The short-term benefit from nurse-led ambulatory care supported by non-invasive haemodynamic assessment in patients after acute heart failure decompensation depends on the time since hospital discharge

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INTRODUCTION

Heart failure (HF) is a complex clinical syndrome characterized by high morbidity and mortality [1]. Each hospitalization due to HF deterioration may have an unfavorable impact on the patient's clinical condition and prognosis [2, 3]. Interventions to reduce readmissions should start in hospital settings, but the crucial issue is their continuation in the post-discharge period [1, 4]. In real-world situations, the hospital stay is usually too short to reach all therapeutic goals. It was estimated that over 50% of HF patients are not sufficiently decongested when leaving the hospital [5, 6]. Moreover, many discharged patients report psychological distress and uncertainty regarding recommendations, which can limit their drug adherence and self-care ability [4]. For this reason, accessibility of outpatient care and the opportunity to provide optimal dosing of medicines, early detection of disease progression and adequate education are crucial to prevent HF readmissions [1].

In the AMULET project (A new Model of medical care with Use of modern methods of non-invasive cLinical assEssment and Telemedicine in patients with heart failure), we offered nurse-led ambulatory care points (ACPs) for HF patients to respond to the shortage of cardiologists. The intention was to have the HF nurse operating the ACP, equipped with an impedance cardiography (ICG) monitor and a bioimpedance body composition analyzer, non-invasive diagnostic tools that have proven to be useful in HF management [7, 8]. The cardiologist was involved only to interpret the collected data, sum up the visit and give final recommendations. In the pilot study of the AMULET project, we evaluated the effects of such an approach and proved that a one-month care program based on nurse-led ACPs improved patients' functional and well-being status, and the consequent assessment of the haemodynamic profile resulted in a high rate of pharmacotherapy modifications [9].

Assuming the importance of the time interval between discharge after acute HF hospitalization and the inclusion in an ambulatory care plan, we aimed to compare the effect of one-month nurse-led ambulatory care on the functional and well-being status between patients recruited at the last day of acute HF hospitalization and those enrolled later, up to six months after discharge.

METHODS

For this secondary analysis, the data from the previously reported prospective and observational study [9] was used. Seventy-three adult

HF patients with at least one hospitalization due to acute HF decompensation within six months prior to enrollment and with a left ventricular ejection fraction (LVEF) ≤49%, were recruited. The inclusion and exclusion criteria are described in detail in our previous paper [9]. Each study participant provided written informed consent to participate in the study, which was approved by the local Ethics Committee (no. 70/WIM/2016).

The ambulatory care plan included three visits to an ACP: an initial visit (Visit 1), a second visit after 7–10 days (Visit 2) and a third visit after 23–37 days (Visit 3). Baseline characteristics were collected at Visit 1 (including the most current laboratory tests). The New York Heart Association (NYHA) classification was used to assess the patient's functional state and the visual analogue scale (VAS), ranging from 1 point ("I feel extremely bad") to 10 points ("I feel great"), to assess well-being [9]. Impedance cardiography (Niccomo, Medis, Ilmenau, Germany) was performed to measure i.e. systolic and diastolic blood pressure (SBP and DBP), heart rate (HR) and thoracic fluid content (TFC). Those parameters were interpreted with reference to a recommendation support module (RSM), which presented predefined target values and alarms. The physicians were instructed to interpret RSM indications according to the staging of alarms marked by colours: white, green, yellow and red. For example, if the TFC value fell within the range of yellow right-side alarm, the patient was supposed to be significantly congested and the recommendation was to introduce diuretic or increase its dose if previously prescribed. The details of RSM were presented in our previous paper [9].

LVEF determined using echocardiography, radionuclide angiography or cardiac magnetic resonance imaging and documented up to 6 months before enrolment was noted. Creatinine and haemoglobin were analyzed from peripheral venous blood samples. The estimated glomerular filtration rate (eGFR) was calculated as per Modification of Diet in Renal Disease (MDRD) formula.

Statistical analysis

Statistical analyses were performed using Stata 16.1 (StataCorp LLC, USA). Data distribution and normality were assessed by visual inspection of histograms and the Shapiro-Wilk test. Descriptive statistics included medians and interquartile ranges (IQR) for continuous variables, as well as frequencies and percentages for categorical variables. The comparison in baseline characteristics between two subgroups of patients, those recruited on the last day of hospitalization (early recruitment [ER], n = 32) and those recruited later (delayed recruitment [DR], n = 41), were performed using the Mann-Whitney U test for continuous variables and the Pearson χ-squared test (or the Fisher's exact test in cases of less than five expected frequencies in each cell of a contingency table) for categorical variables. Generalized estimating equations (GEE) with identity as a link function and exchangeable structures of within-subject correlation matrices were used to assess the influence of selected parameters on the continuous outcome variable (VAS), and random-effect ordered logistic models were used to assess the influence of selected parameters on the ordinal outcome variable (NYHA class), separately for each subgroup. *P*-values less than 0.05 (2-sided) were considered significant for all analyses.

