ORIGINAL ARTICLE

Healthcare costs of a telemonitoring programme for heart failure: indirect deterministic data linkage analysis

Atul Pathak[1]* 📷, Pierre Levy[2], François Roubille[3], Gilles Chatellier[4], Grégoire Mercier[5,6], Sarah Alami[7], Guila Lancman[7], Hélène Pasche[7], Corinne Laurelli[8], Cécile Delval[7], Juan Fernando Ramirez-Gil[8] and Michel Galinier[9,10] 📷

[1]*Department of Cardiovascular Medicine, Princess Grace Hospital, Monaco, Principality of Monaco;* [2]*LEDa – LEGOS, Université Paris Dauphine, PSL Research University, Paris, France;* [3]*Cardiology Department, INI-CRT, CHU de Montpellier, PhyMedExp, Université de Montpellier, INSERM, CNRS, Montpellier, France;* [4]*Clinical Research Unit and CIC 1418 INSERM, George-Pompidou European Hospital, Paris, France;* [5]*Economic Evaluation Unit (URME), University Hospital of Montpellier, Montpellier University, Montpellier, France;* [6]*IDESP, Univ Montpellier, INSERM, Montpellier, France;* [7]*Air Liquide Santé International, Bagneux, France;* [8]*Air Liquide Santé International, Loges en Josas, France;* [9]*Cardiology Department, Rangueil University Hospital, Toulouse, France; and* [10]*Faculty of Medicine, University of Paul Sabatier-Toulouse III, Toulouse, France*

Abstract

Aims   We aim to evaluate the costs associated with healthcare resource consumption for chronic heart failure (HF) management in patients allocated to telemonitoring versus standard of care (SC).

Methods and results   OSICAT-ECO involved 745 patients from the OSICAT trial (NCT02068118) who were successfully linked to the French national healthcare database through an indirect deterministic data linkage approach. OSICAT compared a telemonitoring programme with SC follow-up in adults hospitalized for acute HF $\leq$ 12 months. Healthcare resource costs included those related to hospital and ambulatory expenditure for HF and were restricted to direct costs determined from the French health data system over 18 months of follow-up. Most of the total costs (69.4%) were due to hospitalization for HF decompensation, followed by ambulatory nursing fees (11.8%). During 18-month follow-up, total costs were 2% lower in the telemonitoring versus the SC group, due primarily to a 21% reduction in nurse fees. Among patients with NYHA class III/IV, a 15% reduction in total costs (€3131 decrease) was observed over 18-month follow-up in the telemonitoring versus the SC group, with the highest difference in hospital expenditure during the first 6 months, followed by a shift in costs from hospital to ambulatory at 12 months.

Conclusions   HF hospitalization and ambulatory nursing fees represented most of the costs related to HF. No benefit was observed for telemonitoring versus SC with regard to cost reductions over 18 months. Patients with severe HF showed a non-significant 15% reduction in costs, largely related to hospitalization for HF decompensation, nurse fees, and medical transport.

Introduction

Chronic heart failure (CHF) is a common yet potentially preventable and treatable condition.[1] It can also be life-threatening, characterized by acute episodes of decompensation that often lead to hospitalization.[2–4] CHF is an important contributor to healthcare expenditure, and new approaches are being sought to reduce its high morbidity and mortality, improve patient quality of life, and reduce healthcare costs.[3,5,6]

Non-invasive home telemonitoring may be considered in patients with heart failure (HF) (Class IIb recommendation) to reduce the risk of recurrent cardiovascular and HF hospitalizations and cardiovascular death.[1] Telemonitoring can

facilitate rapid access to care when needed—particularly in at-risk patients (i.e. frail, living in a remote area, low socio-economic status)—can lower patient transport costs and reduce the frequency of face-to-face consultations, the relevance of which was emphasized during the COVID-19 pandemic.[1] Remote medical monitoring is also being investigated as a way to increase the cost-effectiveness of patient management by reducing hospital admissions, especially for chronic conditions such as HF.[7]

The French ETAPES programme (Telemedicine Experiments for the Improvement of Health Care Paths),[7] launched in 2014, is investigating the use of telemonitoring in improving healthcare pathways in several patient groups, including those with CHF, and has been extended to 2022 to more clearly evaluate and define the role of telemonitoring.[8] The anticipated benefits of telemonitoring will be evaluated in ETAPES, based on healthcare resource consumption and associated costs, care organization, and patient satisfaction.[9]

The French Optimization of the Ambulatory Monitoring for Patients With Heart Failure by Tele-cardiology Economic study (OSICAT-ECO) was set up as an ancillary study of the OSICAT trial to investigate healthcare resource use and associated costs through linkage of OSICAT-study participants[10,11] to the French national health insurance data system. The objective of the OSICAT-ECO study was to compare healthcare costs associated with HF healthcare resource consumption in patients on telemonitoring versus standard of care (SC) in France.

