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Mode of Action and Effects of Standardized Collaborative Disease Management on Mortality and Morbidity in Patients With Systolic Heart Failure

The Interdisciplinary Network for Heart Failure (INH) Study

Christiane E. Angermann, MD*; Stefan Störk, MD, PhD*; Götz Gelbrich, PhD; Hermann Faller, MD; Roland Jahns, MD; Stefan Frantz, MD; Markus Loeffler, MD; Georg Ertl, MD; on Behalf of the Competence Network Heart Failure

Background—Trials investigating efficacy of disease management programs (DMP) in heart failure reported contradictory results. Features rendering specific interventions successful are often ill defined. We evaluated the mode of action and effects of a nurse-coordinated DMP (HeartNetCare-HF, HNC).

Methods and Results—Patients hospitalized for systolic heart failure were randomly assigned to HNC or usual care (UC). Besides telephone-based monitoring and education, HNC addressed individual problems raised by patients, pursued networking of health care providers and provided training for caregivers. End points were time to death or rehospitalization (combined primary), heart failure symptoms, and quality of life (SF-36). Of 1007 consecutive patients, 715 were randomly assigned (HNC: n=352; UC: n=363; age, 69±12 years; 29% female; 40% New York Heart Association class III-IV). Within 180 days, 130 HNC and 137 UC patients reached the primary end point (hazard ratio, 1.02; 95% confidence interval, 0.81–1.30; $P=0.89$), since more HNC patients were readmitted. Overall, 32 HNC and 52 UC patients died (1 UC patient and 4 HNC patients after dropout); thus, uncensored hazard ratio was 0.62 (0.40–0.96; $P=0.03$). HNC patients improved more regarding New York Heart Association class ($P=0.05$), physical functioning ($P=0.03$), and physical health component ($P=0.03$). Except for HNC, health care utilization was comparable between groups. However, HNC patients requested counseling for noncardiac problems even more frequently than for cardiovascular or heart-failure–related issues.

Conclusions—The primary end point of this study was neutral. However, mortality risk and surrogates of well-being improved significantly. Quantitative assessment of patient requirements suggested that besides (tele)monitoring individualized care considering also noncardiac problems should be integrated in efforts to achieve more sustainable improvement in heart failure outcomes.

Clinical Trial Registration—URL: http://www. controlled-trials.com. Unique identifier: ISRCTN23325295.

(*Circ Heart Fail*. 2012;5:25-35.)

Key Words: chronic heart failure ■ managed care ■ prognosis ■ quality of life ■ outcomes

Heart failure is a major cause of death and hospitalization and is associated with extensive morbidity and impaired quality of life. Although multiple drug- and device-related therapies have improved outcomes, the prognosis of heart failure patients has remained grim.[1–3] Large surveys from Europe[4,5] and the United States[6] indicate that implementation of evidence-based therapies[7,8] is fragmentary, although guideline adherence improves survival.[9] Multidisciplinary disease management programs (DMP) may bridge the gap between existing therapeutic options and the realities of clinical practice. Since the landmark study by Rich et al,[10] the

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weight of evidence from meta-analyses regarding the impact of such interventions on survival and hospitalization rates[11–15] has paved their way into current treatment guidelines,[7,8]

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From the Department of Internal Medicine I, University Hospital Würzburg, Germany (C.E.A., S.S., R.J., S.F., G.E.); Comprehensive Heart Failure Center, University of Würzburg, Germany (C.E.A., S.S., R.J., S.F., G.E.); Coordination Centre for Clinical Trials, University of Leipzig, Germany (G.G., M.L.); Institute of Psychotherapy and Medical Psychology; University of Würzburg, Germany (H.F.); and Institute for Medical Informatics, Statistics, and Epidemiology, University of Leipzig, Germany (M.L.).

*Drs Angermann and Stork contributed equally to this work.

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Correspondence to Christiane E. Angermann, MD, Department of Internal Medicine I, Comprehensive Heart Failure Center, Straubmühlweg 2a, University of Würzburg, D, 97078 Würzburg, Germany. E-mail angermann_c@klinik.uni-wuerzburg.de

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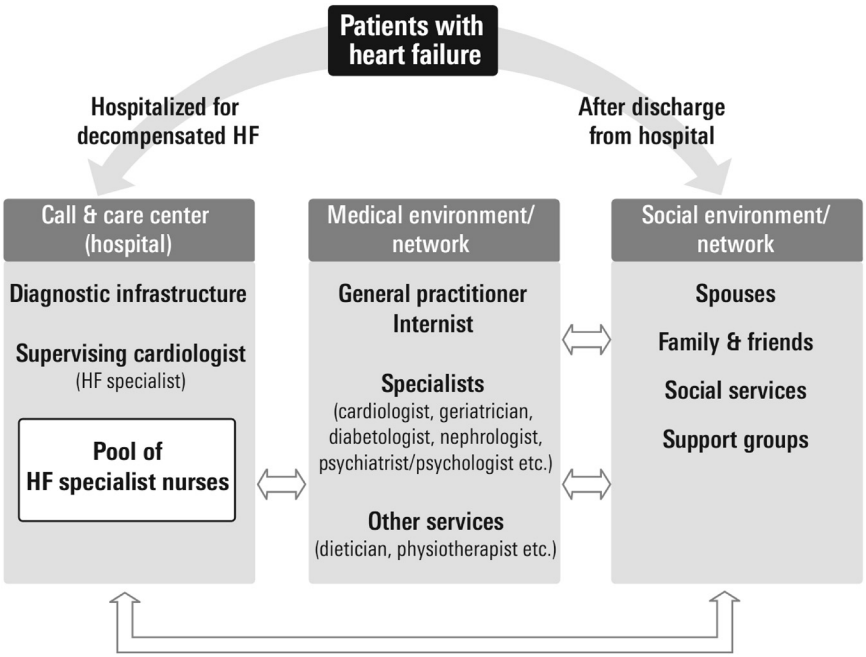

Figure 1. Schematic representation of the HeartNetCare-HF call and care center and interaction pathways within patients' medical and social networks.

although success has not been consistent throughout.[16–18] Recommendations regarding basic elements of DMP have been published,[7,8,19] but prediction of efficacy has remained difficult. Intervention details are usually not provided, which limits reproducibility, and performance characteristics of DMP in individual subjects have never been reported in detail. Thus far, neither larger-scale implementation of promising DMP outside clinical trials nor sustainable reimbursement strategies have been achieved.

The Interdisciplinary Network for Heart Failure (INH) study developed and evaluated in a randomized, controlled trial a nurse-coordinated DMP (HeartNetCare-HF, HNC). The program comprises patient monitoring and education in a collaborative approach involving skilled nurses, general practitioners, and cardiologists and training and supervision for caregivers. During nurse-driven telephone contacts, standardized questions cover cardiac monitoring. Inquiries about general health and well-being allow patients to raise individual problems. Written intervention templates ensure that all nurses pursue monitoring and education in a comparable manner. As part of the INH study protocol, nurses were instructed to document all patient contacts in detail. We hypothesized that compared with usual care (UC), HNC would have a favorable impact on time to death or rehospitalization (combined primary end point) and various prespecified secondary end points in patients discharged from hospital after cardiac decompensation, who represent a well-defined high-risk target population.[20] We further assumed that the study would serve to clarify the mode of action of the program and individual patient requirements, thus providing a rational basis for more targeted health care strategies in heart failure.

Methods

Setting and Study Design

A multidisciplinary team developed the intervention, based on established elements[8,19] and shaped to patient needs.[21] Further, a protocol for specialist nurse training and supervision was devised, and a hospital-based call and care center interlacing patients' medical and social networks was installed at the Würzburg University Hospital (Figure 1).

The INH study was designed as an open, randomized, 2-armed, parallel-group, multicenter trial. Patients were recruited at 9 hospitals in Bavaria and Baden-Württemberg (see online-only Data Supplement Appendix). Follow-up was centralized and performed after 180 days. Approval was obtained from all responsible ethics committees. The trial complied with the Declaration of Helsinki, and Good Clinical Practice and was preregistered at www.controlled-trials.com (ISRCTN23325295).

Patients

Patients age ≥18 years were eligible when hospitalized with signs and symptoms of decompensated heart failure (dyspnea at rest/minimal exercise plus at least 1 of the following: raised jugular venous pressure, peripheral edema, third heart sound, or pulmonary congestion [clinical or chest radiography]) and had a left ventricular ejection fraction (LVEF) ≤40% (echocardiography) at random assignment. Exclusion criteria included only new-onset structural heart disease, logistic or health reasons precluding participation in telephone-based interventions, and lack of written consent. Mentally or physically disabled patients with family assistance to follow the protocol were also eligible.

Recruitment and Random Assignment

At all study sites, study physicians were instructed to consecutively report demographics, New York Heart Association (NYHA) class, and LVEF of eligible subjects. This triggered visits from a specialist nurse who invited study participation, explained trial details, and obtained consent. Patients were randomly assigned 1:1 to either HNC or UC, using sealed envelopes. Central computer-generated block random assignment was used (strata: age [>70 versus ≤70 years], sex, and type of outpatient care [cardiologist versus general practitioner (GP)]).

Postdischarge Care

Usual Care

Patients in UC underwent standard postdischarge planning, which typically included treatment plans, comprehensive discharge letters, and fixed appointments with GPs or cardiologists within 7–14 days.

No restrictions were placed on outpatient care, and patients were urged to ensure that providers always documented type and extent of all health care utilization in their INH patient pass.

HeartNetCare-HF

Patients receiving the intervention underwent HNC on top of UC. INH personnel ensured availability of electronic balances and blood pressure gauges at patients' homes. Patients' GPs received written information on the study and were invited to cooperate.

HNC included the following elements: (1) in-hospital face-to-face contact between specialist nurse, patient, and relatives to explain the intervention, practice supervision of blood pressure, heart rate and symptoms, and provide participants with teaching materials and self-monitoring schemes; (2) telephone-based structured monitoring using a standardized 19-item questionnaire addressing indicators of worsening heart failure, other cardiac symptoms, medication, health care utilization, state of mood, and general health and well-being; (3) uptitration of heart failure medication in cooperation with GPs, where possible, and teaching of patients regarding adjustment of diuretics; (4) needs-adjusted specialist care, which nurses coordinated with patients' physician(s); (5) measures for appropriate education and supervision of interveners to ensure high intervention quality (see online-only Data Supplement Part I for details). All nurses were trained in telephone skills, received supervision by a cardiologist (weekly) and a psychologist (bimonthly), and had unrestricted access to their supervisor for questions.

After weekly contacts during the first month, intervention frequency was individualized according to NYHA class at discharge (weekly or fortnightly in NYHA classes III and IV, monthly in NYHA classes I and II), but also patients' individual needs. After major treatment changes, reassessment calls were scheduled as required. Nurses used dedicated contact logs for written documentation of module(s) executed, issues requiring counseling, and actions taken. Recommended duration of telephone contacts was 10–15 minutes. Treatment goals and forthcoming contacts were jointly fixed by patient and nurse. Emergency telephone access to INH team members and outpatient facilities were available to HNC patients.

Data Collection and Follow-Up

Before discharge, patients underwent standardized evaluation including medical history, physical status, blood chemistry, 12-lead ECG, echocardiography, pulmonary function testing, and generic quality of life (Short Form 36 Health Survey, SF-36).[22] An identical check followed in the INH outpatient clinics after 180 days. Physicians performing the follow-up examination were blinded to patients' initial NYHA class. Patients unable to attend underwent telephone-based follow-up. Health care utilization was extracted from patient passes and reconfirmed by comparison with GP records. Number, duration, and causes of readmissions were verified from discharge letters. Every effort was made to clarify the cause of death, based on hospital records, death certificates, and reports from relatives and physicians. An independent committee adjudicated the end points (see online-only Data Supplement Appendix), blinded to treatment assignment. Because more patients withdrew consent in HNC, potential bias by informative dropout was considered. Life status at day 180 was therefore ascertained in dropouts and reported as uncensored survival data.

End Points

The primary end point was a composite of time to all-cause death or rehospitalization. Prespecified secondary efficacy measures included cardiovascular and all-cause death or hospitalization separately; time to, number, and duration of readmissions; number of patient days alive and not hospitalized; and changes in NYHA class, heart failure medication, cardiac function, and generic quality of life.

Nurses assessed patient compliance, using a summary score (range, 0–100%) from patients' answers to the START Module during the second and the last contact. "Compliance" thus reflects the nurses' estimate of patients' adherence to self-monitoring and pharmacotherapy. Compliance was not assessed in UC because respective questions were considered potential interventions by themselves.

