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## Original Article

## Persistent effect of nurse-led education on self-care behavior and disease knowledge in heart failure patients



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## ABSTRACT

**Purpose:** The guidelines on the management of patients with heart failure support intensive patient education on self-care. The present study aimed to evaluate the short-term and long-term impacts of a structured education provided by a qualified heart failure nurse on patients' self-care behavior and disease knowledge.

**Methods:** One hundred fifty patients (66 ± 12 years) hospitalized for heart failure participated in a structured one-hour educational session by a heart failure nurse. Patients completed a questionnaire comprising 15 questions (nine questions from the European Heart Failure Self-Care Behavior Scale [EHFScB-9] and six on the patients' disease knowledge) one day before and one day and six months after the educational session. Possible responses for each question ranged from 1 (complete agreement) to 5 (complete disagreement).

**Results:** After the educational session, the total EHFScB-9 score improved from 24.31 ± 6.98 to 14.94 ± 6.22, and the disease knowledge score improved from 18.03 ± 5.44 to 10.74 ± 4.30 (both  $P < 0.001$ ). Scores for individual questions ranged from 1.26 ± 0.81 (adherence to the medication protocol) to 3.66 ± 1.58 (everyday weighing habits) before the education. The greatest improvement after education was observed on response to weight gain (−2.00 ± 1.57), daily weight control (−1.77 ± 1.64), and knowledge on the cause of patients' heart failure (−1.53 ± 1.43). At 6-month follow-up, EHFScB-9 score was 17.33 ± 7.23 and knowledge score was 12.34 ± 5.30 (both  $P < 0.001$  compared with baseline). No factor was predictive of an insufficient teaching effect.

**Conclusions:** The educational program led by a qualified nurse improves patients' self-care behavior and disease knowledge with a persistent effect at 6-month follow-up. There are no patient characteristics which preclude the implementation of an educational session.

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## What is known?

- Significant improvements in self-care behaviors could be demonstrated in patients with heart failure immediately after educational sessions using structured scores.
- Guidelines recommend patient education on self-care behaviors in patients with heart failure.

## What is new?

- This study extends previous scores on self-care behaviors in patients with heart failure to knowledge of the disease, showing that knowledge is limited prior to an educational session, even in patients with long-standing disease.

- The longitudinal analysis demonstrated that the knowledge of patients with heart failure on the disease and self-care behaviors increases significantly immediately after a one-hour educational session conducted by a certified heart failure nurse and remains high at 6-month follow-up.
- In heart failure patients with normal neurocognitive capacity, there are no patient characteristics which preclude the implementation of an educational session.

## 1. Introduction

Chronic heart failure is one of the most prevalent cardiovascular diseases with a high rate of recurrent hospital admissions [1–3]. Medical treatment of heart failure is very effective for reduction of symptoms, rehospitalizations, and mortality if applied adequately [4,5]. However, the success of medical treatment depends on high patient adherence to drug therapy and rigorous self-care practices.

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Current guidelines recommend adequate patient education in a multidisciplinary team to achieve self-care objectives [5–7]. Previous studies have indicated that patient education improves clinical outcome parameters in patients with chronic heart failure [8–12]. However, adequate education by the physician caring for the patient is often limited by time constraints. Structured education by a qualified nurse has been reported to be an alternative aiming at improving patients' adherence to medical treatment and patient self-care [8,11–13]. Most of these studies have aimed at improving self-care in patients with heart failure. Self-care and improvements in self-care have been assessed using scales such as the European Heart Failure Self-Care Behavior Scale (EHFScB-9) [14–16]. Non-compliance to patient self-care behavior is a limitation that may be addressed by additional education on heart failure [17–19]. The knowledge on potential education needs beyond self-care remains limited. In particular, patients' knowledge of their disease and the impact of a structured educational program on aspects of disease knowledge and patient self-care remain understudied. Furthermore, the persistent effect of a one-time educational program on patient self-care behavior and disease knowledge during follow-up is not well known. However, only persistent improved knowledge will have an impact on patient outcome.

In contrast to previous studies, which have focused either on self-care behavior or disease knowledge, the present study combined both aspects. Furthermore, it used a longitudinal design to assess whether a one-time educational session has a persistent effect.

Thus, this study assessed 1) the knowledge of self-care behavior and disease knowledge of patients with chronic heart failure, 2) the impact of a structured one-hour educational session by a qualified heart failure nurse on the patients' disease knowledge and self-care behavior techniques immediately after education and at 6-month follow-up, and 3) factors influencing the immediate success of patient education.

