ORIGINAL RESEARCH ARTICLE

Post-discharge short message service improves short-term clinical outcome and self-care behaviour in chronic heart failure

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Abstract

Aims   In addition to giving optimal medical and device therapy, promoting self-care of chronic heart failure (CHF) patients also plays an important role in comprehensive disease management for better outcomes. The study was aimed to investigate whether short message service (SMS) would help to improve death or readmission-free survival and self-care behaviour in CHF patients.

Methods and results   This was a randomized controlled trial. Between December 2011 and September 2015, patients admitted with decompensated CHF in a tertiary referral hospital who fulfilled the inclusion criteria were enrolled and randomized to receive SMS, structured telephone support (STS), or usual care after discharge. All patients were followed up to 180 days after discharge by phone call or clinic visit. Primary endpoint was the 180 day composite event, defined as all-cause mortality or readmission. Secondary endpoints included self-care behaviour and quality of life. Seven hundred sixty-seven patients (61 ± 15 years, 56.5% male) were finally randomized to receive SMS (*n* = 252), STS (*n* = 255), or usual care (*n* = 260). Baseline characteristics were similar among the three groups. Five hundred twenty-five (68.4%) patients were in New York Heart Association Class III or IV, and 472 (61.5%) patients had an ejection fraction of <50%. During a 180 day follow-up, 76 (9.9%) patients died and 274 (35.7%) patients experienced at least one readmission. In a short-term follow-up of 30 days, there was no difference in mortality and the composite endpoint among the three groups (SMS vs. STS vs. usual care: 2.8% vs. 3.1% vs. 3.8% for mortality, *P* = 0.786; 12.3% vs. 14.5% vs. 15.4% for the composite endpoint, *P* = 0.588). The 180 day composite event rate was significantly lower in the SMS and STS groups (50.4% vs. 41.3% and 36.5%, both *P* < 0.05) than in the usual care group, but no difference was observed between the two phone-based intervention groups (*P* = 0.268). Although there was no difference between the two groups, better self-care behaviour was reported in the SMS and STS groups than in the control group (medication compliance, 78.9% vs. 81.4% vs. 69.5%, *P* = 0.011; water restriction, 70.8% vs. 74.5% vs. 61.5%, *P* = 0.013). Quality-of-life score was similar among the three groups at 180 days (*P* = 0.526).

Conclusions   In CHF patients, post-discharge SMS, which appeared as efficient as STS, reduced the 180 day composite event and improved self-care behaviour. SMS intervention could be integrated into CHF management.

Introduction

Heart failure (HF) is associated with frequent hospitalization and high mortality rate, which bring huge health burden to family and society. Though great advances have been made in medical and device therapies for cardiovascular diseases, less improvement in outcome of general chronic HF (CHF) population is observed.[1] This situation is even worse in

China, where HF prevalence was 0.9% in adults, with 1 year mortality rate of 14% and readmission rate of 41% in the latest survey of a decade ago.[2,3]

However, researchers have demonstrated that better self-care behaviours and appropriate exercise training are associated with improvement in quality of life, reduction in readmission, and mortality.[4,5] Education on lifestyle modification can improve HF event-free survival, such as how to conduct regular exercise, sodium and fluid restriction, and regular weighing.[6] Riegel *et al.* have further concluded that HF self-care is about not only lifestyle modification but also the patients' effort to maintain their stableness and to deal with HF signs and symptoms.[7] Therefore, HF self-care requires a much motivation and encouragement.

Various methods have been reported to promote self-care and hence improve outcome of outpatients with HF. Telemedicine methods like structured telephone support (STS) and short message service (SMS) education have shown beneficial effects in optimizing chronic disease management.[8,9] It is suggested that phone-based interventions are widely accessible to patients from different age groups. Our pilot study has also shown that STS-assisted and SMS-assisted management is highly accepted by HF patients.[10] Therefore, we hypothesized that phone-based interventions after discharge would improve clinical outcome and self-care behaviour in patients with CHF.

Methods

Study design and setting

We conducted a non-blinded randomized controlled trial in a large tertiary referral hospital from December 2011 to September 2015. Patients with CHF were given STS intervention (STS group), SMS intervention (SMS group), or usual care (control group) after discharge.