Methods

Study design and patients

OSICAT-ECO is based on data from patients enrolled in the randomized, open-label OSICAT trial (NCT02068118); the study design and primary results are described elsewhere.[10,11] The OSICAT study was conducted between 2013 and 2017, and involved patients hospitalized for acute HF in the preceding 12 months who were randomized to telemonitoring plus a therapeutic coaching programme every 3 weeks versus SC and followed for 18 months. Patients in the telemonitoring group were each given a set of electronic scales and a device for answering symptom questions. Measurement of body weight and recording of HF symptoms were communicated daily by the patient to a secure server and were analysed automatically by a system that generated alerts, with the objective of predicting an episode of cardiac decompensation. In the event of an alert, nurses working at the telemonitoring platform contacted the patient to validate its relevance; if the alert was regarded as clinically relevant, the nurse advised the patient to contact their general practitioner or cardiologist, and telephoned the patient again 48 h

later. SC follow-up was performed according to usual practice by the patient's general practitioner or cardiologist, and generally involved pharmacological and device treatments, along with lifestyle advice and management of coexisting conditions. The results of OSICAT showed that telemonitoring did not lower the rate of the primary outcome (a composite of all-cause death or unplanned hospitalization at 18 months),[10] but it reduced by 21% the relative risk of a first unplanned hospitalization for HF ($P = 0.044$) and led to improvements in the 36-Item Short Form Survey (SF-36) domains of vitality ($P = 0.034$) and social functioning ($P = 0.025$). The study also suggested a possible benefit in three pre-specified subgroups, with a relative risk reduction of first unplanned hospitalization for HF of 29% ($P = 0.02$) in patients with severe HF (NYHA III or IV), of 38% ($P = 0.043$) in socially isolated patients, and of 37% ($P = 0.006$) in patients adherent to body-weight measurement.

The OSICAT-ECO study was based on data from patients in OSICAT who were successfully linked to the French national health insurance data system[12] through an indirect deterministic data linkage approach. In France, almost 99% of French residents are affiliated to French health insurance plans, which collect all reimbursement in public and private practices concerning hospitalization, ambulatory care and medications.[13] These data can be accessed through the Système National des Données de Santé [SNDS] (http://www.snds.gouv.fr/). Patient-level data are available, collected locally from a variety of sources (*carte vitale* [health insurance card of the French national healthcare system], treatment forms, private institution invoices and procedures, and outpatient visits invoiced by public hospitals) and relating to ambulatory and hospital reimbursements.[12] A unique pseudonymized identification number (*numéro d'inscription au répertoire de l'INSEE* [NIR]) derived from the subject's social security number is generated.

In the OSICAT-ECO study, patients aged ≥18 years on 1 January 2013 with HF were identified from SNIIRAM-IC (*système national d'information inter-régimes de l'Assurance Maladie-IC*), extracted from SNDS on 22 June 2016, the date the last patient was enrolled in the OSICAT trial (see *supporting information*). As information on NIR was not collected in the OSICAT trial, an indirect deterministic data linkage approach using multiple indirect identifiers (sex, birth month and birth year, date of hospitalization(s), hospital identifier, date of consultation(s), and date of death if applicable) was applied to the SNIIRAM-IC cohort to identify the OSICAT-ECO cohort.

Cost items

The cost of healthcare resources analysed in the study included direct costs reimbursed by national health insurance related to both hospital expenditure (see *supporting*

information) and ambulatory expenditure in relation to HF, and comprised the following:

1. Hospitalization for HF

a. hospitalization (>1 day) for HF decompensation in an acute-care hospital (including cost for emergency visits when preceding hospitalization);
b. stay in day-care facility (≤1 day) for cardiovascular event (including cost for emergency department visits when preceding hospitalization);
c. visits to the emergency department (not followed by hospitalization);
d. drugs for HF (diuretics, beta-blockers, angiotensin-converting enzyme inhibitors, angiotensin II receptor blockers, digoxin, and ivabradine) delivered in hospital but not during a hospitalization;
e. general medicine and cardiology consultations in hospital.

