

Management of chronic heart failure: Role of home echocardiography in monitoring care programs

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Abstract

AIM: To identify a possible role of home echocardiography for monitoring chronic heart failure (CHF) patients.

METHODS: We prospectively investigated 118 patients hospitalized during the last year for CHF who could not easily reach the pertaining Sanitary District hospital. The patients were followed up with 2 home management programs: one including clinical and electrocardiographic evaluations and also periodic home echocardiographic examinations (group A), the other including clinical and electrocardiographic evaluations only (group B).

RESULTS: At the end of the 18-mo follow-up no significant differences were observed between the 2 groups as regards the primary endpoint: rehospitalization oc-

curred in 4 patients of the group A and in 6 patients of the group B; major cardiovascular events occurred in 2 and in 3 patients, respectively. No significant differences were observed with respect to the secondary endpoints: one vascular event appeared in both the groups, 3 cardiovascular deaths occurred in group A and 2 in group B. No significant differences were observed between the 2 groups as regards the composite endpoint of death plus hospitalization.

CONCLUSION: Home echocardiography for monitoring of CHF patients does not improve the cardiovascular endpoints. In our CHF patients, a low incidence of vascular events was observed.

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Key words: Echocardiography; Chronic heart failure; Home monitoring; Care programs; Cardiovascular events

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INTRODUCTION

Heart failure is one of the most important public health problems in developed countries^[1]. Due to the large

and increasingly ageing population, the direct costs of chronic heart failure (CHF) are continuously growing and can be estimated between 1% and 2% of the total health care budget^[2]. However, as compared with other common cardiovascular diseases, the epidemiological knowledge of heart failure is incomplete, due to the lack of practical definitions and the small number of simple diagnostic techniques adopted^[3].

Echocardiography is a simple and cheap technique used worldwide for the diagnosis of heart failure^[4] especially in asymptomatic patients, who represent most young male and female subjects affected^[5]. Heart failure, however, can be determined by different clinical syndromes with different echocardiography patterns: from the classic picture of clinical symptoms associated with ventricular systolic dysfunction to the more difficult diagnosis of some features of heart failure without echocardiographic signs^[6].

All the epidemiological studies confirm that the high cost of heart failure treatment programs are due to the frequent and repeated hospitalizations^[7]. In order to decrease the incidence of rehospitalization and improve the quality of life of heart failure patients, the recent heart failure management programs^[8] have been based on close monitoring through telephone follow-up and periodic home assessment of the functional status, with appropriate medical therapy.

Home monitoring care is usually conducted with periodic visits and electrocardiograms performed by the referring physicians. Today, to our knowledge, no heart failure home monitoring program has been implemented using more expensive and heavyweight diagnostic instruments.

In the present study, we prospectively investigated a cohort of 118 patients hospitalized during the last year for CHF and monitored with 2 home management programs, one based on clinical and electrocardiographic evaluations, the other also using periodic handheld echocardiographic monitoring.

MATERIALS AND METHODS

Patient enrollment

The present study prospectively evaluated patients with CHF referred to the territorial Sanitary District hospital between 30 January and 30 July 2009. All the recruited CHF patients, aged 70 years or older, gave their informed consent to the study. To be included in the trial, the patients should have been admitted to the hospital for worsening of clinical symptoms or for the appearance of acute cardiovascular events at least once during the last year, and discharged from hospital with a diagnosis of New York Heart Association (NYHA) class III heart failure. In addition, enrolled patients could not easily reach the pertaining Sanitary District hospital for various reasons (e.g., physical barriers, the absence of a lift, and too great distance between home and hospital without help). Patients who were waiting for cardiac surgery or patients who had undergone a cardiac operation

Table 1 Clinical and laboratory parameters of the chronic heart failure patients

	Group A	Group B
Sex (M/F)	31/29	29/29
Age (yr)	77 ± 7	78 ± 6
Weight (kg)	73 ± 16	75 ± 20
Height (cm)	164 ± 4	162 ± 8
Body mass index	28 ± 4	26 ± 6
Systolic blood pressure (mmHg)	140 ± 12	136 ± 10
Diastolic blood pressure (mmHg)	81 ± 8	83 ± 10
Creatinine (mg/dL)	1.8 ± 0.4	1.7 ± 0.6
Azotemia (mg/dL)	62 ± 12	59 ± 10
Uricemia (mg/dL)	6.5 ± 3.0	6.6 ± 2.6
Na (mmol/L)	143 ± 5	141 ± 8
K (mmol/L)	5.0 ± 0.2	4.9 ± 0.8
C-reactive protein (mg/dL)	0.9 ± 0.4	0.9 ± 0.6
B-type natriuretic peptide (pg/dL)	586 ± 260	600 ± 244

Data are expressed as mean ± SD. Differences between groups are not significant.

within 3 mo were excluded from the trial.