Biometrical Assumptions and Data Analysis

Based on literature,[23,24] we assumed a conservative 180-day event rate (all-cause death or rehospitalization) of 30% in UC and a relative risk reduction of 30% in HNC. Assuming a 10% dropout-rate, 700 patients were required to detect this difference, with a power of 0.80 and a 2-sided α of 0.05. Data were analyzed according to intention to treat, and uncensored survival data are reported. The primary hypothesis was tested by log-rank testing. To account for stratification factors and potential confounders, hazard ratios (HR) with 95% confidence intervals (CI) were calculated by Cox proportional hazard regression. Time alive and out of hospital was estimated from extended Kaplan-Meier analyses[25] with standard errors computed by the bootstrap method. All other prespecified quantitative outcomes were assessed by analysis of covariance, adjusting for the baseline value, sex, and age. To test the effect of HNC on NYHA functional class, ordinal logistic regression was performed with NYHA class at follow-up adjusted for baseline NYHA class, and odds ratios (OR) with 95% CIs were reported. Descriptive statistics including independent t test, χ^2 test, and Fisher exact test were used as appropriate to characterize details of the HNC application.

All probability values are 2-sided. Probability values ≤ 0.05 were considered statistically significant. Commercial software was used (SPSS 15.0.1; SPSS Inc, Chicago, IL).

Results

Between March 1, 2004, and August 31, 2007, 1007 patients were screened. Of these, 715 (71%) were randomly assigned to either UC (n=363) or HNC (n=352). Random assignment across predefined strata was successful. Reasons for nonrandomization as given in Figure 2 included severe cognitive dysfunction, Alzheimer's disease, insufficient command of German language, distant residence, lack of telephone access, death before random assignment, or severe noncardiac disorders precluding execution of HNC (eg, deafness). Compared with participants, non–randomly assigned patients were more often female (40% versus 29%, $P=0.001$), older (75±11 versus 68±12 years; $P<0.001$), and more often in NYHA classes III to IV (53% versus 40%; $P<0.001$). LVEF was comparable (30±7 versus 30±8; $P=0.84$). During follow-up, 22 UC and 45 HNC patients withdrew consent ($P=0.003$); 65 UC and 42 HNC patients underwent a follow-up assessment by telephone. No patient was lost to follow-up.

Patient Baseline Characteristics

Baseline characteristics were comparable in both groups (Table 1). The majority of participants were 70 years or older and had multiple comorbidities. Stratification variables and other baseline characteristics were balanced between groups.

Primary Outcome, Death, and Hospitalization

Outcomes are detailed in Table 2. The primary end point was reached in 130 HNC (37%) versus 138 UC patients (38%, Figure 3A). Death occurred more often in UC and rehospitalization slightly more often in HNC. Thus, the composite outcome was comparable (HR, 1.02; 95% CI, 0.81, 1.30; $P=0.89$).

Overall, 32 (9%) HNC and 52 (14%) UC patients died (HR, 0.62; 0.40–0.96; $P=0.03$; Figure 3B). Five of these deaths occurred after dropout (HNC: n=4, UC: n=1). Mul-

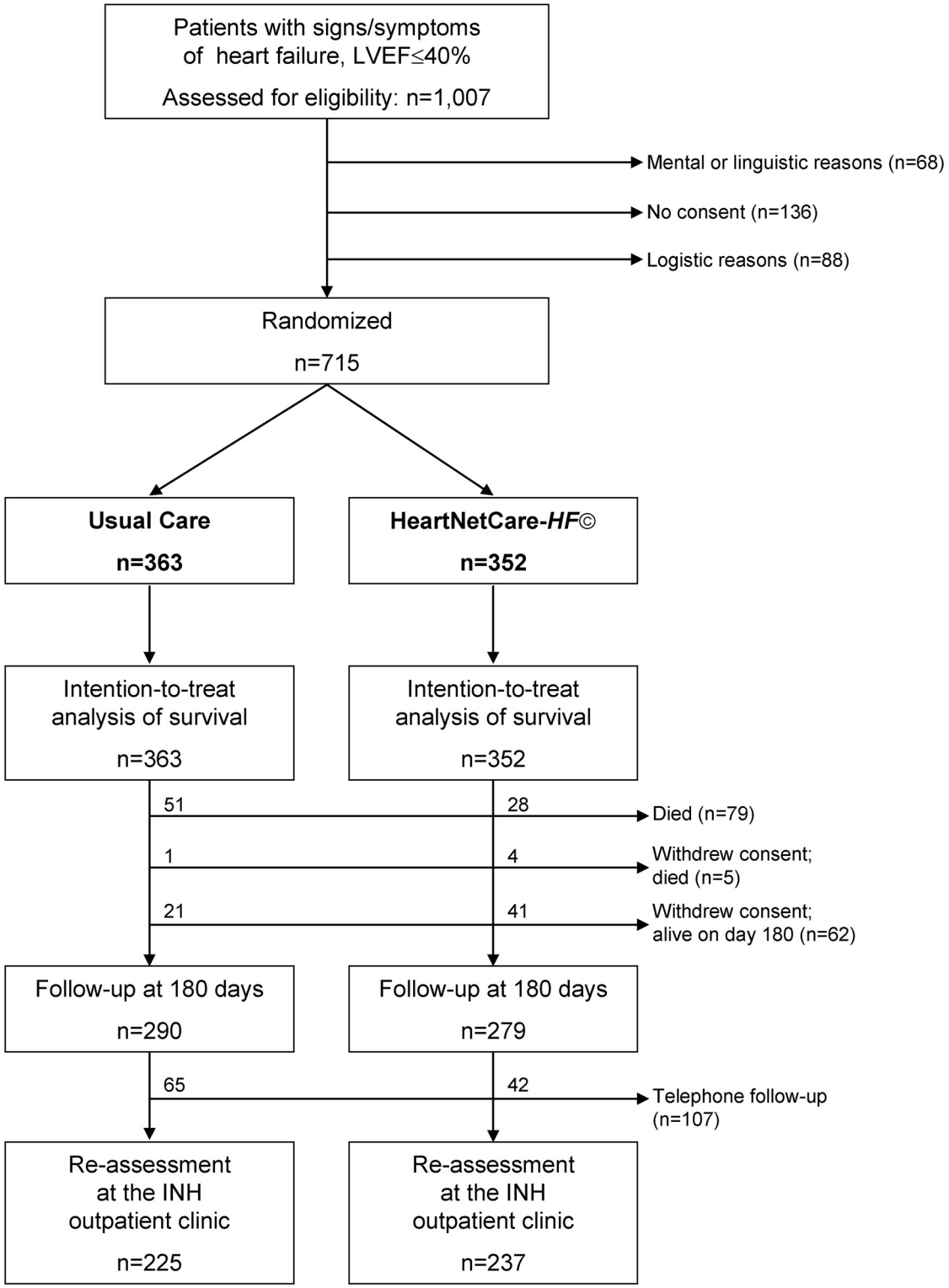

Figure 2. Study flow. Shown are numbers of patients who were screened, entered the study, were randomly assigned, dropped out, and completed the protocol. LVEF indicates left ventricular ejection fraction; INH, Interdisciplinary Network for Heart Failure Study.

tivariable adjustment for age ≥70 (HR, 1.70; 1.02–2.83), female sex (HR, 0.92; 0.57–1.48), NYHA functional class (HR, 2.63 for NYHA class III versus NYHA classes I to II; 1.62–4.26; and HR, 3.82 for NYHA class IV versus NYHA classes I to II; 1.68–8.66), underlying cause of heart failure (HR for coronary artery disease versus other cause, 1.24; 0.78–1.98), and type of outpatient care (HR for cardiologist versus general practitioner, 1.02; 0.50–2.05) did not materially change intervention effects on survival (HR, 0.59; 0.38–0.92; $P=0.02$). Cardiovascular death rates tended to be lower in HNC (22 [6%] versus 35 cases [10%]); HR, 0.66; 0.38–1.12; $P=0.12$).

Table 1. Baseline Characteristics of Study Participants

Variable	All Patients (n=715)	Usual Care (n=363)	HeartNetCare-HF (n=352)
Age, y, mean (SD)	68.6 (12.2)	69.4 (11.5)	67.7 (12.8)
Age ≥70 y, n (%)	379 (53)	195 (54)	184 (52)
Female sex, n (%)	210 (29)	106 (29)	104 (29)
Living alone, n (%)	233 (33)	126 (35)	107 (30)
Diagnosis of heart failure known, n (%)			
<1 y	280 (39)	140 (39)	140 (40)
1–5 y	120 (17)	59 (16)	61 (17)
>5 y	315 (44)	164 (45)	151 (43)
Predominant cause of heart failure, n (%)			
Coronary artery disease	417 (58)	222 (61)	195 (55)
Dilated cardiomyopathy	183 (26)	86 (24)	97 (28)
Hypertension	46 (6)	21 (6)	25 (7)
Other	69 (10)	34 (9)	35 (10)
NYHA functional class, n (%)			
I	16 (2)	7 (2)	9 (3)
II	414 (58)	224 (62)	190 (54)
III	256 (36)	113 (31)	143 (40)
IV	29 (4)	19 (5)	10 (3)
Hospitalization for heart failure within the past 12 mo, n (%)	204 (29)	111 (31)	93 (26)
Measurements, mean (SD)			
Blood pressure, mm Hg			
Systolic	121 (18)	121 (17)	121 (19)
Diastolic	72 (11)	72 (10)	72 (11)
Heart rate,* L/min	80 (19)	80 (18)	80 (20)
Left ventricular ejection fraction, %	30 (8)	30 (8)	30 (8)
Medical history, n (%)			
Current smoker	83 (12)	42 (12)	41 (12)
Myocardial infarction	328 (46)	179 (49)	149 (42)
CABG or PCI	230 (32)	113 (31)	117 (33)
Pacemaker and/or ICD	107 (15)	58 (16)	49 (14)
Comorbidities,† n (%)			
Atrial fibrillation	207 (29)	94 (26)	113 (32)
Peripheral vascular disease or stroke	172 (24)	89 (25)	83 (24)
Hypertension	535 (75)	281 (77)	254 (72)
History of depression	112 (16)	58 (16)	54 (15)
Diabetes mellitus	257 (36)	130 (36)	127 (36)
Chronic obstructive pulmonary disease	138 (19)	65 (18)	73 (21)
Anemia	225 (32)	117 (32)	108 (31)
Renal dysfunction	294 (41)	147 (41)	147 (42)
Uncured malignancy	85 (12)	42 (12)	43 (12)
Heart failure medication‡			
ACEi and/or ARB, n (%)	630 (88)	317 (87)	313 (89)
ACEi and/or ARB equivalence dose relative to recommended dose, %, mean (SD)	43 (29)	41 (29)	44 (29)
β-blocker, n (%)	571 (80)	286 (79)	285 (81)
β-blocker equivalence dose relative to recommended dose, %, mean (SD)	36 (27)	34 (26)	38 (27)
Aldosterone antagonist, n (%)	299 (42)	135 (37)	164 (47)
Diuretic, n (%)	627 (88)	312 (86)	315 (90)
Statin, n (%)	326 (46)	177 (49)	149 (42)
Quality of life (SF-36), mean (SD)			
Physical Functioning Scale	46 (30)	44 (29)	48 (30)
Physical Health Component	35 (11)	34 (10)	36 (11)
Mental Health Component	44 (12)	44 (13)	44 (12)

NYHA indicates New York Heart Association; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; ICD, implantable cardioverter-defibrillator; ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; and SF-36, Short Form 36 Health Survey.

*Heart rate from the ECG.

†Definition of comorbidities: atrial fibrillation from the ECG; hypertension as sitting blood pressure >140/90 mm Hg or previous history of hypertension; chronic obstructive pulmonary disease as either requiring bronchiolytic treatment or newly diagnosed according to Global Initiative for Chronic Obstructive Lung Disease criteria[26]; anemia (World Health Organization criteria) as hemoglobin <12 g/dL in women, <13 g/dL in men[27]; and renal dysfunction as estimated glomerular filtration rate <60 mL/min/1.73 m^2.[28]

‡Heart failure was treated regarding substance classes, but mean daily equivalence doses of β-blockers and ACEi/ARB were only 36% and 43% respectively, of target doses recommended in treatment guidelines.[7,8]

One hundred nineteen patients (34%) were rehospitalized at least once in HNC and 112 (31%) in UC (HR, 1.15; 0.89–1.49; $P=0.28$; Figure 3C). As Table 2 indicates, favorable trends toward later, less frequent, and shorter second readmissions and a calculated overall gain of time alive and out of hospital (+4.6 days per patient; −1.4 to +10.6 days; $P=0.13$) were observed in the HNC arm.