2. Post hospitalization (for HF decompensation)

a. hospitalization in a post-acute care facility;
b. home-based care hospitalization;

3. Ambulatory expenditure

a. drugs and medical devices for HF provided in pharmacies;
b. general practitioner, cardiologist, and nurse fees;
c. ambulatory laboratory tests (blood and urinary ionograms, haemostasis, blood ferritin, natriuretic peptides, lipid profile, renal function);
d. ambulatory medical procedures (cardiac echocardiography, electrocardiogram, magnetic resonance imaging);
e. payments for sick leave (regardless of whether related to HF);
f. medical transport costs for HF (limited to those on the day of HF hospitalization admission or discharge, or consultation with general practitioner or cardiologist).

Cost analysis

Costing was restricted to direct costs and was determined from the perspective of the French national health insurance data system. Costs were attributed from official French national tariffs in 2019 and are expressed in Euros. A national tariff was applied to each hospitalization based on the *Groupes Homogènes de Malades* (GHM) code attributed in the *Programme de Médicalisation des Systèmes d'Information* (PMSI) database (see *supporting information*). GHM tariffs include mainly medical and related procedures, nursing care, treatments (except specific expensive drugs and implants), drugs/devices used, food and accommodation, and investment costs for hospitalized patients. Additional costs per day of hospitalization in an intensive care unit were added to GHM tariffs, when appropriate. For private hospitals, physicians' fees were also added.

To evaluate total expenditure for patients in the study, costs were evaluated over the follow-up period of each patient in the OSICAT trial, either during 18 months for those who completed the study as planned or until death or early discontinuation for other reasons. In addition, to assess the dynamics of costs over time, costs between inclusion and 6 months of follow-up for patients with ≥6 months of follow-up, costs between 6 and 12 months of follow-up for patients with ≥12 months of follow-up, and costs between 12 and 18 months of follow-up for patients with ≥18 months of follow-up were calculated secondarily.

Statistical methods

The statistical analysis plan was developed by Stève Consultants (Oullins, France) and validated by the sponsor and the OSICAT-ECO Scientific Committee. The analyses were performed using SAS version 9.4 (SAS Institute Inc. Cary, NC, USA) and using data from all the OSICAT-ECO study patients. Additional cost analyses were carried out in one of the subgroups identified in the OSICAT trial who may benefit from telemonitoring (i.e. New York Heart Association [NYHA] class III or IV).[10] Owing to the low frequency of patients in NYHA IV, the analyses combined those with NYHA III or IV.

Exploratory comparisons of costs between the telemonitoring and SC groups were carried out using Student's *t*-test via bootstrap estimation. As commonly recommended for cost data,[14] bootstrapping was used to estimate empirically the shape of a statistical sampling distribution. For the cost comparison, random samples were generated from the telemonitoring data with replacement. Similarly, random samples were generated from the SC data with replacement. This procedure was repeated 10 000 times, and the mean of the bootstrapping sample means was calculated for each group. Based on the high number of replicates, the real value of the mean cost could be estimated from the distribution of obtained samples and compared between both groups.

Ethics

The study was approved by the French ethics committee (*Comité éthique et scientifique pour les recherches, les études et les évaluations dans le domaine de la santé*) (*Commission Nationale de l'Informatique et des Libertés* authorization number 919019). In accordance with European and French laws, patients were contacted by letter requesting consent to reuse their data for this study.

Results

Data linkage

Of 990 patients enrolled in the OSICAT trial, 937 were included in the intention-to-treat (ITT) analysis. Fifteen patients in the ITT dataset withdrew their consent to participate in the OSICAT-ECO study and three were excluded because they did not receive the letter requesting consent to reuse their data. Therefore, 919 patients were eligible to participate in the OSICAT-ECO study.

