Nurse-Led Collaborative Management Using Telemonitoring Improves Quality of Life and Prevention of Rehospitalization in Patients with Heart Failure
A Pilot Study

Mariko Mizukawa,1 MSN, Michiko Moriyama,1 PhD, Hideya Yamamoto,1 MD, Md M Rahman,1 PhD, Makiko Naka,1 MSN, Toshiro Kitagawa,2 MD, Shizue Kobayashi,1 CN, Noboru Oda,3 MD, Yuji Yasunobu,4, Miyuki Tomiyama,4 MSN, Nobuyuki Morishima,1 MD, Keiji Matsuda,6 MD and Yasuki Kihara,1 MD

Summary
The effects of disease management using telemonitoring for patients with heart failure (HF) remain controversial. Hence, we embedded care coordination and enhanced collaborative self-management through interactive communication via a telemonitoring system (collaborative management; CM). This study evaluated whether CM improved psychosocial status and prevented rehospitalization in patients with HF in comparison with self-management education (SM), and usual care (UC).

We randomly allocated 59 patients into 3 groups; UC (n = 19), SM (n = 20), and CM (n = 20). The UC group received one patient education session, and the SM and CM groups participated in disease management programs for 12 months. The CM group received telemonitoring concurrently. All groups were followed up for another 12 months. Data were collected at baseline and at 6, 12, 18, and 24 months.

The primary endpoint was quality of life (QOL). Secondary endpoints included self-efficacy, self-care, and incidence of rehospitalization. The QOL score improved in CM compared to UC at 18 and 24 months (P < 0.05). There were no significant differences among the 3 groups in self-efficacy and self-care. However, compared within each group, only the CM had significant changes in self-efficacy and in self-care (P < 0.01). Rehospitalization rates were high in the UC (11/19; 57.9%) compared with the SM (5/20; 27.8%) and CM groups (4/20; 20.0%). The readmission-free survival rate differed significantly between the CM and UC groups (P = 0.020).

We conclude that CM has the potential to improve psychosocial status in patients with HF and prevent rehospitalization due to HF.

Key words: Telenursing, Disease management, Self-care

The number of patients with heart failure (HF) has been substantially increasing worldwide.1,2 Although advances in pharmacological treatments and medical technologies have improved survival rates in patients with HF, the prognosis of patients with HF remains poor,3 and many patients still experience recurrences and rehospitalization due to HF. Also, patients with HF report a large number of distressing symptoms that are associated with worse quality of life (QOL).4

The rate of readmission for exacerbation of HF at 6 months after discharge from the hospital is reported to be 25% in Europe, and 27% in the United States and Japan.6,7 One of the reasons for readmission is lack of self-management, such as inconsistent reduction of water and salt intake, medication nonadherence,7 and a lack of early detection of symptoms and timely feedback for prompt treatment, including hospital visits. Thus, it is critical for patients to acquire self-management skills, and timely access to medical resources. Several HF disease management trials designed to enhance self-management have been conducted since the mid 1990s, and these trials have led to reduced readmission and improved survival and
QOL. However, some patients are still unable to acquire adequate self-management skills despite participating in an educational program in self-management.

Recently, disease management programs that include use of a telemonitoring system for patients with HF have been implemented, and these are largely expected to reduce rehospitalization. The effectiveness of telemonitoring for patients with HF has been assessed in several reviews. However, these reviews reported controversial results, with some studies not supporting the benefits of telemonitoring to reduce rehospitalization and improve their QOL. One reason for not finding significant benefits of telemonitoring on rehospitalization is the absence of interactive communication between patients and their healthcare providers.

As most patients with HF are elderly people suffering from comorbid conditions with severe symptoms, they need medical advice and support in their daily household affairs. Hence, we advocated that timely feedback for assessment, appropriate care coordination, and enhancement of patient self-management should be embedded within the alarming system of a telemonitoring program which we considered as collaborative management (CM). Therefore, our operational definition of CM was a patient working collaboratively with health care professionals to identify problems and manage their diseases and daily life, using a telemonitoring system with timely care coordination in this study. CM is care that strengthens and supports self-management skills and early detection of aggravation symptoms and promotes taking collaborative action to deal with problems related to aggravation.