## 2. Participants and methods

### 2.1. Study subjects

This study was performed at the Bonifatius Hospital Lingen, Germany, as a longitudinal study with patients answering a questionnaire before and after an educational intervention and at 6-month follow-up. Study subjects were patients hospitalized for heart failure symptoms between March 2018 and March 2019. They were classified as having heart failure with reduced ejection fraction ( $\leq 40\%$ ; HFrEF), heart failure with intermediate ejection fraction ( $40\%–50\%$ ; HFmEF), or heart failure with preserved ejection fraction ( $>50\%$ ; HFpEF).

The study aimed to include 150 patients in the educational program. A total of 198 patients were referred by the hospital physicians for the structured educational program performed by a qualified heart failure nurse. Of these, 48 patients were not enrolled into the study: 22 patients rejected the structured educational program, whereas 26 patients were found to be inadequate for it because the structured cognition assessment in ePA-AC (ergebnisorientierte Pflege Assessment Acute Care; ePA-CC GmbH, Wiesbaden, Germany; a result-oriented self-care assessment score) showed a deficit. The ePA-AC is an early detection procedure that records possible symptoms of neurocognitive disorders and indicates the need for in-depth diagnostics; it assesses the following components: orientation, acquisition of knowledge, day-to-day skills, attention, risk of falls and delirium, characteristics of challenging behavior, self-initiated activities, and sleep-wake rhythm. Finally, 150 patients were enrolled into the one-on-one educational session given by a German-speaking, board-certified heart failure nurse.

### 2.2. Study design

This was a longitudinal analysis with questionnaires given to the patients at three time points and patient education used as an intervention. Patients were given a questionnaire consisting of 15 questions one day before and one day after the educational session and at 6-month follow-up. The questionnaire included nine questions from the European Heart Failure Self-Care Behavior Scale (EHFScB-9) [14–16] and six items on the patients' knowledge about their disease. Validity and reliability analysis of the German version of the EHFScB-9 score by Köberich et al. [16] on 109 patients with heart failure demonstrated that the score could be used to distinguish patients with and without HF education. Furthermore, the EHFScB-9 showed significant test-retest reliability with an intraclass correlation coefficient of 0.69 for the total score [16]. The six items on the patients' knowledge about their disease included 1) I know about the function of the heart, 2) I know what heart failure means, 3) I know the symptoms of heart failure, 4) I know the causes of my heart failure, 5) I feel adequately informed about my heart failure disease, and 6) the effects of the drugs prescribed to me are known to me. The six items relate to questions from the previously validated Dutch Heart Failure Knowledge Scale [20] and those from the heart failure knowledge questionnaire described by Kommuri et al. [9]. To each question, the patient had to respond on a 5-point Likert scale, ranging from 1 (I completely agree) to 5 (I don't agree at all). Thus, the total score ranged from 9 to 45 for the EHFScB-9 scale items and 15 to 75 for the total questionnaire including all 15 items.

Each patient participated in an educational session of 60 min. The educational session was a one-on-one session with the patient alone; however, in case of mental limitations of the patient, the presence of a relative or friend caring for the patient was requested during the educational session. The structured educational program included a presentation that provided information on heart function, basic principles of the causes of heart failure and their consequences, and requirements of patient self-care behaviors. The patients were also educated about the specific causes of their heart failure and basic principles of drug therapy. The session on self-care behaviors focused on daily weight monitoring, consequences of weight changes, reduced sodium intake ( $<2,000$  mg/day) and fluid intake ( $<2,000$  ml/day), high adherence to drug therapy, self-observation regarding dyspnea, swellings, and fatigue, and recommendations on regular physical activity. Patients were recommended to speak to a community nurse or physician in case of worsening symptoms. In this part of the session, a brochure on heart failure and self-care behavior and a daily weight diary were used and subsequently given to the patient. Specific difficulties of the patient were discussed; if necessary, other members of the multidisciplinary team were involved in the session.

At 6-month follow-up, the structured questionnaire was given to the patient again. Three regional outpatient cardiologists actively participated in the study and cared for 28 of the patients during out-of-hospital follow-up treatment; the questionnaire was given to these patients by the outpatient cardiologist caring for them. The 122 patients without an outpatient cardiologist obtained the questionnaire from the clinic.