Heart Failure Severity, Medication, and Quality of Life

Clinical evaluation at 180 days demonstrated also more favorable results regarding NYHA class ($P=0.05$), uptitra-

Table 2. Primary and Secondary Outcomes

Variable Death and Rehospitalization	Usual Care (n=363)	HeartNetCare-HF (n=352)	Estimate Hazard Ratio (95% CI)	*P* Value
Death or rehospitalization, n (%)	138 (38)	130 (37)	1.02 (0.81–1.30)	0.89
Death as the first event	26	11		
Rehospitalization as the first event	112	119		
Death from any cause, uncensored, n (%)	52 (14)	32 (9)	0.62 (0.40–0.96)	0.03
CV death, n (%)	35 (10)	22 (6)	0.66 (0.38–1.12)	0.12
Death or rehospitalization for heart failure, n (%)	85 (23)	54 (15)	0.66 (0.47–0.93)	0.02
At least 1 rehospitalization, n (%)	112 (31)	119 (34)	1.15 (0.89–1.49)	0.28
Rehospitalization for heart failure, n (%)	46 (13)	36 (10)	0.81 (0.53–1.26)	0.36
Revascularization: PCI, CABG	23 (6.3)	17 (4.8)	0.75 (0.39–1.43)	0.38
Pacemaker or ICD	36 (9.9)	30 (8.5)	0.85 (0.51–1.41)	0.52
Nonfatal CV event: MI, TIA, stroke	8 (2.2)	7 (2.0)	0.90 (0.32–2.51)	0.84
At least 2 rehospitalizations, n (% of patients rehospitalized at least once)	49 (44)	43 (36)	0.71 (0.47–1.08)	0.11
Duration and No. of Rehospitalizations			Difference* (95% CI)	
Duration of rehospitalization, mean (SD)				
First rehospitalization, days	11.8 (8.5)	11.5 (10.5)	−0.3 (−2.8 to 2.1)	0.78
Second rehospitalization, days	14.8 (16.9)	10.2 (7.6)	−4.7 (−10.2 to 0.9)	0.10
No. of rehospitalizations, mean (SD)	0.52 (1.03)	0.61 (1.30)	0.09 (−0.09 to 0.26)	0.32
No. of CV rehospitalizations, mean (SD)	0.31 (0.71)	0.30 (0.68)	−0.01 (−0.11 to 0·09)	0.85
Days alive and out of hospital, mean (SEM)	158.9 (2.2)	163.5 (2.0)	+4.6 (−1.4 to 10.6)	0.13
Change in Heart Failure Severity			Odds Ratio† (95% CI)	
NYHA class			0.73 (0.53–1.00)	0.05
Worsened, n (%)	50 (17%)	28 (10%)		
Unchanged, n (%)	143 (49%)	145 (52%)		
Improved, n (%)	97 (33%)	106 (38%)		
Change in Heart Failure Medication‡			Difference (95% CI)	
Subjects receiving ACEi and/or ARB, n (%)	−4 (−1%)	−4 (−1%)	0 (−6% to +6%)	0.99
ACEi and/or ARB equivalence dose relative to recommended dose, %, mean (SD)	+2 (29)	+9 (33)	+7 (+2 to +12)	0.009
Subjects receiving β-blocker, n (%)	+15 (+5%)	+20 (+7%)	+2% (−5% to +9%)	0.56
β-Blocker equivalence dose relative to recommended dose, %, mean (SD)	+4 (27)	+12 (27)	+8 (+3 to +12)	0.001
Subjects receiving aldosterone antagonist, n (%)	+17 (+6%)	+12 (+4%)	−2% (−9% to +6%)	0.68
Cardiac Function and Physical Findings§				
Left ventricular ejection fraction, %, mean (SD)	+9.9 (12.3)	+11.7 (12.5)	+1.5 (−0.8 to +3.9)	0.19
Heart rate, L/min, mean (SD)	−8.6 (18.0)	−8.9 (19.8)	−0.2 (−3.7 to +3.3)	0.92
Systolic BP, mm Hg, mean (SD)	+1.1 (21.1)	−0.9 (23.2)	−2.2 (−6.3 to +2.0)	0.31
Diastolic BP, mm Hg, mean (SD)	+2.0 (14.8)	−0.2 (14.0)	−2.3 (−4.9 to −0.3)	0.09
Quality of Life (SF-36)‖				
Physical Health Component, mean (SD)	+1.3 (9.9)	+2.8 (10.0)	+2.1 (+0.2 to +4.0)	0.03
Physical Functioning Scale, mean (SD)	+1.8 (24.7)	+5.9 (25.8)	+4.6 (+0.4 to +8.9)	0.03
Mental Health Component, mean (SD)	+2.3 (12.0)	+2.3 (12.4)	−0.6 (−2.8 to +1.5)	0.57

CI indicates confidence interval; CV, cardiovascular; NYHA, New York Heart Association; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; ICD, implantable cardioverter-defibrillator; ACEi, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; SF-36, Short Form 36 Health Survey; MI, myocardial infarction; and TIA, transient ischemic attack.

*All differences computed as HeartNetCare-HF minus usual care.

†Ordinal logistic regression for NYHA class at follow-up adjusted for baseline value. Data refer to n=290 (usual care) and n=279 (HeartNetCare-HF).

‡Selected substance classes and calculation of mean equivalence dosages according to Heart Failure Treatment Guidelines.[7,8] Data refer to n=290 (usual care) and n=279 (HeartNetCare-HF).

§Data refer to n=225 (Usual Care) and n=237 (HeartNetCare-HF).

‖Data refer to n=200 (Usual Care) and n=218 (HeartNetCare-HF).

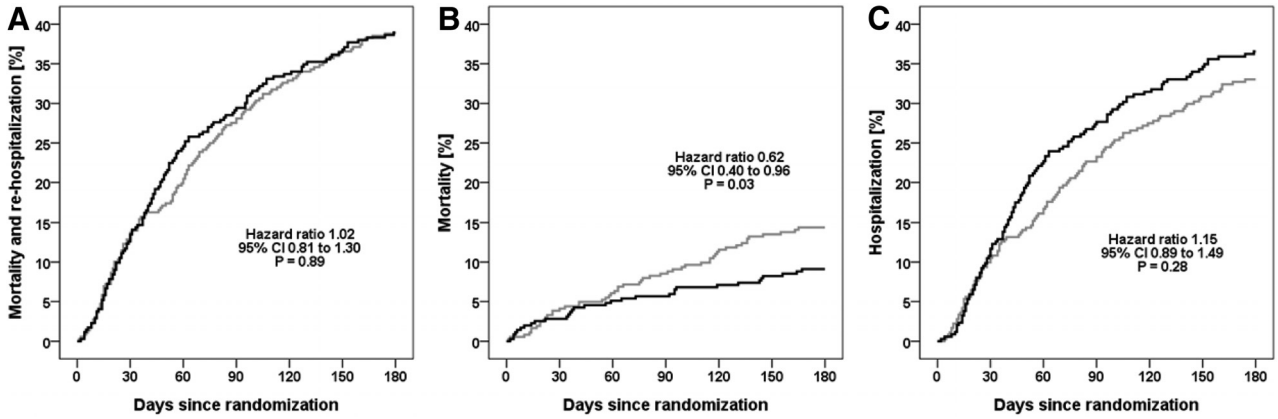

Figure 3. Kaplan-Meier plots of clinical end points in intervention (**black**) and control arms (**gray**). **A**, Primary end point. **B**, Uncensored all-cause mortality. **C**, All-cause hospitalization. CI indicates confidence interval.

tion of heart failure medication as assessed by mean equivalence doses[7,8] of angiotensin-converting enzyme inhibitors or angiotensin receptor blockers ($P=0.009$) and β-blockers ($P=0.001$), and SF-36 Physical Health Component and Physical Functioning (both $P=0.03$) in HNC patients. No differences between groups were found regarding pump function, heart rate, and blood pressure (Table 2).

Application Flow and Performance Characteristics of HNC

Of 352 patients randomly assigned to HNC, 7 died and 16 withdrew consent before the first contact. Thus, 329 subjects received at least 1 intervention. In these, 4057 nurse- and 57 patient-driven telephone contacts (involving 30 patients) took place. Average duration of telephone contacts was 12.5 minutes (95% CI, 11.9–13.1), corresponding to 2.3 calls (2.1–2.4) and 27.6 minutes (25.7–29.5) per patient-month alive, out of hospital, and under observation. Nurses were instructed to respond to every problem raised by the patients, either immediately or after consultation with a physician. Appropriateness of nurse activities was randomly checked by INH cardiologists during supervision sessions.

Table 3 lists nurse activities within the patients' medical and social networks, proportions of patients receiving each HNC module, and average application frequencies in patients receiving a module at least once.

Figure 4A depicts absolute and relative frequencies of different nurse actions within the patients' medical and social networks. GP interactions concerned appointments and collaborative patient care. Interactions regarding visits to specialists pertained to cardiologists (44%) but also rehabilitation specialists (20%), surgeons (7%), dentists (6%), rheumatologists (5%), and other disciplines. Direct communication with relatives and friends represented the most frequent nurse activity in this area.

Figure 4B shows absolute and relative frequencies of HNC monitoring and educational modules performed by the nurses and of questions raised by patients regarding medical problems. Within the standardized HNC program, the START module pursuing monitoring and various educational modules were routinely applied. Together with individualized advice on risk prevention, these applications amounted to 55% of the topics addressed during follow-up (see online-only Data Supplement Part II for details).

Optimizing cardiac pharmacotherapy was a principal task of the nurses. Detailed analysis of respective events exemplifies the complexities of HNC: Of the intervened patients, 84% received repeatedly general advice and education on drugs including self-adjustment of diuretics. In 34%, nurses

Table 3. Proportion of Patients Receiving the Respective Intervention Module and Average Frequency of Application of Each Module

Intervention Modules Applied During 180 Days of Follow-Up (329 Patients Receiving HeartNetCare-HF)	Proportion of Patients Receiving Module, %	Frequency of Application, Average No. of Events Per Patient
Nurse activities within patients' medical and social networks		
Interactions with general practitioner	74	2.8
Communication with hospital regarding patient needs	36	1.7
Arrangement/discussion of visits to specialists	66	2.7
Interaction with patient's social network	56	4.1
Standardized monitoring and education		
Application of intervention module	95	17.2
Individualized risk prevention	92	4.5
Therapy		
Cardiac pharmacotherapy	89	4.5
Noncardiac pharmacotherapy	55	1.7
Nonpharmacological treatment	9	1.0
Cardiovascular and heart failure–related problems		
General cardiovascular problems	82	4.5
Problems related to heart failure	73	3.5
Discussion of angina/chest pain	23	1.9
Noncardiac problems		
Questions regarding other organ systems	85	5.1
Noncardiac pain	33	2.2

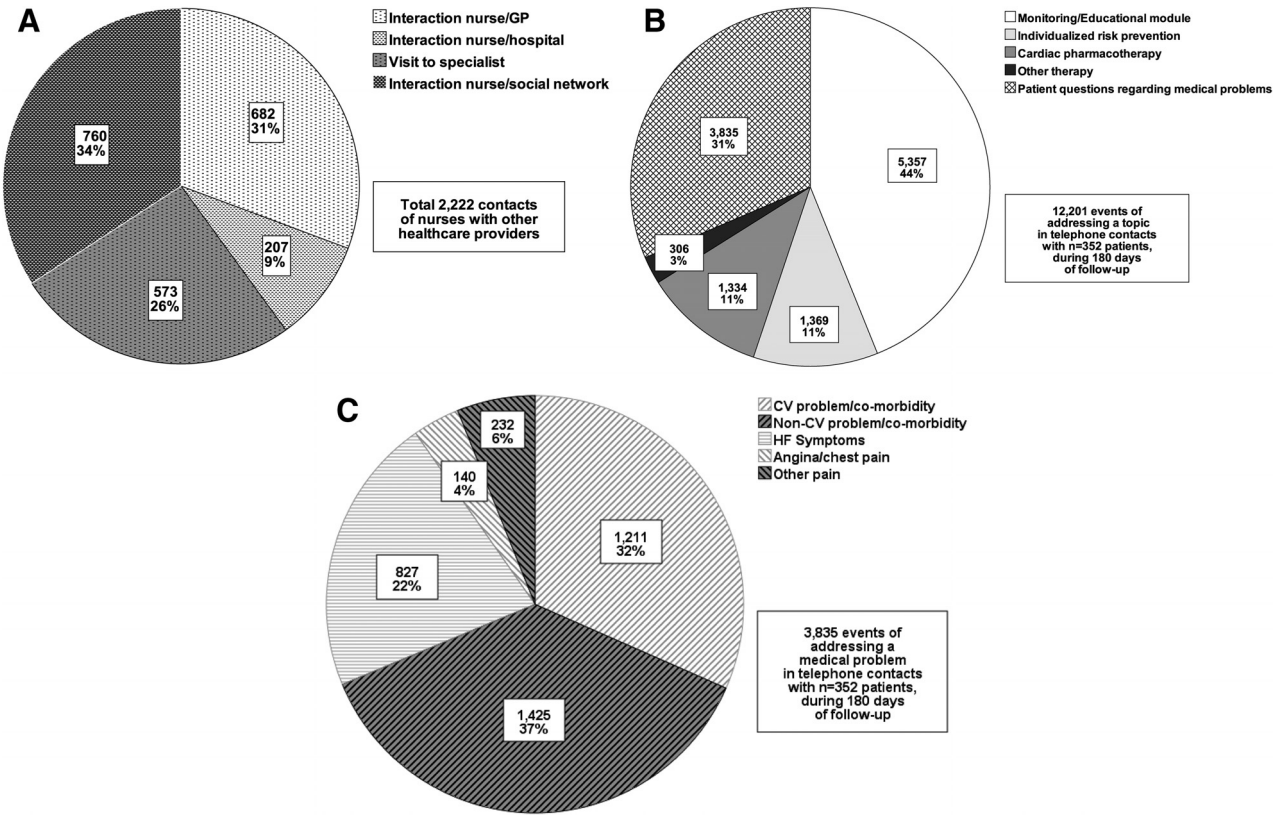

Figure 4. Overview on actions (absolute frequencies and percent) taken by the nurses within the medical and social networks (**A**); topics addressed by nurses during telephone-based standardized monitoring and education versus questions regarding medical problems asked by patients themselves (**B**); and proportions and types of cardiac versus noncardiac medical problems (**C**). GP indicates general practitioner; CV, cardiovascular; and HF, heart failure.

explicitly suggested either dosage increases of diuretics for significant sudden weight gain or, in stable patients, tentative dose decreases. Uptitration of heart failure medication was achieved in 60%, but downtitration for symptomatic hypotension or bradycardia occurred also (15%). Discussion of noncardiac therapy included, for example, vitamin K antagonists, nonsteroidal antiphlogistics, and potential drug side effects (55%). Further, nurses helped patients to attain nonpharmacological treatments, for example, physiotherapy (9%).

