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Home monitoring with technology-supported management in chronic heart failure: A randomised trial

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ABSTRACT

Objectives: We aimed to investigate whether digital home monitoring with centralised specialist support for remote management of heart failure (HF) is more effective in improving medical therapy and patients' quality of life than digital home monitoring alone.

Methods: In a two-armed partially blinded parallel randomised controlled trial, seven sites in the United Kingdom recruited a total of 202 high-risk patients with HF (71.3 years SD 11.1; left ventricular ejection fraction 32.9% SD 15.4). Participants in both study arms were given a tablet computer, Bluetooth-enabled blood pressure monitor and weighing scales for health monitoring. Participants randomized to intervention received additional regular feedback to support self-management and their primary care doctors received instructions on blood investigations and pharmacological treatment. The primary outcome was the use of guideline recommended medical therapy for chronic HF and major comorbidities, measured as a composite opportunity score (total number of recommended treatment given divided by the total number of opportunities the treatment should have been given, with a score 1 indicating 100% adherence to recommendations. Co-primary outcome was change in physical score of Minnesota Living with Heart failure questionnaire.

Results: 101 patients were randomised to "enhanced self-management" and 101 to "supported medical management". At the end of follow-up, the opportunity score was 0.54 (CI 95% 0.46 to 0.62) in the control arm and 0.61 (CI 95% 0.52 to 0.70) in the intervention arm (p=0.25). Physical well-being of participants also did not differ significantly between the groups (17.4 [12.4] mean [SD] for control arm versus 16.5 [12.1] in treatment arm: , p for change = 0.84).

Conclusions: Central provision of tailored specialist management in a multimorbid HF population was feasible. However, there was no strong evidence for improvement in use of evidence-based treatment nor health-related quality of life.

Trial registration: ISRCTN86212709

Keywords

Chronic disease management, heart failure, digital health, complex intervention, randomised clinical trial

What is already known about this subject?

Episodic models of care for chronic heart failure contribute to lack of compliance with guideline-directed medical therapy and poor clinical outcomes. Digital health solutions allow more frequent and efficient data exchange between patients and doctors, and hence facilitate timely optimisation of medical treatment in chronic heart failure.

What does this study add?

This study shows that central provision of tailored specialist management support with the use of commercially available, low-cost devices, enhanced by customised applications is feasible and acceptable by patients. However, this did not result in higher compliance with guideline-directed medical therapy or health-related quality of life.

How might this impact on clinical practice?

Digital health solutions that allow remote monitoring of patients with chronic heart failure are acceptable for patients and provide useful data to guide medical management. Future larger studies with sufficient follow-up duration could explore the effect of a more fully integrated digital system on clinical outcomes.

INTRODUCTION

In high and low income countries alike, studies have consistently reported substantial deviations from optimal delivery of guideline-recommended care for patients with heart failure (HF).[1,2] In particular, titration of evidence-based drugs has proven challenging.[2] The observed gaps between practice and recommendations have been partly attributed to inadequacies of our episodic and poorly integrated models of care that are largely unaware of patients' changing healthcare needs outside the short intervals of their interaction with healthcare professionals.

In recent years, several digital health solutions have been developed to help overcome the challenges of chronic HF management.[3] Although solutions differ widely in design, purpose and implementation, newer generations often share a few key goals. One is the automation of repetitive clinical tasks, such as health monitoring, patient education or drug titration to enable more frequent and efficient data exchange between patients and healthcare professionals. Another is the provision of more timely and detailed analysis of multi-modal data for early warning prediction and proactive management of patients. From a technological point of view, solutions for remote monitoring in HF fall broadly into the two categories of implantable devices or non-invasive external electronic devices. The theoretical advantage of the non-invasive systems is that they are ubiquitously available and hence, offer the opportunity for remote health monitoring and management without costly hardware and invasive procedures.