Participants

Individuals diagnosed with decompensated CHF were screened for eligibility before discharge. Patients were excluded before randomization if they (1) were deceased in hospital, (2) were unwilling to participate, (3) were younger than 18 years, (4) were unable to read in Chinese, (5) do not have a phone, (6) were discharged to a long-term care facility, (7) were planning to receive cardiac surgery within 6 months, (8) were waiting for heart transplantation (9), have malignancy or other critical illness with a life expectancy of <1 year, (10) were unable to participate owing to severe mental disorders, (11) and were participating in other researches. This study was approved by the China Ethics Committee of Registering Clinical Trials, and the protocol

was registered at Chinese Clinical Trial Registry. Written informed consent was obtained from each participant. Demographics and baseline data were collected, including echocardiography, routine blood tests, and Minnesota Living with Heart Failure Questionnaire (MLHFQ).

Randomization and allocation

Participants were enrolled on admission, and ward nurses performed standard care and patient education before discharge. Patients who were alive and fulfilled the inclusion criteria were equally randomized to SMS group, STS group, or usual care group. The random sequence list was generated and encrypted with Excel 2010 and kept by a statistician who had no access to patient information during the trial. When a new patient was included, the statistician put his or her number on the list in discharge order and informed the research nurse with the allocation result. On the other hand, clinicians or nurses did not participate in the randomization or the concealed allocation process. Blinding was not applicable for this study.

Intervention and control

Patients in SMS group as well as their caregivers received standardized messages from text messaging platform operated by research nurses. There were two kinds of messages—educational SMS and reminder SMS. The educational SMSs were condensed messages with knowledge of HF (e.g. symptoms of HF decompensation), while the reminder SMSs were brief messages that prompted patients to do things (e.g. taking medicine or weighing). All educational messages were sent within the first 10 days after discharge, and then the reminder messages were repeated weekly for 1 month. The messages were scheduled to send out automatically. Patients were informed not to reply to the messages.

Patients in STS group received one structured phone call from research nurses within 30 days after discharge, which was made following pre-written structured materials. The nurses were trained with simulation before study. Patients were allowed to call back the nurses during work time for consultation.

All patients received standard care and patient education before discharge, which covered the education contents in both interventions. Patients in control group were not contacted in any form after discharge, until the 180 day follow-up.

All contents used in SMS, STS, and inpatient education were pre-written and reviewed by HF specialists and senior nursing specialists (samples of SMS in *Figure 1*). The contents were based on HF diagnosis and management guidelines,

Figure 1 Sample message by SMS (in Chinese originally and in English for demonstration).
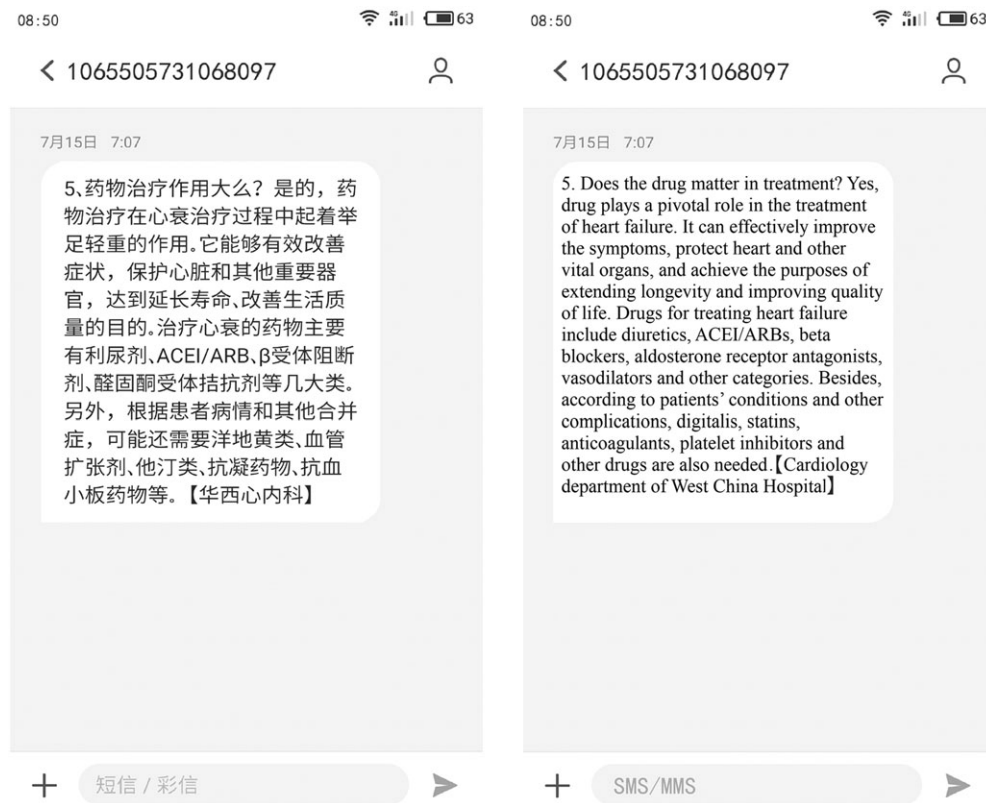
review articles in UpToDate database, and educational materials from Heart Failure Society of America, including the following modules[11–14]:

