Telemonitoring versus standard care in heart failure: a randomised multicentre trial

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Aims

The aim was to assess the effect of a telemonitoring programme vs. standard care (SC) in preventing all-cause deaths or unplanned hospitalisations in heart failure (HF) at 18 months.

Methods and results

OSICAT was a randomised, multicentre, open-label French study in 937 patients hospitalised for acute HF ≤ 12 months before inclusion. Patients were randomised to telemonitoring (daily body weight measurement, daily recording of HF symptoms, and personalised education) ($n = 482$) or to SC ($n = 455$). Mean $\pm$ standard deviation number of events for the primary outcome was 1.30 ± 1.85 for telemonitoring and 1.46 ± 1.98 for SC [rate ratio 0.97, 95% confidence interval (CI) 0.77–1.23; $P = 0.80$]. In New York Heart Association (NYHA) class III or IV HF, median time to all-cause death or first unplanned hospitalisation was 82 days in the telemonitoring group and 67 days in the SC group ($P = 0.03$). After adjustment for known predictive factors, telemonitoring was associated with a 21% relative risk reduction in first unplanned hospitalisation for HF [hazard ratio (HR) 0.79, 95% CI 0.62–0.99; $P = 0.044$]; the relative risk reduction was 29% in patients with NYHA class III or IV HF (HR 0.71, 95% CI 0.53–0.95; $P = 0.02$), 38% in socially isolated patients (HR 0.62, 95% CI 0.39–0.98; $P = 0.043$), and 37% in patients who were $\geq 70\%$ adherent to body weight measurement (HR 0.63, 95% CI 0.45–0.88; $P = 0.006$).

Conclusion

Telemonitoring did not result in a significantly lower rate of all-cause deaths or unplanned hospitalisations in HF patients. The pre-specified subgroup results suggest the telemonitoring approach improves clinical outcomes in selected populations but need further confirmation.

Keywords

Heart failure • Telemonitoring • Patient education • Hospitalisation • Body weight

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Introduction

Heart failure (HF) is a complex, life-threatening clinical syndrome characterised by acute episodes of decompensation that often result in prolonged and repeat hospitalisations.¹ HF is a leading cause of hospitalisation in Western populations, and is associated with significant costs, morbidity, and mortality.^{2,3} HF is an increasingly important contributor to healthcare expenditure,^{2,4,5} and new solutions need to be implemented to reduce its high morbidity and mortality, improve patient quality of life, and reduce healthcare costs.

Global, multidisciplinary, coordinated management of HF reduces the frequency of rehospitalisation^{6,7} and is a class IA recommendation in the European guidelines.¹ Home telemonitoring using an approach similar to that used in the Telemedical Interventional Management in HF-2 (TIM-HF2) trial may be considered for patients with HF to reduce the risk of recurrent cardiovascular and HF hospitalisations and cardiovascular death.⁸ However, randomised trials in non-invasive telemonitoring conducted over the past 10 years^{9–13} have shown conflicting results, because of major differences in the study populations, healthcare systems, and types of telemonitoring. Meta-analyses have, however, reported more consistent benefits in terms of morbidity and mortality.^{14–17}

The primary goal of the Optimization of the Ambulatory Monitoring for Patients With Heart Failure by Tele-cardiology (OSICAT) study was to assess the effect of a telemonitoring programme vs. standard monitoring in preventing all-cause deaths or unplanned hospitalisations over 18 months of follow-up in patients with HF.

Methods

OSICAT (NCT02068118) was a randomised, multicentre, open-label French study. The methods have been described.¹⁸ In brief, the study comprised an 18-month study period, during which patients were randomised to a telemonitoring programme or to standard care (SC).

The protocol and amendments were approved by the French 'Comité de Protection des Personnes' and French competent authority. The study was conducted according to French laws and Good Clinical Practice guidelines and the Declaration of Helsinki. All patients provided written informed consent.

Study patients

Eligible patients (≥ 18 years of age) were subjects who had been hospitalised for acute HF within 12 months before inclusion, had access to a landline telephone or General Packet Radio Service network, and were eligible for treatment through the French social security system.

Patients were excluded from participation for the following reasons: echocardiographic evaluation not available; B-type natriuretic peptide (BNP) < 100 pg/mL or N-terminal prohormone of BNP (NT-proBNP) < 300 pg/mL; life expectancy < 12 months; dialysis; with a heart transplant or left ventricular assist device; need for inotropic treatment; unable to use the study equipment; enrolment in another clinical trial; pregnant or breastfeeding, or of reproductive age and not using contraceptives; and patients under guardianship or wardship.

