Transitional Care of Older Adults Hospitalized with Heart Failure: A Randomized, Controlled Trial

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OBJECTIVES: To examine the effectiveness of a transitional care intervention delivered by advanced practice nurses (APNs) to elders hospitalized with heart failure.

DESIGN: Randomized, controlled trial with follow-up through 52 weeks postindex hospital discharge.

SETTING: Six Philadelphia academic and community hospitals.

PARTICIPANTS: Two hundred thirty-nine eligible patients were aged 65 and older and hospitalized with heart failure.

INTERVENTION: A 3-month APN-directed discharge planning and home follow-up protocol.

MEASUREMENTS: Time to first rehospitalization or death, number of rehospitalizations, quality of life, functional status, costs, and satisfaction with care.

RESULTS: Mean age of patients (control n = 121; intervention n = 118) enrolled was 76; 43% were male, and 36% were African American. Time to first readmission or death was longer in intervention patients (log rank $\chi^2 = 5.0$, $P = .026$; Cox regression incidence density ratio = 1.65, 95% confidence interval = 1.13–2.40). At 52 weeks, intervention group patients had fewer readmissions (104 vs 162, $P = .047$) and lower mean total costs ($7,636 vs $12,481, $P = .002$). For intervention patients, only short-term improvements were demonstrated in overall quality of life (12 weeks, $P < .05$), physical dimension of quality of life (2 weeks, $P < .01$; 12 weeks, $P < .05$) and patient satisfaction (assessed at 2 and 6 weeks, $P < .001$).

CONCLUSION: A comprehensive transitional care intervention for elders hospitalized with heart failure increased the length of time between hospital discharge and readmission or death, reduced total number of rehospitalizations, and decreased healthcare costs, thus demonstrating great promise for improving clinical and economic outcomes. **J Am Geriatr Soc 52:675–684, 2004.**

Key words: transitional care; older adults; heart failure; comorbid conditions; rehospitalizations

A growing body of science suggests that older adults coping with multiple comorbid conditions and complex therapeutic regimens are particularly vulnerable during the transition from hospital to home. A review of 94 studies reported between 1985 and 2001 revealed that the transition of older adults from hospital to home is associated with high rates of preventable poor postdischarge outcomes.[1] Individual factors contributing to negative outcomes include multiple comorbid conditions, functional deficits, cognitive impairment, emotional problems, and poor general health behaviors. System factors associated with poor outcomes include breakdowns in communication between providers and across healthcare agencies, inadequate patient and caregiver education, poor continuity of care, and limited access to services. As a result, at least one-third of all patients and caregivers report substantial unmet needs and high levels of dissatisfaction. Rehospitalization rates for these patients are high, with one-quarter to one-third considered preventable.[2,3]

Elders with heart failure have the highest rehospitalization rate of all adult patient groups, with estimated annual total direct healthcare expenditures exceeding $24.3 billion.[4] This patient group is representative of the growing segment of the U.S. population living longer with chronic health problems and experiencing breakdowns in care during multiple transitions from hospital to home that negatively affect their quality of life and consume substantial healthcare resources. Similar to most chronically ill elders, these patients typically have multiple comorbid medical conditions, numerous disabling symptoms,

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complex medication regimens, and limited self-management skills.[5] Comorbidity contributes substantially to increased rehospitalization rates and healthcare costs for elders with heart failure.[6–8] Thus, attention to the comprehensive care management needs of this patient group has the potential to reduce total healthcare costs.

Although reports of randomized, controlled trials (RCTs) have yielded important information regarding the management of adults hospitalized for heart failure,[9–12] little is known about the effectiveness of care management strategies for elders experiencing an acute episode of heart failure complicated by multiple other chronic health conditions. Only two single-site RCTs have tested multidisciplinary, nurse-directed, home-based interventions specifically targeting hospitalized older adults (aged 65) and including patients with both diastolic failure (approximately 50% of elders) and coexisting chronic conditions (which account for approximately 40% of rehospitalizations of older patients).[13,14] Both studies demonstrated only short-term reductions in heart-failure rehospitalizations and no effect on readmissions due to comorbid conditions. Available evidence suggests that a multidimensional, individualized approach targeting patients and their caregivers and emphasizing needs associated with the acute heart-failure event and coexisting conditions is the most clinically relevant and potentially effective intervention. Given the established association between breakdowns in care during the transition from hospital to home and poor postdischarge outcomes, such an intervention needs to continue through the postdischarge period to assure longer-term improvements in patient and caregiver outcomes.

The objective of this RCT was to examine the sustained effect of a 3-month comprehensive transitional care (discharge planning and home follow-up) intervention directed by advanced practice nurses (APNs) for elders hospitalized with heart failure on time to first readmission or death, total rehospitalizations, readmissions due to heart failure and comorbid conditions, quality of life, functional status, patient satisfaction, and medical costs. This study presents, on a spectrum of clinical and economic outcomes, the first multisite assessment of a transitional care intervention targeting the comprehensive set of serious health problems and risk factors common in elders throughout an acute episode of heart failure.