Thus far, there have been no studies comparing a self-management program (SM) with SM with telemonitoring and usual care. Therefore, we designed a 3-armed trial. We hypothesized that CM was most required for patients who have severe symptoms and need self-management to improve QOL. For patients who stay at home and have severe symptoms, health care workers need a careful intervention; therefore, we used a small sample size as a pilot study.

The goal of HF treatment should not only be prolongation of survival, but also ensuring that the patient has a high QOL, as patients with HF have physical limitations, debilitating symptoms, difficulty coping with treatment, poor knowledge, distressing emotions, multiple comorbidities, and personal struggles.

The purpose of the present study was to compare the effectiveness of CM and SM with usual care in improving psychosocial status (as assessed by QOL, self-efficacy, and self-care behavior scores) among patients who experienced hospitalization for HF. We also compared their effectiveness in reducing rehospitalization and all-cause mortality within 24 months.

Methods

Study design: This study was a pilot, open-label, 3-arm randomized controlled trial (RCT) conducted among outpatients with a diagnosis of HF at 5 acute care hospitals in Hiroshima Prefecture, Japan. These 5 hospitals are designated centers that provide cardiac rehabilitation and develop and implement disease management systems for patients with HF in the community. The study duration was 24 months in total, which was divided into a 12-month intervention period and a 12-month observation period. The study period was from January 2013 to September 2015.

Setting and sample: Patients with a diagnosis of HF who met the criteria and agreed to participate were assessed by nurses to determine their eligibility for inclusion in this study. The inclusion criteria were as follows: diagnosed with HF, classified as New York Heart Association (NYHA) Class II to IV at registration, but III or IV when exacerbated; has at least one previous admission for HF or one unplanned hospital visit for exacerbation of HF within the 2 years prior to registration; and currently living at home.

The exclusion criteria were as follows: severe comorbidity that had a treatment priority; inability to stand for body weight measurement; inability to communicate by telephone; cognitive impairment scores of ≤ 20 out of 30 on the revised Hasegawa’s Dementia Scale; and physical difficulty undergoing the trial procedure.

Procedure and randomization: After providing written informed consent, patients were randomly allocated into one of the following 3 study groups: the usual care (UC) group, the Self-Management (SM) group which underwent the self-management program, and the Collaborative Management (CM) group which underwent the same self-management as in the SM group plus a collaborative management program with telemonitoring. As this was a pilot study, we used a feasibility approach to determine the sample size. Recruitment ended when the total number of patients reached 60.

A research assistant at a HF research center conducted stratified random allocation using the permuted block method. As the prognosis of HF varies depending on severity and etiology, patients were randomized into one of the 3 groups after stratification by NYHA class (II or III/IV), cause of HF (ischemic or no ischemic heart disease), left ventricular ejection fraction (LVEF) (< 40% or ≥ 40%), estimated glomerular filtration rate (< 60 or ≥ 60 mL/minute/1.73 m²), and use of insulin. At registration, medical histories including comorbidities, treatments, and prescribed medications and laboratory test data were obtained from the patients’ medical records. In addition, questionnaires were administered to the patients by the research nurses. The study protocol was reviewed and approved by the institutional review board of Hiroshima University Hospital (Approval No. 350) and the institutional review board of each hospital. Written informed consent was obtained from each patient. This study was conducted in accordance with the Declaration of Helsinki. The trial was registered with the University Hospital Medical Information Network clinical trial registry (No. UMIN000030221).

Study intervention: Table I describes the intervention contents in each group. Patients in all groups were provided with a notebook in which they were required to record daily self-monitoring data such as weight, blood pressure (BP), and pulse. Patients in the UC group received one standard education session at enrollment using a pre-existing booklet. Patients were provided HF treat-
ment by their physician. Patients in the intervention groups (SM and CM groups) participated in disease management programs for 12 months. In addition, patients in the CM group received telemonitoring intervention. All patients were then followed up for another 12 months.