Study procedures

At the enrolment visit (managed by the investigator cardiologist), patients were randomly assigned (1:1), in a centralised manner, to telemonitoring or to SC (comprising conventional follow-up at the discretion of their general practitioner or referring cardiologist). All patients were followed up via four telephone calls, conducted by the clinical study technicians (at 15 days, 6 months, 12 months, and 18 months, all ± 15 days), during which information was collected on any hospitalisations, adverse events, and concomitant treatments. The telemonitoring programme comprised two elements: electronic devices and a personalised educational component. Patients in the telemonitoring group were each provided with an identical set of electronic scales to measure body weight and a device for answering eight symptom questions (online supplementary Table S1). Measurement of body weight and recording of HF symptoms were communicated daily to a secure server and were analysed automatically by an expert system that generated alerts, as necessary, with the aim of predicting episodes of cardiac decompensation. In the event of an alert, the nurses, who had access to the alerts on working days, contacted the patient to validate its relevance. If appropriate, they advised the patient to contact their general practitioner or cardiologist, with a follow-up call 48 h later. However, it was not planned to analyse the physician's actions.

The personalised educational component consisted of an information pack related to the management of HF, and to telephone calls every 3 weeks with the same nurses, specialised in HF management and patient education. The following educational aims were established in conjunction with the patient: knowledge of the disease and related medications, recognition of the signs of cardiac decompensation, and adherence to lifestyle advice about diet and physical activity.

Study management

The electronic case report form was provided and managed by BEPATIENT (Paris, France). Patient follow-up was managed by the clinical investigational centre at the University Hospital Centre (Toulouse, France). The study centres were monitored by three clinical research organisations (Platinnes, Paris, France; HealthID, Paris, France; Clinact, Vélizy-Villacoublay, France) and by Air Liquide Santé International (Loges-en-Josas, France). Data management was done by Air Liquide Santé International. The statistical analysis was performed by a clinical research organisation (Inferential, Paris, France).

A scientific committee (online supplementary Appendix S1) validated the objectives, methodology, and scientific quality of the study, and participated in the development and validation of the protocol. A blinded clinical events committee adjudicated all deaths and hospital stays, and assessed whether they were planned or unplanned, or related to a cardiovascular origin or to HF.

Study outcomes

The primary outcome was the composite of all-cause deaths or unplanned hospitalisations at 18 months. The secondary outcomes (all at 18 months) were: all-cause death; unplanned hospitalisations for any cause; the composite of unplanned hospitalisations for a cardiovascular cause or cardiovascular death; unplanned hospitalisations for cardiovascular cause; cardiovascular death; unplanned hospitalisations for HF; cumulative number of days in hospital for any unplanned cause; cumulative number of days in hospital for any unplanned cardiovascular cause; cumulative number of days in hospital for any unplanned HF cause; days lost due to unplanned cardiovascular hospitalisations or all-cause

Figure 1 Patient flow chart. SC, standard care.

death; Short Form-36 (SF-36) questionnaire scores including eight general dimensions and two composite scores: the Physical Component Summary and the Mental Component Summary. Data on adverse events were collected by investigators during patient consultations or were recorded during the four technician-led telephone interviews. Deaths and hospitalisations are reported as efficacy criteria.

The primary and secondary outcomes were analysed in three pre-specified subgroups: New York Heart Association (NYHA) class III or IV, socially isolated status, and adherence to self-measurement of body weight (telemonitoring group only). Social isolation was defined as: SF-36 Mental Health score <45; Mental Component Summary score <35; Mental Health <50 plus Mental Component Summary <40; medical history of depression or mood disorders/alterations; or use of concomitant antidepressant medications. Adherence was calculated as the ratio of the number of days with body weight measurement divided by the number of effective days (corresponding to the number of days in the study minus the number of days when weight could not be measured).

Statistical analysis

Assuming an estimated frequency of the composite primary criterion of 35% in the control group, with a reduction in the relative risk of 30% with telemonitoring,¹⁹ it was estimated that a sample of 870 patients including a 10% loss to follow-up rate would have 90% power to detect a difference in the primary outcome at a significance level of 0.05 for a 2-sided test. Following a protocol amendment, the sample size was increased to 990 to counterbalance the predicted 10% loss of patients before the intervention set-up.