Figure 4C details patients' questions on medical problems, which corresponded to 31% of all topics discussed during follow-up (3835 events): Among the general cardiovascular problems, blood pressure (hypotension or hypertension) was most frequently addressed (66% of the patients). Complaints related to heart failure concerned peripheral edema (47%), dyspnea (36%), vertigo (29%), and tiredness (26%). Remarkably, the largest proportion of questions, 37% (1425 events) related to noncardiac problems: Gastroenterological issues including nutrition were brought up at least once by 44% of the patients, musculoskeletal problems and diseases by 31%, neuropsychiatric disorders including depression and cognitive dysfunction by 37%, and nephrological problems including fluid balance by 22%. Questions regarding less common conditions related, for example, to pulmonary problems (20%), diabetes (9%), or anemia (4%). Although counseling for typical angina or chest pain was not uncommonly requested (23%), advice for noncardiac discomfort, for example, musculoskeletal (21%) or gastrointestinal (5%) pain or headache (4%) was sought even more often.

Patient Compliance

In HNC, compliance among participants remaining in the study was high both at baseline and follow-up (85±17% and 84±19%, respectively). Patients who later dropped out had lower compliance (70±27%).

Physician Contacts

Across the entire study population, mean contact frequencies with GPs (home and office visits) were 13.5±10.6 in HNC and 12.9±11.1 in UC, respectively (P=0.46). Mean numbers of visits to cardiologists were 0.7±2.3 and 0.7±2.6 per patient in HNC and UC, respectively (P=0.86), and of visits to other specialists, 1.3±5.4 and 2.1±9.9, respectively (P=0.17). In HNC, this included also specialist care arranged by the INH team. Average numbers of contacts per patient-month alive, out of hospital, and under observation were 2.4±1.8 versus 2.4±2.1 (GP, P=0.82), 0.1±0.4 versus 0.1±0.4 (cardiologists, P=0.88), and 0.2±0.9 versus 0.4±1.7 (other specialists, P=0.12) in HNC and UC, respectively.

Discussion

In this randomized, controlled trial involving patients hospitalized for decompensated heart failure, HNC did not reduce the primary combined end point of time to either all-cause death or rehospitalization. Whereas the dominant event of the

composite, rehospitalization, tended to be more frequent in HNC, a 38% reduction in all-cause mortality risk (32 patients in HNC versus 52 in UC) was observed. Adequate early readmissions might have prevented fatalities, thus contributing to lower mortality rates in HNC patients. Although the absolute numbers of deaths were relatively small, we consider this result as substantive and promising because it proved consistent with various other prespecified secondary end points also representing important heart failure treatment goals[7,8]: Significantly greater improvement of NYHA class and psychometric parameters indicated that HNC patients also enjoyed a superior quality of life. Our data further emphasize the need for consideration of noncardiac problems in heart failure and encourage collaborative care models shaped according to individual requirements to improve outcomes. Notably, the more favorable results in intervened patients materialized despite similar intensity of health care utilization and frequency of interventional procedures including device therapy in both groups.

Throughout the entire follow-up period, standardized monitoring based on the START module (see online-only Data Supplement Part I) ascertained persistently high compliance with self-monitoring and drug adherence. In contrast, a recent telemonitoring study, using a telephone-based voice response system without structured personal contacts, reported much lower acceptance because after 180 days, only 86% of participants made any calls and only 55% made the requested minimum of 3 calls per week.[29] Nonadherence may hence have contributed to the disappointing results of this study. Our results indicate that by HNC, a much larger proportion of the heart failure population might be kept in the program long term.

Remarkably, HNC improved secondary end points in patients treated well regarding guideline-mandated substance classes.[7,8] Because dosage increases in heart failure medication achieved during follow-up were only modest, improved drug adherence rather than drug uptitration might have been the most crucial HNC effect in this respect. Because good compliance was documented in HNC patients, fairly regular intake of heart failure medication can be assumed. In contrast, especially the elderly are under UC conditions inclined to reduce or stop treatment initiated during hospitalization, since nonadherence rates of 30–60% to drugs and of 30–80% to nonpharmacological treatment recommendations were reported in the literature.[30]

The telephone-based HNC intervention substituted face-to-face contacts except for an initial personal encounter. This saved patients from having to attend outpatient services, facilitated specialist care also in subjects otherwise unable to participate for reasons of infirmity, resources or geographical distance, and reached patients at home. Quantitative evaluation of nurse activities within the medical network demonstrated frequent interactions and collaboration of different health care providers. Moreover, direct regular communication between nurses and the patients' social network improved knowledge, self-empowerment and coping strategies within families and strengthened compliance with therapeutic modifications.

Comorbidities observed in our study population resembled those in heart failure registries,[9] and mortality rates were much higher than in most drug trials in which such conditions often constitute exclusion criteria.[31] Correspondingly, more than 80% of our patients sought advise for noncardiac even more frequently than for cardiovascular conditions. Counseling was requested for numerous problems known to also impact on quality of life and other outcomes, for example, depression and cognitive impairment, renal or pulmonary dysfunction, diabetes, anemia, and various types of pain. This is important because it demonstrates objective needs of this population that comprehensive care models must integrate with specific surveillance to account for the complex facets of the heart failure syndrome as well as the physical problems of multimorbidity and old age. Consequently, the training for specialized personnel must be shaped to provide such skills.

Frequency and content of counseling regarding pharmacotherapy varied widely, which illustrates why technically based response systems could never adequately meet respective patient needs. Although a predefined HNC goal, uptitration of heart failure medication was not always possible, and various clinical situations even demanded downtitration. Assistance in fluid management was often required, although nurses regularly taught self-adjustment of diuretics in HNC patients. Thus, a highly individualized approach including consideration of drugs for comorbidities and their potential side effects or interactions proved necessary in this type of patient.

Earlier reviews failed to provide definite conclusions about the general value of DMP in heart failure though demonstrating the potential for benefits in principle.[11–15] Heterogeneity in outcomes even of large, well-designed trials[17,23,24,32] probably resulted from the methodological and clinical diversity of length of follow-up, type of intervention, and in particular characteristics of participants. Although in stable low-risk patients an intervention facilitating timely treatment of worsening heart failure improved short-term[23] and even long-term rehospitalization rates,[33] similar interventions in high-risk populations comparable to ours reduced fatalities but not hospital readmissions.[17,18] Further, intervention quality appeared of relevance. Thus, decentralized delivery of care without prespecified supervision of caregivers and lack of collaboration between different health care providers as in the COACH trial[17] might perhaps explain comparatively smaller beneficial effects in this study.

Our study satisfies several quality criteria rarely met in earlier DM research: It considered patient preferences as identified in a previous INH survey,[21] used precisely characterized intervention modules, measured health care utilization, recruited a well-defined study population, and accounted for needs of the interveners. The protocol scheduled prospective documentation of the actual application flow, where in a collaborative approach, skilled nurses interacted with patients and their medical and social networks. This approach provided, for the first time, precise information on patients' actual requirements. Collection bias was avoided by comprehensive cross-check of the patient passes with other health care documentation in both study arms. All end points were adjudicated by an independent committee blinded to treatment assignment.

Other telemonitoring techniques have been proposed that use remote-access technology by means of external, wearable, or implantable electronic devices and facilitate frequent or even continuous monitoring.[34] Although 2 recent large,

well-designed trials[29,35] using such tools as an exclusive intervention failed to improve outcomes, this does not preclude their potentially beneficial role as an adjunct to patient surveillance. In support of this concept, both monthly nurse-based telephone support alone or combined with daily electronic transmission of vital parameters reduced total mortality, and only daily telemonitoring on top of the telephone support also reduced hospitalization frequency.[24] Thus, novel technologies may serve heart failure patients best if integrated in a program encompassing different health care services and empowering patients to assume responsibility and actively participate in the management of their disease. Our data complement this concept because they provide unequivocal evidence that a comprehensive strategy of heart failure care also must address coexisting noncardiac problems.

Some limitations must be mentioned. Although all-cause mortality risk and surrogates of well-being improved significantly, the primary composite end point of our study was neutral. Although encouraging, these results call for better definition of relevance and value of each of the modules used to find in populations with different levels of risk in each case the most appropriate combination of human and technology-based resources. Further, the relatively short follow-up period in the INH study precludes extrapolation to longer-term outcomes. We covered, however, the most vulnerable period after hospitalization,[20] and many patients gained immediate benefit. Another limitation regards blinding: Although patients were unaware of the trial hypotheses, placebo effects might have influenced outcomes. However, we did not encounter such bias in our analyses. Of further concern is the generalizability of results, but, compared with other trials,[17,29] the number of nonparticipants was small. Because patients with preserved LVEF were excluded from this trial, our findings cannot be extrapolated to this large population. Last, intervention and follow-up were centralized and performed by a highly motivated team. Reproducibility of our results remains thus to be proven at other institutions, including nonacademic hospitals. Detailed documentation should, however, enable motivated personnel to attain comparable success.

In conclusion, we developed and evaluated a structured collaborative DMP for patients hospitalized for systolic heart failure. After 180 days, the primary composite end point was neutral. However, mortality risk and important surrogates of patient well-being were improved. Analysis of the application flow in individual subjects provided deeper understanding of patient requirements and highlighted the importance of noncardiac comorbidities and complications in the heart failure population. Our findings encourage health care strategies aiming to align different care modules in multidisciplinary collaborative programs and integrating novel (tele)monitoring technologies with comprehensive individualized care for both cardiac and noncardiac problems, in efforts to achieve more sustainable improvement in heart failure outcomes.

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Disclosures

None.

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CLINICAL PERSPECTIVE

The present study developed a nurse-coordinated health care program (HeartNetCare-HF), which pursued telephone-based monitoring and education in a collaboration between skilled nurses, general practitioners, and specialists; responded to questions raised by patients; and provided supervision for caregivers. The program was evaluated versus usual care in a prospective, randomized, controlled trial in 715 patients after discharge from hospitalization for cardiac decompensation. Nurses were asked to prospectively document all modules executed during contacts, issues requiring counseling and subsequent actions taken. We hypothesized (1) that the program would have a favorable impact on time to death or rehospitalization (composite primary end point) and improve further secondary outcomes, including quality of life, and (2) that the study would elucidate the mode of action of the program in individual subjects and thus help to identify the most important components regarding outcome. Patient compliance with the program was satisfactory. After 180 days, the primary composite end point was neutral. However, all-cause mortality risk and important surrogates of patient well-being including quality of life were improved. Application flow in individual subjects indicated a broad spectrum of patient needs and highlighted in particular the importance of noncardiac problems in this elderly and multimorbid population. Our findings encourage a multidisciplinary collaborative approach to comprehensive health care strategies that combine modules selected according to individual patient requirements and risk profile and integrate monitoring technologies with tailored care for both cardiac and noncardiac problems to achieve sustainable improvement of heart failure outcomes.

Supplemental Material
CONTENTS

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Selection study materials of the *HeartNetCare-HF*™ program

- Contact Log
- Telephone Frequency Algorithm
- Module START
- Module SYMPTOMS
- Documentation System of monitoring and education

Part II, pages 17-23

Details the nurse actions and topics extending the information given in figures 4 A-C of the manuscript.