The SNIIRAM-IC extraction included 4 155 885 beneficiaries. A total of 745 patients from the 919 eligible patients were successfully linked to the SNIIRAM-IC cohort, with a linkage success rate of 81.1% (745/919). Of these patients, 49.7% (n = 370) were in the telemonitoring group and 50.3% (n = 375) were in the SC group (*Figure 1*). The characteristics of the study groups remained balanced after data linkage, indicating that the initial randomization was retained, and the OSICAT-ECO cohort was similar to the OSICAT cohort (Supporting Information, *Table S1*). The percentage of men was similar in OSICAT and OSICAT-ECO (72.3% vs. 72.9%, respectively), the mean age was approximately 70 years, and half (49.1% vs. 51.3%) had a NYHA class III or IV.

Study patients

The mean age of the study patients was 69.6 ± 12.5 years at inclusion, 72.9% were men, and 51.3% were in NYHA class III or IV. Most patients (62.6%) had HF with reduced ejection fraction (≤40%). The baseline characteristics of patients in the telemonitoring and SC groups are shown in *Table 1*. Median (Q1, Q3) length of follow-up was around 18 months (546 days; 361, 548) (mean follow-up 14 months for the telemonitoring group [422 ± 183 days] and 15 months for the SC group [455 ± 167 days]).

Cost analysis and healthcare resource use

All study patients

Most of the total costs (69.4%) were due to HF hospitalization (12 164 of 17 431 Euros) over 18-month follow-up. Ambulatory nursing fees were the second highest cost (11.8%, 2067 Euros), followed by ambulatory medical procedures or laboratory tests for HF (4.7%, 829 Euros) and medical transport for HF (3.2%, 558 Euros). During 18-month follow-up, total costs were 2% lower in the telemonitoring group than in the SC group (*Table 2*), due primarily to a 21% reduction in ambulatory nursing fees.

Figure 1 Patient disposition. SNIIRAM, Système National d'Information Inter-Régimes de l'Assurance Maladie.
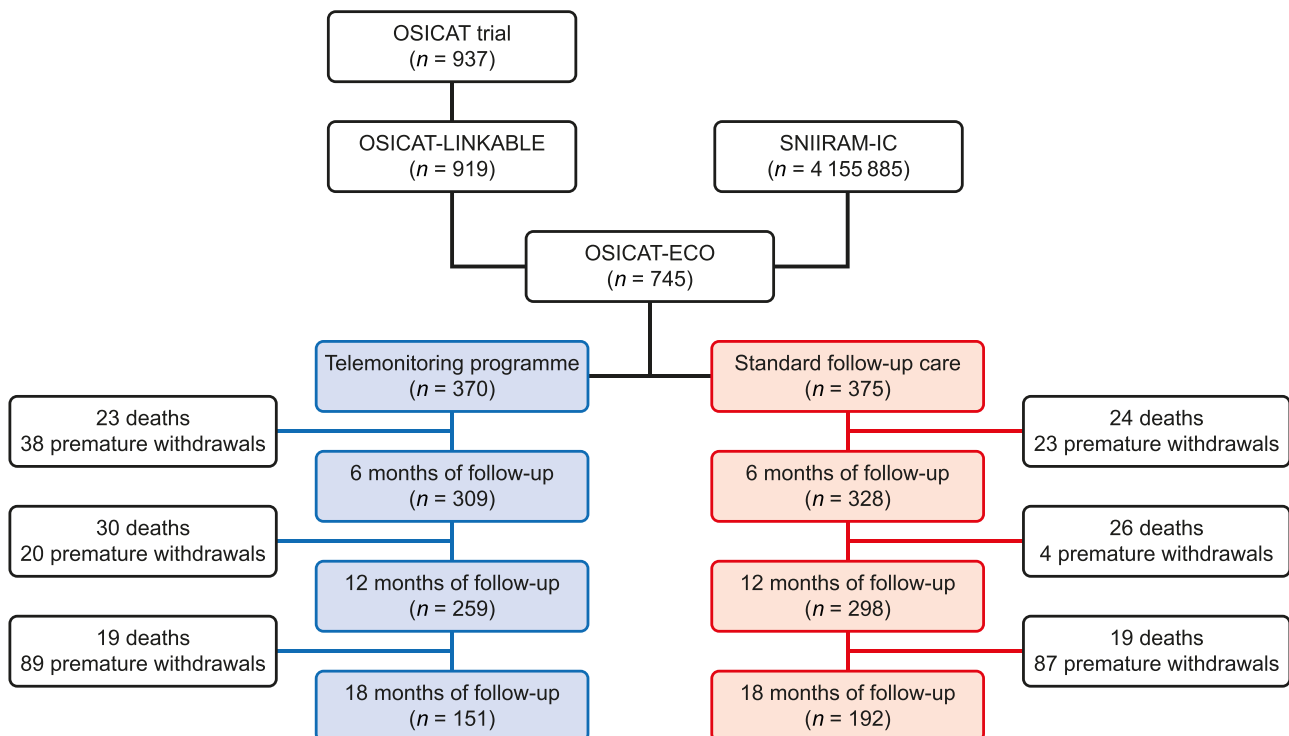
Table 1 Baseline characteristics of OSICAT-ECO patients