More specifically, the patients in the intervention groups received monthly face-to-face counseling provided by intervention nurses for the first 6 months, which is the minimum duration required for behavior modification. Each session lasted 30 minutes. We used educational booklets developed by researchers according to clinical guidelines and were based on ethnological field observation at home and interviews with patients who have HF and discussions with cardiologists, chronic disease nurse specialists, and dieticians. The content of the educational sessions included knowledge about the etiology and self-management of HF; symptom and sign management; diet, especially salt and water restriction; smoking cessation; reduction of alcohol intake; adherence to medications; physical activity/exercise; prevention of infection; and stress management.

In the first educational session, the intervention nurses identified risk factors by assessing laboratory test data, conducting interviews regarding diet and daily activities, collecting psychosocial information, and assessing the patients’ physical conditions. Then, the nurse and the patient worked together to develop a long-term goal for the program and short-term goals (action plans related to the management of diet, exercise, and other daily activities) for the following months. For the first 6 months, the nurse evaluated the patient’s records, referring to laboratory data during the monthly sessions, and revised action plans for the following months to increase the patients’ self-efficacy. To anchor the behavioral changes made, the intervention nurse asked each patient about their emotional and physical changes and praised their achieved goals. The monthly evaluation and revision of action plans by the nurses continued for the following 12 months.

In addition, patients received noninvasive physiologic telemonitoring devices to measure BP, pulse rate (PR), and body weight for 12 months. The patients set up the devices at home and were asked to take measurements daily. The data were transmitted to the nurse’s computer, which was situated at a research center. The intervention nurses checked the data at 10:00 every morning. If one of the data points exceeded the prespecified personal normal range, as determined by cardiologists on an individual basis, the nurse immediately called the patient and assessed the causes of the abnormalities, such as diet and activities, and then provided additional guidance and advice if needed. The intervention nurse arranged physician visits or contacted the patient care manager for care coordination, as needed.

Commercially available telemonitoring devices were used to monitor weight and BP (HM5000P and CH-550P, respectively; CITIZEN SYSTEMS CO. LTD., Tokyo). The data were transmitted wirelessly via a Bluetooth connection to the server software application, Multihome gateway, which was developed by CYBERCROSS JAPAN CO. LTD, (Tokyo).

To ensure quality, 9 intervention nurses were recruited from 5 hospitals, and they underwent training sessions in the management of HF and behavioral modification counseling. During the intervention, the nurses conducted monthly conferences to review their interventions together with specialized nurses.

**Study endpoints:** Scores for QOL were set as the primary endpoint despite setting outcomes broadly to assess the effects of CM with telemonitoring in this pilot study.

The secondary endpoints were scores for self-efficacy and self-care behavior, rehospitalization for HF, all-cause mortality, and a composite of rehospitalization for HF and all-cause mortality to compare the effects of the programs. In addition, to evaluate the feasibility of the program, the rate of continuation was assessed.

**Primary endpoint — scoring of quality of life (QOL):** The Minnesota Living with Heart Failure Questionnaire (MLWHFQ) was used to assess patient QOL.

The MLWHFQ (reliable with weighted kappa of 0.84) is a self-administered 21-item questionnaire. Scores range from 0 to 105, with higher scores indicating poorer QOL.

**Secondary endpoints — self-efficacy, self-care behavior, rehospitalization for HF, all-cause mortality, and a composite of rehospitalization for HF and all-cause mortality:** The Chronic Disease Self-Efficacy Scale (CD-SES) and European Heart Failure Self-Care Behavior Scale (EHFScBS) were used to assess patient self-efficacy and self-care behavior, respectively. The CD-SES (reliable with Cronbach’s alpha of 0.89) consists of a self-administered 24-item questionnaire. Scores range from 24 to 96, with higher scores indicating higher self-efficacy. We used a Japanese version of the EHFScBS (total Cronbach’s alpha of 0.71, suggesting that internal consistency was satisfactory; the intraclass correlation coefficient of the scale was 0.69 and weighted kappa for individual items was 0.33-0.87, suggesting that test-retest reliability was adequate); this instrument consists of a 12-item self-administered questionnaire. Scores range from 12 to 60, with higher scores indicating poorer self-care behavior.