For each patient, factors such as age, gender, marital status, time since diagnosis of chronic heart failure, prior hospitalization for heart failure, and educational session alone versus with a family member or friend were recorded. This information was used to identify the factors potentially influencing the success of the educational program as defined by the difference in total point score in the patient questionnaire immediately before and after the educational session.

For each patient, information on clinical events during a 6-

month follow-up period after the educational program was obtained by analyzing hospital charts, contacting the treating outpatient physicians, and maintaining a structured telephonic contact with the patients. Evaluated clinical follow-up events included hospitalization for heart failure and death. Furthermore, information on the New York Heart Association function class (NYHA class) at follow-up was obtained. The educational session was performed with the patient alone for 112 patients and performed together with a family member or friend for 38 patients.

This study was approved by the ethical review board of the Bonifatius Hospital Lingen. Each patient provided written informed consent to the study.

### 2.3. Statistical analyses

All analysis was performed using MedCalc statistical software (Version 4.2), and IBM SPSS software (IBM, Version 26). Unless otherwise specified, data are expressed as Mean ± SD. For categorical variables, comparisons were made using  $\chi^2$  tests. For continuous variables, comparisons were made using paired sample Student's *t*-test and Wilcoxon rank-sum tests, respectively. Univariate and multivariate logistic regression analyses were performed to determine the predictors of immediate success of the educational session. A *P* < 0.05 was considered statistically significant.

**Table 1**  
Patient characteristics (n = 150).

Characteristics		n (%)	
Gender	Male	112 (74.7)	
	Female	38 (25.3)	
Age, years, Mean ± SD (range)		66 ± 12 (19–90)	
Marital status	Single	34 (22.7)	
	Married	92 (61.3)	
	Widow	24 (16.0)	
NYHA function class	I	13 (8.7)	
	II	13 (8.7)	
	III	73 (48.7)	
	IV	28 (18.7)	
	Not Known	23 (15.3)	
Number of hospitalizations		103 (68.7)	
Time since diagnosis of heart failure, days, Median (IQR)		41 (6–1,597)	
Heart failure category	HFrEF	100 (66.7)	
	HFmEF	41 (27.3)	
	HFpEF	9 (6.0)	
Ejection fraction, %, Mean ± SD		34.5 ± 10.2	
Etiology	Ischemic heart disease	59 (39.3)	
	Dilative cardiomyopathy	65 (43.3)	
	Hypertensive cardiomyopathy	5 (3.3)	
	Restrictive cardiomyopathy	5 (3.3)	
	Valvular heart disease	10 (6.7)	
	Non-compaction cardiomyopathy	3 (2.0)	
	Post myocarditis	2 (0.7)	
	Tako-Tsubo- cardiomyopathy	1 (0.7)	
	Prior myocardial infarction		31 (20.6)
	Comorbidities	Hypertension	130 (86.0)
Atrial fibrillation/atrial flutter		67 (44.6)	
Chronic kidney disease		31 (20.6)	
Diabetes		47 (31.3)	
Chronic obstructive lung disease		12 (8.0)	
Peripheral vascular disease		10 (6.6)	
Beta receptor blocker		142 (94.7)	
ACE inhibitor		94 (62.7)	
Medication	AT1 receptor antagonist	23 (15.3)	
	Neprilysin inhibitor	29 (19.3)	
	Mineralocorticoid receptor antagonist	105 (70.0)	
	Diuretic	100 (66.7)	
	ICD	15 (10.0)	
	CRT	18 (12.0)	

Note: NYHA = New York Heart Association. HFrEF = heart failure reduced ejection fraction. HFmEF = heart failure intermediate ejection fraction. HFpEF = heart failure preserved ejection fraction. ACE = angiotensin-converting enzyme. AT1 receptor antagonist = angiotensin-II-receptor-subtype-1 antagonist. ICD = internal cardiac defibrillator. CRT = cardiac resynchronization therapy.

### 3. Results

#### 3.1. Patient baseline characteristics

Baseline characteristics of the 150 patients who received training from a heart failure nurse are presented in Table 1. Most patients were male, and 54.7% of patients had been recently diagnosed with heart failure. The median time since heart failure was diagnosed was 41 days (IQR 6–1,597 days) at the time of patient education, indicating that several patients already had a long-standing history of heart failure. Moreover, 32 patients had had prior hospitalizations for heart failure.