- Figure 4.1 Visits to specialists
- Figure 4.2 Educational modules
- Figure 4.3 Individualized risk prevention
- Figure 4.4 Heart failure symptoms and CV problems
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- Figure 4.6 Pain
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INH study committees and investigators

Supplemental Material

Part I

This Supplement is provided by the authors
to give readers additional information about
HeartNetCare-HF™

In **Part I** of the Supplement we provide a selection of study materials (Contact Log, Telephone Frequency Algorithm, Module START and Module SYMPTOMS of the telephone-based intervention, Documentation System of monitoring and education) in order to illustrate some basic elements of comprehensive patient care based on *HeartNetCare-HF*™.

In **Part II** of the Supplement we provide details on nurse actions and topics discussed in patient contacts given in figure 4 of the manuscript.

This complete English version of *HeartNetCare-HF*™ is made available by the authors for interested clinician scientists upon request. Presently the programme will only be transferred to users willing to commit themselves to prospective documentation and evaluation of their application of *HeartNetCare-HF*™.

Contents (Part I of the Supplement)

I. Contact Log

The Contact Log provides the user with the identifier of the patient concerned and with the contact information of patient and general practitioner; further the patient's predominant cause of heart failure and the NYHA functional class at discharge are recorded.

The upper field of the form provides a documentation structure for (bidirectional) patient-nurse contacts; there, the nurse documents the type of module executed (e.g., Module Symptoms, see section IV. of this Supplement) and the duration of the contact. She further specifies any issues that demand monitoring and/or clarification.

The middle field serves to document therapeutic and lifestyle aims agreed on between patient and nurse/physician; a few common standard aims are pre-specified, other aims may be added. All aims are defined in a team approach between physicians and nurses, and agreed upon with the patients. Heart failure specialist and nurse meet regularly (weekly at program start, twice a month later) in order to review the patient charts and to perform necessary (re-)evaluations and adaptations regarding the therapeutic/diagnostic strategy. All relevant information and recommendations are transferred to the general practitioners.

The lower field provides the set of abbreviations that may be used while completing the forms.

CONTACT Log **Patient-ID** __ __ __ __ - __

Name _____ Surname _____ DOB _____

Predominant cause of heart failure: _____ **NYHA class I II III IV**

Tel. Patient _____ **Tel. GP** _____

Date	Who called? Nurse / Patient	Patient reached? y / n	Type of module executed	Duration of Contact (min)	Comment	Date of next scheduled call

	Aim (Physician)	Aim (Nurse)	Target (Modification)	Aim reached? y / n
Edema				
Weight control				
Heart rate control				
Blood pressure control				
Physical activity				
Medication				
Quit smoking				
Other aims				

Abbreviations for Modules

Standard (Symptoms/ medication/treatment)	=	**X**			
Psychol. dimensions	=	**P**	Education on phys. activity	=	**P**
Education on symptoms	=	**S**	Education on nutrition	=	**N**
Education on medication	=	**M**	Satisfaction with treatment	=	**S**

Abbreviations for Aims

Edema	=	**E**	Dyspnoe	=	**Dy**
Body weight	=	**BW**	Angina pectoris	=	**AP**
Heart rate	=	**HR**	Physical activity	=	**Ex**
Blood pressure	=	**BP**	Medication	=	**Med**

II. Frequency of telephone monitoring according to NYHA functional class at patient discharge

This algorithm predetermines the telephone frequency of nurse-triggered calls depending on the patient's NYHA functional class at discharge from hospital.
The frequency may be increased according to patient's needs, if deemed necessary as a consequence of worsening clinical status of the patient.

Black telephone symbols indicate obligatory calls.
Grey telephone symbols indicate optional calls.

NYHA functional class

Week	IV	III	II-I	
1	☎	☎	☎	
2	☎	☎	☎	
3	☎	☎	☎	
4	☎	☎	☎	
5	☎	☎		
6	☎	☎		
7	☎	☎		
8	☎	☎	☎	
9	☎	☎		
10	☎	☎		
11	☎	☎		
12	☎	☎	☎	
13	☎	☎		
14	☎	☎		
15	☎	☎		
16	☎	☎	☎	
17	☎	☎		
18	☎	☎		
19	☎	☎		
20	☎	☎	☎	
21	☎	☎		
22	☎	☎		
23	☎	☎		
24	☎	☎	☎	
25	☎	☎		**6 Months**
26	☎	☎		

III. Module START

Prior to study start, six modules were specified for *HeartNetCare-HF*©:

- ►START
- ►SYMPTOMS
- ►MEDICATION
- ►PHYSICAL ACTIVITY
- ►DIET & NUTRITION
- ►COPING STRATEGIES

Prior to engaging in telephone monitoring, nurses acquire specific telephone skills while undergoing a formal training. They are taught to keep the conversation concise and to the point, but at the same time to remain empathic and patient. Nurses are advised to generally keep the time for telephone contacts below 20 minutes per call.

The START Module is performed at the beginning of every scheduled telephone contact.

We advise beginners in telephone monitoring to adhere to the exact wording of the questionnaire. Over time, and with better knowledge of a particular patient, nurses may rephrase sentences, but need to take care to always address in a standardized fashion the essence of each question, and always document the patients' anwers.

All modules may also be taught and monitoring can take place via a patient proxy, e.g. spouse, relative, or nursing home worker.

Module START (Opening, symptoms, medication, psychological screening)

Opening

„Good morning, do you remember that we had agreed on this telefone date? Is it okay to talk now?
I suggest 15 to 20 minutes for this telefone call. Do you agree with that?“
„Do you have questions regarding our last telefone call? Has anything been left unclear?“

→ (give feedback; make notes in response sheet if important)

„Do you have your SYMPTOM CALENDAR at hand? As you know, we always start with this calendar.”

General Health

1 *„How would you describe your general health?“* **→ make note**

1	2	3	4	5
Excellent	Very good	Good	Moderate	Bad

2 *„Compared with your general health state at discharge from hospital / since our last telephone contact, how would you rate your general health **now**?“* **→ make note**

1	2	3	4	5
Much better	Somewhat better	Pretty similar	Somewhat worse	Much worse

Body Weight

3 *„Have you measured your weight?* **___ kg** **→ make note**

4 *„Has your body weight increased over the last week(s)?“* **no / yes** **→ make note**

→ if increased >1.5 kg: adapt diuretic treatment
→ if not measured, assume unsatisfactory compliance: motivate and explain the importance of daily determination of body weight

Blood Pressure

5 *„Have you measured your resting (!) blood pressure?“* **___ / ___ mmHg** **→ make note**

„How was your BP yesterday?“ (do not document, but take it as an indicator of compliance)

→ if not measured: motivate and explain the importance of daily blood pressure measurements
→ if BP_{syst} ≥140 or if BP_{diast} ≥90 mmHg at both indications: inform GP & discuss actions
→ if BP_{syst} ≤85 mmHg: inform GP & discuss actions

Heart Rate

6 *„Have you measured your resting (!) heart rate?“* **___ beats/min.** **→ make note**

„And how was your pulse yesterday?“ (do not document, but take it as an indicator of compliance)

7 *„Is your pulse regular?“* **no / yes** **→ make note**

→ if not measured: motivate and explain the importance of assessment of pulse / heart rate
→ if pulse >90 bpm or <50 bpm: inform GP
→ if irregular: check whether this is new information (premature beats? atrial fibrillation?)
→ if new onset: inform GP

Edema

8 *„Have you noted swelling of your ankles or lower legs?“* **→ make note**

1	2	3
No	Slight (small dint, vanishing after short while)	Considerable (deep dints, stay there for a longer time)

- **→ if not assessed: motivate and explain the importance of regular monitoring of edema**
- **→ if no edema: this may indicate sufficient treatment and adequate fluid balance, but you also have to consider the possibility of diuretic over-treatment (dry skin/mouth, low urine volume)**
- **→ if edema: assess severity and time course and consider situation against the background of concomitant symptoms and medication; consider adaptation of diuretic treatment; consider informing patient's GP or cardiologist**

Dyspnoea / Fatigue (NYHA classification)

9 *„Do you experience dyspnea/breathlessness/fatigue at simple tasks during your normal life or at rest?”*

→ make note

1	2	3	4
Never, no limitation	Minor compromise at light physical activity	Major compromise at physical activity	At rest or with any slight effort during everyday life

Falls

10 *„Did you experience any falls recently?“* **no / yes** **→ make note**

Angina Pectoris / Heart & Thorax Pain

11 *„Do you suffer from chest pain during everyday life activities?“*

1	2	3
Never	Sometimes (<once per week)	Often, pain is regularly inducible

Other Medical Care

12 *„Have you been in hospital since our last call?“* **no / number of days (!)** **→ make note**

13 *„Have you seen a cardiologist?“* **no / number of visits (!)** **→ make note**

14 *„Have you seen your GP?“* **no / number of visits (!)** **→ make note**

15 *„Did you call emergency help?“* **no / number (!)** **→ make note**

Medication

16 *„Were there any changes in your medication (type and dose) since our last call?“* **no / yes** **→ make note**

- **→ if yes: document in detail on respective page**

Mood Screening

17 *„How is your mood/temper today?“*

„How would you rate it **on a scale of one (=best) to six (=worst)?“**
„You rated your mood __ (check last value) during our last call. The value now is: ___?“ **→ make note**
„Has your mood changed substantially since our last contact?“

- **→ If mood is rated „5“ or „6“, and/or if the bad mood is not explained by particular transient circumstances, perform the depression check using the respective module.**

Compliance

18 → **Study Nurse: Please rate patient overall compliance on a scale of 1 (=best) to 6 (=worst) based on items 1-17. Please document pecific problems in the Contact Log Sheet.**

Daily Life

19 *„How do you get on with your daily life?“* **Rate on a scale of 1 (=best) to 6 (=worst)?“**

The standard questionnaire is now completed.
If the patient agrees and if there is still enough time (duration of entire contact <20min), additional teaching is possible using another module.

Scheduling the Next Call (*examples*)

„I would like to contact you again in 2 days time to check whether the adaptation of the diuretic treatment has worked.“

„I would like to call you again in 1 week from now in order to hear whether the situation with your heart rate /blood pressure / body weight has improved / stabilized.“

„Since the situation seems stable now, I suggest to call you again in 14 days / in 4 weeks from now.“

„I suggest the following date: _____, at ___ o´clock.“ → **make note**

„Please, don't forget to have your Symptom Calendar ready for the next contact. As you know, we always start with the symptoms and I will start asking you about your heart rate, blood pressure and body weight results.“

„Do you have any further questions? In case that new questions arise, write them down and we will discuss them the next time.“

! ***„Please remember that in case of sudden or severe problems you must contact your GP straight away. If in doubt, you also can contact us. You will find our number / emergency number on the patient pass or the symptom calendar.“***

Satisfaction with Treatment

„How satisfied are you with the current treatment?
Rate on scale from 1 (=best) to 6 (=worst)…

20 *… regarding medication...“* → **make note**

21 *… regarding medical care….“* → **make note**

„Do you have any suggestions how our cooperation could be improved? We would be interested to know.“
→ **if useful, document in the Comments field of the Contact-Log.**

IV. Module SYMPTOMS

After completion of the START module, the nurse may choose to add another module or parts of another module. Whether educational modules are additionally addressed besides the START module, depends on the time left, the psycho-emotional and physical condition of the patient, the need to deal with important alternative issues (social problems, daily life issues, comorbidities etc.) and the general disposition of the patient. The appropriate module is chosen according to individual requirements as expressed by the patient or identified by the nurse/doctor.

The module SYMPTOMS serves to illustrate the approach taken to education in *HeartNetCare-HF*©: A module may be taught across several telephone contacts. By asking questions about the contents of the previously addressed educational module nurses assure that patients remember the main messages of the last telephone session. Cross-reference is made to the *Patient Brochure on Heart Failure* which is part of the educational materials patients receive when entering the program.

Generally, the specialized nurses are taught to deliver and control the most important information first. Repetition may be a very important element, in particular in patients with cognitive dysfunction. Less important information is taught only after the patients have achieved a sound understanding and enduring knowledge of the most essential aspects of each educational module, in particular regarding medications, self-control and self-empowerment.

Module SYMPTOMS

In general: Any teaching module (i.e., this module SYMPTOMS, which teaches the general and patient-specific symptomatology of heart failure) **should follow the module START**. Therefore, keep in mind that the whole telephone contact should, as a rule of thumb, not exceed **20 minutes**. It may be necessary and advisable to split the teaching modules in several parts. Keep it simple and concise. Repeat important aspects several times during different calls. Do always document on the Contact Log, which modules you have been covering and which aims you have agreed on with the patient. It should be possible to cover most modules in the course of 6 months.
Try to refer to the Patient Brochure on Heart Failure as often as possible (e.g., specific pages). Ask him/her whether he/she has read the particular section you intend to cover in your module. Encourage the reading and give positive feedback if the patient has managed. Ask whether he/she has managed to execute the advice you gave last time. If the patient is not able/willing to read the respective sections, you may proceed with instructions without the brochure.

