Impact of heart failure management unit on heart failure-related readmission rate and mortality

Stéphane Zuily, Patrick Jourdain, Daniel Decup, Nelly Agrinier, Jean Loiret, Serge Groshens, François Funck, Michel Bellorini, Yves Juillière, François Alla

Department of Cardiology, Nancy University Hospital, Vandoeuvre-lès-Nancy, France
Heart Failure Department, Pontoise Hospital, centre hospitalier René Dubos, 6, avenue de l’Île-de-France, 95301 Pontoise, France
Department of Medicoeconomic Analysis, Pontoise Hospital, centre hospitalier René Dubos, Pontoise, France
Department of Clinical Epidemiology and Evaluation, Nancy University Hospital, Nancy, France
Nancy-Université, Paul Verlaine Metz University, Paris Descartes University, EA 4360 Apemac, Nancy, France

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Summary
Background. — Heart failure is the leading cause of hospital admissions and an economic burden. In accordance with European guidelines, a dedicated heart failure unit was created in René Dubos Hospital (Pontoise, France) in 2002.
Aim. — To evaluate the impact of an in-hospital heart failure management unit on heart failure prognosis.
Methods. — We conducted a descriptive study of all-cause in-hospital mortality and heart failure related readmission rates in the year after the first admission for heart failure, from January 1997 to December 2007. The Chi² test, a trend test and linear regression were performed.
Results. — There were no significant differences in patient characteristics (age, sex, diabetes mellitus, left ventricular ejection fraction < 45%) other than renal insufficiency, in patients admitted for heart failure from 1997 to 2007. After the creation of the heart failure unit, we observed a significant decrease in heart failure related readmission rate from 21.7% in 2002...
to 15.6% in 2007 ($p < 0.0001$), whereas there was no difference in this rate before the creation of the unit (34.3% in 1997 and in 2001; $p = 0.90$). All-cause in-hospital mortality rate decreased from 9.3% in 1997 to 5.1% in 2007 ($p < 0.0001$) and showed a tendency to decrease after the creation of the heart failure unit ($p = 0.06$).

**Conclusion.** — Heart failure related readmission rates in new patients in the year after the first admission for heart failure reduced dramatically after the creation of the heart failure unit. All-cause in-hospital mortality in heart failure patients decreased over the 10-year study period.

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**MOTS CLÉS**
- Insuffisance cardiacaque ;
- Insuffisance ventriculaire gauche ;
- Education thérapeutique ;
- Hospitalisation de jour ;
- Pronostic

Résumé

**Introduction.** — L’insuffisance cardiaque (IC) est une des causes majeures d’hospitalisation et représente un fardeau économique important. En accord avec les recommandations européennes, une unité thérapeutique d’insuffisance cardiaque (UTIC) a été créée en 2002 à l’hôpital René Dubos (Pontoise, France).

**Objectif.** — Évaluer l’impact de la création d’une UTIC sur le pronostic des patients hospitalisés pour IC.

**Méthodes.** — Nous avons réalisé une étude descriptive du taux de mortalité inhospitalière toutes causes confondues chez les patients hospitalisés pour IC ainsi que du taux de réhospitalisation pour IC dans l’année suivant la première hospitalisation pour IC, de janvier 1997 à décembre 2007. Le test du Chi², le test de tendance et une régression linéaire ont été utilisés.

**Résultats.** — Entre 1997 et 2007, les caractéristiques des patients hospitalisés pour IC n’étaient pas significativement différentes (âge, sexe, diabète, FEVG < 45 %), exception faite de l’insuffisance rénale. Après la création de l’UTIC en 2002, nous avons observé une diminution significative du taux de réhospitalisations pour IC de 21,7 % en 2002 à 15,6 % en 2007 ($p < 0,0001$) alors que ce taux ne différait pas avant la création de l’UTIC (34,3 % en 1997 et 2001; $p = 0,90$).

Le taux de mortalité inhospitalière toutes causes confondues a diminué en passant de 9,3 % en 1997 à 5,1 % en 2007 ($p < 0,0001$) avec une tendance à la diminution suite à la création de l’UTIC ($p = 0,06$).

**Conclusion.** — Le taux de réhospitalisations pour IC dans l’année suivant la première hospitalisation pour IC a diminué significativement après la création de l’UTIC. La mortalité inhospitalière toutes causes confondues chez les patients insuffisants cardiaques a diminué significativement durant ces dix dernières années.