To date, several randomised trials have reported outcomes on the use of non-invasive external monitoring systems.[3] Although the complex nature of interventions and their contexts make their direct comparison challenging, a few lessons have been learned from failures and successes of such studies. One is the need for high usability of the technological solutions, without which patient adherence will be low and any desired effects elusive.[4,5] A second is the need for targeting patients who are most likely to benefit from the intervention. Third, it has been suggested that monitoring frequency should be high and the time constant of the feedback loop short for responding to more rapid changes in health status. Fourth, patients with HF tend to have multiple comorbidities which often determine their outcomes. Therefore, a patient-centric monitoring system should ideally facilitate management of major comorbidities.

To overcome some of these challenges, we initiated the SUPPORT-HF programme. In an earlier development phase of the work, we co-designed a user-friendly non-invasive home monitoring system with input from patients and their carers and found the system to be effective in supporting

a typical cohort of HF patients.[6,7] We also found that despite no active medical intervention, patient satisfaction and adherence to the monitoring system was high, even among those with low digital technology literacy.[8]

In this paper, we report the final clinical results of a multi-centre randomized controlled trial that assessed the efficacy of the remote specialist medical management system.

METHODS

The trial rationale, design, baseline characteristics and statistical analysis plan have been reported in more detail elsewhere.[9]

Trial hypothesis and intervention

SUPPORT-HF 2 aimed to test the hypothesis that in patients with HF, home monitoring with an integrated risk prediction and disease management service, which provided tailored alerts and advice to patients and clinical decision support to healthcare practitioners, is more effective in optimising medical therapy than home monitoring with the same monitoring equipment but without the use of the integrated data analysis and a centralised decision support service to advise general practitioners.

Study participants and setting

Adults with a confirmed diagnosis of HF, irrespective of its underlying aetiology, were eligible for recruitment, provided they were judged to have a clear potential to benefit from home monitoring and management (average self-assessed NYHA class II to IV in the week before randomisation, or BNP >100 pmol/L / NT-pro-BNP >130 pmol/L within 30 days prior to randomisation, or at least two unmet treatment targets). Patients were also selected to be at high risk of death or hospitalisation (estimated one-year mortality risk >10% or at least one hospital admission related to HF in the previous 12 months). Recruitment was initiated at 7 UK hospital sites and patient consent and follow-up took place in the participants' homes. The trial has been registered at ISCRTN (ISRCTN86212709) and ethics approval was obtained from the medical research and ethics committee (approval date 28/08/2014, reference 14/SS/1025).

Comparison groups

Consenting participants entered a run-in phase and were asked to use the SUPPORT-HF 2 home monitoring system. This included a touch-screen tablet computer that was connected via Bluetooth to a blood pressure and heart rate monitor, and a weighing scale. The tablet computer enabled

automatic recording of readings and their onward transfer via mobile or Wi-Fi to the central data server. A specially developed app enabled participants to record their symptoms, review their readings, notify central clinical staff about change in health status or medication, request a call-back or use the educational material to support HF self-management.

During the run-in period, which lasted 7 to 10 days, additional information for eligibility assessment was gathered. This included blood investigations, echocardiogram and ECG reports. This phase also allowed review of 3G mobile or WiFi network connectivity at the participant's home. During this time, patients' primary care practitioners, HF nurses and cardiologists (as applicable) were also informed about patients' potential enrolment. Patients who remained eligible and willing to participate at the end of the run-in phase were then randomised to the study intervention or control arm by the central research staff using a web-based randomisation programme based on a minimisation algorithm that stratified for type of HF (reduced vs. preserved ejection fraction), patient's estimated risk of death (based on their MAGGIC score[10]) and study site. The control group was conceptualised as an attention control to reduce placebo and "loser" effect that could systematically change the behaviour of participants. In addition, participants were blinded from the actual study hypothesis as positive names were given to both trial groups (i.e., "enhanced self-management" for the control group and "supported medical management" for the intervention group). Trial management staff involved in patient recruitment and outcome data collected were also blinded to treatment allocation. Detailed description of the complex intervention by treatment allocation can be found in an earlie report.[9]

Trial outcomes

The primary outcome of the trial was "guideline-recommended medical therapy", defined as treatment consistent with guidelines for management of patients with chronic HF and assessed at the end of last trial follow-up for each participant. Treatment targets were established for every patient before randomisation based on the NICE (National Institute for Health and Clinical Excellence) guidelines for management of chronic HF [11] and complemented with recent ESC (European Society of Cardiology) guidelines for the use of disease-modifying drugs in HF [12], as well as clinical practice guidelines for management of major co-morbidities in patients with HF (atrial fibrillation, ischaemic heart disease, hypertension).