Explain: „The underlying cause of heart failure in this individual patient“

„Mr X, as you know you suffer from heart failure, which is weakness of the heart muscle. There are multiple causes of heart failure.

22 *Do you know what the cause of heart failure is in your specific case?“*

→ **If answer is “yes”, let the patient explain briefly in his/her own words; clarify if necessary; then continue with next question.**
→ **If unknown, explain.**

Explain: „Signs & symptoms of heart failure“

23 *„Now we talk about the symptoms of heart failure and how to detect and monitor them. Do you know what “symptoms” are, really? Have you read the section in the brochure which covers that topic? Yes? Very good. Maybe, you could explain using your own words what your understanding is of the “symptoms of heart failure”?”*

→ **If clear, continue with next point.**
→ **If unknown, explain and make sure that your patient has understood everything.**
Refer to further reading and explanations in the Patient Brochure.

Compile a list of symptoms that is specific and instructive for this particular patient (with the help of the Patient Brochure)

24 *„Mr X, do you know which symptom among the different ones we were talking about is **especially** important for you?“*

„Mr X, do you know what causes this (these) symptom(s) in heart failure?“

If the patient cannot list the important symptoms, repeat again. Explain, that the symptoms are listed in the Symptom Calendar, that monitoring is essential, and discussion of symptoms will take place in every telephone contact.

If you feel that the patient has not understood yet, keep repeating. Do not continue with specific information, if the basic information could not be anchored.

„It is very important that you understand how symptoms in heart failure develop. There are signs and symptoms that may indicate already early that your general health is worsening. Can you explain, using your own words, how shortness of breath or the swollen ankles etc. develop?“

Proper understanding of how symptoms develop and how important they are in the disease process can become a very important motivating factor. The patient should be instructed that it is he/she him-/herself who is in charge of continuous monitoring and early recognition of worsening symptoms. Encourage your patient to be alert but also confident that – with the help from all different sides (nurse, GP, cardiologist, social services) – he/she will be able to stabilize health.

<u>The patient needs to understand the (causal) relationship between the following components</u>:
Fluid retention and gain in body weight—worsening of pump function—blood and fluid congestion in the lung and liver, veins of the neck and veins of the legs—worsening of fluid retention and weight gain

→ **Indicate that details can be found in the Patient Brochure (give specific pages).**

Monitoring the Symptoms (→indicate use of Symptom Calendar)

25 Symptom ankle edema

„Now you know how to check for ankle edema. Could you imagine to perform this check daily? Do you foresee any problems with this?“

„What could you/ What should we change to get around these problems? What exactly is the problem? Who could help you with it? (family? Social services?)“

„What would be your own approach to solve such problems?“

„How should the daily control of ankle edema be implemented in your daily life?“

26 Symptom body weight (→ Symptom Calendar)

„We´ve been talking several times already about the importance of the daily weight check. Do you still remember why that is so important?“

„Do you know why some patients gain a lot of weight in a very short period of time? **→ see above (23).**

„Do you have weighing scales at home? Can you weigh yourself? Do you check your weight daily? Do you document your weight in the Symptom Calendar? Anywhere else?“

„Could monitor your weight on a daily basis? Could you do that every morning? Do you foresee any problems there?“

27 Symptom heart rate (→ Symptom Calendar)

„Assessment of the pulse gives you 2 informations. Do you know what they are?“

→ How many beats per minute; pulse regular or irregular?

„Do you know what a normal heart rate is? What was your heart rate today?

→55 to 85 bpm may be considered normal; however, the heart rate is very variable and depends on physical or emotional stress or rest; in general, a low-normal heart rate (50-65 bpm at rest) is advantageous because the heart can perform its work more efficiently then;
please mind very low (<40 bpm) and very high heart rates (>90 bpm at rest; >140 bpm at low grade activity).

„What do you do if you notice an unusually high heart rate at rest (90 bpm)?“

„What do you do if you notice that your heart rhythm is irregular?“

→ *Contact* **your GP or cardiologist, or contact the nurse at the heart failure clinics.**

28 Symptom blood pressure (→ Symptom Calendar)

„Do you take your blood pressure regularly? How do you measure it? What type of blood pressure monitor do you use? Do you measure at the upper arm or at the wrist? Does your blood pressure monitor work properly?“

→ Measurement at the wrist may be easier for most people (especially elderly subjects). Always use the same machine; initially, double check that the machine works fine (at GP/clinics/pharmacy).

„Do you understand the meaning of the values displayed by the blood pressure monitor? Shall I explain it for you?“

[the following is not 100% accurate in pathophysiological terms, but appropriate for patient education]

Explain: The upper and lower value indicate the highest and lowest pressure built up by your heart in the large blood vessels. High blood pressure is known as hypertension. When the pressure is too high, your heart needs to pump harder than normal to keep the blood circulating. Uncontrolled hypertension increases the risk of heart failure development. If heart failure is already established, high blood pressure increases the risk of fluid retention in the lungs and dyspnea. If hypertension is the cause for heart failure, close monitoring of blood pressure is mandatory.

„ How was your BP today?Do you know the recommended ranges fort the upper and lower blood pressure?"

Systolic BP:<135 mmHg; diastolic BP: <85 mmHg; however, the blood pressure tends to vary with every heart beat; therefore, these values are only approximations, and a single BP measurement should not be overemphasized; it is very important that the blood pressure is within recommended ranges on the long run, especially for patients whose heart failure is due to high BP.

„Is your BP sometimes much too high or much too low? What do you do then?

Ideally, you should teach on an individual basis how your patient should react in that case; hypotensive BP levels are also very common; check whether the medication has been changed recently (e.g., uptitration of ACE-I oder β-blocker); it is always a matter of judgement whether lower BP should be tolerated in order to achieve higher target levels of medication or whether the symptoms are prohibitive; usually, this needs to be discussed with the GP/cardiologist.

29 Symptom dyspnea (breathlessness) (→ Symptom Calendar)

„Are you currently limited by shortness of breath? How many flights of stairs are you able to climb? Do you wake up at night because of sudden bouts of breathlessness? Is the dyspnea brought on by light or heavy exercise? Have you experienced any changes regarding these symptoms since our last contact?"

→ Advise the patient to document how severely he is compomised by dyspnea in the symptom calendar. The patient may also read the respective session in the booklet.

30 Symptom chest pain (angina pectoris) (→ Symptom Calendar)

„Have you recently been limited by chest pain? Do you experience pain with light or heavy exercise? Do you have chest pain at night? At rest? Do you use nitroglycerin spray or capsules? Does the pain improve with nitroglycerin? After how many minutes?"

→ Nitro-positive: pain ceases after 2 to 5 (-8) minutes.

→ Nitro-negative: pain persists → may indicate high risk !or pain may be due to other cause.

31 Targets agreed on until the next telephone call

Find an agreement, which symptoms should be monitored by the patient until the next telephone contact.

Don't aim too high. Go step by step.

Tell your patient he may read up further details in the heart failure brochure.

Re-emphasize the importance of symptom control and patient´s willingness to cooperate for the patient outcome (esp., quality of life, rehospitalisation).

→ Document the targets/aims on Page 1 on the Contact Log Sheet (under „*comments*").

You may use the following abbreviations:

E = Edema of the legs	**HR** = Heart rate (pulse)	**Dy** = Dyspnea (shortness of breath)
BW = Body weight	**BP** = Blood pressure	**AP** = Angina pectoris (chest pain)

V. Documentation System

For documentation purposes nurses transform the patients' answers in a (semi-)quantitative fashion as indicated on the forms. Documentation may be paper-based or part of an electronical patient record and may be used for follow-up and quality control.

All answers are saved in the Documentation System, ordered by date.

The same simple principle is applied throughout all modules:
All mandatory questions of a module are numbered; numbers correspond to the respective numbers of the Documentation Sheet.

Each module has a colour code that corresponds to the colour of the respective section of the Documentation System.

Documentation System	Date:											
	Initials:											
Symptoms / Med. Care												
1.	General Health (scale 1-5)											
2.	Change in general health (scale 1-5)											
3.	Body weight (kg)											
4.	Weight gain? (y / n)											
5.	Blood pressure (mmHg; syst./diast.)											
6.	Heart rate (beats per min)											
7.	Heart rate regular (y / n)											
8.	Ankle edema? (scale 1-3)											
9.	Dyspnea? (auf scale 1-4)											
10.	Falls? (y / n)											
11.	Angina pectoris? (scale 1-3)											
12.	Hospitalized (number)											
13.	Cardiologist consulted? (number)											
14.	GP consulted? (number)											
15.	Emergency call? (number)											
16.	Medication changed? (y / n)											
17.	Mood (scale 1-6)											
18.	Compliance (scale 1-6)											
19.	Daily life (scale 1-6)											
Satisfaction with treatment												
20.	In terms of medication (scale 1-6)											
21.	In terms of gen. medical care (scale 1-6)											
Education on symptoms y = module executed, n = module not executed												
22.	Individual cause of HF (y / n)											
23.	The concept of symptoms (y / n)											
24.	Which symptoms are important (y / n)											
25.	Ankle edema (y / n)											
26.	Body weight (y / n)											
27.	Heart rate (y / n)											
28.	Blood pressure (y / n)											
29.	Dyspnea (y / n)											
30.	Angina pectoris (y / n)											
Aims												
31.	Defined and checked by nurse (y / n)											

Documentation sheet	Date:											
	Initials:											
Medication y = module done, n = module not done												
32. Diuretics	(y / n)											
33. Betablocker	(y / n)											
34. ACE-inhbitor / ARB	(y / n)											
35. Digitalis	(y / n)											
36. *Other* _____	(y / n)											
37. _____	(y / n)											
38. _____	(y / n)											
Physical activity y = module done, n = module not done												
39. Block A	(y / n)											
40. → Target agreed on	(y / n)											
41. Block B	(y / n)											
42. → Target agreed on	(y / n)											
43. Breathing techniques												
44. →is exercised	(y / n)											
Diet & Nutrition y = module done, n = module not done												
45. Overweight	(y / n)											
46. →Aim agreed on	(y / n)											
47. Nutrition	(y / n)											
48. → Aim agreed on	(y / n)											
Psychologcal dimensions												
49. Vitality	(scale 1-6)											
50. Resources	(scale 1-6)											
51. Social support	(scale 1-6)											
52. Subj. disease model	(scale 1-6)											
53. May be corrected?	(scale 1-6)											
54. Coping	(scale 1-6)											
55. Depression	(*Major* = **S**, *Minor* = **L**)											
56. PHQ-9 depression score	(Score)											
57. Suicidal?	(y / n)											
58. Anxiety	[**N**(o), **P**(anic), **O**(ther)]											

Supplemental Material

Part II

The following figures report absolute and relative frequencies. They detail the nurse actions and topics discussed in patient contacts given in *figures 4 A-C* of the manuscript.

Figure 4.1

Visits to specialists

Visits to specialists were repeatedly arranged or discussed at least once between nurse and patient in 66% of our study population. Besides cardiologists, this concerned numerous other medical disciplines.