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**Abbreviations**

- BNP: B-type natriuretic peptide
- CI: confidence interval
- ESC: European Society of Cardiology
- HF: heart failure
- LVEF: left ventricular ejection fraction
- RCT: randomized controlled trials

**Background**

In many industrialized countries, HF is the leading cause of hospitalization for patients over 65 years of age [1] and about 40% of patients are readmitted in the year after their first admission for HF [2]. The overall prognosis for systolic HF is poor and the 1-year survival rate for severe HF is lower than that for most cancers [3]. HF also presents a huge economic burden [4]. In developed countries, mainly because of readmissions, HF accounts for up to 1–2% of total health costs [5] and this is expected to continue to increase in the future [4,6]. Studies from different settings have shown that non-compliance with medication, diet or symptom monitoring causes the majority of readmissions due to HF [7].

Over the past decade, we have seen an explosion of new treatment options for patients with HF, with a documented benefit for clinical outcome. As described recently in the updated guidelines from the ESC [8], management of chronic HF is a complex issue and an organized system of specialist HF care should be established to improve the outcome of patients with HF.

Since the introduction of the first HF programme in Europe [9,10], different models have been developed in several European countries, organized and delivered according to local and national healthcare needs. Several RCTs have compared these kinds of programmes for HF with usual care [11–13], and meta-analyses [14–17] have confirmed that they reduce mortality and hospital readmissions and indicate strong potential improvements in quality of life and cost savings [18,19].

Unfortunately, only a few European countries have a large number of organized structures for HF care and follow-up [20]: of the 33 RCTs included in the last meta-analysis [17], only five involved multidisciplinary and...
in-hospital approaches. All other RCTs involved nurse-led or pharmacist-led education or after-discharge management. This emphasizes the importance of creating an in-hospital HF management programme, in terms of efficacy for patients.

In order to guide and stimulate the further development of HF management programmes in France, the aim of this study was to evaluate the impact of an in-hospital HF unit (that included an in-patient hospitalization unit, an outpatient unit and an education structure) on all-cause in-hospital mortality rates and HF-related readmission rates in the year after the first admission for HF.

**Methods**

**Data sources**

Each patient admitted to René Dubos Hospital (Pontoise, France) from January 1997 to December 2007 was recorded. Furthermore, as part of standard procedure, information from patient case records was used, at the time of hospital discharge, to code diagnoses according to the 10th Revision of the World Health Organization International Classification of Diseases [21]. A single cardiologist coded the diagnoses to enable each individual's hospitalization record since 1997 to be analysed with a high degree of accuracy. This cardiologist reviewed all charts and certified the diagnosis. The present analysis was planned retrospectively to find differences in HF-related readmission rates and all-cause in-hospital mortality rates after the initiation of the HF management unit.

**Patients**

All patients were scheduled for a full clinical examination and control of medication and comorbidity. In all patients, the New York Heart Association class was estimated. Blood chemistry was analysed by standard methods and BNP was measured during outpatient hospitalization (scheduled within 1 month of the index hospitalization) by an in vitro immunoassay using a triage R meter (Biosite®, Inc., San Diego, CA, USA). Transthoracic echocardiography was performed during the index hospitalization using a Philips/Hewlett-Packard Sonos 5500® echocardiography system (Philips®, Amsterdam, Netherlands). LVEF was calculated according to the recommendations of the ESC [8].

According to the recommendations [8,22], all patients with HF class II—IV (New York Heart Association) and left ventricular dysfunction assessed by transthoracic echocardiography after medical stabilization were eligible for inclusion.

HF main diagnosis was assessed from information in the hospital records at discharge. Recorded admissions from January 1997 to December 2007 were screened to identify and select only those patients with a first admission caused primarily by the following (International Classification of Diseases): HF (I50), congestive HF (I50.0), left ventricular dysfunction (I50.1), cardiogenic shock (R57.0). We then excluded all patients who had a previous hospital admission for HF according to their medical records and after a reliable anamnesis.

**HF management unit**

An HF management unit was created in January 2002 in René Dubos Hospital (Pontoise, France). Each patient with a new diagnosis of HF was included directly in the HF management programme at discharge.