Characteristic	Telemonitoring (n = 370)	Standard of care (n = 375)
Male sex	277 (74.9%)	266 (70.9%)
Age in years, mean (SD)	69.2 (12.6)	70.0 (12.4)
BMI $\geq$ 30 kg/m^2	115 (31.1%)	103 (27.5%)
NYHA class	N = 365	N = 372
I	19 (5.2%)	19 (5.1%)
II	154 (42.2%)	163 (43.8%)
III	148 (40.5%)	159 (42.7%)
IV	44 (12.1%)	31 (8.3%)
HF category		
HF with reduced ejection fraction ($\leq$40%)	224 (60.5%)	242 (64.5%)
HF with preserved ejection fraction (>40%)	143 (38.7%)	133 (35.5%)
Undefined	3 (0.8%)	0 (0.0%)
Coronary heart disease	182 (49.2%)	183 (48.8%)
History of atrial fibrillation	140 (37.8%)	128 (34.1%)
Chronic renal disease	106 (28.7%)	113 (30.1%)
COPD	69 (18.6%)	76 (20.3%)
Cancer[a]	55 (14.9%)	58 (15.5%)
Depression	15 (4.1%)	19 (5.1%)
Arterial hypertension	226 (61.1%)	211 (56.3%)
Dyslipidaemia	207 (55.9%)	203 (54.1%)
Diabetes	115 (31.1%)	140 (37.3%)
Socially isolated at inclusion[b]	85 (24.7%)	88 (25.1%)

[a]Medical history or coexisting condition.
[b]Defined as SF-36 mental health subscore <45, or mental component summary composite score <35, or combination of SF-36 mental health subscore <50 and mental component summary composite score <40, or medical history of depression or mood disturbances/alterations, or use of concomitant antidepressant medications.

Table 2 Mean cost and cost savings in Euros for all patients (during a median of 18 months' follow-up)

Cost items	Cost (€)		Difference (TLM minus SC)	
	Telemonitoring (n = 370)	Standard of care (n = 375)	€[a]	%
Hospital expenditure				
Hospitalization for HF (>1 day) in an acute-care hospital facility	12 274	12 057	+217	+2%
Stay in day-care facility for cardiovascular event	439	541	−101	−19%
Hospitalization in a post-acute care facility after HF hospitalization	63	198	−135	−68%
Home-based care hospitalization for HF	23	66	−44	−66%
Visit to emergency department[b]	8	10	−2	−20%
Drugs for HF delivered in hospital	90	105	−15	−14%
General medicine consultation in hospital	42	39	+3	+6%
Cardiology consultation in hospital[c]	24	29	−5	−17%
Ambulatory expenditure				
Drugs for HF in pharmacies	291	316	−25	−8%
Medical devices for HF in pharmacies	60	43	+17	+40%
GP fees	155	150	+5	+3%
Cardiologist fees	49	38	+11	+27%
Nurse fees	1829	2303	−474	−21%
Ambulatory laboratory tests of interest	762	686	+77	+11%
Ambulatory medical procedures of interest	96	116	−19	−17%
Payments for sick leave	486	539	−53	−10%
Medical transport for HF	586	531	+55	+10%
Total				
Hospital expenditure[d]	13 002	12 913	+89	+1%
Ambulatory expenditure	4313	4721	−407	−9%
Total	17 273	17 588	−315	−2%

GP, general practitioner; HF, heart failure.
[a]None of the differences were statistically significant.
[b]Not followed by hospitalization.
[c]The specialty of the physician seen during the consultation is not well coded in hospital.
[d]Total of hospital expenditure is not equal to the sum of hospital item costs due to missing data.