### Table 1. Intervention Details

| Intervention Details                              | UC group | SM group | CM group |
|--------------------------------------------------|----------|----------|----------|
| Physician visit (once in 2-4 weeks depending on condition of patient) | +        | +        | +        |
| Discharge education 1 time at enrollment         | +        | N/A      | N/A      |
| Recording weight, blood pressure, and pulse on self-management notebook | +        | +        | +        |
| Self-management education 1 time/month × 6 times  | N/A      | +        | +        |
| Telemonitoring: a nurse checks data and calls patients as needed for 12 months | N/A      | N/A      | +        |

UC indicates usual care; SM, self-management; CM, collaborative management; and N/A, not applicable.
Parameters of QOL, self-efficacy, and self-care behavior were assessed at enrollment and at 6, 12, 18, and 24 months. This information was collected directly by research nurses or completed by the patients themselves and returned via postal mail.

All data, including hospitalization for HF, were collected from medical records by the intervention nurses at each hospital. Hospitalization for HF was defined as an unplanned overnight stay in a hospital because of progression in HF symptoms or directly related to HF.

**Data analysis:** Data analysis was performed according to the intention-to-treat principle by the assigned group. To ensure comparability of the randomized samples, all baseline outcomes at the time of registration were analyzed. Data are expressed as the mean ± standard deviation. The Kruskal-Wallis test was used to compare continuous variables with a skewed distribution among the 3 groups. Categorical variables are expressed as number (%) and were compared using the chi-square test.

To compare changes in the MLWHFQ, CD-SES, and EHFScBS scores among the 3 groups, the Kruskal-Wallis test was performed. Pairwise comparisons were made for further exploration using the Mann-Whitney U test. Friedman’s test was performed to observe within-group comparisons, and the Wilcoxon signed-rank test was used to compare changes at 6, 12, 18, and 24 months from baseline, when these were significant.

Because the baseline-observation-carried-forward (BOCF) approach shows similar results as observed case analysis, it was used to account for the missing data from patients who discontinued the study, to evaluate the changes in CD-SES, MLWHFQ, and EHFScBS scores. Kaplan-Meier curves were generated for time-to-event analysis. Cumulative incidence curves in the 3 groups were compared using a log-rank test. A corresponding hazard ratio and 95% confidence interval was estimated using Cox proportional hazards models. The significance level was set at <0.05. Statistical analyses were performed using IBM SPSS version 21 (IBM Corp., Armonk, NY, USA).

**Results**

**Baseline features and completion rate of the study:** A total of 61 patients were recruited into the study by cardiologists from 5 hospitals between January 2013 and September 2013; of these, 59 agreed to participate. After randomization, 19 patients were enrolled in the UC group, 20 in the SM group, and 20 in the CM group. One patient withdrew consent immediately after randomization. Another patient was re-hospitalized for HF and died before baseline data collection and intervention; both of these patients were in the SM group. Therefore, of the remaining 57 patients, 19 patients were assigned for analysis in the UC group, 18 in the SM group, and 20 in the CM group (Figure 1). The baseline characteristics of the patients were similar among the 3 groups (Table II). The mean age was 71.6 years and 62.7% of the patients were male. The principal causes of HF were ischemic (30.5%), cardiomyopathy (27.1%), and valve-related (27.1%). Hypertension was the most common comorbidity. In total, 57.6%, 40.7%, and 1.0% of the patients were classified as NYHA class II, III, and IV, respectively. The mean LVEF was 41.8%. Regarding medication, 78.0% of the patients had received beta-blockers, and 67.8% had received an angiotensin-converting-enzyme inhibitor or angiotensin-receptor blocker.