Co-primary outcomes were the physical functioning subscale of the Minnesota Living with Heart Failure (MLWH) questionnaire and changes to self-assessed NYHA class, to assess the impact of the intervention on physical well-being of participants.

Secondary outcomes investigated the biochemical and physiological efficacy of the intervention, assessed by the validated MAGGIC risk score[10]; blood BNP / NT-pro-BNP level at the end of the trial for each participant; the proportion of patients in sinus rhythm who have a heart rate between 50-70 bpm; and the proportion of patients with a serum potassium reading in the ideal range for HF (4.0-4.9mmol/L) at the end of the trial.

Power calculations

We assumed the opportunity score in the control group at the end of the study to be 0.7 (i.e., at the end of the study, participants will have received 70% of the treatment recommendation that they would have been eligible for as assessed at the beginning of the study). We further assumed that an absolute 20% difference in the use of appropriate medication between groups to be realistic and important. To detect such a difference with 90% power ($2\alpha=0.05$) required randomisation of 82 participants per trial arm. To take account of attrition, we set a target of 200 participants in total. Assuming a mean score of 25 (SD 10) in the control group on the physical subscale of the MLWHF questionnaire,[13] randomisation of 200 patients will also have 90% power at two-sided alpha 0.5 to detect a 5-point difference in the MLWHF physical subscale between the two groups at the end of the study, or 75% power to detect a 4-point difference in the subscale.

Statistical analysis

A detailed statistical analysis plan has been published before.[9] In brief, guideline-recommended medical therapy was measured as an opportunity score across all participants in each of the two management arms before randomisation and at the end of follow-up. This opportunity score is the total number of times a treatment was given, divided by the total number of chances that providers had to give the treatment to the participants,[14] calculated for each treatment arm separately. Since the management of patients with reduced ejection fraction (HFREF) differs from those with preserved ejection fraction (HFPEF), the opportunity scores were calculated separately for each type of HF patient and then aggregated with a weighting factor that represents the fraction of participants with preserved or reduced ejection fraction across the two treatment arms. In patients with reduced ejection fraction, treatment targets for disease modifying agents included both initiation as well as recommended target doses as discrete variables (fraction of recommended

doses). Other treatment targets were considered as binary variables only. The overall intervention effect for the trial was measured as the difference in change in the opportunity score from baseline to end of follow-up. Opportunity scores, and changes over time, were summarised through their means and 95% confidence intervals, and compared using t tests. Results at the end of follow-up on the Minnesota Living with Heart Failure score, subdivided by the physical, social and emotional subscales and overall, were summarised using mean (SD), unless highly skewed, in which case median (IQI) was used instead. Changes from baseline were similarly summarised and compared using t-tests. Similar methods were used for comparison of secondary outcomes. All analyses were as per the 'intention-to-treat' principle and tests were carried out at the two-sided 5% significance level. All the statistical analyses in this paper were performed using R, version 3.6.2 (R Foundation for Statistical Computing, Vienna, Austria).

Patient and Public Involvement

The study was supported by a patient advisory group which provided input to the programme of research. This patient advisory group met on a regular basis for the duration of the study. Patients partnered with the research team in the design of the study, drafting of the informational material, and pilot testing of trial procedures. At the end of the study, the patient advisory group commented on the findings and contributed to the dissemination plan.