Table 3 Mean cost and cost savings in Euros for patients with NYHA III and IV at inclusion (during a median of 18 months' follow-up, with a mean follow-up of 13 months in the telemonitoring group and 14 months in the SC group)

Cost items	Cost (€)		Difference (TLM minus SC)	
	Telemonitoring (n = 192)	Standard of care (n = 190)	€[a]	%
Mean (SD) follow-up (days)	400.0 (193.5)	432.8 (179.0)		
(95% confidence interval)	(371.8, 427.1)	(407.2, 457.7)		
Hospital expenditure				
Hospitalization for HF (>1 day) in an acute-care hospital facility	13 115	15 025	−1910	−13%
Stay in day-care facility for cardiovascular event	370	539	−169	−31%
Hospitalization in a post-acute care facility after HF hospitalization	121	188	−68	−36%
Home-based care hospitalization for HF	44	75	−32	−42%
Visit to emergency department[b]	8	11	−3	−31%
Drugs for HF delivered in hospital	119	103	+16	+16%
General medicine consultation in hospital	42	37	+5	+13%
Cardiology consultation in hospital[c]	25	27	−2	−9%
Ambulatory expenditure				
Drugs for HF in pharmacies	284	308	−24	−8%
Medical devices for HF in pharmacies	33	71	−38	−53%
GP fees	164	127	+37[d]	+29%
Cardiologist fees	47	35	+13	+37%
Nurse fees	2141	3106	−965	−31%
Ambulatory laboratory tests of interest	699	757	−58	−8%
Ambulatory medical procedures of interest	101	123	−23	−18%
Payments for sick leave	500	366	+134	+37%
Medical transport for HF	466	776	−310	−40%
Total				
Hospital expenditure[e]	13 917	15 776	−1860	−12%
Ambulatory expenditure	4434	5668	−1234	−22%
Total	18 237	21 368	−3131	−15%

[a]None of the differences were statistically significant except for GP fees.
[b]Not followed by hospitalization.
[c]The specialty of the physician seen during the consultation is not well coded in hospital.
[d]P = 0.047.
[e]Total of hospital expenditure is not equal to the sum of hospital items costs due to missing data.
GP, general practitioner; HF, heart failure; SD, standard deviation.

No significant differences in total costs and healthcare resource use were observed between the telemonitoring and SC groups at any time during follow-up (Supporting Information, *Figure S1*). The costs decreased in a similar manner in both groups, being highest in the first semester of follow-up (reflecting HF hospitalizations) and decreasing thereafter. Ambulatory expenses remained relatively constant throughout.

### Subgroup of New York Heart Association class III and IV patients

Costs and cost reductions in the subgroup of patients with NYHA class III or IV are shown in *Table 3* and *Figure 2*. A substantial but not statistically significant reduction in costs with telemonitoring, related primarily to reduction of HF hospitalization, nurse fees, and medical transports was observed: a decrease of €3131 (15% reduction) was made over a median follow-up of 18 months (mean 13 months in telemonitoring group vs. 14 months in SC group). Total cost reductions were observed in the telemonitoring group relative to the SC group throughout the study, with a 14% reduction from 0–6 months (€1513 saving), a 26% reduction over 6–12 months (€1557 saving), and a 21% reduction at 12–18 months (€1003 saving)

(Supporting Information, *Table S2*). Savings in hospital expenditure were 15% in the first semester, rising to 30% in the second (both driven by savings in HF hospitalization), and decreasing to 3% in the third. In contrast, savings in ambulatory expenditure increased from 10% to 20% and 37% over the corresponding follow-up periods.

Discussion

This economic analysis compared the overall costs related to HF in patients from the French OSICAT study who were randomized to telemonitoring versus those allocated to SC follow-up. The costs of HF hospitalization represented 69.4% of the total costs related to HF, similar to what is reported in the literature[15,16]; ambulatory nursing fees accounted for a further 11.8% of total costs. No benefit was observed for telemonitoring versus SC with regard to cost savings over 18 months of follow-up in the overall population. Among the subgroup with severe HF (NYHA class III or IV), a substantial but not statistically significant reduction in