(1) understanding HF;
(2) HF symptoms, signs of exacerbation, and the right time to visit a doctor;
(3) pharmacologic treatment of HF, including the purpose, necessity, and side effects of each medicine;
(4) lifestyle modification, including smoking cessation, limiting salt and water intake, weighing, avoid catching cold, and regular exercise;
(5) appointment adherence, including the appropriate time to visit a doctor, and the information a doctor needs to know; and
(6) motivating and encouraging.

Follow-up

All participants were followed up until 180 days by phone call or clinic visit after discharge. Death and hospitalization were recorded as major events. Patients and/or their caregivers were asked to recall if any major event happened, when, and where. Patients were required to bring their latest medical record at every clinic visit, if any. In case of potential missing event, electronic medical records of all the participants were searched in our medical system at the end of follow-up.

Outcome measurements

The primary endpoint was a composite of all-cause hospitalization or death. The secondary endpoint was improvement in self-care behaviour or quality of life.

Self-care behaviour contains medication compliance, weight monitoring, salt restriction, water restriction, and exercise, as follows:

(1) Medication compliance: taking medicine as prescribed; otherwise regarded as non-compliance that patients withdrawing medicine or reducing dosage by themselves.
(2) Weight monitoring: weighing themselves more than three times a week.
(3) Salt restriction: using a salt-restriction recipe; avoiding souse food.
(4) Water restriction: drinking an equal or less amount of water compared with urine output.
(5) Exercise: mild-to-moderate aerobic exercise, no less than 30 min each time and at least three times a week.

The health-related quality of life was measured by MLHFQ. It contains 21 items with a total score from 0 to 105. A higher score indicates a worse quality of life in patients with HF.[15]

Sample size calculation

The study was designed to detect a statistically significant difference at a power of 80%, an α level of 0.05. In previously published studies, the event-free survival in HF patients had an 8–13% increase after various transitional care programmes, such as home visit, telephone, and mail.[16,17] Therefore, a 15% reduction of the composite endpoint in the intervention groups (i.e. SMS group and STS group) over a 6 month follow-up was selected for sample size calculation. Consequently, 250 patients were needed in each group.

Data entry and statistics

Data entry was independently performed by two researchers using EpiData 3.1 (The EpiData Association, Odense, Denmark). Analyses were conducted following the intention-to-treat principle. Categorical variables were expressed as frequency and percentages and analysed by χ^2 test. Continuous variables in normal distribution were expressed as mean ± SD; non-normal distribution was expressed as median and inter-quartile range. Continuous variables were tested by Kolmogorov–Smirnov test for normality and analysed by one-way ANOVA or Kruskal–Wallis test, as appropriate. Kaplan–Meier survival analysis was conducted to estimate time to the first composite endpoint, death, and readmission. The Cox proportional hazards test was performed to adjust for confounding factors. All statistical analyses were conducted using the SPSS 22.0 (IBM Corp., Armonk, NY). A P-value < 0.05 was considered as statistically significant.

Results

As shown in *Figure 2*, 1041 hospitalized decompensated CHF patients were screened for eligibility from December 2011 to March 2015. Among them, 767 patients were included and randomly assigned to SMS group ($n = 252$), STS group ($n = 255$), and usual care group ($n = 260$). There were 730 (95.2%) patients who completed follow-up on the primary