METHODS

Study Sample

The study was conducted at six Philadelphia academic and community hospitals. All patients aged 65 and older admitted to study hospitals from their homes between February 1997 and January 2001 with a diagnosis of heart failure (diagnosis-related group 127 validated at discharge) were screened for participation. Eligible patients had to speak English, be alert and oriented, be reachable by telephone after discharge, and reside within a 60-mile-radius service area of the admitting hospital. Elders with end-stage renal disease were excluded because of their access to unique Medicare services. Of 641 patients screened, 37.3% were enrolled, a percentage comparing favorably with RCTs involving a similar population.[14,15] Enrollees (n = 239) and nonenrollees (n = 402) were similar in mean age (76 vs 77, $P = .089$), race (64% vs 69% white, $P = .20$) and sex (57% vs 59% female, $P = .804$). The primary reasons for nonenrollment were residence located outside of the defined service area, patients discharged before consent could be obtained, and patient or family member refusal, most often because of an established relationship with a home health agency.

Study Design

The University of Pennsylvania institutional review board approved the study protocol. After screening patients within 24 hours of hospital admission for eligibility and obtaining informed consent, research assistants (RAs) blinded to study aims and groups obtained baseline sociodemographic and health status data and notified the project manager, who assigned patients to study groups using a computer-generated, institution-specific block 1:1 randomization algorithm.

Control Group

Control group patients received care routine for the admitting hospital, including site-specific heart failure–patient management and discharge planning critical paths and, if referred, standard home agency care consisting of comprehensive skilled home health services 7 days a week. Standards of care for all study hospitals include institutional policies to guide, document, and evaluate discharge planning. The discharge planning process across hospital sites was similar. The attending physician was responsible for determining the discharge date, and the primary nurse, discharge planner, and physician collaborated in the design and implementation of the discharge plan. Standards and processes of care for the primary home care sites were also similar. These included use of liaison nurses to facilitate referrals to home care; availability of comprehensive, intermittent skilled home care services in patients' residences 7 days per week; and on-call registered nurse availability 24 hours per day. Fifty-eight percent (71/121) of the control group received referrals for skilled nursing or physical therapy after the index hospital discharge.

Intervention Group

In collaboration with patients' physicians, three APNs implemented an intervention extending from index hospital admission through 3 months after the index hospital discharge. The intervention included all of the following components: (1) a standardized orientation and training program guided by a multidisciplinary team of heart failure experts (composed of a geropsychiatric clinical nurse specialist, pharmacist, nutritionist, social worker, physical therapist, and board-certified cardiologist specializing in the treatment of heart failure) to prepare APNs to address the unique needs of older adults and their caregivers throughout an acute episode of heart failure; (2) use of care management strategies foundational to the Quality-Cost Model of APN Transitional Care,[16,17] including identification of patients' and caregivers' goals, individualized plans of care developed and implemented by APNs in collaboration with patients' physicians, educational and behavioral strategies to address patients' and caregivers' learning needs, continuity of care and care coordination across settings, and the use of expert nurses to deliver and manage clinical services to high risk patient groups; and (3) APN implementation of an evidence-based protocol, guided by national heart failure guidelines[18,19] and designed specifically for this patient group and their caregivers with a unique focus on comprehensive management of needs and therapies associated with an acute episode of heart failure complicated by multiple comorbid conditions.

The protocol consisted of an initial APN visit within 24 hours of index hospital admission, APN visits at least daily during the index hospitalization, at least eight APN home visits (one within 24 hours of discharge), weekly visits during the first month (with one of these visits coinciding with the initial follow-up visit to the patient's physician), bimonthly visits during the second and third months, additional APN visits based on patients' needs, and APN telephone availability 7 days per week (8 a.m. to 8 p.m., weekdays; 8 a.m. to noon, weekends). If a patient was rehospitalized for any reason during the intervention period, the APN resumed daily hospital visits to facilitate the transition from hospital to home, but the length of time devoted to the intervention for such patients did not extend beyond 3 months postindex hospital discharge. Although the study protocol guided patient management and specified a minimum number of APN hospital and home visits, it allowed the APN considerable flexibility to individualize care.

Masters-prepared nurses with general expertise in the management of conditions common in older adults were recruited. Their knowledge and skills in the management of elders with heart failure were assessed. APNs participated in a 2-month orientation and training program focused on developing their competencies related to early recognition and treatment of acute episodes of heart failure in elders, with particular attention to how it complicates and is complicated by common comorbid conditions such as diabetes mellitus or depression. Content and clinical experiences included review of relevant evidence-based guidelines, case study discussions led by multidisciplinary team members, and participation in clinical rounds. Particular attention was paid to educating APNs regarding optimal therapeutic management (e.g., medications, exercise). The training program emphasized application of educational and behavioral strategies in the home to address patients' and caregivers' unique learning needs. Finally, APNs were prepared to implement the study protocol using the constellation of care management strategies identified earlier. Once patient enrollment began, APNs had access to multidisciplinary team members via e-mail or phone for consultation on their most challenging cases.

After completion of the training program, APNs assumed responsibility for discharge planning while the patient was hospitalized and substituted for any visiting nurse services that might have been ordered at discharge during the 3 months after hospital discharge. During the patient's hospitalization, a comprehensive patient assessment using valid and reliable instruments was conducted that addressed the following: patients' and caregivers' goals; nature, duration, and severity of heart failure and comorbid conditions; physical, cognitive, and emotional health status; general health behaviors and skills; and availability and adequacy of social support.

A major focus of APNs' intervention during the hospitalization phase was collaboration with physicians and other providers to optimize the patient's health status at discharge, design the discharge plan, and arrange for needed home care services. Special emphasis was placed on preventing functional decline and streamlining medication regimens. APNs were able to provide input to the nursing staff regarding the discharge needs of patients and caregivers, thus maximizing the time staff nurses devoted to these areas. APNs worked with discharge planners to prevent duplication of postdischarge services and coordinate the ordering of essential medical supplies.