#### 3.2. Patient knowledge on disease and self-care before the educational session

The questionnaire scores prior to the educational program indicated that the patients' knowledge of their disease and self-care behavior objectives was only moderate. Table 2 demonstrates the mean scores obtained for the six questions on disease knowledge and the nine questions of the EHfScB-9 before the educational session. There was a considerable variation in the responses to the questions. The score was low on the understanding of the patients regarding the causes of their heart disease. Among the EHfScB-9

**Table 2**  
Answer score to the nine questions on self-care (EHFScB-9) and the six questions on patient disease knowledge.

Item	Prior (n = 150)	After (n = 150)	Follow-up (n = 143)	Δ Score (After vs. Prior)	After vs. Prior		Follow-up vs. Prior	
					t	P	t	P
					<b>Disease knowledge</b>			
Q1: I know the function of the heart	2.49 ± 1.10	1.76 ± 0.80	2.06 ± 1.02	-0.70 ± 1.02	-9.94	<0.001	-9.45	0.009
Q2: I know what heart failure means	2.58 ± 1.21	1.68 ± 0.84	1.91 ± 1.03	-0.87 ± 1.18	-9.96	<0.001	-10.44	<0.001
Q3: I know the symptoms of heart failure	3.16 ± 1.38	1.81 ± 0.99	2.17 ± 1.12	-1.33 ± 1.32	-13.18	<0.001	-12.21	<0.001
Q4: I know the causes of my heart failure	3.65 ± 1.33	2.11 ± 1.09	2.47 ± 1.21	-1.53 ± 1.43	-14.43	<0.001	-13.16	<0.001
Q5: I feel adequately informed about my heart failure disease	3.00 ± 1.27	1.53 ± 0.79	1.94 ± 1.07	-1.45 ± 1.32	-14.50	<0.001	-13.25	<0.001
Q6: The effects of the drugs prescribed to me are known to me	3.14 ± 1.28	1.85 ± 1.02	1.91 ± 1.00	-1.29 ± 1.36	-12.66	<0.001	-13.52	<0.001
<b>Total score of disease knowledge</b>	<b>18.03 ± 5.44</b>	<b>10.74 ± 4.30</b>	<b>12.34 ± 5.30</b>	<b>-7.26 ± 5.08</b>	<b>-15.72</b>	<b>&lt;0.001</b>	<b>-14.41</b>	<b>&lt;0.001</b>
<b>Self-care behavior</b>								
Q7: I weigh myself every day	3.66 ± 1.58	1.87 ± 1.26	2.34 ± 1.42	-1.77 ± 1.64	-14.97	<0.001	-13.67	<0.001
Q8: If my shortness of breath increases, I contact my doctor or nurse	2.64 ± 1.38	1.50 ± 0.87	1.68 ± 1.02	-1.15 ± 1.39	-10.96	<0.001	-11.04	<0.001
Q9: If my feet/legs become more swollen than usual, I contact my doctor or my nurse	2.55 ± 1.40	1.57 ± 1.01	1.82 ± 1.22	-0.99 ± 1.54	-9.38	<0.001	-9.49	<0.001
Q10: If I gain 2 kg in 3 days I contact my doctor or my nurse	3.57 ± 1.56	1.57 ± 1.09	1.98 ± 1.36	-2.00 ± 1.57	-16.91	<0.001	-14.93	<0.001
Q11: I do not drink more than 1.5–2.0 L/day	2.51 ± 1.39	1.76 ± 1.00	2.06 ± 1.11	-0.74 ± 1.32	-8.71	<0.001	-8.90	<0.001
Q12: If I experience increased fatigue, I contact my doctor or my nurse	3.05 ± 1.48	1.67 ± 1.04	2.09 ± 1.25	-1.39 ± 1.46	-12.51	<0.001	-11.14	<0.001
Q13: I eat a low salt diet	3.07 ± 1.30	2.18 ± 1.07	2.31 ± 1.06	-0.79 ± 1.27	-9.78	<0.001	-11.00	<0.001
Q14: I take my medication as prescribed	1.26 ± 0.81	1.14 ± 0.49	1.19 ± 0.76	-0.11 ± 0.74	-3.80	0.1342	-5.32	0.464
Q15: I exercise regularly	2.07 ± 1.12	1.68 ± 0.87	1.86 ± 1.16	-0.39 ± 0.92	-6.47	0.0035	-7.04	0.632
<b>Total score of EHFScB-9</b>	<b>24.31 ± 6.98</b>	<b>14.94 ± 6.22</b>	<b>17.33 ± 7.23</b>	<b>-9.46 ± 7.23</b>	<b>-15.52</b>	<b>&lt;0.001</b>	<b>-14.12</b>	<b>&lt;0.001</b>
<b>Total score of EHFScB-9 and disease knowledge</b>	<b>42.34 ± 10.07</b>	<b>25.69 ± 9.60</b>	<b>29.66 ± 11.70</b>	<b>-21.96 ± 15.63</b>	<b>-17.20</b>	<b>&lt;0.001</b>	<b>-15.19</b>	<b>&lt;0.001</b>