Figure 2 Mean cost analysis over time according to telemonitoring or standard of care follow-up for patients with severe HF (NYHA III or IV) at inclusion. SC, standard of care; TLM, telemonitoring.
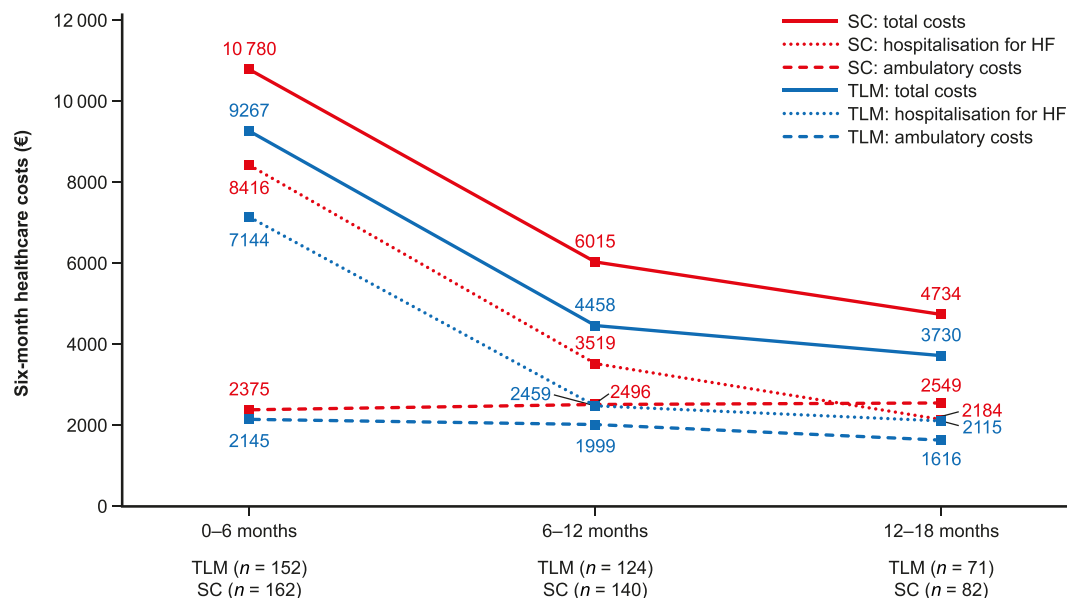
costs was observed with telemonitoring, with the highest difference in hospital expenditure apparent during the first 6 months—the period when the patient is most at risk of rehospitalisation—then a shift in costs from hospital to ambulatory at 12 months.

The OSICAT-ECO study adopted a design approach mixing data from a randomized controlled trial with the comprehensive real-world data issued from the French national health insurance data system. Data from the OSICAT study were matched with data in the French national administrative reimbursement database, enabling the inclusion of costs related to HF over 18 months of follow-up regardless of whether incurred in or out of hospital. The linkage success rate was above 80% and compares favourably with previous studies reporting rates ranging from 76% to 90%.[17–19] Moreover, the characteristics of the two study groups remained balanced in OSICAT-ECO patients, which is an important criterion for data linkage validity.

Conflicting results have been reported from randomized trials in non-invasive telemonitoring,[20–25] largely due to differences in the populations, healthcare structures, and types of remote monitoring, whereas meta-analyses have shown more consistent benefits for morbidity and mortality.[26–29] Health-economic data on telemedicine are now emerging. A cost-utility analysis from a Danish study in 274 patients with HF reported that 'telehealthcare' (comprising a tablet, digital blood pressure monitor, and a set of scales) in addition to usual care was highly cost-effective.[30] Patients were instructed to perform measurements once to twice a week, and specialized HF nurses were responsible for the education, instructions, and monitoring, and were given the authority to

change medications if indicated. The nurses could also contact the HF clinic for guidance on specific issues. Patients in the control group received the usual care, whereby general practitioners were responsible for monitoring patients. The authors reported an adjusted reduction in costs of £5096 (5960 Euros) (95% confidence interval 8736–1456) per patient, corresponding to a reduction in total healthcare costs of 35%.

The Telemedical Interventional Management in Heart Failure II trial (TIM-HF2) has shown that non-invasive remote patient management in HF reduced days lost due to unplanned cardiovascular hospital admissions and all-cause death; it was also cost-effective compared with usual care alone, being associated with overall cost savings and improved clinical effectiveness.[31] One difference between TIM-HF2 and our study is that patients with major depression were excluded in the former, whereas socially isolated patients (based on SF36 score, depression, or use of antidepressant medication) were retained in our study.