After patients were discharged to their homes, APNs conducted targeted assessments to identify changes in patients' health status. APNs' involvement throughout the transition from hospital to home provided a safety net designed to prevent medication and other medical errors and assure accurate transfer of information. As a result of advanced physical assessment skills, including expertise in evaluating responses to therapy, APNs were able to identify early signs of problems such as impending volume overload and, in collaboration with patients' physicians, implement strategies to prevent the onset of symptoms or to minimize their effects. Unless working under specific guidelines unique to treating physicians, APNs collaborated with each patient's physician regarding adjustments in medications and other therapies.

Face-to-face interactions with the patient's physician during the hospitalization and initial follow-up visit (aimed at promoting continuity of care) helped to foster collaborative relationships. APNs' expertise in management of heart failure and common comorbid conditions, coupled with their ability to coordinate care, nurtured these relationships and provided patients with increased access to symptom management tools. For example, in collaboration with physicians, APNs were able not only to teach patients and caregivers about early symptom recognition, but also to coach them regarding effective treatment, such as the use of as-needed diuretics. Positioning patients and caregivers to manage their symptoms was a goal for all intervention group patients.

Patients' goals were the primary sources of motivation to promote adherence to therapies and behavioral change. Although approaches to achieve these goals were based on patients' and caregivers' identification of strategies that worked best for them, all patient teaching was audiotaped with tapes and recorders left for patients and caregivers to review throughout the intervention period. If applicable, videocassette recorder tapes featuring management of common comorbid conditions (e.g., diabetes mellitus) were also left with patients and caregivers to review. At the conclusion of the intervention, APNs provided patients, caregivers, physicians, and other providers with summaries of goal progression, unresolved issues, and recommendations.

Outcome Measures

RAs blinded to study aims and groups conducted standardized patient telephone interviews at 2, 6, 12, 26, and 52 weeks after index hospital discharge to obtain information about rehospitalizations and unscheduled acute care visits to physicians, clinics, and emergency departments; quality of life (assessed using the Minnesota Living with Heart Failure Questionnaire[20]); and functional status (measured using the Enforced Social Dependency Scale[21]). Patient satisfaction was assessed (using an investigator-developed instrument) at 2 and 6 weeks postindex hospitalization. Prior testing of this instrument revealed that, for control patients who did not receive home follow-up, the hospital experience was too far removed for accurate recall and the generation of reliable data.

Data on number of, timing of, and reasons for hospital readmissions, unscheduled acute care visits, and care provided by visiting nurses or APNs and other healthcare personnel were abstracted from patients' records and bills requested by the project manager via telephone calls and letters to physicians, hospitals, and home care agencies. All records from physicians' offices and records from remote hospitals and home care agencies were copied and mailed or sent by facsimile to the research offices at the University of Pennsylvania. RAs traveled to local hospitals and home care agencies and copied records on-site. Two cardiologists specializing in the treatment of heart failure blinded to study group validated reasons for rehospitalizations and categorized them as index related, comorbid (diagnoses abstracted from medical record during index hospitalization), or new health problem. Resource costs were estimated using standardized Medicare reimbursements for services used.[22] The cost of the intervention, including time devoted by APNs to the preparation of patient education materials, was calculated by assessing the intervention-related effort of APNs and multidisciplinary team experts (from detailed logs) and applying representative annual salaries for APNs and individual team members plus benefits. Costs of pharmaceuticals, over-the-counter drugs, other supplies, and indirect costs were not collected.

Statistical Analysis

The primary endpoint was time to first rehospitalization or death.[10,11,13] Patients alive and not hospitalized were censored at study completion (190/239; 79.5%). Patients not completing follow-up (49/239; 20.5%) were censored at withdrawal. Based on previous results,[14] it was estimated that 102 patients per group were required to achieve 80% or greater power to detect a control-to-intervention group hazard ratio of 1.61.[23] Enrollment ended with 118 intervention and 121 control group subjects, allowing for losses to follow-up, statistical adjustment for institution, and other a priori risk factors. Secondary analyses defined death as a censoring event (24/239; 10%).

Group-specific Kaplan-Meier survival curves[24] were constructed. Intervention efficacy was assessed using proportional hazards regression,[25] adjusting for institution and a priori baseline prognostic factors including self-rated health, hospitalizations during prior 6 months, and living arrangement.[14] Confounding factors that changed the risk ratio by more than 15%[26] and prognostic factors with $P<.05$ were added to the a priori model. The proportional hazards assumption was examined using time-dependent covariates. Intervention and covariate effect sizes were expressed using incidence density ratios (IDRs) with 95% confidence intervals (CIs).[25]

Secondary endpoints included time to first rehospitalization, cumulative days of rehospitalization, mean readmission length of stay, number of unscheduled acute care visits after discharge, other measures of healthcare utilization, cost of postindex hospitalization medical services, quality of life, functional status, and patient satisfaction. All analyses were performed using the intention-to-treat principle.[27]

Resource utilization comparisons (including acute care visits, home visits, and hospital readmissions) were examined overall and by resource category over four periods (0–12, 0–3, 3–6, and 6–12 months). Descriptive statistical comparisons were performed using Wilcoxon rank sum tests, dividing by follow-up days to adjust for unequal observation periods. Standardized unit costs were assigned to each service and aggregated across services within patients and groups. Group-specific average total intervention costs were adjusted for incomplete follow-up using the method of Lin et al.[28] This method involved incorporating the Kaplan-Meier survival estimates of the conditional survival probabilities into the computation of average cost per patient. Ninety-five percent nonparametric percentile CIs and two-sided *P*-values of group differences were derived from a bootstrapped empiric sampling distribution (1,000 iterations).[29,30] This method involved randomly selecting with replacement from the intervention and control samples 118 and 121 observations, respectively, re-estimating the group specific Kaplan-Meier survival curves for each bootstrap sample, re-computing the Lin et al. estimates of average treatment costs separately for each group, and then re-computing difference in mean total costs.