Note: A total of 15 questions were provided in a patient questionnaire before an educational session (Prior), one day after the educational session (After), and at 6-month follow-up (Follow-up). HFSB = European Heart Failure Self-Care Behavior Scale.

questions, the scores for daily weight control and seeking medical advice in case of significant weight gain were also considerably low. In contrast, most patients responded that regular intake of the prescribed medication was performed with high accuracy. The total score for the six disease knowledge questions was  $18.0 \pm 5.4$ , and the total score for the EHFScB-9 questions was  $24.3 \pm 7.0$ . The total score considering all 15 questions was  $42.3 \pm 10.1$  prior to the education session; 61 patients had a total score  $>45$  before the education session.

### 3.3. Patient knowledge on disease and self-care immediately after the educational session

One day after the educational program, all patients responded to the follow-up questionnaire. There was a significant change in the average score of almost all 15 questions (Table 2), which was associated with the patients' knowledge about their disease and self-care behaviors. The total scores for the six questions on disease knowledge, the nine EHFScB-9 questions, and all questions were significantly lower one day after the educational session ( $P < 0.001$ ). After the educational session, 44 patients showed a change in total score  $>20$  points from baseline. The highest score improvements were observed for questions which had low scores before the educational session. In particular, the scores on the patients' knowledge about the cause of their heart failure (mean difference  $-1.5 \pm 1.4$ ), daily weight control (mean difference  $-1.8 \pm 1.6$ ), and seeking medical advice in case of weight gain  $>2$  kg in 3 days (mean difference  $-2.0 \pm 1.6$ ) changed significantly.

### 3.4. Patient knowledge on disease and self-care at 6-month follow-up after the educational session

Seven patients died during the follow-up period. In total, 67% of patients responded to the follow-up questionnaire. The mean score of all 15 questions remained low at 6-month follow-up (Table 2).

The scores for intake of medication were very good before the educational session and remained unchanged immediately after education and at follow-up. The reported level of exercise was the same at 6-month follow-up as that before the educational session.

### 3.5. Predictors of educational success

Univariate and multivariate logistic regression analyses evaluated factors that significantly affected the score improvement  $>20$  points after the educational session. The factors gender, age, marital status, ischemic cause of heart failure, or training performed with the patient alone or together with a relative or friend did not have a significant effect on score improvement  $>20$  points. Time interval since diagnosis of heart failure and the educational session had a significant effect on knowledge score improvement  $>20$  points in the univariate analysis, with a lower disease duration being associated with a higher likelihood of a change in knowledge score  $>20$  points (*OR* per day 0.999,  $P = 0.040$ ). However, in a multivariate logistic regression analysis, neither factor was found to have a significant impact on significant changes in knowledge scores.

### 3.6. Clinical outcome after patient education

During the 6-month follow-up period after hospitalization and patient education, seven patients died, and 50 were rehospitalized for heart failure. There was no statistical difference in the total knowledge score immediately after the educational session between patients with and without a clinical event at follow-up ( $27.3 \pm 14.2$  vs.  $23.1 \pm 13.6$ ).

## 4. Discussion

### 4.1. Impacts of the structured education on patients' self-care behavior and disease knowledge

This study demonstrates that 1) the knowledge of patients with

heart failure on the disease and self-care behaviors is limited prior to an educational session, even in patients with long-standing disease; 2) patient knowledge on the disease and self-care increases significantly immediately after a one-hour educational session by a qualified nurse and remains high six months after the session; and 3) there are no patient characteristics that may preclude the implementation of an educational session.