At the end of the 6-mo recruitment period, 118 CHF patients (60 male, 58 female; mean age, 78 ± 8 years) were enrolled in the trial. Anthropometric characteristics and laboratory data are summarized in Table 1. An ischemic etiology was diagnosed in 49 subjects (42%), a hypertensive etiology in 25 (21%), cardiac valve failure in 21 (18%), and idiopathic dilated cardiomyopathy in 23 (19%). Diabetes was present in 24 patients (20%), hypertension in 58 (49%) and permanent atrial fibrillation in 28 (24%). In 20 patients (17%) the glomerular filtration rate was decreased as in stage III-IV kidney disease, and 2 patients were on dialysis 2 or 3 times per week. Seventeen patients (14%) were affected by chronic obstructive pulmonary disease and 32 patients (27%) showed signs of previous ischemic cerebral events. The results of echocardiography examinations at the beginning of the trial are shown in Table 2.

Follow-up

The patients enrolled were randomized into 2 groups of 60 and 58 subjects, and treated according to evidence-based guidelines: (1) group A with 60 patients was home monitored with clinical evaluations and electrocardiogram (ECG) every 3 months, and also echocardiography examinations on the 6th, 12th and 18th months (Vivid E General Electric Medical System, Milwaukee, United States); and (2) group B with 58 patients was home monitored with clinical evaluations and ECG every 3 mo.

All the patients completed the Minnesota Living Heart Failure Questionnaire at the beginning and at the end of the trial, and received the telephone number of the physicians.

Events occurring during the 18-mo follow-up and the results of the final echocardiography performed in all patients were transmitted to an independent observer, unaware of the features of the follow-up.

At the end of the trial, the randomization code was

Table 2 Echocardiographic parameters in the 2 chronic heart failure groups at the beginning of the study

	Group A	Group B
End diastolic volume (mL)	170.8 ± 72.8	166.8 ± 78.4
End systolic volume (mL)	106.3 ± 64.2	105.3 ± 70.2
Stroke volume (mL)	60.2 ± 15.8	57.6 ± 18.2
Ejection fraction (%)	35.8 ± 11.8	35.0 ± 14.0
Isovolumetric relaxation time (ms)	97.2 ± 25.6	93.9 ± 29.7
Peak E wave velocity (m/s)	0.86 ± 0.98	0.85 ± 0.68
Peak A wave velocity (m/s)	0.67 ± 0.69	0.66 ± 0.19
Peak E deceleration time (ms)	187.6 ± 67.2	190.4 ± 64.4
TDI peak E' wave velocity (m/s)	0.09 ± 0.06	0.08 ± 0.09
TDI peak A' wave velocity (m/s)	0.08 ± 0.05	0.08 ± 0.07
E/E' ratio	10.75 ± 6.31	10.62 ± 5.14
Pulmonary systolic pressure (mmHg)	24 ± 8	28 ± 6

Data are expressed as mean ± SD. Differences between groups are not significant. TDI: Tissue Doppler imaging.

Table 3 Endpoints in the 2 chronic heart failure groups (%)

Endpoint	Group A	Group B
Primary endpoint		
Hospitalization	6 (10)	9 (15.5)
Worsening symptoms of HF	4	6
Major vascular events	2	3
Secondary endpoint		
Home treated vascular events	1 (1.7)	1 (1.7)
Cardiovascular death	3 (5)	2 (3.4)
Combined endpoint		
Cardiovascular deaths + hospitalizations	9 (15)	11 (18.9)

Differences between groups are not significant. HF: Heart failure.

opened and the events occurring and the echocardiography examinations were ascribed to the 2 groups for comparison.

Endpoints

The primary endpoint was rehospitalization for worsening of heart failure symptoms and/or for the appearance of major vascular events during the 18-mo follow-up. Secondary endpoints included home treated vascular events, cardiovascular death and the composite endpoint of death plus rehospitalization.