Tertiary analyses compared quality of life, functional status, and patient satisfaction over time using Wilcoxon rank sum tests. Quality-of-life and functional status comparisons must properly account for missing values[31] because the mechanism generating missing values is not ignorable,[32] thus making analyses restricted to complete cases biased. To this end, measures were transformed to ordinal scales by assigning a score of 0 to patients who died (which was carried forward to subsequent time periods) and 1 to patients who were hospitalized during scheduled assessments. Nonmissing scores were grouped into quartiles, with the lowest quartile receiving a score of 2 and the top quartile a score of 5. Patients with a missing value who did not die or become hospitalized but who had prior and subsequent nonmissing values were assigned the score from the prior nonmissing time. The Wilcoxon test for patient satisfaction outcome was based on raw scores and did not incorporate categories for deaths and hospitalizations.

RESULTS

Intervention and control groups were similar in all baseline sociodemographic characteristics. With the exception of hypertension, there were no statistically significant differences, and overall the groups appeared clinically similar (Table 1). Mean age was 76; 43% were male, and 36% were

Table 1. Baseline Sociodemographic and Health Characteristics (N = 239)

Characteristic	Intervention n = 118	Control n = 121	*P*-value
Age, mean ± SD	76.4 ± 6.9	75.6 ± 6.5	.355
Gender, n (%)			
Male	47 (40)	55 (44)	
Female	71 (60)	66 (56)	.433
Race, n (%)			
African American	40 (34)	46 (38)	
White	78 (66)	75 (62)	.59
Education, n (%)			
<High school	52 (44)	54 (44)	
>High school	66 (56)	67 (55)	1.00
Retired or unemployed, n (%)	98 (82)	109 (90)	.178
Social support, n (%)			
Spouse	48 (41)	51 (42)	
Other relative and/or friend	27 (23)	30 (25)	
No one	43 (36)	40 (33)	.879
Income, $, n (%)			
<10,000	34 (29)	45 (37)	
10,000–19,999	31 (26)	33 (27)	
≥20,000	18 (15)	20 (17)	
Missing	35 (29)	23 (19)	.792
Insurance, n (%)			
Health maintenance organization	42 (36)	52 (43)	
Medicare only	13 (11)	10 (8)	
Medicare + Medicaid	9 (7)	10 (8)	
Medicare + supplemental	54 (46)	49 (41)	.636
Type of admission to hospital, n (%)			
Elective	24 (20)	19 (15)	
Emergency	92 (78)	100 (83)	
Transfer	2 (2)	2 (2)	.544
Index length of stay, mean ± SD	5 ± 2.9	4.6 ± 2.3	.245
Patient subjective health rating,[33] n (%)			
Excellent/good	4 (3.4)	2 (1.7)	
Fair	87 (74)	92 (76)	
Poor	27 (23)	27 (22)	.877
Physician visits (within past 6 months), mean ± SD	6.2 ± 3.6	6.6 ± 5.6	.726
Hospital admissions (within past 6 months), mean ± SD	1.1 ± 1.6	1.1 ± 1.3	.991
Hospital discharges (within past 30 days), mean ± SD	0.3 ± 0.6	0.2 ± 0.4	.177
Functional status,[21] mean ± SD			
Personal	17.1 ± 5.8	16.9 ± 5.8	.815
Social	8.4 ± 2.6	8.6 ± 2.6	.719
Total	25.5 ± 8	25.4 ± 7.8	.629
Quality of life,[20] mean ± SD			
Emotional	6.6 ± 7.4	6.4 ± 7.4	.823
Physical	21.7 ± 10.8	20.8 ± 9.5	.55
Total	38.0 ± 20.9	36 ± 19.5	.476
Number of daily prescription medications, mean ± SD	7 ± 3.1	6.5 ± 2.7	.262
Number of health conditions,* mean ± SD	6.4 ± 2.5	6.4 ± 2	.748
Coronary artery disease, n (%)	62 (53)	54 (45)	.22
Hypertension, n (%)	54 (46)	71 (59)	.046
Atrial tachycardia, n (%)	45 (38)	39 (32)	.339
Diabetes mellitus, n (%)	44 (37)	46 (38)	.887
Pulmonary disease, n (%)	41 (35)	30 (24)	.093
Type of heart failure (as documented in the medical record), n (%)			
Systolic	70 (59)	65 (53)	
Diastolic	48 (40)	56 (46)	.434

(continued)

Table 1. Continued

Characteristic	Intervention n = 118	Control n = 121	*P*-value
Documented ejection fraction, n (%)	88 (72)	98 (80)	
<20%	12 (14)	17 (17)	.755
20 to <25%	10 (11)	9 (9)	.760
25 to <35%	28 (32)	30 (30)	.914
35 to <45%	26 (30)	28 (28)	.942
≥45%	12 (14)	14 (14)	1.00

* Active health problems requiring therapy as reported by patients and documented in the medical record.
SD = standard deviation.