Figure 2 Flow chart of the study.
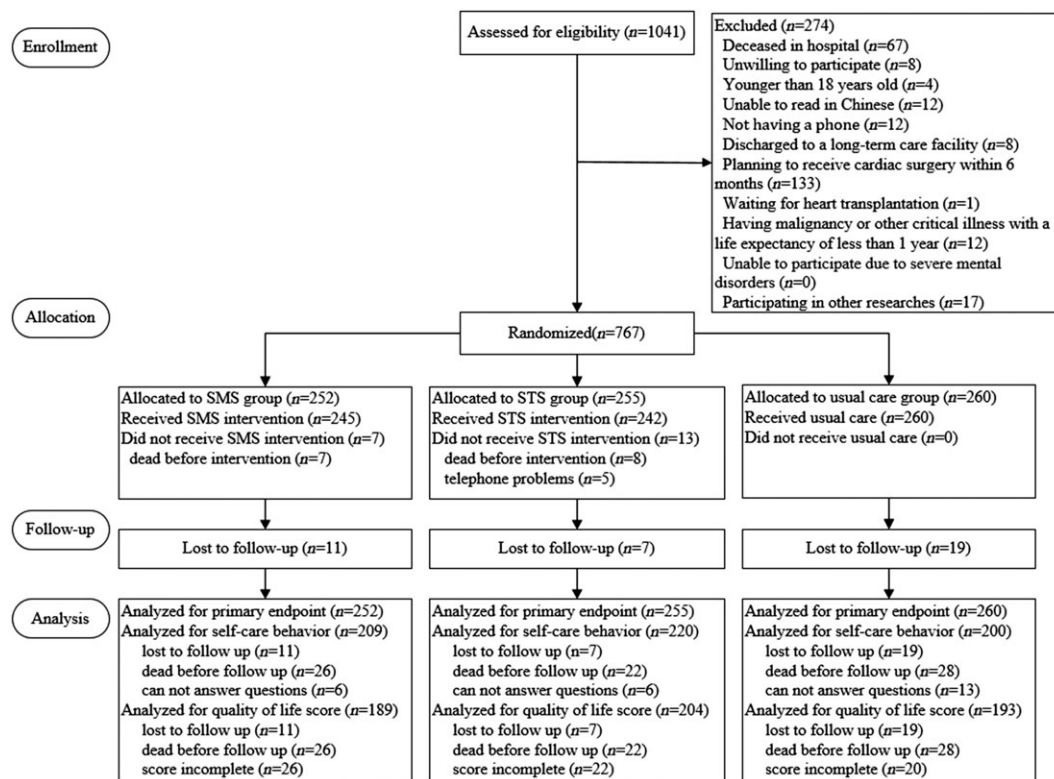
endpoint. Among the survivors, 586 (89.6%) patients completed follow-up on the secondary endpoint.

Baseline characteristics

There were more men in the study (433, 56.5%), and mean age of the population was 61 ± 15 (18–93) years. More than two-thirds of the patients (525, 68.4%) were in New York Heart Association (NYHA) Class III or above at discharge, and 61.5% of them had an ejection fraction (EF) of <50%. Non-ischaemic cardiomyopathy was the most common cause of HF (293, 38.2%). All baseline characteristics were balanced among the three groups, except that more patients received cardiac resynchronization therapy (CRT) or CRT with defibrillator in the STS group than in others (*P* = 0.007). The baseline characteristics are shown in *Table 1*.

Mortality and readmission

A total of 76 patients (9.9%) died within 180 days after discharge. There was no difference in mortality among the three groups (SMS vs. STS vs. control: 10.3% vs. 8.6% vs. 10.8%, *P* = 0.694). Two hundred seventy-four patients (35.7%) had at least one readmission by the end of follow-up. The mortalities at 30, 90, and 180 days were 3.3%, 6.4%, and 9.9%, respectively, and readmission rates were 11.9%, 24.1%, and 35.7%, respectively. There was no significant difference in 30 day event rate among the three groups (SMS vs. STS vs. control: 12.3% vs. 14.5% vs. 15.4% for the composite endpoint, *P* = 0.588; 10.7% and 11.8% vs. 13.1% for readmission, *P* = 0.709; 2.8% and 3.1% vs. 3.8% for mortality, *P* = 0.786). As shown in *Table 2*, SMS and STS significantly reduced the composite endpoint and readmission in 180 days. Event-free survival was better in the SMS and STS groups when compared with the control group (*Figure 3(A,B)*). HF-related events were similar between the three groups (*Table 2*). However, no significant difference was found between the two phone-based intervention groups (*Table 2* and *Figure 3*).