An outpatient hospitalization was scheduled within 1 month of the first hospital discharge. The multidisciplinary programme involved cardiologists, nurses, diabetics and physiotherapists, and included patient education, drug titration, diagnostic testing, telephone consultation, physical examination and diagnostic tests. Patient education included a combination of verbal and written information. Intensive pharmacological treatment was based on evidence-based guidelines current at the time of study [22]. Drug titration was mainly protocol-led and included diuretics, beta-blockers, angiotensin-converting enzyme-inhibitors, angiotensin II receptor blockiers and aldosterone receptor antagonists. Diagnostic tests were routine laboratory tests (creatinine, potassium), BNP concentration, electrocardiogram and 6-minute walk test. All patients underwent a complete transthoracic echocardiography assessment in the left lateral position. Parasternal long and short axis, and apical two- and four-chamber views were recorded. Colour flow and Doppler measurements were undertaken for assessment of valves.

Left ventricular systolic dysfunction was measured by the Simpson method. Left ventricular diastolic dysfunction was assessed according to evidence-based guidelines current at the time of study (presence of normal or only mildly abnormal left ventricular systolic function; evidence of abnormal left ventricular relaxation, filling, diastolic distensibility or diastolic stiffness) [23].

HF was diagnosed using the ESC [8,22] criteria, i.e. symptoms of HF, objective evidence of left ventricular dysfunction and/or response to treatment directed towards HF.

A follow-up plan was devised for each patient, aiming for monthly visits alternating between the general practitioner and HF unit, although the patients were free to see their general practitioner whenever they wished. Subsequently, group education sessions were planned for within 6 weeks of hospital discharge. These sessions were run by a cardiologist and the study nurse. The study team at the HF unit was available for consultation during normal working hours and received calls from both patients and their general practitioners. At times of worsening symptoms, patients were advised to see their general practitioner in the first instance.

**Endpoints**

The primary endpoint was the HF-related readmission rate. Although there is no unanimous agreement on the endpoints to be used for HF trials, we consider readmission rate to be clinically relevant, related directly to the primary goal of the trial. The secondary endpoint was the all-cause in-hospital mortality rate of patients admitted for HF. Finally, average length of hospital stay was recorded from 1997 to 2007.

**Statistical analysis**

Continuous variables are expressed as mean ± standard deviation, and categorical data as numbers and percentages.
Our main outcome was HF-related readmission rate. The HF-related readmission rate was measured as number of new patients readmitted for HF within the year after the first admission for HF, over the total of new patients admitted for HF in the same year. Our secondary outcome was all-cause in-hospital mortality rate, which was measured as the number of patients who died during hospitalization for HF, over the total number of patients admitted for HF. We also measured the length of hospital stay during the 10-year follow-up.

Comorbidity rates were compared using the Chi² test. HF-related readmission rate and all-cause in-hospital mortality rate were compared using the two-sided Cochran-Armitage test for trend. The mean age and length of hospital stay were compared using linear regression. A \( p < 0.05 \) was considered statistically significant. Statistical analyses were performed using SAS 9.1 software (SAS Institute Inc., Cary, NC, USA).

## Results

### Sample characteristics

From January 1997 to December 2007, the total number of new patients admitted for HF was 3200 (range per year: 179–377 patients). The population consisted of 1556 men (48.6%), with a mean age per year ranging from 68.5 ± 15.7 years to 74 ± 12.7 years; 53.7% of patients presented with systolic HF (LVEF < 45%), 15.4% had renal insufficiency and 20.2% had diabetes mellitus. Concerning these characteristics, no significant differences were found from 1997 to 2007, except for renal insufficiency: there was a significant increase after the creation of HF unit, from 10% \( (n = 31) \) in 2002 to 22% \( (n = 70) \) in 2007 \( (p = 0.001) \) (Table 1). Overall, 58% of patients had arterial hypertension and 62% had coronary artery disease.

Regarding treatments, after index hospitalization, 82% of patients received renin-angiotensin system blockers and 52% of patients received beta-blockers. After outpatient hospitalization, 92% of patients received beta-blockers.

BNP concentration measured during outpatient hospitalization scheduled within 1 month after index hospitalization was 258 ± 290 pg/mL.

### HF-related readmission rate

Before the creation of HF unit (1997 to 2001), the HF-related readmission rate ranged from 32.1% to 36.2%, with no significant difference \( (p = 0.90) \). After the creation of the HF management unit, starting from 2002, we observed an overall decrease in the HF-related readmission rate, ranging from 21.7% in 2002 to 15.6% in 2007 \( (p < 0.0001) \). Overall, we observed a dramatic decrease in the HF-related readmission rate from 1997 to 2007, with a highly significant difference \( (p < 0.0001) \) (Table 2, Fig. 1).