Statistical analysis

The CHF hospitalization rate was assumed to be 50% per year^[9-11]. Assuming a significance level of 5%, a power of 90%, a duration of the trial of 18 months and an expected hospitalization rate of 20% per year in the echocardiographic group, we could observe significant differences if each group had at least 55 CHF patients.

Data are expressed as mean ± SD. Differences between continuous variables were evaluated using the unpaired two-tailed Student *t* test. Discrete variables were summarized by frequency (percent). Differences between discrete variables were assessed using the Chi-square test, the Fisher exact test being used when necessary. A *P* value < 0.05 was considered statistically significant.

Table 4 Echocardiographic parameters in the 2 chronic heart failure groups at the end of the study

	Group A	Group B
End diastolic volume (mL)	168.8 ± 71.4	170.1 ± 74.2
End systolic volume (mL)	108.1 ± 60.1	109.3 ± 60.8
Stroke volume (mL)	56.2 ± 15.4	57.3 ± 18.3
Ejection fraction (%)	35.7 ± 10.8	35.8 ± 12.6
Isovolumetric relaxation time (ms)	97.6 ± 26.2	94.1 ± 30.6
Peak E wave velocity (m/s)	0.83 ± 0.52	0.88 ± 0.44
Peak A wave velocity (m/s)	0.66 ± 0.49	0.69 ± 0.32
Peak E deceleration time (ms)	187.9 ± 63.2	191.7 ± 69.2
TDI peak E' wave velocity (m/s)	0.08 ± 0.04	0.08 ± 0.05
TDI peak A' wave velocity (m/s)	0.06 ± 0.09	0.07 ± 0.04
E/E' ratio	10.5 ± 5.3	11.08 ± 6.2
Pulmonary systolic pressure (mmHg)	26 ± 12	30 ± 10

Data are expressed as mean ± SD. Differences between groups are not significant. TDI: Tissue Doppler imaging.

RESULTS

During the 18-mo follow-up, 15 patients were hospitalized, 6 in group A (4 for worsening of the symptoms, one for myocardial infarction, one for ischemic stroke) and 9 in group B (6 for worsening of the symptoms, 3 for myocardial infarction). In addition, one home-treated myocardial infarction occurred in group A, and one home-treated stroke occurred in group B. Finally, during the 18-month follow up, 3 patients of Group A (one male, 2 female), and 2 patients in Group B (one male, one female) had cardiovascular death (Table 3).

The routine laboratory analysis did not show any difference between the 2 groups, either at baseline or at the end of the study. From the CHF common baseline value of 580 ± 269 pg/dL, B-type natriuretic peptide changed to 360 ± 205 pg/dL in Group A and to 420 ± 260 pg/dL in Group B (not significant). The echocardiography parameters obtained in both groups at the end of the trial are shown in Table 4.

The answers to the Minnesota Living Heart Failure Questionnaire at the end of the trial were substantially similar in both groups.

DISCUSSION

Heart failure represents one of the most important public health problems in Western countries, with a higher incidence in ageing subjects, and a related increase in the health care costs^[1,2]. CHF home care should reduce the frequent, repeated and expensive hospitalizations and improve the management of patient disability in the last stages of the illness. An upgrading of CHF home care could be achieved with the use of some recent technological innovations such as home telemonitoring of patients. In this regard, recent clinical studies have provided different results. In the Home-HF study, 182 patients with a recent hospitalization for heart failure were randomly assigned to daily telemonitoring of symptoms, body weight, blood pressure, heart rate and blood oxygen saturation or to a package of intensive,

conventional, expert care (control group). There were no differences in rate and duration of hospitalization for any cause, though the home monitoring group showed a significantly lower rate of hospitalization for worsening heart failure^[12]. The results on the hospitalization rate disagree with the findings of the Home or Hospital in Heart failure (HHH) study, in which 461 CHF patients with a recent hospitalization and left ventricular ejection fraction lower than 40% were randomly assigned either to conventional care ($n = 160$) or to telemonitoring ($n = 301$). There was no significant effect of home telemonitoring in reducing cardiac death plus heart failure hospitalization, or in reducing the number of re-hospitalizations or the bed-days occupancy for heart failure^[13]. It is interesting to note that telemonitoring of CHF patients did not demonstrate any effect on mortality rate either in the Home-HF and in the HHH study.