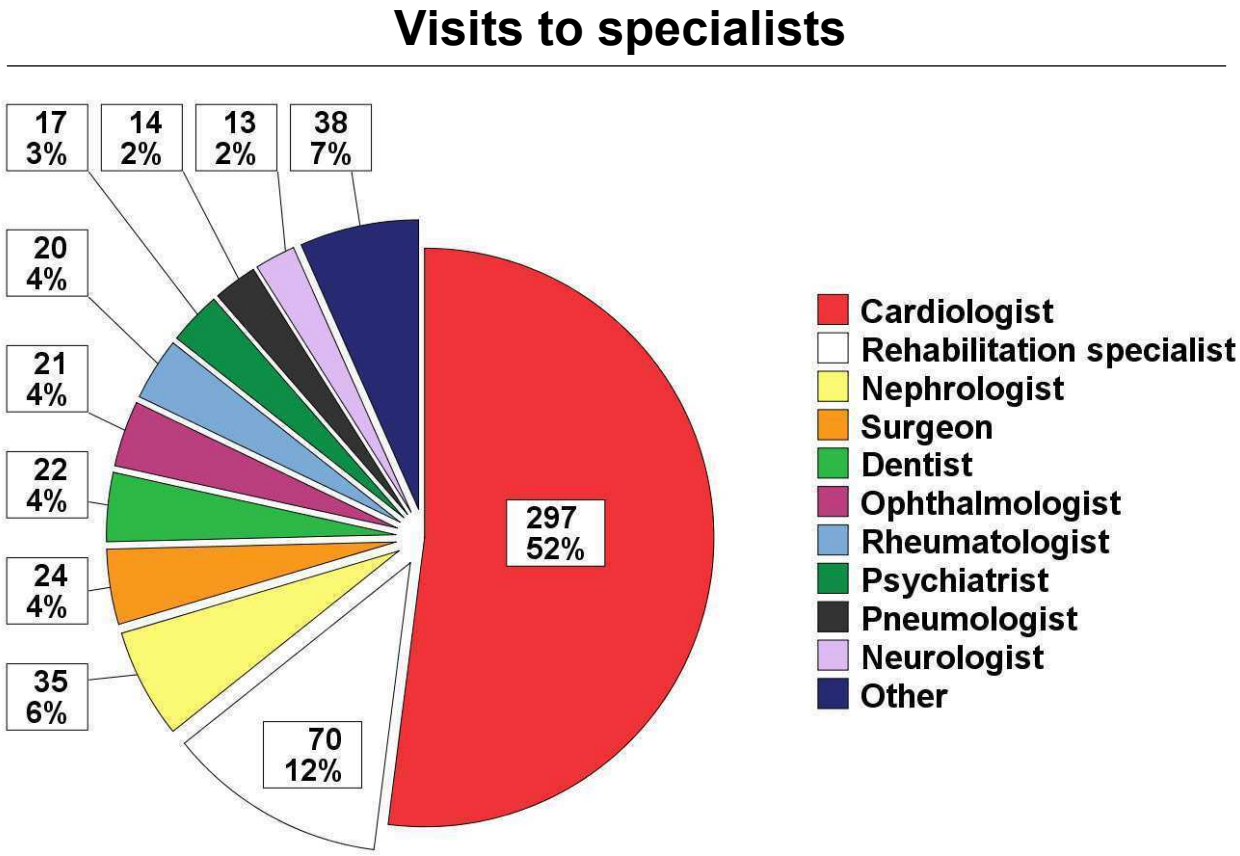


Figure 4.2

Educational modules

HeartNetCare-HF™ comprises several educational modules. At the time of randomization individual treatment goals were jointly defined for each patient by skilled nurses and physicians. Nurses chose the hierarchy and frequency of application of modules according to these goals and patients' needs. However, the START module, which serves to monitor heart failure signs and symptoms, general health and well being, medication and health care utilization, was performed first during each telephone contact. Nurses were requested to cover the set of modules applicable to an individual subject within six months. They tested patients' knowledge about applied modules during subsequent contacts and repeated the education as required.

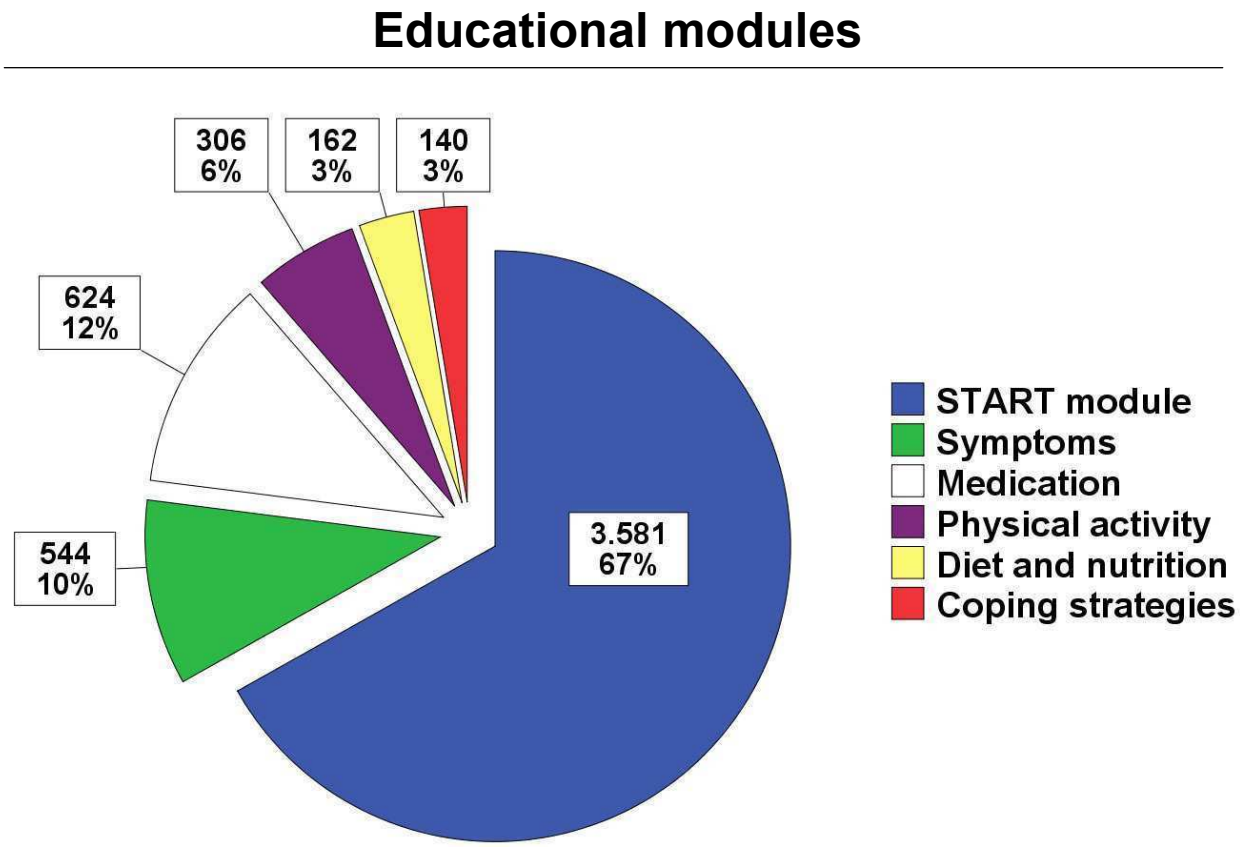


Figure 4.3

Individualized risk prevention

Nurses were trained to counsel patients regarding cardiovascular risk factors according to individual risk profiles. It belonged to their tasks to identify clinically relevant modifiable risk factors and to develop personalized approaches together with the patients to improve their individual risk profiles. Weight control and physical activity were the most frequently discussed topics, followed by nutrition and fluid control.

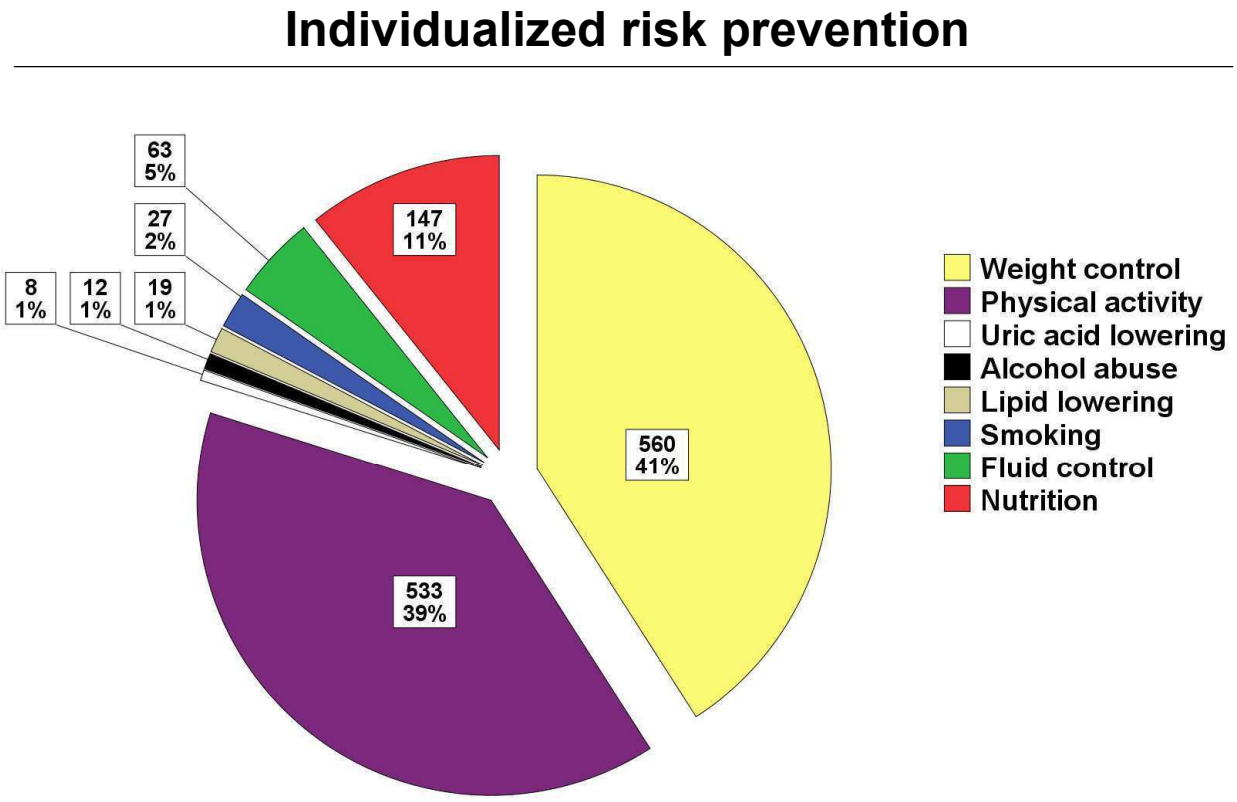
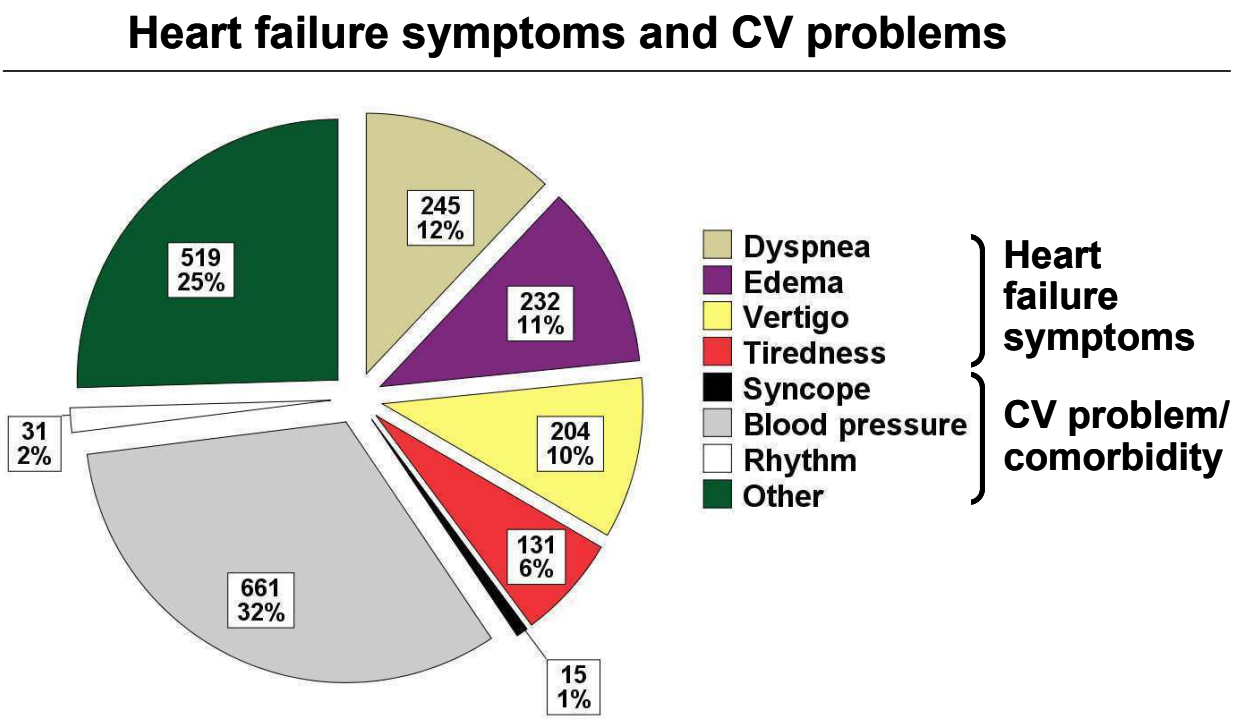


Figure 4.4

Cardiovascular problems and heart failure symptoms

In the START module standardized questions cover cardiac and in particular heart failure monitoring. Questions about general health and well-being provide opportunities for patients to bring problems up. Problems related to hyper- or hypotension were most frequently discussed. Heart failure signs and symptoms were also addressed by the majority of participants.