A retrospective cohort study using SCAD data matched with French Health Insurance data involved 528 patients with HF in Normandy, France.[32] SCAD, funded by ETAPES, is a 3-month telemonitoring programme associated with therapeutic education. This study assessed the difference in direct costs between the year before and the year after inclusion in the SCAD programme, which differs from the methods used in OSICAT-ECO, and showed that total health expenditure decreased significantly by a mean of 18% (€3210/patient) in the year after enrolment versus the 12 months prior (*P* < 0.0001). There was a bias; however, as 99 patients who died within the 12 months after SCAD initiation were ex-

cluded, which is the period most of the costs occur during the end of life. Together, these studies demonstrate the potential for medical telemonitoring to optimize patient care and reduce total costs related to HF decompensation.

OSICAT was conducted before ETAPES was launched, so there are differences in the approaches used for telemonitoring. ETAPES is based on three elements: a medical device with algorithm generating alerts, direct management by a cardiologist of the transmitted alerts, and a therapeutic coaching programme,[33] whereas remote monitoring in OSICAT was based on two elements, with no direct monitoring by a cardiologist. In the event of a clinical alert, the nurse telephoned the patient to contact their physician or cardiologist after the alert was validated by the patient.[10] In contrast, today, ETAPES involves a direct alert to the patient's cardiologist, facilitating a rapid treatment response.

Limitations

An indirect deterministic data linkage approach using multiple identifiers was applied to the SNIIRAM-IC cohort. The most severe patients (NYHA class III and IV) were more easily linked, as expected, because data linkage was based on hospitalizations. Some of the cost items, such as payments for sick leave and emergency department visits not followed by hospitalizations, were not strictly specific to HF. The study sample size calculation for the OSICAT trial was based on its primary clinical objective, with a composite outcome. It was not therefore designed to show a statistical difference in costs between study groups. This was particularly true for subgroup analyses performed in OSICAT-ECO, which should be interpreted with caution and considered as preliminary exploratory results in the absence of sufficient statistical power. Moreover, it is well known that in studies with low numbers of patients, mean costs may be sensitive to small numbers of patients with high levels of resource use, resulting in skewed distribution of costs. However, the arithmetic mean remains the most informative measure of total healthcare costs as needed for healthcare policy decisions. Indeed, as less than half (43.4%) of the OSICAT-ECO study patients had at least one classic hospitalization for HF decompensation over their 18-month follow-up, median values do not provide any information. As this study was randomized, the costs of HF management before entry were not considered. Finally, the findings may not be applicable to other national healthcare systems.

Conclusions

In this economic study, based on patients enrolled in a randomized, open-label clinical trial, HF hospitalization and ambulatory nursing fees represented the majority of the costs related to HF. Whereas no benefit was observed for telemonitoring versus SC with regard to cost reduction over 18 months in the overall population, patients with severe HF showed a substantial non-significant reduction in costs, largely related to hospitalization for HF decompensation, nurse consultations, and medical transports.

Conflict of interest

Prof. Pathak reports grants, personal fees and non-financial support from CDM e-Health; and personal fees and non-financial support from Novartis, Abbott, Merck, Servier, Medtronic, Boston Scientific. P. Levy received personal fees from stève consultants. Prof. Roubille reports grants, personal fees and non-financial support from Air Liquide Santé International; grants and personal fees from Abbott, Novartis, Astra Zeneca; and personal fees from Vifor, Servier, Abiomed, Zoll, Medtronic, Resmed, LVL, Eole and Pfizer. Dr Chatellier reports personal fees from Air Liquide Santé. Dr Mercier reports personal fees from Air Liquide Santé International, during the conduct of the study. S. Alami is an employee of Air Liquide Santé International and shareholder in Air Liquide. Dr Lancman is an employee of Air Liquide Santé International and shareholder in Air Liquide. H. Pasche is an employee of Air Liquide Santé International and shareholder in Air Liquide. C. Laurelli is an employee of Air Liquide Santé International and shareholder in Air Liquide. Dr Delval is an employee of Air Liquide Santé International and shareholder in Air Liquide. Dr Ramirez-Gil is an employee of Air Liquide Santé International and shareholder in Air Liquide. Prof. Galinier reports grants and personal fees from Chronic Care Connect/Air Liquide.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Characteristics of patients before and after matching.

Table S2. Mean cost savings over time in Euros for patients with NYHA III and IV at inclusion.

Figure S1. Mean cost analysis over time according to telemonitoring or standard of care follow-up for all patients. HF, heart failure; SC, standard of care; TLM, telemonitoring.

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