.37
ED visits (n = 133)		
Number of adherent days	749	747
Number of days at risk	1565	1461
Crude adherence rate	0.48	0.51

Abbreviation: ED, emergency department.

TABLE 4

Incidence Rate Ratios and 95% Confidence Intervals for Adherence, Adjusted for Selected Confounders

	IRR (95% CI)	*P*
Model 1: Effect of hospitalizations on subsequent adherence, adjusted for event number and discharge to skilled nursing facility (N = 492)[a]		
Adherence		
Posthospitalization	0.81 (0.77–0.86)	<.001
Event number	0.93 (0.89–0.97)	.002
Discharge to skilled nursing facility	0.88 (0.76–1.02)	.100
Robustness analysis: Effect of hospitalizations on subsequent adherence, excluding patients discharged to a skilled nursing facility (N = 366)		
Adherence		
Posthospitalization	0.87 (0.81–0.93)	<.001
Event number	0.93 (0.87–0.97)	.003
Model 2: Effect of ED visits on subsequent adherence, adjusted for event number (N = 133)		
Adherence		
Post-ED visit	1.04 (0.94–1.15)	.458
Event number	0.88 (0.82–0.93)	<.001

Abbreviations: IRR, incidence rate ratio; CI, confidence interval; ED, emergency department.

[a]We found that there was no statistically significant evidence for effect modification from discharge to a skilled nursing facility on event number (P = .904) or posthospitalization period (P = .935).