In addition to the phone-based interventions, univariate Cox regression analysis also identified chronic renal disease, anaemia, atrial fibrillation, EF, creatinine, blood urea nitrogen, haematocrit, and N-terminal pro-B-type natriuretic peptide level as potential confounders for predicting the primary endpoint. Multivariate analysis showed that STS remained an

Table 1 Demographics and clinical characteristics among three groups (*n* = 767)

Characteristic	SMS group (*n* = 252)	STS group (*n* = 255)	Control group (*n* = 260)	*P*-value
Age	60 ± 15	62 ± 14	61 ± 15	0.189
Gender, male	145 (57.5)	139 (54.5)	149 (57.3)	0.745
NYHA III or IV	175 (69.4)	178 (69.8)	172 (66.2)	0.617
Cardiovascular risk profile				
Ischaemic heart disease	47 (18.7)	56 (22.0)	55 (21.2)	0.630
Non-ischaemic cardiomyopathy	108 (42.9)	95 (37.3)	90 (34.6)	0.148
Valvular heart diseases	66 (26.2)	69 (27.1)	75 (28.8)	0.789
Hypertension	82 (32.5)	93 (36.5)	94 (36.2)	0.588
Diabetes mellitus	70 (27.8)	77 (30.2)	92 (35.4)	0.164
COPD	31 (12.3)	41 (16.1)	29 (11.2)	0.226
Chronic renal disease	26 (10.3)	32 (12.5)	23 (8.8)	0.388
Systolic blood pressure, mmHg	113 ± 15	114 ± 14	114 ± 15	0.508
Diastolic blood pressure, mmHg	70 ± 10	69 ± 10	69 ± 10	0.326
Heart rate	83 ± 20	84 ± 22	84 ± 23	0.998
Atrial fibrillation	108 (42.9)	102 (40.0)	120 (46.2)	0.369
LVEF, %	44 ± 17	42 ± 16	45 ± 17	0.139
Pharmacotherapy				
ACEI/ARB	127 (50.4)	139 (54.5)	140 (53.8)	0.609
Beta-blocker	162 (64.3)	145 (56.9)	170 (65.4)	0.096
Aldosterone antagonists	163 (64.7)	190 (74.5)	181 (69.6)	0.055
Diuretics	195 (77.4)	208 (81.6)	193 (74.2)	0.134
Digoxin	114 (45.2)	106 (41.6)	105 (40.4)	0.513
Device therapy				
ICD	13 (5.2)	13 (5.1)	17 (6.5)	0.724
CRT or CRT-D	17 (6.7)	29 (11.4)	11 (4.2)	0.007
Laboratory test				
Hb, g/L	132 ± 24	132 ± 23	131 ± 23	0.858
Hct, %	40.7 ± 6.6	40.9 ± 6.7	40.4 ± 6.8	0.753
Cr, μmol/L	104.6 ± 62.7	105.0 ± 60.9	97.1 ± 44.6	0.625
BUN, mmol/L	8.2 ± 3.9	8.7 ± 4.6	8.1 ± 4.2	0.287
NT-proBNP, pg/mL	3223 (1544, 8205)	3765 (1323, 8032)	3120 (1626, 7006)	0.878

ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin II receptor blocker; BUN, blood urea nitrogen; COPD, chronic obstructive pulmonary disease; Cr, creatinine; CRT, cardiac resynchronization therapy; CRT-D, cardiac resynchronization therapy with defibrillator; Hb, haemoglobin; Hct, haematocrit; ICD, implantable cardioverter-defibrillator; LVEF, left ventricular ejection fraction; NT-proBNP, N-terminal pro-B-type natriuretic peptide; NYHA, New York Heart Association.

Table 2 Composite endpoint, death, and readmission rate among three groups

|	SMS n (%)	STS n (%)	Control n (%)	OR (95% CI)		
				SMS vs. control	STS vs. control	SMS vs. STS
Composite endpoint	104 (41.3)	93 (36.5)	131 (50.4)	0.819 (0.677, 0.991)[a]	0.724 (0.591, 0.886)[b]	1.132 (0.909, 1.409)
Death	26 (10.3)	22 (8.6)	28 (10.8)	0.958 (0.578, 1.587)	0.801 (0.471, 1.362)	1.196 (0.697, 2.053)
Readmission	85 (33.7)	78 (30.6)	111 (42.7)	0.790 (0.632, 0.988)[c]	0.716 (0.568, 0.904)[d]	1.103 (0.856, 1.421)
HF-related event	69 (27.4)	62 (24.3)	83 (31.9)	0.858 (0.656, 1.122)	0.762 (0.576, 1.008)	1.126 (0.838, 1.513)
HF-related death	21 (8.3)	18 (7.1)	24 (9.2)	0.903 (0.516, 1.580)	0.765 (0.426, 1.374)	1.181 (0.645, 2.162)
HF-related readmission	54 (21.4)	49 (19.2)	66 (25.4)	0.844 (0.616, 1.157)	0.757 (0.546, 1.050)	1.115 (0.790, 1.575)

CI, confidence interval; OR, odds ratio.
[a]$P = 0.039$.
[b]$P = 0.001$.
[c]$P = 0.037$.
[d]$P = 0.004$.