Primary and secondary analyses were done on adjudicated events in the intention-to-treat population (i.e. all randomised evaluable

patients). The primary analysis was a comparison of the number of all-cause deaths or unplanned hospitalisations at 18 months [reported as mean $\pm$ standard deviation (SD)] divided by the effective duration of follow-up between the two groups using a negative binomial regression model. All hospitalisations were included for each patient. Deaths that occurred during hospitalisation with an overnight stay were counted as two events. Time-to-event parameters are reported as medians [quartile (Q) 1, Q3], presented using Kaplan–Meier curves and compared exploratively using the log-rank test. Exploratory multiple-factor Cox model analyses were performed to identify predictors of time-to-event parameters (online supplementary Appendix S1) and to express the study group effect after adjustment for these factors. Each dimension and each composite SF-36 score were analysed separately within a mixed model to account for differences in duration of follow-up.

Statistical analyses were performed using SAS version 9.4 software (SAS Institute, Inc, Cary, NC, USA).

Results

Between May 2013 and June 2016, 990 patients were enrolled at 38 centres: 507 patients were randomly assigned to receive telemonitoring and 483 to receive SC. Fifty-three patients were excluded from the analysis, leaving 937 patients in the intention-to-treat group, 632 (67.4%) of whom completed the 18-month study period (Figure 1).

Over half of the patients ($n = 501$; 53.5%) were enrolled at university hospitals; 16.9% ($n = 158$) in other hospitals, 12.3% ($n = 115$) in nursing facilities, 9.8% ($n = 92$) in private clinics, and 7.6% ($n = 71$) in private practices. Most patients (73.6%; $n = 690$)

Table 1 Patient characteristics and heart failure treatments at inclusion (intention-to-treat)

	Telemonitoring (n = 482)	SC (n = 455)
Men	354 (73.4%)	323 (71.0%)
Age, years, mean $\pm$ SD	70.0 $\pm$ 12.4	69.7 $\pm$ 12.5
<60 years	93 (19.3%)	105 (23.1%)
60 to <80 years	268 (55.6%)	237 (52.1%)
$\geq$ 80 years	121 (25.1%)	113 (24.8%)
Weight, kg, mean $\pm$ SD	79.3 $\pm$ 18.2	77.2 $\pm$ 17.8
BMI, kg/m ² , mean $\pm$ SD	27.6 $\pm$ 6.0	27.1 $\pm$ 5.5
SBP, mmHg, mean $\pm$ SD	119.6 $\pm$ 19.9	118.9 $\pm$ 19.3
DBP, mmHg, mean $\pm$ SD	69.9 $\pm$ 11.2	69.5 $\pm$ 12.2
Pulse rate, bpm, mean $\pm$ SD (n = 936)	73.7 $\pm$ 15.4	72.7 $\pm$ 13.9
eGFR (MDRD) mL/min, mean $\pm$ SD (n = 933)	60.5 $\pm$ 25.5	60.6 $\pm$ 25.1
NYHA class (n = 927)		
I	29 (6.1%)	32 (7.1%)
II	210 (44.2%)	196 (43.4%)
III	182 (38.3%)	185 (40.9%)
IV	54 (11.4%)	39 (8.6%)
Ischaemic heart disease (n = 935)	232 (48.2%)	211 (46.5%)
Heart failure (n = 933)		
Right/global	295 (61.5%)	269 (59.4%)
Left	185 (38.5%)	184 (40.6%)
LVEF, %, mean $\pm$ SD (n = 934)	39.3 $\pm$ 14.5	38.1 $\pm$ 15.2
$\leq$ 40%	280 (58.5%)	280 (61.5%)
>40% to $\leq$ 50%	95 (19.8%)	89 (19.6%)
>50%	104 (21.7%)	86 (18.9%)
BNP, pg/mL, median (Q1, Q3) (n = 402)	510 (303, 900)	484 (301, 929)
NT-proBNP, pg/mL, median (Q1, Q3) (n = 534)	3519 (1778, 6553)	3277 (1666, 6914)
Previous participation in an ETP	109 (22.6%)	114 (25.1%)
Cardiovascular risk factors		
Arterial hypertension	296 (61.4%)	246 (54.1%)
Dyslipidaemia	269 (55.8%)	248 (54.5%)
Family history of cardiovascular disease	109 (22.6%)	73 (16.0%)
Obesity (BMI $\geq$ 30 kg/m ²)	140 (29.0%)	122 (26.8%)
Smoking	111 (23.0%)	116 (25.5%)
Comorbidities of interest		
Coronary heart disease	236 (49.0%)	228 (50.1%)
Diabetes mellitus	146 (30.3%)	161 (35.4%)
Chronic renal disease (n = 936)	129 (26.8%)	128 (28.1%)
COPD	89 (18.5%)	89 (19.6%)
Concomitant pre-specified HF treatments		
Loop diuretics	447 (92.7%)	417 (91.6%)
Beta-blockers	379 (78.6%)	367 (80.7%)
ACE inhibitors or ARBs	354 (73.4%)	345 (75.8%)
Aldosterone antagonists	220 (45.6%)	211 (46.4%)
Ivabradine (n = 932)	23 (4.8%)	37 (8.2%)
Digoxin (n = 935)	28 (5.8%)	15 (3.3%)
Implantable cardioverter-defibrillator	60 (12.4%)	60 (13.2%)
Cardiac resynchronisation therapy	0 (0.0%)	1 (0.2%)

ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blocker; BMI, body mass index; BNP, B-type natriuretic peptide; COPD, chronic obstructive pulmonary disease; DBP, diastolic blood pressure; eGFR, glomerular filtration rate; ETP, educational therapeutic programme; HF, heart failure; LVEF, left ventricular ejection fraction; MDRD, Modification of Diet in Renal Disease; NT-proBNP, N-terminal pro B-type natriuretic peptide; NYHA, New York Heart Association; Q, quartile; SBP, systolic blood pressure; SC, standard care; SD, standard deviation.

were enrolled while hospitalised for HF. Median (Q1, Q3) number of patients enrolled at each centre was 10 (6, 25; range 1–194). Study patients were typical of HF patients, with similar rates of baseline characteristics in both groups. Most participants were male (72.3%), with a mean $\pm$ SD age of 69.9 $\pm$ 12.4 years; 25.0%

were older than 80 years (Table 1). Sociodemographic characteristics are detailed in online supplementary Table S2. Mean $\pm$ SD overall adherence to daily self-measurement of body weight (telemonitoring group; n = 482) was 59.9 $\pm$ 35.5% (median 74.6%, Q1, 34.1, Q3, 89.9); adherence was lowest in the first trimester (50.4%),

Table 2 Primary and secondary outcomes at 18 months (adjudicated events) (intention-to-treat)

	Telemonitoring (n = 482)	SC (n = 455)	RR/HR (95% CI)	P-value
All-cause deaths or unplanned hospitalisations				
Patients with ≥ 1 event	255 (52.9%)	254 (55.8%)	—	—
Mean $\pm$ SD number of events	1.30 $\pm$ 1.85	1.46 $\pm$ 1.98	RR 0.97 (0.77–1.23)	0.80 ^a
Mean $\pm$ SD time to first event (days)	149.1 $\pm$ 142.1	144.3 $\pm$ 139.8	HR 0.94 (0.78–1.12)	0.47 ^b
Median (Q1, Q3) time to first event (days)	105 (30, 232)	84 (29, 238)		
All-cause deaths				
Patients with event	91 (18.9%)	89 (19.6%)	—	—
Mean $\pm$ SD time to event (days)	255.8 $\pm$ 146.3	253.2 $\pm$ 158.2	—	0.85 ^c
Median (Q1, Q3) time to event (days)	252 (148, 369)	233 (100, 390)		
Unplanned all-cause hospitalisations				
Patients with ≥ 1 event	242 (50.2%)	241 (53.0%)	—	—
Mean $\pm$ SD number of events	1.11 $\pm$ 1.67	1.27 $\pm$ 1.82	RR 0.97 (0.78–1.21)	0.77 ^a
Mean $\pm$ SD annualised cumulative number of days in hospital (n = 481)	36.3 $\pm$ 54.4	34.1 $\pm$ 47.0	—	0.34 ^d
Unplanned hospitalisations for cardiovascular cause or cardiovascular deaths				
Patients with ≥ 1 event	208 (43.2%)	201 (44.2%)	—	—
Mean $\pm$ SD number of events	0.96 $\pm$ 1.56	1.07 $\pm$ 1.75	RR 0.97 (0.74–1.27)	0.83 ^a
Mean $\pm$ SD time to first event (days)	145.7 $\pm$ 145.0	144.0 $\pm$ 144.2	—	0.99 ^c
Median (Q1, Q3) time to first event (days)	95 (29, 203)	79 (28, 246)		
Unplanned hospitalisations for HF				
Patients with ≥ 1 event	141 (29.3%)	160 (35.2%)	—	—
Mean $\pm$ SD number of events	0.59 $\pm$ 1.26	0.75 $\pm$ 1.42	RR 0.84 (0.62–1.15)	0.28 ^a
Mean $\pm$ SD annualised cumulative number of days in hospital for any unplanned HF cause (n = 301)	37.5 $\pm$ 52.7	33.4 $\pm$ 48.3	—	0.63 ^d
Mean $\pm$ SD time to first event (days)	157.6 $\pm$ 157.9	144.5 $\pm$ 143.0	HR 0.79 (0.62–0.99)	0.044 ^b
Median (Q1, Q3) time to first event (days)	97 (32, 252)	79 (28, 236)		