### All-cause in-hospital mortality rate

The all-cause in-hospital mortality rate for patients hospitalized for HF appeared to decrease significantly during the 10-year follow-up \( (p < 0.0001) \). Mortality rate did not differ before the creation of HF unit (from 1997 to 2001; \( p = 0.638 \),
Table 2  Heart failure-related readmission rate in the year after initial discharge from the hospital.

<table>
<thead>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new patients admitted/year</td>
<td>198</td>
<td>179</td>
<td>221</td>
<td>265</td>
<td>286</td>
<td>314</td>
<td>338</td>
<td>352</td>
<td>377</td>
<td>350</td>
<td>320</td>
</tr>
<tr>
<td>Number of new patients readmitted for HF in the year after the first admission for HF</td>
<td>68</td>
<td>59</td>
<td>80</td>
<td>85</td>
<td>98</td>
<td>68</td>
<td>108</td>
<td>94</td>
<td>94</td>
<td>59</td>
<td>50</td>
</tr>
<tr>
<td>HF-related rate of readmission of new patients in the year after the first admission for HF</td>
<td>34.3</td>
<td>33.0</td>
<td>36.2</td>
<td>32.1</td>
<td>34.3</td>
<td>21.7</td>
<td>32.0</td>
<td>26.7</td>
<td>24.9</td>
<td>16.9</td>
<td>15.6</td>
</tr>
</tbody>
</table>

HF: heart failure.

Discussion

In this study, after the creation of the HF management unit, we observed a significant decrease in the HF-related readmission rate from 2002 to 2007, whereas there was no difference in rates before the creation of the HF management unit, i.e., from 1997 to 2002. The all-cause in-hospital mortality rate for patients hospitalized for HF decreased significantly during the 10-year follow-up and we observed a trend towards a decrease after the creation of the HF unit, from 2002 to 2007, but without statistical significance. Finally, we noticed that the average length of hospital stay decreased during the 10-year follow-up.

The increase in the HF-related readmission rate, in particular in 2003, can be explained on the one hand by the heat wave that occurred in August 2003 in our country, which led to many hospital admissions and deaths related not only to HF [24], and on the other hand, by the absence of the cardiologist involved in the HF unit due to health problems. A large drop in readmission rate immediately after the creation of the programme can be explained by the motivation of the staff.

Concerning renal insufficiency, we suppose that the increase since the creation of the HF unit can be explained by treatment: when used in optimal doses to treat patients with HF, renin-angiotensin system blockers improve clinical outcomes but can cause renal impairment [25]. Concerning all other comorbidities, because no significant differences were found from 1997 to 2007, we suppose that HF-related readmission rate evolution was not related to these comorbidities.

Several models of follow-up care for HF patients exist in Europe but a few European countries have a large number of organized programmes for HF [20]. For example, in Sweden, the concept of HF nurses working in an outpatient clinic first occurred in the literature in 1983. Since then, many HF clinics have been created and evaluated by RCTs. In France, the lack of HF clinics and such RCTs led us to conduct only observational studies.

In Medicare-managed care plans, there is widespread use of HF disease management. However, the programmes focus primarily on patient self-management rather than on engaging physicians in medication management and compliance with guidelines. Mehrrota et al. [26] raised the concern that these programmes will not be able to achieve the quality improvement and cost savings demonstrated previously in clinical trials of HF disease management.
Despite these differences, our results are quite similar to the results of international studies. In a recent trial, Doughty et al. [27] concluded that the main effect of integrated HF management was attributable to the prevention of multiple admissions and associated reduction in bed days. They showed a decrease in hospital admission rate in the intervention group involved in HF management compared with usual care for patients with HF. The main effect of HF management intervention was attributable to the prevention of multiple all-cause readmissions. In a recent meta-analysis, Roccaforte et al. [17] aimed to re-evaluate the evidence concerning the impact of intensive HF management intervention was attributable to the prevention of multiple all-cause readmissions. In a recent meta-analysis, Roccaforte et al. [17] aimed to re-evaluate the evidence supporting the effectiveness of an HF management programme in improving relevant clinical outcomes — mortality first—in a much larger sample of studies and patient populations. Eight trials showed a statistically significant reduction in the HF-related hospitalization rate in the interventional group compared with usual care; none demonstrated an increase. The combined odds ratio (Yusuf-Peto method) was 0.58 (CI 0.50—0.67), but with a statistically significant test for heterogeneity, without identifying any study as the likely source of heterogeneity. The combined relative risk was 0.69 (CI 0.63—0.77, no heterogeneity) and the random effect odds ratio was 0.56 (CI 0.42—0.71, with some degree of heterogeneity). This meta-analysis confirmed, extended and updated findings published previously by McAlister et al. [16].