Figure 3 Kaplan–Meier survival analysis among three groups.
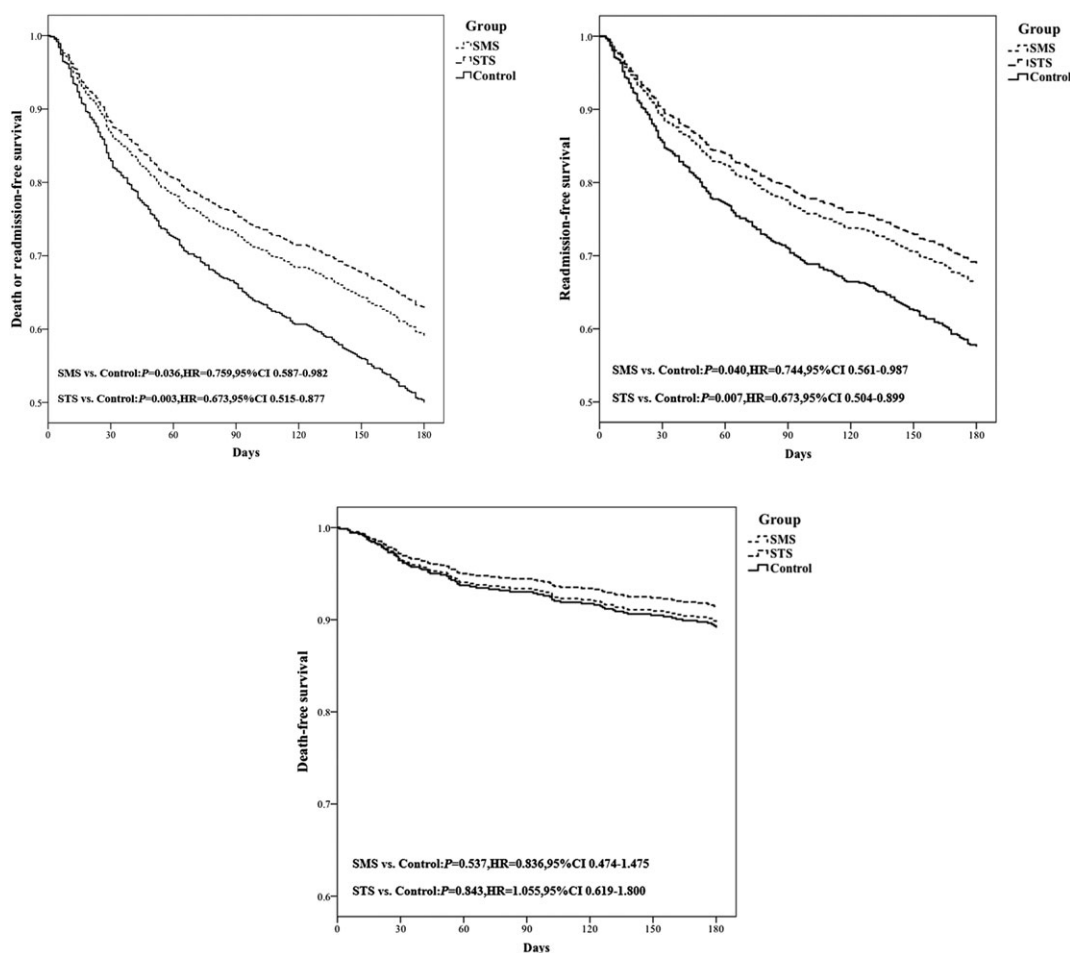
independent predictor of fewer composite endpoints after adjusting for other confounders (*Table 3*). Furthermore, the Cox regression was conducted in HF with reduced EF (HFrEF) (EF < 50%) and HF with preserved EF (HFpEF) (EF ≥ 50%) patients, respectively. In HFpEF patients, STS intervention remained independently effective in multivariate analysis [STS vs. control: hazard ratio (HR) = 0.599, 95% confidence interval (CI) = 0.388–0.927, *P* = 0.021; SMS vs. control: HR = 0.803, 95% CI = 0.543–1.189, *P* = 0.274]. However, the phone-based interventions were not independently relevant to the endpoint after adjusting for confounders in HFrEF patients (STS vs. control: HR = 0.711, 95% CI = 0.497–1.019,