As shown in Figure 1, patients were followed for a median of 24.0 months (range, 1.4-24 months). Fifteen patients (78.9%) in the UC group, 14 (77.8%) in the SM group, and 15 (75.0%) in the CM group completed the 24-month study. During the first year, 7 patients discontinued their participation (UC group, n = 2; SM group, n = 2; CM group, n = 4), and during the following year, 6 patients were lost to follow-up (UC group, n = 2; SM group, n = 2; CM group, n = 2). Over the study period, all-cause mortality was observed in 3 (15.8%), 4 (22.2%), and 3 (15.0%) patients in the UC, SM, and CM groups, respectively. Among them, two patients who had dropped out of the study died (in SM and CM groups) due to HF.

**Implementation of collaborative management:** With respect to adherence of the 20 patients in the CM group to the measurement of daily vital signs and allowing nurses to check their data and call them when there were abnormal data we report the following. Two patients discontinued the study due to long-term hospitalization for a non-cardiac cause and death from HF and one patient withdrew consent at 3 months. The completion rate of the 12-month program in the CM group was 85.0% (Figure 1). Two patients transmitted their data intermittently. Thus, 14 (70.0%) participants were at least 70.0% compliant with daily data transmission using telemonitoring, with no break in information transfer for >30 days (except during hospitalization).

Regarding the number of contacts by phone in the CM group, a total of 162 calls were made by intervention nurses during the 12-month monitoring period; the reasons for calls were weight gain/loss, elevated/decreased BP, tachycardia/bradycardia, missing transmitted data, guidance and advice, care coordination, and confirmation of the patient’s condition after providing advice. The frequency of calls made by intervention nurses varied depending on the patient. Two patients received only one telephone call throughout the entire 12-month period. Ten patients received 2 to 10 calls, and 4 patients had 11 to 20 calls. One patient had 47 telenursing interventions, which was the maximum.

**Primary endpoint — QOL:** Figure 2A shows the score changes in QOL from baseline to each time point (6, 12, 18, and 24 months). The QOL scores in the CM group were significantly different from the remaining two groups (P = 0.029 at 18 months and P = 0.039 at 24 months) when the 3 groups were compared. Thus, pairwise comparisons were made for further exploration. Scores significantly improved in the CM group compared with the UC group at 18 and 24 months (P = 0.014, P = 0.016, respectively) and with the SM group at 18 months (P = 0.044). Comparing QOL within each group using the Friedman test, significant improvement was observed only in the CM group (P = 0.001). Scores at 6, 12, 18, and 24 months in particular had significantly improved compared with the baseline assessment (P = 0.002, P = 0.012, P =
Figure 1. Eligibility, randomization, follow-up, and completion rates of the programs. UC indicates usual care; SM, self-management; CM, collaborative management; and HF, heart failure.
Secondary endpoints — self-efficacy, self-care behavior, rehospitalization for HF, all-cause mortality, and the composite of rehospitalization for HF and all-cause mortality: Figure 2 shows the score changes in self-
efficacy and self-care behavior from baseline to each time point (6, 12, 18, and 24 months). Regarding self-efficacy (Figure 2B) and self-care behavior (Figure 2C), there were no significant differences observed among the 3 groups. However, compared within each group, only the CM group had significant changes in self-efficacy ($P = 0.001$) (Figure 2B) and in self-care behavior ($P = 0.002$) (Figure 2C). At 6 and 18 months, scores had significantly improved, compared with the baseline score in self-efficacy ($P = 0.001$, $P = 0.020$, respectively) (Figure 2B). Furthermore, at 6, 12, and 18 months, scores had significantly improved, compared with the baseline score in self-care ($P = 0.005$, $P = 0.021$, $P = 0.022$, respectively) (Figure 2C).

Over the 24-month period, 20 patients (35.1%) experienced rehospitalization due to recurrence of HF, including 11 (57.9%) in the UC group, 5 (27.8%) in the SM group, and 4 (20.0%) in the CM group. Although there was no difference in the number of patients with two or more HF rehospitalizations (Table III), there were significantly fewer patients with one HF rehospitalization in the CM group ($P = 0.042$).