Current guidelines on chronic heart failure management recommend that patients should be enrolled in a multidisciplinary care management program to improve the quality of life and reduce the risk of heart-failure-related hospitalization and, potentially, mortality [5–7]. The guidelines are based on previous studies that demonstrated that educational programs had an impact on patients' self-care behavior and disease knowledge [8–13,21]. A systematic review by Ditewig et al. [12] of nineteen randomized controlled trials indicated that self-management interventions had a positive effect on all-cause hospital readmission rate, chronic-heart-failure-related hospitalization rate, and quality of life, but their effect on mortality was non-significant.

Low knowledge of disease and self-care is associated with a lower level of heart-failure-related quality of life [22]. Educational programs should improve patient understanding of heart failure causes, symptoms, and disease trajectory and symptom monitoring and self-care behavior. Self-care is a process that facilitates behaviors that maintain physiological stability by guiding the patients' awareness of symptoms and direct the management of those symptoms [23]. Knowledge is necessary for effective self-care and is a requirement for high compliance. Self-care behavior is effectively evaluated by the EHFScB-9, whereas knowledge is evaluated by knowledge scores such as the Dutch Heart Failure Knowledge Scale [20] or a heart failure knowledge questionnaire as proposed by Kommuri et al. [9]. Kommuri et al. used 30 questions to assess patients' knowledge about disease management and dietary sodium intake. These questions evaluate different issues than the EHFScB-9, which focuses on self-care. The 9-item EHFScB-9 has become a validated and widely applied instrument to assess heart-failure-specific self-care in multiple populations [14–16,24]; a German version is also widely used [24]. The scale includes items related to two factors: consulting behaviors and adherence to the regimen. Thus, it standardizes behavior analysis on parameters such as daily weighing to assess fluid retention and seeking medical assistance when symptoms of heart failure occur. It can be used to analyze the effects of educational programs.

Several studies have shown that patient education on self-care behavior reduces readmission rates and care costs and improves the quality of life [8,10,12]. The impact of self-care behavior on mortality is less evident [4,8,11]. Koelling et al. [8] demonstrated in a randomized, controlled study on 223 patients with systolic heart failure that a one-hour teaching session at hospital discharge significantly reduced the risk of hospitalization during a 180-day follow-up period compared with a control group.

However, high rates of noncompliance on self-care behaviors have been demonstrated in patients with heart failure [17,19]. Van der Wal et al. [17] reported low compliance on regular weighing, exercise, and fluid restriction and high compliance on medication and appointment keeping. Compliance is positively associated with knowledge and beliefs; depressive symptoms have a negative impact on compliance. While self-care behavior is important for improved clinical outcomes, non-compliance contributes to worsening heart failure symptoms and to hospitalization [17,19]. A key factor contributing to sufficient compliance is adequate knowledge about heart failure [17,19]. Therefore, in the present study, knowledge about heart failure was included in the educational session and knowledge assessment.

Several studies [9,17,20,25] have demonstrated that heart failure

knowledge scores are significantly improved after a nurse education intervention and better in patients that do not experience clinical events such as death or rehospitalization during a 6-month follow-up period [9]. In the present study, we aimed to address patients' knowledge of the disease and self-care behaviors in the nurse-led education. Furthermore, the short-term and long-term impacts of both educational aspects were evaluated.

We found an average total EHFScB-9 score of  $24.3 \pm 7.0$  points prior to the educational session, which indicated a need for improvement. The score is consistent with the range reported in previous studies: Köberich et al. [16] reported a total score of  $20.1 \pm 6.4$  in 90 non-educated patients; Lee et al. [24] reported an average total score of  $18.1 \pm 6.1$ ; and Vellone et al. [26] reported an average total score of  $23.9 \pm 6.9$ . The correct intake of medication was found to be the item with the highest scores in our study. This finding is consistent with previous reports [14,24,26]. After the educational session, the average total score of EHFScB-9 in our study decreased to  $14.9 \pm 6.2$  points, indicating a major impact of the qualified nurse's education.

The average score on the six disease knowledge questions in our study was  $18.0 \pm 5.4$  points prior to the educational session, indicating a lack of disease understanding. This finding is in agreement with a study by van der Wal et al. [20], which demonstrated, using the Dutch Heart Failure Knowledge Scale, a mean score of only 10.9 on a 15-point scale prior to an educational session. Improvements in disease understanding are a key element in improving patient compliance to medication and self-care behaviors [17]. After the educational session, a considerable increase was observed in the patients' knowledge of their disease. We propose that future studies evaluating educational programs should include both heart-failure-specific knowledge and self-care behavior. This would require adding questions on heart-failure-specific knowledge to the EHFScB-9 or combining it with heart failure knowledge scores.