African American. Forty-six percent of the control group had diastolic failure, compared with 40% of the intervention group ($P = .434$). The primary physician for 50% (60/121) of the control group and 43% (51/118) of the intervention group was a board-certified cardiologist; physician generalists (internal or family medicine) cared for the remaining 50% (61/121) of the control group and 57% (67/118) of the intervention group throughout the episode of acute heart failure. Of the 121 control-group patients, 39% (48/121) were prescribed an angiotensin-converting enzyme inhibitor, compared with 37% (44/118) of intervention-group patients.

Twenty-four patients (10%) had died by 52 weeks postdischarge (13 control vs 11 intervention, $P = .830$). Study follow-up did not differ significantly between control and intervention groups (means = 281 vs 279 days; $P = .871$). The 31% attrition due to death or withdrawal (37/121 control; 36/118 intervention, $P = .99$) was consistent with another RCT involving a similar patient population.[14,15] Most of the attrition (32/239) occurred at the 52-week data collection point (17 intervention group; 15 control group) because patients moved and could not be located, did not answer the telephone despite multiple calls, or did not want to be bothered. There were no significant differences in the severity of illness between control-group patients (24/121) and intervention-group patients (25/118) lost to follow-up as assessed using baseline ejection fraction, number of hospitalizations in 6 months before index hospitalization, number of comorbid conditions, and number of prescription medications.

Rehospitalization and Death

Rehospitalizations or deaths at 52 weeks were lower in the intervention group (56/118 (47.5%) vs 74/121 (61.2%), adjusted $P = .01$). The distribution of times to first readmission or death was similarly shifted toward longer time intervals in the intervention group than in the control group (Kaplan-Meier log rank $\chi^2 = 5.0$, $P = .026$). The estimated proportions ± standard error of patients in the intervention group remaining alive and with no hospital readmission at 30, 60, 90, 180, and 365 days postdischarge were 0.869 ± 0.033, 0.750 ± 0.043, 0.071 ± 0.045, 0.600 ± 0.047, and 0.445 ± 0.050, respectively. These proportions were significantly lower in control patients: 0.737 ± 0.041, 0.621 ± 0.046, 0.558 ± 0.047, 0.444 ± 0.047, and 0.321 ± 0.046, respectively. Similarly, the estimated median event-free survival of patients in the APN intervention and control groups was 131 and 241 days, respectively. There were no statistically significant group differences (at $P < .05$) by time interactions whether time was defined as an interval variable ($P = .472$) or dichotomized at 2, 6, 12, or 26 weeks. The crude IDR from the simple Cox regression was 1.48 (95% CI = 1.05–2.09, $P = .027$). Only number of daily medications at admission had $P \leq .05$ when added to the a priori multivariable model ($P = .014$). The final multivariate model–adjusted IDR was 1.65 (95% CI = 1.13–2.40, $P = .001$) (Table 2). Relative efficacy did not vary by institution. When follow-up was censored at death, the unadjusted and adjusted IDRs were 1.44 (95% CI = 1.00–2.07) and 1.58 (95% CI = 1.07–2.34), respectively.

Table 2. Time to First Rehospitalization or Death by Patient Characteristic (Multivariate Cox Proportional Hazards Model)

Variable	Incidence Density Ratio (95% Confidence Interval)	*P*-value
Control group versus intervention group	1.65 (1.13–2.40)	.001
Fair or poor self-rating versus good or excellent self-rating	1.29 (0.83–2.00)	.263
Number of prior hospitalizations within the past 6 months	1.19 (1.06–1.35)	.005
Living with spouse versus relative or friend*	0.81 (0.51–1.29)	.376
Living alone versus with relative or friend*	0.59 (0.35–0.98)	.043
Number of daily medications	1.09 (1.02–1.16)	.014
Site†		.176

* Likelihood ratio test for prior living arrangements $\chi^2 = 4.262$, $df = 2$, $P = .119$.
† Likelihood ratio test for site differences $\chi^2 = 7.663$, $df = 5$.

Table 3. Rehospitalizations and Hospital Days 1 Year After Index Hospitalization Discharge

Variable	Intervention (n = 118)	Control (n = 121)	*P*-value*	Relative Risk (95% Confidence Interval)
Patients rehospitalized, n (%)				
> 1 time	53 (44.9)	67 (55.4)	< .121	1.24 (0.95–1.60)
> 2 times	34 (28.8)	44 (36.4)	< .218	1.20 (0.89–1.60)
Rehospitalizations, n				
Index-related	40	72	< .184	
Comorbidity-related	23	50	< .013	
New health problem	41	40	< .881	
Total	104	162	< .047	
Rehospitalizations per patient/year†	1.18	1.79	< .001	
Total hospital days	588	970		
Per patient, mean ± SD	5.0 ± 7.3	8.0 ± 12.3	< .071	
Per rehospitalized patient, mean ± SD	11.1 ± 7.2	14.5 ± 13.4	< .411	

* Wilcoxon rank sum tests used to compare the distribution of per patient rates for number of rehospitalizations and hospital days; chi-square for proportion of patients rehospitalized.
† Rehospitalization rate per patient year: total rehospitalizations/total nonhospital days times 365.
SD = standard deviation.