CI, confidence interval; HR, hazard ratio; RR, rate ratio; SC, standard care; SD, standard deviation.

^aNegative binomial regression model with log link for the expected rate of events (i.e. number of events divided by the effective duration of follow-up).

^bMultivariable Cox regression model.

^cLog-rank test for time to event.

^dWilcoxon's rank sum test.

due to study material shipping, increasing to 74.0% in the second trimester, and decreasing slightly thereafter (online supplementary Figure S1). Mean $\pm$ SD exposure during the study period was 14.4 $\pm$ 6.1 and 15.3 $\pm$ 5.7 months, respectively.

Primary and secondary outcomes are detailed in Table 2 and online supplementary Table S3. Mean $\pm$ SD number of events for the primary outcome during the 18-month study period was 1.30 $\pm$ 1.85 in the telemonitoring group and 1.46 $\pm$ 1.98 in the SC group [rate ratio 0.97, 95% confidence interval (CI) 0.77–1.23; negative binomial regression $P = 0.80$] (Table 2). Median (Q1, Q3) time to all-cause death or first unplanned hospitalisation was 105 (30, 232) days in the telemonitoring group and 84 (29, 238) days in the SC group (log-rank $P = 0.68$) (Figure 2A).

Primary and secondary outcomes in pre-specified subgroups are detailed in online supplementary Tables S4 and S5. In patients with NYHA class III or IV HF, mean $\pm$ SD number of events during the 18-month period was 1.53 $\pm$ 1.98 for telemonitoring vs. 1.99 $\pm$ 2.26 for SC (rate ratio 0.82, 95% CI 0.62–1.10; $P = 0.18$) (online supplementary Table S4). Median time to all-cause death or first unplanned hospitalisation was 82 days in the telemonitoring group and 67 days in the SC group ($P = 0.03$) (Figure 2B).

In socially isolated patients, mean number of events was lower in the telemonitoring group (1.30 $\pm$ 1.66 vs. 1.89 $\pm$ 2.14; rate ratio 0.60, 95% CI 0.39–0.92; $P = 0.02$) (online supplementary Table S4), with no difference in time to first event between study groups ($P = 0.15$; Figure 2C). In the telemonitoring group, patients who were $\geq 70\%$ adherent to body weight measurement had a lower mean $\pm$ SD number of events than patients who were $< 70\%$ adherent (rate ratio 0.58, 95% CI 0.41–0.81; $P = 0.001$), with a statistically significant difference in time to first event of the primary outcome in favour of $\geq 70\%$ adherent patients (61 vs. 133 days) ($P = 0.01$; Figure 2D).

Mean $\pm$ SD number of unplanned hospitalisations for HF was 0.59 $\pm$ 1.26 for telemonitoring and 0.75 $\pm$ 1.42 for SC (rate ratio 0.84, 95% CI 0.62–1.15; $P = 0.28$) (Table 2). Median time to first unplanned hospitalisation for HF was 97 days in the telemonitoring group and 79 days in the SC group ($P = 0.12$) (Figure 3A). After adjustment for known predictive factors, telemonitoring was associated with a 21% relative risk reduction in first unplanned hospitalisation for HF (hazard ratio 0.79, 95% CI 0.62–0.99; $P = 0.044$).