RESULTS AND DISCUSSION

In terms of baseline characteristics, ER subjects presented a lower estimated glomerular filtration rate (eGFR) and a higher NYHA class than DR ones. No other statistically significant differences were observed (Table 1). In the analysis of visit-to-visit VAS scores, statistical differences were noted for the following: Visit 1 vs Visit 3 and Visit 2 vs

Table 1. The comparison between subgroups (early vs delayed recruitment)

		Early recruitment (n = 32)		Delayed recruitment (n = 41)		
Baseline characteristics						
Male/female, n (%)		25/7 (78/22)		30/11 (73/27)		0.626
Age, years, median (IQR)		70.0 (60.5–80.5)		65.0 (55.0–73.0)		0.056
BMI, kg/m^2, median (IQR)		29.7 (24.7–33.0)		30.0 (26.0–32.0)		0.951
LVEF, %, median (IQR)		28 (23–37)		30 (25–40)		0.507
Hemoglobin, g/dl, median (IQR)		13.8 (12.1–14.9)		14.4 (12.5–15.5)		0.476
eGFR, ml/min, median (IQR)		55 (43–67)		73 (61–85)		0.001
VAS, points, median (IQR)		6 (5–7)		7 (5–8)		0.354
NYHA, points, median (IQR)		2 (2–3)		2 (2–2)		0.008
Visit to visit results		*P*				
VAS, median (IQR)	V1	6 (5–7)	*P*-value:	7 (5–8)	*P*-value:	—
	V2	7 (5–8)	V1–V2: 0.405	7 (6–8)	V1–V2: 0.018	
	V3	7 (6–9)	V1–V3: 0.002 V2–V3: 0.022	7 (6–8)	V1–V3: 0.107 V2–V3: 0.453	
NYHA class: I/II/III, %	V1	9/50/41	*P*-value:	15/75/10	*P*-value:	
	V2	21/55/24	V1–V2: 0.060	19/66/15	V1–V2: 0.914	
	V3	37/48/15	V1–V3: 0.002 V2–V3: 0.114	17/71/12	V1–V3: 0.995 V2–V3: 0.919	

Abbreviations: BMI, body mass index; eGFR, estimated glomerular filtration rate; IQR, interquartile range; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association; V, visit, VAS, visual analogue scale

Visit 3 in ER subgroup ($P = 0.002$ and $P = 0.022$, respectively) and Visit 1 vs Visit 2 in DR subgroup ($P = 0.018$), with a final relative increase of 18% in ER and 6% in DR subjects. As for the NYHA class, statistical differences were observed only for the ER subgroup, as follows: Visit 1 vs Visit 3 ($P = 0.002$) and Visit 1 vs Visit 2 (borderline $P = 0.060$). No statistical difference within visits was observed for DR (Table 1).

The results of this secondary analysis revealed that the nurse-led ambulatory care program was effective when introduced just after discharge in patients after acute HF deterioration, as showed by improvement in functional class and well being. Some clinical and laboratory characteristics, that differentiated compared groups (baseline NYHA class and eGFR), might be related with gained benefit and this issue should be further investigated in larger study groups.

The transition from inpatient to outpatient care is a crucial phase, in which many clinical and haemodynamic changes may occur, including unfavorable and demanding therapeutic interventions [2]. A coordinated discharge plan, based on early outpatient follow-up appointments, is strongly recommended [1] but difficult to provide for all patients because of limited access to ambulatory cardiologists. To address these challenges, our model of care is based on ACPs operated by HF nurses, where the clinical assessment of vital signs is enriched by objective noninvasive diagnostic tools and a recommendation support module. The detailed hemodynamic assessment enables patient-tailored pharmacotherapy and the involvement of HF nurses provides the opportunity to reduce the workload of cardiologists.

Our study revealed that patients recruited to the post-discharge outpatient care program on the last day of acute HF hospitalization differed from those enrolled later after discharge with improvement in both functional and well-being status. The observed benefit from nurse-led care supports an increasingly emphasized role of the nurse in the chain of care for HF patients [10]. Our concept might be integrated with other innovative outpatient care ideas such as the comprehensive HF care programs [11] or day-care HF units [12].

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