Readmissions and Hospital Days at 1 Year

Fewer intervention group patients were rehospitalized postindex discharge than control group patients (44.9% vs 55.4%, $P = .12$) (Table 3). There were 104 readmissions of intervention group patients versus 162 control group patients ($P = .047$) (readmission rate per nonhospitalized

Table 4. Costs (Reimbursements) for Rehospitalizations, Acute Care Visits, and Home Visits for 52 Weeks after Index Hospitalization Discharge

Parameter	Control (n = 121) Mean Number of Visits ± SD	Control (n = 121) Cost, $	Intervention (n = 118) Mean Number of Visits ± SD	Intervention (n = 118) Cost, $	*P*-value Number of Visits	*P*-value Cost
Rehospitalizations						
Index-related		314,955		175,960		.152
Comorbidity-related		498,110		175,840		.015
New health problem		246,134		235,453		.997
Total hospitalizations		1,065,927		587,253		.088
Rehospitalizations						
0–3 months		489,420		236,144		.010
0–6 months		841,164		381,725		.030
6–12 months		218,035		205,528		.235
Acute care visits						
Physician's office	0.8 ± 1.6	5,169	0.8 ± 1.5	4,549	.609	.636
Emergency room	0.3 ± 1.2	5,650	0.1 ± 0.4	1,780	.116	.105
Home visits						
Visiting nurse	6.3 ± 13.2	64,531	1.1 ± 4.9	11,837	< .001	< .001
Advance practice nurse	0	0	12.1 ± 6.7	104,019*	—	—
Physical therapists	1.0 ± 4.4	10,918	0.7 ± 3.0	7,120	.703	.708
Social workers	0.0 ± 0.4	534	0.0 ± 0.1	178	.678	.678
Home health aides	1.1 ± 5.1	11,081	0.9 ± 5.5	9,167	.286	.286
Total home visits	9.5 ± 19.0	97,883	± 12.2	138,649	< .001	< .001
Totals		1,163,810		725,903		.404
Per patient		9,618		6,152		
Lin estimate		12,481		7,636		.002

Note: Visits and costs are aggregate values. Visits and costs were standardized for unequal follow-up by converting to costs per day in the study before significance testing.
* Includes costs of multidisciplinary team members' services.
SD = standard deviation.

Table 5. Quality of Life (QoL) Comparing Intervention and Control Groups

	QoL Total Score Category*				QoL Physical Dimension Category†		QoL Emotional Dimension Category‡	
	APN		Control		APN	Control	APN	Control
Time Period	n	Mean ± SD	n	Mean ± SD	Mean ± SD			
Baseline	117	2.4 ± 0.7	118	2.3 ± 0.7	2.8 ± 0.9	2.8 ± 0.9	3.3 ± 1.3	3.3 ± 1.2
2 weeks	114	3.0 ± 1.2¶	112	2.7 ± 1.2	3.5 ± 1.2§	3.0 ± 1.2	3.6 ± 1.3#	3.3 ± 1.4
6 weeks	99	3.1 ± 1.3	109	2.9 ± 1.4	3.6 ± 1.4	3.3 ± 1.5	3.5 ± 1.5	3.3 ± 1.6
12 weeks	89	3.2 ± 1.5‖	100	2.7 ± 1.5	3.6 ± 1.4‖	3.1 ± 1.6	3.6 ± 1.6	3.2 ± 1.7
26 weeks	86	2.9 ± 1.6	92	2.6 ± 1.5	3.3 ± 1.6	3.0 ± 1.7	3.2 ± 1.7	3.1 ± 1.8
52 weeks	75	2.8 ± 1.8	74	2.6 ± 1.7	3.1 ± 1.9	2.9 ± 1.9	3.1 ± 1.9	3.0 ± 1.9

Note: The Minnesota Living with Heart Failure questionnaire has 21 items and provides a total score (range 0–105) and two subscales. Each item is self-rated on a 0- to 5-point scale. The physical and emotional subscales are subset sum scores with 8 and 5 items each, with ranges from 0 to 40 and 0 to 25, respectively. Higher scores reflect lower QoL.

* 0 = Died; 1 = Hospitalized; 2 = 1st Quartile Score (>35); 3 = 2nd Quartile Score (>18 to ≤35); 4 = 3rd Quartile Score (>7 to ≤18); 5 = 4th Quartile Score (≤7) Highest QoL.

† 0 = Died; 1 = Hospitalized; 2 = 1st Quartile Score (>21); 3 = 2nd Quartile Score (>12 to ≤21); 4 = 3rd Quartile Score (>4 to ≤12); 5 = 4th Quartile Score (≤4).

‡ 0 = Died; 1 = Hospitalized; 2 = 1st Quartile Score (>6); 3 = 2nd Quartile Score (>1 to ≤6); 4 = 3rd Quartile Score (>0 to ≤1); 5 = 4th Quartile Score (≤0).

Difference between groups: § $P<.01$; ‖ $P<.05$; ¶ $P=.07$; # $P=.094$.