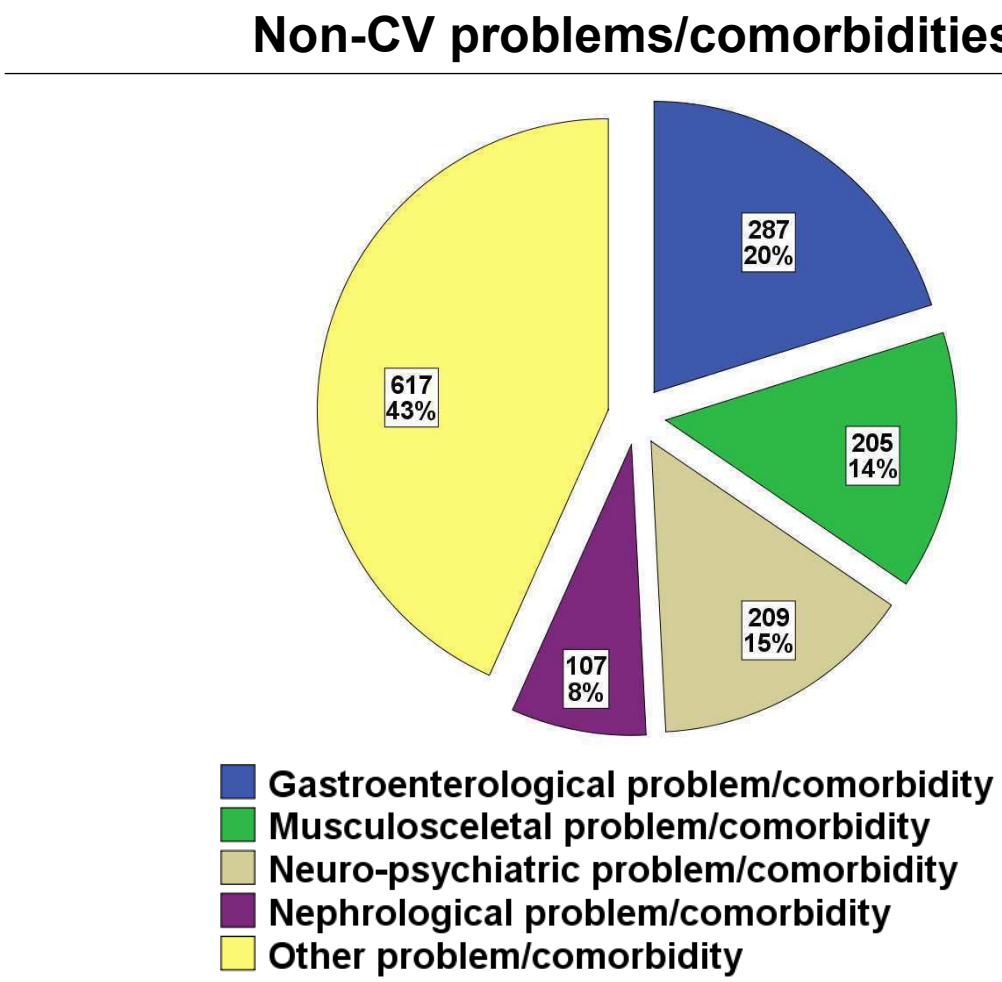


Abbreviation: CV = cardiovascular

Figure 4.5

Non-cardiovascular problems and comorbidities

Almost all patients repeatedly (on average more than 5 times per patient!) requested counselling regarding non-cardiovascular problems. This was an unexpected observation in our study, and additional training and information of the skilled nurses had to be provided during the supervision sessions. Nurses coordinated specialist contacts as required after consultation with their supervisor, but were often able to provide advice and comfort to the patients themselves or in collaboration with general practitioners.



Abbreviation: non-CV = non-cardiovascular

Figure 4.6

Pain

Besides typical anginal chest pain, patients frequently reported other types and sources of pain. Musculo-skeletal pain was particularly common. As a consequence, nurses received specific training regarding potential side effects of analgesic drugs. As an example, they were thus enabled to inform patients and carefully consider fluid balance when using non-steroidal antiphlogistic drugs.

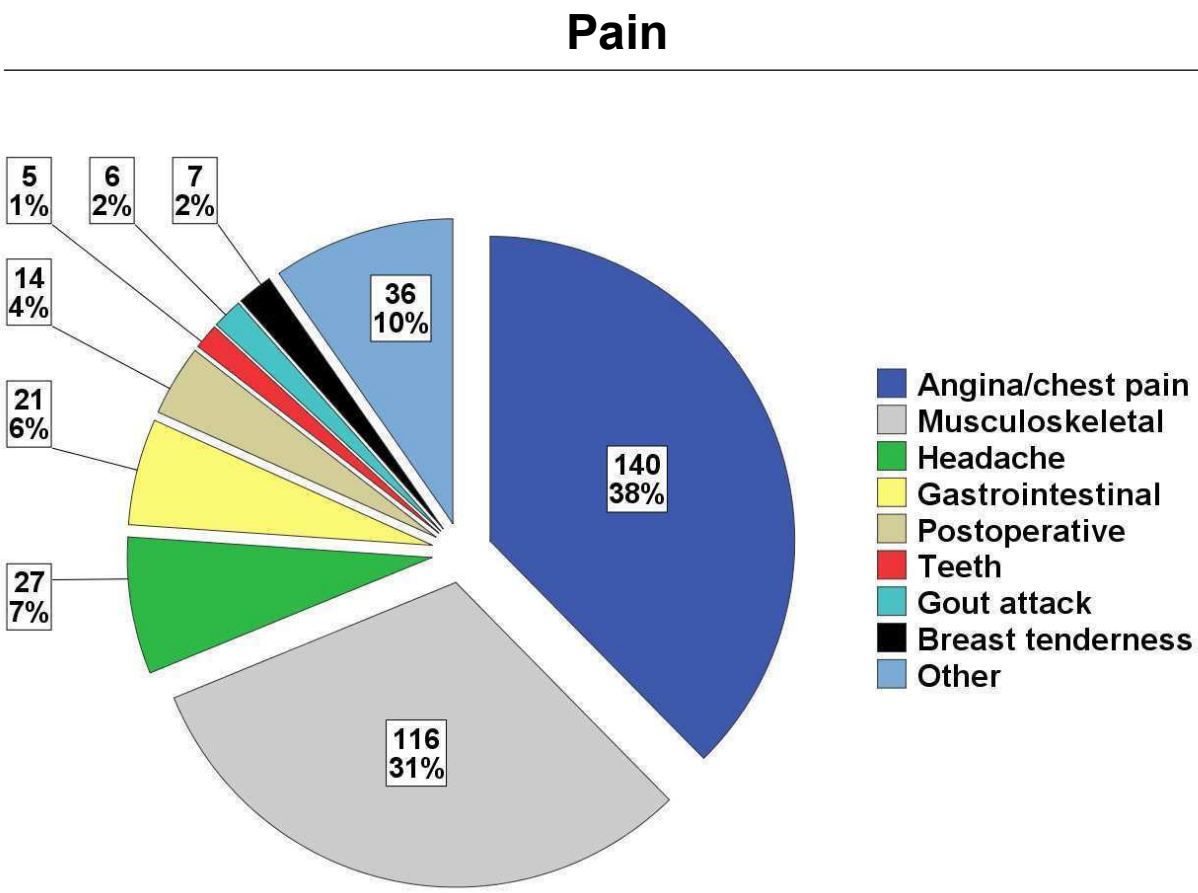
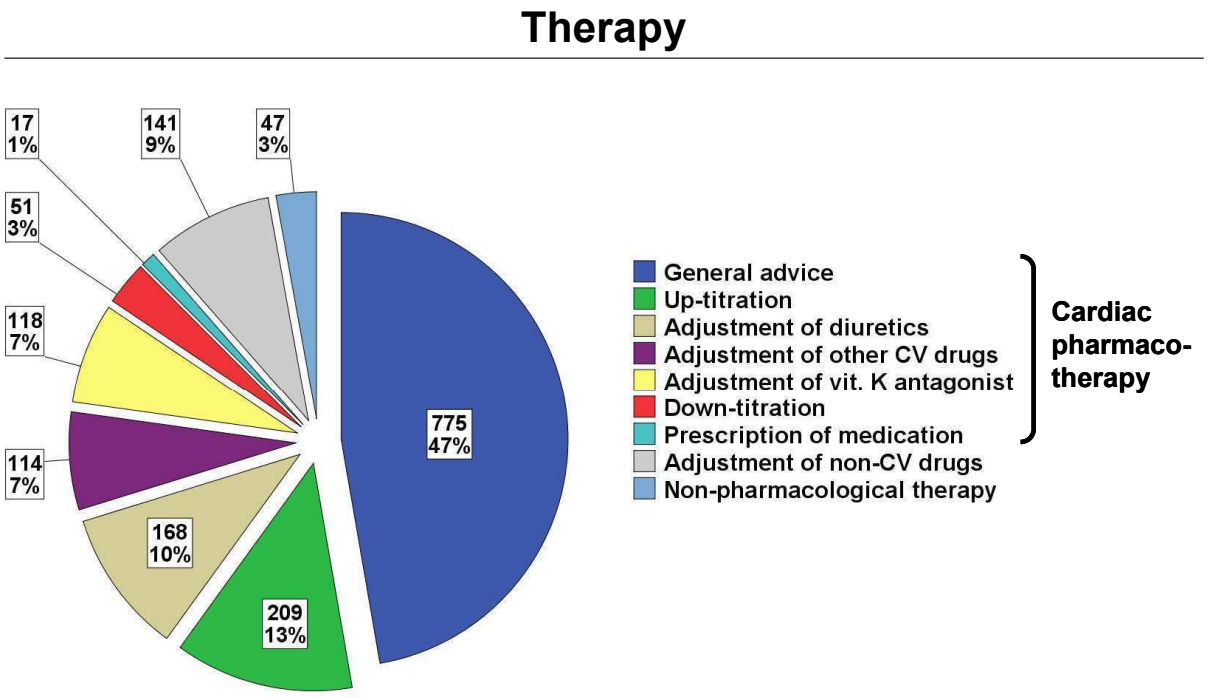


Figure 4.7

Pharmacological and non-pharmacological therapy

Optimizing heart failure therapy was one of the nurses' principal tasks. General information and advice were repeatedly provided, as knowledge about the mode of action of the various heart failure drugs and abour the benefits and potential side effects to expect was considered one major factor to ensure drug adherence. It turned out that up-titration of beta blockers and angiotensin converting enzyme inhibitors, angiotensin receptor blockers or beta blockers were not feasible in all patients, that symptoms requiring down-titration were not uncommon and that patients frequently needed help regarding adjustment of diuretics. Nurses were also frequently questioned regarding non-cardiac drugs, while non-pharmacological treatment (e.g. physiotherapy) was a much rarer concern in this multimorbid patient population.



Abbreviation: CV = cardiovascular

Supplemental Material

Part III

INH STUDY COMMITTEES AND INVESTIGATORS

The INH Steering Committee

C.E. Angermann, G. Ertl (Dept.of Internal Medicine I, University Hospital Würzburg, and Comprehensive Heart Failure Center, University of Würzburg, Germany), H. Faller (Institute of Psychotherapy und Medical Psychology, University of Würzburg, Germany), M. Löffler (Institute for Medical Informatics, Statistics and Epidemiology, University of Leipzig, Germany)

The INH Endpoint Adjudication Committee

T. Neumann (West German Heart Center, University of Essen, Germany), B.M. Pieske (Medical University of Graz, Austria), H. Schunkert (Medical Department II, University of Lübeck, Germany).

The INH Independent Advisory Board

K. Berger, H.W. Hense (Institute for Epidemiology and Social Medicine, University of Münster, Germany), D. Sunder-Plaßmann (German Association of Public Insurance Companies, Essen, Germany)

The INH Trial Investigators (all Germany)

C.E. Angermann, D. Berliner, S. Brenner, M. Breunig, N. Deubner, S. Frantz, G. Güder, G. Ertl, R. Jahns, C. Morbach, S. Störk (Dept. of Internal Medicine I, University Hospital Würzburg, and Comprehensive Heart Failure Center, University of Würzburg, Germany), H. Faller, M. Schowalter (Institute of Psychotherapy und Medical Psychology, University of Würzburg); G. Gelbrich, Dr. C. Prettin, (Coordination Center for Clinical Trials, University of Leipzig); M. Löffler (Institute for Medical Informatics, Statistics and Epidemiology, University of Leipzig); M. Meesmann, J. Brandl, L. Possler (INH Center Juliusspital, Würzburg); B. Jany, S. Baron, M. Held (INH Center Missionsärztliche Klinik, Würzburg); P. Deeg, B. Hofmann (INH Center Deegenbergklinik, Bad Kissingen); M. Borst, M. Haag (INH Center Caritas Krankenhaus, Bad Mergentheim); H.W. Sudholdt (INH Center Städtisches Krankenhaus, Wertheim); H. Ruppin (INH Center Kreiskrankenhaus, Tauberbischofsheim); W. Swoboda (INH Center AWO-Klinik, Würzburg).