Table 3 Univariate analysis and multivariate analysis on composite endpoint

Variable	Univariate analysis			Multivariate analysis		
	HR	95% CI	P-value	HR	95% CI	P-value
Age, 10 years	1.038	0.963~1.120	0.327			
Gender, male	0.900	0.724~1.119	0.342			
Diabetes mellitus	1.163	0.926~1.460	0.194			
COPD	1.049	0.763~1.441	0.770			
Chronic renal disease	1.665	1.226~2.262	0.001	1.327	0.883~1.994	0.173
Anaemia	1.259	0.973~1.629	0.080	1.052	0.744~1.485	0.776
Atrial fibrillation	1.351	1.088~1.677	0.007	1.291	1.029~1.620	0.028
LVEF, 10% increase	1.079	1.021~1.151	0.021	1.080	1.006~1.160	0.034
Heart rate, 10 b.p.m. increase	1.041	0.991~1.094	0.109			
Systolic blood pressure, 10 mmHg	0.962	0.893~1.035	0.296			
Cr, 10 μmol/L	1.019	1.003~1.035	0.018	0.982	0.956~1.010	0.203
BUN, 5 mmol/L	1.250	1.116~1.400	<0.001	1.221	1.034~1.442	0.019
NT-proBNP, 1000 pg/mL	1.025	1.013~1.037	<0.001	1.023	1.009~1.037	0.001
Hct, 10%	0.863	0.732~1.019	0.082	0.984	0.794~1.219	0.881
Group			0.009			0.034
SMS vs. control	0.759	0.587~0.982	0.036	0.795	0.611~1.035	0.088
STS vs. control	0.673	0.515~0.877	0.003	0.705	0.536~0.926	0.012

HR, hazard ratio. Other abbreviations as in Tables *1* and *2*.

$P = 0.063$; SMS vs. control: HR = 0.768, 95% CI = 0.537–1.098, $P = 0.148$), though they showed beneficial effects in univariate analysis.

Self-care behaviour

Patients in SMS or STS group reported better self-care behaviour than did the control group in medication compliance (SMS vs. control: $P = 0.029$; STS vs. control: $P = 0.005$) and water restriction (SMS vs. control:

$P = 0.046$; STS vs. control: $P = 0.004$). Self-care behaviour was reported to be similar between the SMS group and STS group. Weight monitoring was the least-implemented item in that only one-fifth of patients reported it even in the intervention groups (*Table 4*).

Quality of life

No difference in MLHFQ was observed among the three groups at both enrollment or 180 day follow-up (*Table 5*).

Table 4 Rates of self-care behaviour among three groups

	SMS	STS	Control	RR (95% CI)		
	n (%)	n (%)	n (%)	SMS vs. control	Phone vs. control	SMS vs. phone
Medication compliance	165 (78.9)	179 (81.4)	139 (69.5)	1.136 (1.012, 1.275)[a]	1.171 (1.047, 11.309)[b]	0.970 (0.883, 11.066)
Weight monitor	30 (14.4)	45 (20.5)	27 (13.5)	1.063 (0.656, 11.722)	1.515 (0.979, 12.346)	0.702 (0.460, 11.070)
Salt restriction	157 (75.1)	159 (72.3)	135 (67.5)	1.113 (0.983, 11.260)	1.071 (0.944, 11.215)	1.039 (0.928, 11.164)
water restriction	148 (70.8)	164 (74.5)	123 (61.5)	1.151 (1.001, 11.324)[c]	1.212 (1.060, 11.386)[d]	0.950 (0.846, 11.067)
Exercise	130 (62.2)	132 (60.0)	111 (55.5)	1.121 (0.952, 11.319)	1.081 (0.917, 11.274)	1.037 (0.891, 11.206)

RR, relative risk.
[a]$P = 0.029$.
[b]$P = 0.005$.
[c]$P = 0.046$.
[d]$P = 0.004$.

Table 5 Minnesota Living with Heart Failure Questionnaire among three groups

Variables	SMS	STS	Control	P-value
Total score at baseline	62.9 ± 22.2	61.0 ± 23.2	61.9 ± 23.3	0.455
Total score at 180 day follow-up	27.7 ± 16.1	25.5 ± 16.6	26.7 ± 16.8	0.526
Changes in total score	34.4 ± 23.9	33.7 ± 23.5	35.0 ± 25.5	0.703

At the end of follow-up, the total score of MLHFQ was similarly declined in each group (*P* = 0.703).