RESULTS

Between October 2015 and June 2017, 363 patients were identified from 7 UK centres and assessed for eligibility. Of these, 128 were ineligible at the screening visit and a further 33 were ineligible following full eligibility assessment after the run-in period. 101 were randomised to 'enhanced self-management' and 101 'supported medical management' (**Figure 1**). The characteristics of study participants at baseline are shown in **Table 1**. Randomised groups were similar in age and sex distribution, co-morbidities and level of competency in using digital technologies.

At baseline, there was no material difference between the groups in their physical measurements, left ventricular ejection fraction, functional status or quality of life. Mean left ventricular ejection fraction was 32.9% (SD 15.4%), and 60.8% of patients were classified as having HF with reduced ejection fraction. Median MAGGIC risk score was 22.6 in the control group and 22.1 in the intervention group, indicating a predicted 1-year probability of death of about 12%.

Individualised treatment opportunities were determined prior to randomisation, taking account of HF subtype, major cardiovascular comorbidities, pre-existing treatments and their intensity as appropriate. Overall, 11 treatment opportunities were assessed for participants with HFREF and 4

for those with HFPEF. Level of adherence to individual treatment opportunities stratified by type of HF and at baseline as well as end of trial are shown in **Supplementary Table 1**.

The aggregated opportunity scores at baseline and end of trial are shown in **Table 2.** Overall, weighted mean opportunity score at baseline was 0.52 (95% Confidence Interval 0.44, 0.60) in the control group and 0.53 (0.43, 0.62) in the intervention group. Disaggregated scores by type of HF showed similar scores for HFREF as well as HFPEF. At the end of the follow-up (6.2 months (IQR 1.4)), the opportunity score remained unchanged in the control group (change in weighted score 0.03 [-0.02, 0.07]) and showed an 8% increase in the intervention arm (0.08 [0.02, 0.15]). However, the confidence intervals were wide and difference between groups statistically not meaningful (p=0.2) (**Table 2**).

The effects on subscales and overall score of the MLWHF questionnaire as the co-primary trial outcome are shown in **Table 3.** There was no evidence for a meaningful difference in change in the overall score or any of its subscales.

Effects on secondary outcomes are shown in **Table 4.** With the exception of a slightly more intensive reduction in systolic blood pressure in the intervention group (-2.9 mmHg vs 1.3 mmHg, p=0.03), there was no material difference in outcomes between treatment groups.

During follow-up, 19 participants died, of which 5 were due to cardiovascular events; 69 patients were admitted to hospital, with 26 having had at least one unplanned admission for cardiovascular or renal events (**Table 5**). There was no evidence of a material difference in such clinical outcomes between treatment groups.

DISCUSSION

In this trial of remote specialist management for patients with HF, we found no evidence for improved treatment or change in health-related quality of life after about 6 months of treatment.

Several reasons could potentially explain the neutral results of SUPPORT-HF2. First, with only 202 randomised participants, it is possible that the trial was simply underpowered to detect a significant difference between groups. Our sample size estimation for the primary endpoint assumed an absolute 20% difference in treatment opportunity score between randomised groups. In the absence of any previous trials reporting a change in evidence-based treatments, this difference was

felt to be both realistic and feasible. However, our intervention was not as effective as expected as demonstrated by the modest 8% improvement in use of appropriate medications in the intervention arm with a wide confidence interval (95% CI 2 to 15%) versus no significant change in the control arm (3% 95% CI -2 to 7%, p=0.20). Therefore, it is plausible that a larger trial could have improved precision and enabled detection of more modest treatment effects.

Second, although we established a central clinical support team to reduce the burden of monitoring and management to primary care practicioners, that central steam was still reliant on the on the willingness and responsiveness of the local primary care practitioners. Even though centralised decion making reduced the burden of work to non-study clinicians, the latter were still responsible for making the changes to prescriptions as per the recommendations by the central team regarding changes in treatment. To increase the chances of treatment modification, letters were sent on behalf of patient's local cardiologists and recommendations broken down into small steps with frequent (typically bi-weekly) follow-up. This design has advantages over trials such as the BEAT-HF trial, which were not integrated with physician care for active medication intervention.[5] However, this might still not have been sufficiently efficient or effective in increasing compliance with guideline-recommended medical therapy. Whether central management of participants' medications that reduce the burden of treatment to primary care practitioners, for instance through direct central drug prescribing could offer a better solution requires further research. Feedback from non-study clinicians would have been crucial to understand their experience and views on the trial in general and patients' management in particular, and to identify weaknesses that need to be addressed in future studies.