APN = advanced practice nurse; SD = standard deviation.

year 1.18 vs 1.79; IDR = 0.66; $P<.001$). Of rehospitalizations, 23 of 104 (22%) in the intervention group versus 50 of 162 (31%) in the control group were related to comorbidities ($P=.013$), 40 (38%) versus 72 (44%) for heart failure ($P=.184$) and 41 (39%) versus 40 (24%) for new health problems ($P=.881$). Hospital days were fewer in intervention patients (588 days vs 970 days, $P=.071$). There were 43 intervention patients versus 40 control patients with two or fewer rehospitalizations ($P=.77$) and 11 intervention patients versus 28 control patients with three or more rehospitalizations ($P<.001$).

Effect Persistence

Although results were similar in direction regardless of time interval examined, the intervention effect declined as the time postintervention increased. Relative differences between groups in index-related (11 vs 35) and comorbidity-related (12 vs 28) rehospitalizations were greatest during the 3 months postdischarge active-intervention period. Additional APN group reductions were observed for index- (11 vs 22) and comorbidity-related (4 vs 13) rehospitalizations in Months 3 through 6, although the incremental benefit of the intervention group was less than in Months 0 through 3. Although preexisting study-group differences were sustained, there were no additional declines between groups in rates of rehospitalization 6 to 12 months postindex hospitalization discharge (index-related, 18 vs 15; comorbidity-related, 7 vs 9).

Cost Analyses

Total and mean costs (reimbursements) per patient were lower in the intervention group than in the control group (Table 4). Mean 52-week total costs adjusted for unequal follow-up were $7,636 for the intervention group, compared with $12,481 for the control group, yielding estimated mean cost savings of $4,845 per patient (nonparametric bootstrapped 95% CI of true difference in mean total costs $8,975.84–$1,301.02; $P=.002$). Although adjusted mean number of and estimated costs for home visits for the 52 weeks after index hospitalization discharge were higher for the intervention group, these increased costs were offset by reductions in heart failure– and comorbidity-related rehospitalizations within the first 6 months post-index hospital discharge.

Quality of Life, Functional Status, and Patient Satisfaction

The intervention group reported greater overall quality of life at 12 weeks ($P<.05$) and in the physical dimension at 2 weeks ($P<.01$) and 12 weeks ($P<.05$) (Table 5). Satisfaction with care was greater in intervention patients at 2 and 6 weeks ($P<.001$) (Table 6). Statistically significant group differences in functional status did not emerge, although less dependency was, on average, observed (Table 7).

DISCUSSION

In this multisite RCT, a comprehensive intervention directed by APNs experienced in the care of older adults and management of heart failure and working in close

Table 6. Patient Satisfaction Comparing Intervention and Control Groups

	Patient Satisfaction Score Category	
	Advanced Practice Nurse	Control
Time Period	n (Mean ± Standard Deviation)	
2 weeks	99 (83.0 ± 10.3*)	97 (74.6 ± 10.4)
6 weeks	92 (83.1 ± 9.6*)	91 (77.8 ± 11.2)

Note: The Patient Satisfaction Score is investigator-developed and -tested instrument with 25 items self-rated on a 0- to 4-point scale with range 44 to 100. Higher scores reflect greater satisfaction.

* Difference between groups: $P<.001$.

Table 7. Functional Status Scores Comparing Intervention and Control Groups

	Total Dependency Category*				Personal Dependency Category†		Social Dependency Category‡	
	APN		Control		APN	Control	APN	Control
Time Period	n	Mean ± SD	n	Mean ± SD	Mean ± SD			
Baseline	117	3.3 ± 1.1	120	3.3 ± 1.1	3.3 ± 1.1	3.4 ± 1.1	3.5 ± 1.1	3.5 ± 1.1
2 weeks	111	3.4 ± 1.2	112	3.3 ± 1.2	3.4 ± 1.2	3.3 ± 1.3	3.6 ± 1.2	3.4 ± 1.2
6 weeks	99	3.4 ± 1.3	109	3.1 ± 1.4	3.4 ± 1.3	3.1 ± 1.4	3.5 ± 1.4	3.2 ± 1.4
12 weeks	97	3.5 ± 1.3	104	3.1 ± 1.4	3.5 ± 1.4	3.2 ± 1.6	3.6 ± 1.4	3.3 ± 1.5
26 weeks	92	3.3 ± 1.3	97	3.0 ± 1.5	3.3 ± 1.6	3.0 ± 1.7	3.6 ± 1.6	3.2 ± 1.7
52 weeks	76	3.1 ± 1.5	71	2.9 ± 1.6	3.0 ± 1.7	2.9 ± 1.9	3.3 ± 1.8	3.0 ± 1.9

Note: The Enforced Social Dependency Scale consists of 12 6-point scales (4 for each capacity). Total scores (range 12–72) and subscores (range 4–24) are computed. Higher scores reflect greater dependency. QoL and function, missing values due to deaths, and hospitalizations were incorporated into transformed ordinal scales. Distributions were compared between groups using Wilcoxon rank sum tests.

* 0 = Died; 1 = Hospitalized; 2 = 1st Quartile Score (> 30); 3 = 2nd Quartile Score (> 23 to ≤ 30); 4 = 3rd Quartile Score (> 17 to ≤ 23); 5 = 4th Quartile Score (≤ 17) highest function.

† 0 = Died; 1 = Hospitalized; 2 = 1st Quartile Score (> 20); 3 = 2nd Quartile Score (> 15 to ≤ 20); 4 = 3rd Quartile Score (> 11 to ≤ 15); 5 = 4th Quartile Score (≤ 11).