The relative risk reduction of first unplanned hospitalisation for HF was 29% in patients with NYHA class III or IV HF (hazard

Figure 2 Time to first unplanned hospitalisation for any cause or death from any cause during the 18-month study period: (A) all patients; (B) New York Heart Association (NYHA) class III or IV; (C) socially isolated patients; (D) patients who were $\geq 70\%$ or $< 70\%$ adherent to body weight measurements (telemonitoring group) (standard care group included for comparison).

ratio 0.71, 95% CI 0.53–0.95; $P = 0.02$), 38% in socially isolated patients (hazard ratio 0.62, 95% CI 0.39–0.98; $P = 0.043$), and 37% in patients who were $\geq 70\%$ adherent to weight measurement (hazard ratio 0.63, 95% CI 0.45–0.88; $P = 0.006$). Time-to-event curves are shown in Figure 3B–D. SF-36 scores showed statistically significant improvements in vitality ($P = 0.034$) and social functioning ($P = 0.025$) for telemonitoring vs. SC (Table 3).

Discussion

This large, randomised French study comparing telemonitoring with standard monitoring showed no reduction in the primary composite outcome of all-cause deaths or unplanned hospitalisations over 18 months of follow-up in patients hospitalised for acute HF ≤ 12 months before inclusion. Among the secondary outcomes, telemonitoring reduced the relative risk of occurrence of first unplanned hospitalisation for HF by 21% after adjustment for known predictive factors. Median time to first HF hospitalisation was also numerically delayed by 18 days in the telemonitoring group, but the difference did not reach the level of statistical significance. The results suggest a benefit in three pre-specified subgroups: patients with severe HF (NYHA class III or IV), socially

isolated patients, and patients who showed high adherence to body weight measurement.

Telemonitoring studies report conflicting results. The TIM-HF study¹⁰ reported no reduction in all-cause death or the composite outcome of cardiovascular death or hospitalisation for HF with telemonitoring vs. SC in 710 chronic HF patients. The TIM-HF2 trial²⁰ reported that remote patient management resulted in fewer days lost due to unplanned cardiovascular hospitalisation and all-cause death compared with SC in a carefully selected HF population. Consequently, in the 2019 Heart Failure Association expert consensus report, telemonitoring, using a similar approach to that in the TIM-HF2 study, may be considered.⁸ The telemonitoring system used in TIM-HF2 is not, however, easily reproducible in clinical practice. The telemedical centre with physicians and HF nurses was available 24/7 and could act promptly according to the individual patient's risk profile, using baseline and follow-up biomarker values. In addition, patients transmitted a variety of biomedical data (i.e. daily body weight, blood pressure, heart rate, analysis of heart rhythm determined by electrocardiogram, peripheral capillary oxygen saturation, self-rated health status) to the telemedical centre. Finally, patients received regular education on HF. This remote patient management was tailored to the German

Figure 3 Time to first unplanned hospitalisation for heart failure: (A) all patients; (B) New York Heart Association (NYHA) class III or IV; (C) socially isolated patients; (D) patients who were $\geq 70\%$ or $< 70\%$ adherent to body weight measurements (telemonitoring group) (standard care group included for comparison).

Table 3 Change from baseline in Short-Form 36 scores for vitality and social functioning (intention-to-treat)

SF-36 score	Telemonitoring (n = 482)		SC (n = 455)	
	n	Mean $\pm$ SD	n	Mean $\pm$ SD
Vitality score				
Baseline ^a	444	37.4 $\pm$ 18.8	417	39.0 $\pm$ 19.2
Change from baseline				
12 months	307	9.0 $\pm$ 23.7	322	5.7 $\pm$ 22.1
18 months	284	11.1 $\pm$ 21.8	303	7.3 $\pm$ 21.7
Social functioning score				
Baseline ^a	445	78.5 $\pm$ 28.0	418	76.1 $\pm$ 29.8
Change from baseline				
12 months	307	4.4 $\pm$ 33.8	321	-0.3 $\pm$ 35.5
18 months	284	3.8 $\pm$ 33.9	303	3.2 $\pm$ 33.3

SC, standard care; SD, standard deviation; SF-36, Short-Form 36 health survey.

SF-36 scores showed significant improvements in vitality ($P = 0.034$) and social functioning ($P = 0.025$) for telemonitoring vs. SC. Each dimension of the SF-36 score was analysed separately within a mixed repeated measurements analysis of covariance model to account for differences in duration of follow-up

^aFirst telephone study visit with clinical study technicians.

healthcare system, and involved a selected population, with specific emphasis on the interaction between a telemedical centre and local caregivers, and is not easily applicable to other healthcare systems or representative of the spectrum of HF patients in clinical practice.