Third, we selected a trial design that mitigated the risk of placebo effect, which may have resulted in dilution of treatment effects. In a trial of home monitoring and management, it is difficult to fully blind participants and study staff to treatment allocation and this might bias effect estimates towards the intervention. In SUPPORT-HF 2, we elected to have an attention control group, rather than a usual care group. Although this design is one of the most rigorous approaches possible in open-label trials, it might have led to dilution of treatment effects, in particular for subjective outcomes, such as quality of life. However, we acknowledge that an improvement in quality of life or biomarkers such as BNP may not be necessary for improving patient-important outcomes, as trials such as TIM-HF 2 have recently demonstrated.[15] Related to this, one could argue that our co-primary endpoints might not have been ideal to measure the full impact of remote monitoring. For instance, much of the clinical advantage of invasive remote monitoring systems seems to be

attributable to more precise measurement of fluid status and change in diuretic treatment. This element of care, however, could not be incorporated into the treatment opportunity score because there is no general target for diuretic treatment in HF patients. As a proxy for risk and fluid status measurement, we measured several biomarkers (potassium, BNP, heart rate, and blood pressure). Although for most of these outcomes, changes appeared to be in favour of the intervention, the study was not sufficiently powered to measure a meaningful difference between randomised groups for these outcomes or more distal clinical outcomes such as death or hospitalisation.

Fourth and finally, although the intervention was delivered in 7 hospital sites across the UK, the actual treatment changes were implemented by many primary care practitioners as there was no control over which practices patients were registered with. Therefore, it is possible that some primary care practitioners were simultaneously looking after patients in different trial arms, which may have resulted in dilution of treatment effects. For instance, the recommendations issued for patients in the intervention arm would increase the knowledge of doctors in general and hence might result in better care for other patients, including those in the control arm.

CONCLUSION

SUPPORT-HF2 shows that central provision of tailored specialist management support with the use of commercially available, low-cost devices, enhanced by customised applications is feasible and acceptable by patients. The design of the trial provides a rigorous framework for testing the effect of a new care pathway that uses digital technologies to provide specialist care to patients and non-specialists. Future larger studies with sufficient follow-up duration could explore the effect of a more fully integrated digital system on clinical outcomes.

Contributorship Statement

Kazem Rahimi, Mark Woodward, Reza Khorshidi, Raymond Fitzpatrick, Lionel Tarassenko, Mike Denis, John Cleland (planning, conduct, and reporting); Milad Nazarzadeh (statistical analysis and drafting), Ana-Catarina Pinho-Gomes (drafting and editing), Toshiaki Ohkuma (statistical analysis). The details of SUPPORT-HF-2 committees and invistigators are described below:

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Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Data sharing statement

Data (deidentified participant data) are available upon reasonable request from the corresponding author.

Transparency declaration: The manuscript's guarantor (KR) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the

study have been omitted; and that any discrepancies from the study as planned have been explained.

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Figure 1. Trial profile

Table 1. Baseline characteristics by treatment allocation.