Discussion

The current study found that phone-based interventions improved all-cause hospitalization or mortality as the composite endpoint in patients with HF at 180 day follow-up. These interventions also modified self-care behaviour such as medication compliance and fluid restriction. However, SMS and STS showed no significant differences in those endpoints.

The clinical outcome of HF patients in China is poor,[18] which might be attributed to the proved role of non-compliance of medication, diet, and other lifestyle requirements.[19] A number of interventions involving patient education or telemonitoring of HF patients resulted in less readmission.[20–22] In our study, we found SMS beneficial in the improvement of both readmission and self-care, which was different from the findings by Sethares and Elliott in their pilot study with a smaller population, a shorter follow-up duration, and different message contents.[23] Rather than helping patients to perceive benefits and barriers, we focused on educating patients to build their own HF knowledge and on guiding them to achieve self-care compliance. Phone call intervention was demonstrated to lower readmission and lower mortality or not,[20,24–26] except that one study in Hong Kong showed no significant difference in readmission rate but has a lower mortality.[17] These conflicts may be attributed to different study population enrolled in the aforementioned studies. Perhaps patients with severe conditions are more likely to benefit from the interventions, like the participants of our study in worse NYHA classification (68.4% and 42.1% patients in NYHA Class III and IV, respectively). Nevertheless, the differential effect of phone-based interventions in HFpEF or HFrEF patients remained unexplainable from the current study.

In China, post-discharge clinic follow-up on schedule is not available in many patients mainly owing to inadequate facilities, deficit in medical staffs, lack of knowledge in patients, and geographical barriers. Therefore, interventions that facilitate a remote connection with patients would be adopted in chronic disease management to fill up the huge gap in patient follow-up. SMS was used in the management of chronic diseases such as diabetes mellitus, asthma, and hypertension, which showed beneficial effects on outcomes.[27,28] SMS has great advantages in China, because it is ubiquitous, affordable, and manpower saving. According to the Communication Industry Report published in March 2015 by the Ministry of Industry and Information Technology, proximately 1.3 billion people in China used mobile phones, which indicated that almost everyone could receive short messages via mobile phones. In our previous study, we found that 95.6% patients were willing to accept SMS intervention. Moreover, the text messaging carries more information in written form for patients and their caregivers to review at any time. In China, an ordinary mobile phone text costs ~0.1 RMB (i.e. one US dollar can deliver >60 text messages), which is much cheaper than making phone calls or printing out booklets. In addition, text messaging with prepared contents can be conducted by a specialized computer operator other than physicians, nurses, and other paramedical staffs; therefore, it takes a shorter time and less effort than any other kind of intervention to send messages in batches.

Like in other studies, no difference in quality-of-life scores was noted among the three groups at baseline and 180 days.[20,23,29] Among self-care behaviour, medication compliance and water restriction were improved in phone-based intervention groups while salt restriction was achieved at a similarly high level in all the three groups. Low sodium diet is generally accepted by patients with hypertension, heart diseases, or renal diseases, which is not specific for HF patients only. Poorly implemented weight monitoring in the current study corroborates another survey conducted in China, which demonstrated that only 12.4% CHF patients weighed themselves three times a week.[30] Similar to the findings in the COACH study,[6] interventions such as STS and SMS were not helpful for increasing exercising compliance; therefore, other methods need to be adopted and tested for this purpose.

The current study has several limitations. First, upon the study design, >20% of population with HF was excluded from randomization. Those were patients in end-stage diseases or waiting for a recent cardiac surgery to treat HF aetiologies. As the impact of an educational intervention programme would be very limited or confounded in these groups, these groups were not regarded as the target population of the current study. Second, follow-up of the endpoints was based on phone calls and was not frequent enough. It may affect the data collection and processing on events, medications, and some other variables that could have been included, like weights. However, the phone follow-up was conducted by well-trained research nurses with pre-written structured materials at hand in order to obtain every detail as needed. Third, the current SMS platform was not designed to receive messages from participants and to send personalized messages instead of standardized texts only. Next, the combination of text messaging and smartphone apps would be our interests of further studies to provide better long-term management for CHF patients.

Conclusions

Phone-based SMS and STS can reduce composite endpoint and readmission rate in patients with CHF at 180 days after

discharge. Patients reported better self-care behaviour after the interventions. SMS and STS were both effective on improving clinical outcome and self-care behaviour. Further studies and practice are warranted to explore more interactive and tailored interventions for CHF patient management.

Conflict of interest

None declared.

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