Our results can also be compared with those observed in France. Firstly, based on the French database, HF-related admission rates increased from 1997 (242.6/100,000 residents) to 2005 (290.3/100,000 residents) [28]. Our results are in agreement and showed that the HF-related admission rate per year increased from 1997 (n=198) to 2007 (n=320). In parallel, the HF-related readmission rate decreased after 2002, in part due to HF unit hospitalization and disease management. Secondly, HF-related mortality decreased significantly from 1990 to 2005 (−34%) and from 2000 to 2005 (−13%) [28]. Our results are similar because the all-cause in-hospital mortality rates for patients hospitalized for HF decreased significantly during the 1997–2007 period.

Multidisciplinary care of HF remains cost-effective and cost-beneficial when combined with optimal medical care. The significant clinical and cost benefits suggest that this intensive approach to multidisciplinary care and medical management should become the standard of care for HF [29]. Our results suggest that the average length of hospital stay decreased during the 10-year follow-up. Although our study is not designed for economic evaluation, we can suppose that, because of the reduction in hospital readmissions, the overall cost of care will have decreased after the creation of the HF unit.

Every clinic needs to undergo regular evaluation. The present study supposed that the readmission rate could be used to evaluate the efficiency of the work of the HF unit. This instrument could be validated in order to improve the HF unit’s evaluation. It is of great importance to continue to evaluate the clinics from a health-economic perspective and for patient satisfaction, quality of life and compliance with valid and reliable instruments. Actually, ESC guidelines [8] recommend that an organized system of specialist HF care should be established to improve outcomes of HF patients. Unfortunately, only a few European countries have a large number of organized programmes for HF care and follow-up [20].

**Strength and limitations**

As in any observational study, there are a number of limitations that require comment. We finally chose readmission rate as our primary endpoint. In spite of some limitations, we estimate that readmission rate was clinically relevant, related directly to the primary goal of the trial. Zanolla et al. [30] demonstrated that the event of hospitalization apparently represents an objective, “hard” endpoint; patients with HF also have an impaired quality of life and increased morbidity requiring frequent hospitalizations. Among the European programmes that evaluated care, frequency of readmission was the outcome monitored most frequently, followed by patient satisfaction and quality of life [20].

Moreover, we have to be aware of the limitations inherent in data collected by ICD codes, which we have to rely on to identify the study sample. It is, however, very difficult to ensure that all the factors were taken into account, particularly the grade of HF, the type and severity of ventricular dysfunction, the comorbidities and the number and type of drugs with their possible interactions and side-effects that can influence the rate of adverse events.

Furthermore, if only in-hospital data were collected and the number of deaths that occurred outside hospital was unknown, this might not have consequences for the HF-related readmission rate and cannot be a competing risk for readmission.

Finally, we conducted an observational study and not a randomized prospective study in order to assess the decrease in HF-related readmission rates and all-cause in-hospital mortality rates. This was an observational study and data were collected retrospectively; as such, it has significant limitations (no randomized and controlled groups, lack of comparability between patients through the years). However, our results are similar to data available in and outside France.

Despite these limitations, we have highlighted the potential benefit of specialist care in optimizing the management of newly diagnosed HF patients.

**Conclusion**

Since the HF intensive integrated management was developed at René Dubos Hospital (Pontoise, France), HF-related readmission rates in new patients within the year after the first admission for HF decreased dramatically. Furthermore, mortality in HF patients was confirmed to have decreased during the 10-year study period, thereby confirming the impact of HF care management on HF prognosis. Because of the limitations, further prospective studies will be necessary to confirm these findings and to study the cost implications of this strategy.

In the future, evaluation methods such as certification of special competency may be required to ensure that providers have appropriate training and clinical experience to treat this very important disease process. This kind of evaluation, based on an endpoint like readmission rate, may help the HF management unit to justify their programme.
Conflict of interest

None.

References