	Randomized comparisons	
	Enhanced self-management (control)	Supported medical management (Intervention)
Number of participants	101	101
Age (years), mean (SD)	70.4 (11.9)	72.8 (11.1)
Sex, female, n (%)	31 (31%)	26 (26%)
Co-morbidities, n (%)		
Hypertension	48 (48%)	46 (46%)
Ischaemic heart disease	55 (54%)	52 (51%)
Stroke/transient ischaemic attack	13 (13%)	14 (14%)
Atrial fibrillation	63 (62%)	65 (64%)
Chronic kidney disease	14 (14%)	16 (16%)
Diabetes mellitus	30 (30%)	34 (34%)
Chronic obstructive lung disease	21 (21%)	14 (14%)
Asthma	6 (6%)	10 (10%)
Previous venous thromboembolism	4 (4%)	6 (6%)
Level of competency in use of digital technologies		
Very limited or none, n (%)	47 (47%)	41 (41%)
Competent, n (%)	46 (46%)	51 (50%)
Expert, n (%)	8 (8%)	9 (9%)
Left ventricular ejection fraction (%), mean (SD)	36.7 (12.4)	36.7 (11.6)
Systolic blood pressure (mmHg), mean (SD)	122.6 (18.2)	127.5 (21.7)
Diastolic blood pressure (mmHg), mean (SD)	73.7 (10.3)	73.7 (10.8)
Heart rate (beats per minute), mean (SD)	71.9 (13.1)	69.7 (11.7)
Body mass index (kg/m^2), mean (SD)	28.6 (7)	28.3 (5.9)
BNP (pg/ml), median (IQI)	187.1 (81.4; 456.7)	257.0 (141.2; 386.0)
NT-pro-BNP (pg/ml), median (IQI), n	1141.5 (642.0; 1852.0)	1570.0 (596.0; 3819.0)
Creatinine (µmol/L), median (IQI), n	101.0 (84.0; 133.0)	110.0 (87.0; 134.0)
Urea (mmol/L), median (IQI), n	8.8 (6.1; 12.0)	8.7 (6.6; 11.5)
Potassium (mmol/L), mean (SD)	4.5 (0.6)	4.5 (0.5)
Haemoglobin (g/dl), median (IQI)	13.6 (11.9; 14.3)	13.5 (11.5; 14.2)
NYHA class		
Class 1	32%	33%
Class 2	24%	32%
Class 3	37%	26%
Class 4	8%	10%
MAGGIC risk score, mean (SD)	22.6 (7.6)	22.1 (6.6)
Quality of life and well-being		
MLWHF Overall, mean (SD)	36.2 (24.9)	35.2 (24.8)
MLWHF Physical, mean (SD)	18.8 (12.3)	17.8 (11.8)
MLWHF Social, mean (SD)	9.9 (8.6)	10.3 (8.8)
MLWHF Emotional, mean (SD)	7.5 (6.8)	7.2 (7)
EQ5D score, mean (SD)	5 (3.4)	4.9 (3.9)

SD: standard deviation; BNP: Brain natriuretic peptide test; NT-pro-BNP: NT-proB-type Natriuretic Peptide blood test; NYHA: The New York Heart Association Classification for classifying the extent of heart failure; MAGGIC: The Meta-analysis Global Group in Chronic Heart Failure; MAGGIC risk score: The MAGGIC risk score is a simple and powerful method of risk stratification for morbidity and mortality in heart failure with preserved ejection fraction; MLWHF: Minnesota Living with Heart Failure questionnaire

Table 2. Comparison of opportunity scores, by randomised treatment allocation

Opportunity score	Enhanced self-management (control)		Supported medical management (intervention)		*P*-values	
	Reduced EF (n=61) mean (95% CI)	Preserved EF (n=40) mean (95% CI)	Reduced EF (n=62) mean (95% CI)	Preserved EF (n=39) mean (95% CI)	$P_{\text{for Reduced EF}}$	$P_{\text{for Preserved EF}}$
Opportunity score at the baseline	0.52 (0.45, 0.58)	0.54 (0.42, 0.67)	0.53 (0.45, 0.61)	0.53 (0.40, 0.65)	0.89	0.90
Opportunity score at the end	0.55 (0.49, 0.61)	0.54 (0.40, 0.67)	0.63 (0.56, 0.70)	0.57 (0.42, 0.72)	0.08	0.77
Change in opportunity score	0.04 (-0.006, 0.08)	-0.003 (-0.06, 0.05)	0.09 (0.04, 0.14)	0.07 (-0.04, 0.18)	0.13	0.24
Weighted opportunity score at the baseline	0.52 (0.44, 0.60)		0.53 (0.43, 0.62)		0.87	
Weighted opportunity score at the end of trial	0.54 (0.46, 0.62)		0.61 (0.52, 0.70)		0.25	
Change in weighted opportunity score	**0.029 (-0.019, 0.072)**		**0.08 (0.02, 0.15)**		**0.20**	

* End: after six months; change: the first measurement after six months minus the first measurement after randomization; EF: Ejection fraction

Table 3. Treatment effects on Minnesota Living with Heart Failure questionnaire, overall and subscales.