We found a persistent improvement of knowledge about self-care behavior and disease at 6-month follow-up. Thus, disease knowledge and knowledge on self-care behavior remained significantly higher at follow-up than that at baseline indicating that the educational session has a persistent effect on heart-failure-related clinical endpoints. This is an important finding because there are very few reports on the persistence of the teaching effect [10,27]. A previous study by Jaarsma et al. [10] described a persistent increase in self-care behavior at nine months after an educational intervention; however, there was the attrition of the initial effect over time. In contrast, in a study by Linne et al. [27] the initial intervention effect persisted almost unchanged at six months.

We did not find patient characteristics that preclude the effect of the educational session on self-care and knowledge level; this finding is in agreement with a previous study by Jonkman et al. [21] which also stressed that self-management interventions should not be limited to subgroups of patients with heart failure. In contrast, Smeulders et al. [28] reported a greater benefit of a self-management program in patients with lower educational level and higher cognitive status. However, they used cardiac-specific quality-of-life parameters as an endpoint, which was not evaluated in our study.

The total score after the educational session did not significantly differ between patients with and without follow-up clinical events. This finding may be due to the limited number of patients included in the study and the short follow-up period of six months. It contradicts the findings of previous studies with a control group [27,29]. Owing to the lack of a control group without education, the knowledge level of our patient group was generally high, which may have precluded the observation of an association between knowledge level and subsequent events.

## 4.2. Limitations

This study included only a limited number of patients. However, considering the longitudinal nature of the study with follow-up assessments at six months, the number of patients is reasonable compared with those in previous studies [9,10,25,27]. At six months after the educational session, only 67% of patients answered the follow-up questionnaire. This limitation is due to the structure of the German healthcare system, which does not allow public hospitals to provide outpatient care. Thus, patient follow-up included attempts to obtain contact by mail or telephone, which were unsuccessful in 33% of patients. This may have generated a bias in the evaluated persistence of the educational effect. However, there were no differences in patient characteristics between those with and without follow-up. Patients considered to be mentally inadequate for a one-hour educational session on the basis of a structured cognition assessment were excluded from this study. This may have induced a bias in the effect of the nurse educational session in the total population of patients with heart failure. Cognitive impairments such as difficulties in learning are frequent among patients with heart failure [30] and may prevent the potential inclusion of patients into nurse-based educational programs.

This was not a randomized trial with a comparison group without an educational session. Thus, the clinical effect of the educational session on outcome parameters could not be evaluated. The six questions on patients' knowledge about heart failure have not been evaluated regarding reliability and validity. Thus, it has not been demonstrated that the improvement in the patients' disease knowledge scores accurately reflects their improved knowledge about the disease. The answers to the questions may represent a subjective self-assessment of the patient instead of an objective analysis. Similarly, the improvement in the reported self-care score may not represent the actual practices of the patients but rather the improved knowledge of patients on what should be done.

Collaborative network research programs should be undertaken in the future to address gaps and limitations of monocenter studies on self-care knowledge as suggested previously [31]. This should allow larger patient numbers and may provide specific answers to patient subgroups. Furthermore, it should support knowledge transfer and support innovations in self-care research [31].

## 5. Conclusion

Knowledge of patients with heart failure on disease and self-care behavior needs improvement. A nurse-based educational program significantly improves the knowledge of patients on these aspects and has a lasting effect. There is no specific patient subgroup that does not benefit from the educational program. Further research is necessary to explore whether the improvements in disease knowledge and knowledge on self-care behaviors result in actual changes in behavior. This may be done in collaborative network research programs.

## Ethical consideration

Ethical approval was obtained by the review board of the Bonifatius Hospital Lingen. Written informed consent was obtained from each patient.

## CRediT authorship contribution statement

**Astrid Hüsken:** Conceptualization, Methodology, Statistical analysis, Writing-Original Draft. **Rainer Hoffmann:** Writing-

Reviewing and Editing, Funding Acquisition. **Sofien Ayed:** Formal analysis, Writing-Original Draft.

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## Declaration of competing interest

There are no conflicts of interest for any of the three authors.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijnss.2021.03.002>.

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