In our study, a home care program which included periodic echocardiography has been adopted. Periodic home echocardiography, in fact, could be useful for the early detection of a sudden decrease in systolic function so that one could consider a different therapeutic approach, e.g., resynchronization therapy. In addition, home echocardiography could clarify the cause of new onset clinical signs, for example the diagnosis of new onset aortic stenosis could be made and the related treatment (transcatheter aortic valve implantation or surgical valve replacement) could be chosen. This study was designed to detect differences in the medical history of 2 different home monitored groups of patients. No significant differences were observed between the 2 groups as regards the primary endpoint, (rehospitalization and/or the appearance of major vascular events). Rehospitalization for worsening of heart failure symptoms occurred in 4 patients of the echocardiography monitored group and in 6 patients of the usual care group; hospitalization for the appearance of major cardiovascular events occurred in 2 and in 3 patients, respectively. No significant differences were observed between the 2 groups with respect to the secondary endpoints: one major vascular event was treated at home in group A and one vascular event was treated at home in group B, cardiovascular deaths occurred in 3 (5%) patients of the echocardiographic group and in 2 (3.4%) patients of the usual-care group. No significant differences were observed between the 2 groups with respect to the composite endpoint of death plus hospitalization: 9 patients (15%) in the echocardiography group, 11 patients (19.9%) in the usual care group, respectively.

These data agree with those recently reported by Chaudhry *et al.*^[14], who, in a population of 1653 CHF patients randomly assigned to undergo either telemonitoring (826 patients) or usual care (827 patients), concluded that telemonitoring did not improve either the primary endpoints (readmission for any reason or death for any cause) or the secondary one (hospitalization for heart failure, number of days in hospital and number of hospitalizations). As mentioned earlier, in the Home-HF trial^[12],

in which expensive electronic instruments monitoring daily signs and symptoms were used, no differences in rate and duration of hospitalization for any cause were reported. Home echocardiography also could be expensive. However, it is intriguing that different and more costly interventions are not clearly associated with lower hospitalizations or cardiovascular events^[15]. In addition, an absolute low rate of mortality (primary endpoint) and a low incidence of major vascular events were observed in our CHF patients burdened by a high cardiovascular risk (NYHA class III or at least one hospitalization during the last year). Again, we observed a low rate of the combined endpoint of death plus hospitalization. The data obtained in our study substantially differ from the data of the EuroHeart Failure Survey^[16], in which 24% of the 11327 CHF patients included were readmitted to the hospital within 12 weeks of discharge, and a significantly higher mortality rate (13.5%) was observed.

There are several possibilities for these unexpected results. First, all patients were followed at home by their cardiologist, with specific expertise in the ambulatory management of CHF. Therefore, all the patients had physical examinations with evaluation of vital parameters and routine laboratory analysis at the programmed and evidence-based times. Second, upgrading of clinical and laboratory evaluation was performed in particular in patients who live in places with physical barriers making it difficult to reach the pertinent Sanitary District hospital, and in fact the home monitored patients living in these remote places answered the Minnesota questionnaire in the same way. Third, all patients were treated according to current guidelines with all the necessary adjustments of the drugs dosages at each visit.

In our study, however, home echocardiography did not improve the cardiovascular outcomes of CHF patients.

Further studies with a large number of patients and a longer follow-up are needed to clarify which could be the better home monitoring program for improving the natural history and the prognosis of patients with chronic heart failure.

COMMENTS

Background

To decrease the incidence of re-hospitalization and improve quality of life of chronic heart failure (CHF) patients, home monitoring programs may be beneficial.

Research frontiers

Comparison of 2 home monitoring programs: (1) clinical evaluations and electrocardiographic (ECG) every 3 mo, and echocardiography examinations on the 6th, 12th and 18th months; and (2) clinical evaluations and ECG every 3 mo only.

Innovations and breakthroughs

Home echocardiography did not improve the cardiovascular outcomes of CHF patients.

Applications

Home monitoring programs are aimed at improving the natural history and the prognosis of patients with CHF.

Peer review

The paper is well written and methodology sound. The findings highlights the importance of regular monitoring and proper treatment of heart failure based on guidelines on outcome and not necessarily investigations that were not prompted by the clinical symptoms and signs of patients.

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