Kaplan-Meier event-free survival curves showed that the rates of readmission for HF were significantly different ($P = 0.048$), with significant improvement in the CM group, as compared with the UC group ($P = 0.020$). The hazard ratio for HF readmissions in the CM group versus the UC group was 0.29 (95% CI, 0.09 to 0.92; $P = 0.035$) (Figure 3).

A high number of patients experienced repeated hospitalizations. The main reasons for repeated hospitalizations were cardiac disease and planned treatment; other reasons, such as pneumonia, were also observed (Table IV).

During a 24-month follow-up period, the all-cause mortality rate was 15.8% ($n = 3$; one each from a cardiovascular event, lung cancer, and drowning) in the UC group, 22.2% ($n = 4$; one each from HF, pneumonia, asphyxia, and multiple organ failure) in the SM group, and 15.0% ($n = 3$; one each from HF, pneumonia, and cerebral hemorrhage) in the CM group. However, there was no significant difference in the reduction of the number of days from enrollment to death among the 3 groups ($P = 0.859$). Occurrence of the composite of all-cause mortality and rehospitalization for HF tended to be different among the 3 groups ($P = 0.068$).

### Discussion

This study demonstrated that compliance to a 12-month program of CM with telemonitoring was effective (85.0%), which is consistent with a previous meta-analysis (75% to 98.5%). In addition, adherence to the CM program as measured by the rate of daily data transfer was also high (70%) compared with other studies (61.4% to 80%).

Although the sample size was small, the QOL score in the CM group was significantly improved compared with the UC (at 18 and 24 months) and SM (at 18 months) groups. The CM program showed that QOL, self-efficacy, and self-care scores at the 6-month or later-time points were significantly improved from the initial scores. The rate of rehospitalization for HF was significantly reduced in the CM group compared with the UC group. The composite outcomes of all-cause mortality and rehospitalization tended to be lower in the CM group than in the other groups. Although other explanations might be possible, one reason for the reduction in hospitalization among patients in the CM group was due to the early detection of abnormal findings and timely intervention by nurses, in consultation with cardiologists. Daily monitored observation of vital signs, such as increased body weight or decreased BP, enabled nurses to immediately call the patient and inquire about their symptoms. In addition, mutual cooperation between nurses and health care workers to support elderly patients in daily life is also important. These support systems are thought to be particularly necessary for patients who live alone to prevent worsening of symptoms.

Telemonitoring is thought to play an important role in disease prevention by enabling patients to receive early care. In previous studies, telemonitoring did not show improved outcomes using a physician-led telemonitoring or voice response system. In the “HOMES-HF” study carried out in Japan, Kotooka stated that one possible reason for non-improvement in the rehospitalization rate was...
Figure 3. Kaplan-Meier estimates of time to rehospitalization for heart failure. HR indicates hazard ratio; UC, usual care; SM, self-management; and CM, collaborative management.

Table IV. Reasons for Rehospitalization

| Reason for Hospitalization | UC group | SM group | CM group | Total |
|---------------------------|----------|----------|----------|-------|
| Participants hospitalized for all causes | 13 (68.4%) | 11 (61.1%) | 12 (60.0%) | 36 (63.2%) |
| Number of hospitalizations for all causes | 34 | 23 | 25 | 82 |
| Cardiac disease (Heart Failure/Infective Endocarditis/Arrial Fibrillation/Myocardial Infarction) | 28 | 10 | 12 | 50 |
| Cardiac treatment (battery exchange of device/ablation) | 1 | 2 | 2 | 5 |
| Cancer | 1 | 1 | 0 | 2 |
| Stroke/TIA/Cerebral hemorrhage | 1 | 0 | 2 | 3 |
| Pneumonia/pneumonitis | 1 | 4 | 0 | 5 |
| Fracture/lumbar spondylosis | 1 | 3 | 2 | 6 |
| Medical disease (Diabetes mellitus/Renal Failure/Anemia) | 1 | 1 | 2 | 4 |
| Others | 0 | 2 | 5 | 7 |

UC indicates usual care; SM, self-management; CM, collaborative management; HF, heart failure; SD, standard deviation; TIA, Transient ischemic attack.

due to the lack of interactive communication. In our study, we provided collaborative support through a nurse and health care workers, rather than only focusing on vital signs. Thus, the effectiveness of telemonitoring seems to be a result of direct interaction with healthcare workers who can arrange and provide comprehensive care for patients.