Compared with TIM-HF2,²⁰ patients in OSICAT had more severe disease: 71% were enrolled while in hospital (vs. none in TIM-HF2), 24 (2.6%) patients underwent a heart transplant during the study, and 10.0% of patients were in NYHA class IV (vs. <1% in TIM-HF2). Additionally, major depression was an exclusion criterion in TIM-HF2. The mortality rate was lower in TIM-HF2 at 12 months (8% in the telemonitoring group vs. 12% in SC group) than in OSICAT in 18 months (19% and 20%, respectively) confirming that less severe patients were enrolled in TIM-HF2.

Event rates in OSICAT concur with the European HF Pilot Survey,²¹ a study conducted in 12 European countries and involving 5118 patients with acute or chronic HF. All-cause death at 1 year was 17.4% in hospitalised patients with HF, and 43.9% of the population was readmitted to hospital. Corresponding rates were lower in stable/ambulatory HF patients (7.2% and 31.9%, respectively).²¹ In the present study, almost one-fifth of the patients died over 18 months of follow-up and half had an unplanned readmission to hospital, most commonly for a cardiovascular cause. Both studies confirm the poor medium-term prognosis for the spectrum of patients with HF.

The US Better Effectiveness After Transition-HF (BEAT-HF) study²² compared telemonitoring with SC in 1437 patients (median age 73 years) with HF after hospitalisation. Telemonitoring involved health coaching telephone calls plus telemonitoring with electronic equipment that collected daily information on blood pressure, heart rate, symptoms, and body weight. No reduction in the primary outcome of 180-day all-cause readmissions was observed (adjusted hazard ratio 1.03, 95% CI 0.88–1.20; $P = 0.74$), but 180-day quality of life (mean 28.50 for telemonitoring vs. 32.63 for SC) was significantly different in the telemonitoring group in unadjusted and adjusted analyses (both $P = 0.02$). Follow-up in the BEAT-HF study was, however, only 6 months.

A systematic review¹⁷ of 37 studies comparing telemonitoring (defined as the transmission of medical data, e.g. body weight, blood pressure, heart rate) vs. SC in patients with HF reported that telemonitoring reduced the risk of all-cause death (relative risk 0.81, 95% CI 0.70–0.94) and HF-related death (relative risk 0.68, 95% CI 0.50–0.91), and that intensive monitoring (i.e. transmission of ≥ 3 data or daily transmission) increased the effectiveness of this approach. However, the benefit was observed only in the studies that reported long-term follow-up. A trend towards reduced risk of HF-related hospitalisation was reported in the telemonitoring group. Given wide heterogeneity in the types of telemedicine, healthcare systems, and patient populations, each approach needs to be evaluated individually and over the long term.

Better tailoring HF programmes is vital, as the results of our study suggest that selected patients could draw greater benefits. We identified a possible benefit of telemonitoring in patients with severe HF (NYHA class III or IV), in socially isolated patients, and in patients who showed high adherence to body weight measurement. However, these exploratory results should be interpreted with caution. The primary outcome was reduced by 42.0% ($P = 0.001$)

in patients who were highly adherent to body weight measurement, and by 40.0% ($P = 0.02$) in socially isolated patients, but this finding needs confirmation in a sufficiently powered trial, as there was no difference in time to first event between study groups. Relative risk of occurrence of first hospitalisation for HF was also reduced by 37% in patients who were highly adherent to body weight measurement, by 38% in socially isolated patients, and by 29% in patients with NYHA class III or IV.

The threshold for adherence of $\geq 70.0\%$ to daily body weight measurement in the present study was based on the median adherence rate (74.6%), with 53.8% of the patients in the telemonitoring group $\geq 70\%$ adherent. This compares with a 97% rate of patients who were at least 70% compliant with daily data transfer to the telemedical centre in the TIM-HF2 study.²⁰ The difference in rates highlights the difficulties with patients following healthcare recommendations in everyday clinical practice. Regular personal monitoring and contact with healthcare professionals and the use of technical devices appear to positively influence behaviour and improve adherence to healthcare instructions.²³ However, the recommended frequency of monitoring varies, with the French Haute Autorité de santé guidelines²⁴ recommending that self-measurement of body weight is monitored at the frequency recommended by the healthcare professional, from daily to at least twice a week. The European guidelines,¹ in contrast, recommend daily weight measurement.

A small, recent study reported that 49% of patients hospitalised with HF reported social isolation, which was strongly associated with HF rehospitalisation within 90 days after discharge.²⁵ Social support provided by family and friends is linked with lower hospital readmission rates and better adherence to medications in individuals with HF, whereas lack of such support and living alone are related to psychosocial distress.²⁶ To make disease management programmes more efficient, effective, and cost-effective, vulnerable patients living alone are an important group to target, with close follow-up and home nursing being crucial aspects of their treatment.