Items	Enhanced self-management (n=87)		Supported medical management (n=86)		*P* for change
	End mean (SD)	Change mean (SD)	End mean (SD)	Change mean (SD)	
Physical	17.4 (12.4)	0.09 (2.2)	16.5 (12.1)	0.02 (2.3)	0.84
Social	9.5 (8.3)	0.37 (3.1)	10.3 (9.0)	0.13 (2.0)	0.55
Emotional	7.5 (7.4)	0.2 (1.7)	7.8 (7.3)	0.15 (0.9)	0.83
Overall score	34.5 (25.9)	0.66 (5.0)	34.7 (26.4)	0.30 (4.4)	0.63

Table 4. Treatment effects on secondary outcomes.

Variable	n	Enhanced self-management (Control)		n	Supported medical management (Intervention)		*P* for change
		End mean (SD)	Change mean (SD)		End mean (SD)	Change mean (SD)	
NYHA score	96	2.22 (0.94)	0.09 (0.41)	88	2.17 (0.92)	0.01 (0.41)	0.17
MAGGIC score	88	22.55 (7.59)	- 0.10 (1.53)	94	22.22 (6.87)	0.0 (1.32)	0.63
BNP (pg/ml) †	57	140.2 (55.7, 295.2)	-1.10 (72.5)	43	25.6 (95.0, 416.0)	- 7.94 (38.1)	0.57
NT-pro BNP (pg/ml) †	32	853.5 (393.5, 2361.2)	52.37 (331.6)	41	120.0 (311.5, 1481.5)	-372.5 (2371.2)	0.26
Blood pressure systolic (mmHg)	96	122.4 (20.6)	1.26 (13.4)	91	122.2 (19.4)	-2.88 (12.8)	0.03
Blood pressure diastolic (mmHg)	96	71.5 (10.5)	-0.37 (7.3)	91	70.8 (10.0)	-1.33 (7.2)	0.37
Binary outcomes		Baseline n/N (%)	Final n/N (%)		Baseline n/N (%)	Final n/N (%)	P_{final}
Heart rate 50 to 70 bpm (if in sinus rhythm)		45/90 (50)	27/63 (42.8)		49/95 (51.6)	39/61 (53.9)	0.02
Serum potassium (4.0 to 4.9 mmol/L)		64/101 (63.4)	58/88 (65.9)		65/101 (64.4)	55/83 (66.3)	0.96
Controlled hypertension (SBP < 130 and DBP <80 mmHg)		56/101 (55.4)	61/97 (62.8)		54/101 (53.5)	60/98 (61.2)	0.81
Diagnosis of depression		4/79 (5.1)	13/76 (17.1)		7/79 (8.9)	16/78 (20.5)	0.58

n: sample size; bpm: beats per minute; SBP: systolic blood pressure; DBP: diastolic blood pressure

† For quantitative variables that are known to be skewed, median (1st, 3rd quartile) shown instead.

Table 5. Treatment effects on death and hospitalisations

Outcome	Enhanced self-management n=101	Supported medical management n=101	*P*-value*
All events			
Death	6 (5.9%)	13 (12.8%)	0.09
Hospital admissions	29 (28.7%)	40 (39.6%)	0.13
Cardiovascular events			
Cardiovascular death	3 (2.97%)	2 (1.98%)	0.65
Hospital admissions for cardiovascular or renal outcomes	13 (12.9%)	13 (12.9%)	1.00

* Calculated using Chi-square test