All psychosocial scores were significantly improved from the initial scores among patients only in the CM group. It is thought that comprehensive care using telemonitoring and telephone counseling by nurses enhances a patient’s self-care ability and alleviates anxiety about dis-
ease. Even if patients receive self-management education regarding HF, most patients with HF cannot successfully change their lifestyle or behavior. Because these patients may be unaware of symptoms caused by exacerbation of HF, they cannot respond to worsening symptoms. By providing daily practical advice and decision support, and by motivating and praising them, patients can acquire self-management skills. Riley, et al stated that a patient’s understanding of the management of HF is influenced by timely feedback and discussions with telemonitoring nurses. Many patients in the CM group stated they felt secure during the intervention period; a previous systematic review reported that a telemonitoring system provided a sense of reassurance and security by fostering a feeling in patients that they had a lifeline to expert care.

Although the SM group showed reduced readmission for HF compared with the UC group, this difference was not statistically significant. Additionally, compared with the SM group, the CM group exhibited greater reduction in hospitalizations; however, this difference was not statistically significant. Both the SM and CM groups received the same self-management educational intervention for 6 months. Some participants were able to manage their HF exclusively through this self-management education program. At the same time, some patients with severe HF conditions who were readmitted might need telemonitoring intervention. In fact, some participants in the CM group did not need telephone intervention because they changed their lifestyle through the self-management education and did not exceed the normal ranges in their data. More than half of the participants in the CM group required fewer than 10 phone calls over 12 months. Exchanging notebooks between nurses and participants worked well and provided good satisfaction and adherence. This result suggests that not all participants needed telemonitoring and collaborative care. Koehler, et al also stated that future research should focus on identifying those target populations most likely to respond to this intervention.

In addition, a previous cross-sectional survey showed that although HF telemonitoring was expected to reduce hospitalization and increase patient self-care, it had not been well implemented. The reasons considered were due to a lack of medical resources or protocols. Thus, future studies are necessary to evaluate patients for whom telemonitoring is appropriate and to explore the appropriate protocol according to the clinical indications.

The main limitation of this study is the small number of participants and higher dropout (20 %) because of hospitalization or death in each group, which exceeded our expectations. Therefore, psychological and behavioral scale scores needed to be complemented using the BOCF approach; these scores may not fully reflect the actual results. In this pilot study, we did not obtain a significant improvement in the CM group, as compared with the SM group. Therefore, further studies including a larger number of participants observed for a longer period are needed. Secondly, despite our personalized intervention, there were rather high rates of hospitalization and mortality due to various causes among patients included in this study. Pneumonia and renal disorders were the main causes for rehospitalization, as previously reported. Considering the older and severe-stage patient population, we need to conduct systemic risk assessment and management and in-depth analysis to reveal who needs collaborative management with telemonitoring.

Conclusions

It was feasible for us to conduct CM for patients with HF using a telemonitoring system in a community care setting. When we compare the means, with the UC group as reference, patients in the CM group had greater reductions in readmission rate and greater improvements in QOL.

As the rate of hospital readmission due to aggravation of HF continues to rise in Japan, HF management programs become increasingly important. In the future, we need to identify those patients who require telemonitoring and collaborative care. To prevent hospital readmission, nurses need to assess patients to determine whether they can manage HF with self-management education or whether they need additional support from nurses using a telemonitoring system. Appropriate allocation of services reduces the risk of hospital readmission and eliminates unnecessary costs for telemonitoring devices and medical personnel.

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Disclosure

Conflicts of interest: The authors declare that there are no conflicts of interest.

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