As seen with the huge volume of literature, there is a growing interest in home telemonitoring in patients with chronic conditions. Use of telemedicine in general will progressively expand, and may be particularly useful in view of the current coronavirus disease 2019 health crisis.

Limitations

Whereas this open-label study involved a large, heterogeneous population with HF enrolled across the spectrum of medical facilities in France, over half were enrolled in university hospitals; the results may not therefore be applicable to all patients with HF. Data on body weight and frequency of measurement were not collected in the SC group to avoid interference with routine management. The relative risk reduction of 30% used in the sample size estimation may have been overestimated and thus the study did not have sufficient power to detect a benefit from telemonitoring in the overall population. The primary outcome of all-cause deaths or unplanned hospitalisations at 18 months was broad based. The study was also conducted before the TIM-HF2 trial²⁰ reported,

and the Experimental Telemedicine And Provision of Enhanced Services (ETAPES) programme²⁷ launched. Therefore, there are differences in the approaches used for telemonitoring. In OSICAT, in the event of a medical alert, the nurse contacted the patient who was in turn to contact their general practitioner. The corresponding actions taken by the physician were recorded, based on the patients self-reporting, during the nurse follow-up call 48 h later. In contrast, ETAPES involves a direct alert to the patient's cardiologist, facilitating a rapid treatment response. ETAPES is, therefore, more closely aligned with TIM-HF2 with regard to the management of the alerts than with OSICAT. Consequently, studies are required to further investigate these promising exploratory findings, and should perhaps focus on more specific outcomes, such as unplanned hospitalisation for HF, and could include the direct management of alerts by the patient's cardiologist, as recommended in the ETAPES programme.

Conclusions

In this French study, a telemonitoring approach combined with a therapeutic coaching programme did not lower the rate of all-cause deaths or unplanned hospitalisations in HF patients. Some subgroups may benefit from this approach, but future studies are required to further investigate these exploratory findings. Defining populations more adequately should be the next step in HF management, and special emphasis should be placed on closely monitoring patient adherence to optimise the effectiveness of telemonitoring.

Acknowledgements

The authors thank the Air Liquide Santé International project team (Les Loges-en-Josas and Gentilly, France); CDM e-Health team (Jouy-en-Josas, France); the medical expert Michel Cadilhac (Kelly OCG, Paris, France); the clinical investigational centre of University Hospital Centre (Toulouse, France), represented by

Claire Thalamos, MD; the clinical research organisation Cardiovascular European Research Centre (Massy, France), represented by Marie-Claude Morice, MD, Medical Director; the clinical research organisation project team of HealthID (Paris, France); the clinical research organisation project team of Clinact (Vélizy-Villacoublay, France); the clinical research organisation project team of EURAXI (Tours, France); and the clinical research organisation project team of Inferential (Paris, France).

Sophie Rushton-Smith, PhD (MedLink Healthcare Communications, London) provided medical writing assistance, under the direction of the authors, and was funded by CDM e-Health.

Funding

The study was supported by Alere E-Sante (Jouy-en-Josas, France) from 2013 to beginning of 2016 and by CDM e-Health (Jouy-en-Josas, France) from 2016 onwards. The sponsors participated in study site selection, monitoring, supervision of data collection, data analysis, clinical study report and publication.

Conflicts of interest: M.G. reports grants and personal fees from Chronic Care Connect/Air Liquide. F.R. reports grants, personal fees and non-financial support from Air Liquide Santé International; grants and personal fees from Abbott, Novartis, AstraZeneca; and personal fees from Vifor, Servier, Abiomed, Zoll, Medtronic, Resmed, LVL, Eole and Pfizer. P.B. reports grants, personal fees from CDM e-Health, Novartis, and Amgen. J.M.F. reports personal fees from CDM e-Health, Midi-Gascogne centre. J.M. receives personal fees from Boston Scientific. J.E.R. reports personal fees from Novartis and AstraZeneca. M.S. reports grants from CDM e-Health; personal fees and other from Novartis; and other from AstraZeneca and BMS. V.B. reports personal fees from Sanofi-Aventis France. C.D., G.L., H.P. and J.F.R.G. are employees of Air Liquide Santé International and shareholders in Air Liquide. A.P. reports grants, personal fees and non-financial support from CDM e-Health; and personal fees and non-financial support from Novartis. All other authors have nothing to disclose.

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