‡ 0 = Died; 1 = Hospitalized; 2 = 1st Quartile Score (> 10); 3 = 2nd Quartile Score (> 8 to ≤ 10); 4 = 3rd Quartile Score (> 6 to ≤ 8); 5 = 4th Quartile Score (≤ 6).

APN = advanced practice nurse; SD = standard deviation.

collaboration with patients' physicians increased time to first readmission or death through 1 year postindex hospital discharge, reduced the total number of rehospitalizations, and decreased medical costs of elders hospitalized with both systolic and diastolic heart failure. Overall quality of life and the physical dimension of quality of life were improved at only one (12 weeks) and two (2 and 12 weeks) of the five follow-up points, respectively. Patient satisfaction, assessed only through 6 weeks, was also enhanced.

The study confirms earlier results about the short-term effectiveness of such interventions in improving heart failure–related outcomes in older adults.[9–14] Additionally, this study is the first to demonstrate reductions in rehospitalizations caused by comorbid conditions and reductions in overall hospitalizations and costs of elderly patients hospitalized with both systolic and diastolic heart failure.

Unlike many disease-management interventions, a flexible protocol guided APNs, enabling them to individualize the schedule and content of patient care to manage heart failure, comorbid conditions, and other health and social problems that contribute to poor outcomes. This approach is especially important because exacerbation of coexisting conditions cause 40% of rehospitalizations of elders with heart failure.[6–8] In this study, patients had a mean of six active, comorbid problems. Absolute reductions in rehospitalizations due to heart failure (n = 32) and comorbid conditions (n = 27) were similar. In contrast, earlier reports of nurse-directed interventions designed specifically for older adults resulted in substantial short-term reductions in heart failure readmissions but no significant difference in readmissions for other causes.[13,14]

This intervention did not simply delay hospital readmissions but avoided them, with significant reductions in total readmissions persisting through 52 weeks postindex discharge (9 months postintervention). The greatest reductions in index and comorbidity-related rehospitalizations were observed during the 3-month intervention (23 vs 63). Rehospitalizations were further reduced, but at a lower rate, during the 3 months immediately after to the intervention (15 vs 35). Although previous differences in cumulative rehospitalization rates were sustained beyond 3 months postintervention (study Months 6–12), index- and comorbidity-related rehospitalizations were not further reduced (25 vs 24).

Themes identified in case studies maintained by APNs for all intervention patients suggest that, although many patients demonstrated growth in their ability to manage their health needs, the progressive nature of heart failure and other chronic conditions, severity of resulting symptoms, and elders' increasing frailty (i.e., increased functional or cognitive deficits) may necessitate some level of on-going APN involvement. Thus, an extended intervention may provide additional reductions in rehospitalizations over time, but the incremental benefits and cost-effectiveness of such an intervention need to be rigorously evaluated.

Compared with other reported interventions for the management of heart failure care,[9–12] the protocol employed in this study was unique in that it was directed by APNs; substituted for traditional postdischarge skilled nursing follow-up; and focused on the complex care of older adults coping with heart failure, multiple comorbid conditions, and other risk factors. It appears that its success largely derived from two factors: (1) the continuity of care provided by the same APN who coordinated the patient's hospital discharge plan and implemented it in the patient's home and (2) the use of highly skilled APNs who are prepared to use a holistic approach to address the complex needs of patients and their caregivers and whose skills in collaboration and coordination enable them to navigate an intricate, often disjointed care system to promote continuity of care.

Although assessment of the relative contributions of various intervention components is necessary to optimize cost-effective clinical programs, such evaluation strategies generally fail to capture the synergy achieved by a multidimensional approach and to adequately account for variation between patients in components needed and used. Nonetheless, the absolute and incremental effect of such interventions needs to be assessed by type of heart failure, type of physician-nurse provider team, and case mix. Such studies will require significantly larger sample sizes.

The higher direct costs of the intervention ($115,856 vs $64,531) resulting from the increased mean number of APN home visits relative to routine home care (13.2 vs 6.3 visits), higher salaries commanded by APNs, and involvement of multidisciplinary heart failure experts (limited to their participation in APN training and individual consultation on fewer than 10% of intervention cases) were more than offset by savings from reductions in other home visits ($16,465 vs $22,533), acute care visits to physicians or the emergency department ($6,329 vs $10,819), and hospitalizations ($587,253 vs $1,065,927). The net result was a 37.6% reduction in total costs over the 12-month study period ($725,903 vs $1,163,810, $P<.002$; $6,152 vs $9,618 per person).

In summary, these study findings substantially inform our understanding of patient management strategies needed to improve clinical outcomes for a growing population of elders living longer with multiple, debilitating conditions while reducing overall costs. They suggest the potential benefit of a comprehensive, multidisciplinary, individualized intervention directed by clinical nurse experts that spans the entire episode of acute illness and bridges the transition from hospital to home.

Transitional care programs such as this have typically not been adopted because of lack of Medicare reimbursement, the absence of effective marketing forces, the challenges such care present to the culture of current medical practice, which is characterized by the organization of care into distinct and separate silos (i.e., hospital and home care), and limited meaningful longitudinal integration of physician and nursing care to support patients' needs throughout an acute episode of illness.

Although further research is required to define the relative effectiveness and cost effectiveness of alternative intervention designs and components, to define the optimal length and intensity of interventions, and to further examine the generalizability of findings across a broader spectrum of geographic and care settings, the clinical and economic effectiveness of these interventions support the value of their more widespread use.

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