Identification of factors predictive of hospital readmissions for patients with heart failure

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OBJECTIVE: The objective was to evaluate whether severity of cardiac illness, cognitive functioning, and functional health of older adults with heart failure (HF) and psychosocial factors related to caregiving are predictive of hospital readmissions for those with HF.

DESIGN: A prospective, descriptive, predictive design was used.

SETTING: The study took place in 2 community hospitals in northeastern Ohio.

SAMPLE: Originally 156 patient-caregiver dyads were interviewed within 7 to 10 days of hospital discharge, but only 128 dyads completed the study. Subjects had HF and their mean age was 77.3 years. Their caregivers were mostly women with a mean age of 64.8 years.

RESULTS: Fourty-four percent of the patients were readmitted to the hospital within 3 months. Among patients, severity of illness was moderate, blood pressure was within normal limits, functional and cognitive status were high. For patients, the interaction of severity of cardiac illness and functional status predicted risk of hospital readmission. Among caregivers, depressive symptoms and perceived stress were low; informal social support and caregiving appraisal were high. The interaction of caregiver stress and depression were significant predictors of risk of hospital readmission.

CONCLUSION: Nurses should consistently assess changes in patients' cardiac symptoms in addition to their ability to provide self-care. Since patients with HF are at high risk for readmission, further study is needed to determine whether interventions designed to increase spousal support would decrease hospital readmissions. (Heart Lung® 2003;32:88-99.)

Heart failure (HF) is the most common reason for hospitalization and readmission of individuals over 65 years of age.[1] More than 600,000 hospitalizations in the United States are attributed to HF, costing the patient and health care system over $10 billion per year.[2] During the first 3-month period after discharge, researchers found that approximately 33% to 40% of older adults with HF were rehospitalized.[1,3,4] Many patients and their caregivers are not prepared for the lifestyle adjustments that accompany a chronic illness such as HF, and stress may arise when assistance is needed. Stress may be related to physical, psychological, and social problems that are encountered by the patient and caregiver. Therefore, the purpose of this phase of a longitudinal study was to determine to what extent severity of cardiac illness, cognition, and functional status of patients with a primary diagnosis of HF and caregiver psychosocial factors were predictive of early hospital readmissions.

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Background

A diagnosis of HF is complicated by the complex interplay between aging and physical and psychosocial factors affecting patients and their caregivers. The following review addresses findings about HF patients and their caregivers.

Patient factors

Physical factors affecting older adults with HF include symptoms of shortness of breath, edema, fatigue, chest pain, and complications of other chronic health problems.[5] Risk factors associated with hospital readmissions for HF are ischemic heart disease, severity of illness, low blood pressure, and a previous hospital admission for HF.[6] In a study of a multidisciplinary treatment approach to

patients with HF, systolic blood pressure significantly predicted hospital readmission during a 90-day period.[4]

Increasing age is related to substantial changes in the cardiovascular system, and the prevalence of cognitive impairment increases drastically for those persons over 85 years of age.[5,7] Deficits in cognitive functioning may result from inadequate oxygenation, transient ischemic attacks, atherosclerosis, or even Alzheimer's disease.[8,9] Subtle chronic disturbances in cerebral perfusion secondary to poor cardiac output may have an adverse effect on brain cell metabolism.[10] Persons with cognitive impairment may have difficulty performing activities of daily living which necessitates prompting by a caregiver to participate in self-care. This prompting may increase the amount of burden experienced by the caregiver. Increasing age, cognitive impairment, and a preadmission disability in instrumental activities of daily living (IADLs) have been found to be predictive of functioning in activities of daily living (ADLs).[11] Fethke, Smith, and Johnson[12] reported that the number of diagnoses, chronic conditions, and medications were significant predictors for hospital readmission soon after discharge but declined over time post-discharge.

Caregiver factors

In addition to changes in health, readmission to the hospital may be related to multiple intrapersonal and extrapersonal factors such as caregiver support. In a survey of 178 Medicare-certified home care agencies, stressors related to hospital readmission were acute illness of the patient, lack of caregiver support, and unsuitable home environment.[13] Vinson, Rich, Sperry, and McNamara[14] found that inadequate social support was a contributing factor in 21% of preventable hospital readmissions. Schwarz[15] found that greater use of tangible forms of social support by the caregiver was significantly related to fewer hospital readmissions of patients with chronic illness.

Additional factors that may influence how caregivers cope with the needs of the HF patient include their perceived stress, depressive symptomatology, and negative appraisal of the situation. Increased caregiver stress may negatively affect compliance with medication schedules, and their anxiety may interfere with following patient care instructions. Marchi-Jones, Murphy, and Rousseau[16] reported that as the care recipient's functional status declined, caregiver stress increased with the care recipient's IADL scores most significantly related to caregiver stress. Dissatisfaction with social support, length of time helping, perceived health, and lack of home health care contribute to the stress of caregiving.[15] Furthermore, with chronic stress, depressive symptoms are often experienced by caregivers at a rate as high as 43%.[17]

Depressive symptomatology results when the needs of family caregivers are not met and may influence the caregiver's willingness or ability to care for the older care recipient. The fit between the caregiver's capacity and the ability to meet the needs of the care recipient may determine whether the care recipient can remain at home.[18] A lack of fit would have a detrimental effect on the quality of life for both the caregiver and care recipient. Furthermore, research findings indicate that a caregiver's appraisal of the caregiving role determines whether depressive symptoms arise.[19] A caregiver's appraisal of the situation is influenced by the demands placed on them, the impact on their lifestyle, satisfaction gained from helping others, whether they perceive mastery of problems that arise, and informal social support provided by family and friends.[20] Better psychological health was reported by caregivers who perceived high, stable social support over the course of one year or believed that significant others were willing to provide assistance in the future.[21]

Whereas patients with HF are often scheduled for regular health appointments, their problematic symptoms may show up at any time. Many patients and their families do not recognize these symptoms of progressive HF, deny that a problem exists, or try to take care of the problem by adjusting medications.[14] Because of decreased reimbursement for home care visits, less opportunity exists for teaching in the home, assessment of the care recipient's condition, and assessment of the home environment. These factors may lengthen the person's rehabilitation period, increase the patient and families' distress, and result in more hospital readmissions rather than enhancing self-care. One possible means of maximizing resources to reduce hospital readmissions is a comprehensive evaluation of the physical and cognitive health status of patients and the psychosocial needs of caregivers. In this study, predictors of hospital readmissions were measured within 7 to 10 days of hospital discharge. Therefore, the primary research hypotheses are:

1. Increased patient age, greater severity of cardiac illness, lower blood pressure, reduced cognitive function, and poorer functional sta-

tus will significantly increase the risk of hospital readmission for patients with HF.
2. Increased caregiver age, greater perceived stress, greater depressive symptomatology, negative caregiving appraisal, and poor informal social support will significantly increase the risk of hospital readmission for patients with HF.

METHODS

Design

A prospective, descriptive, predictive design was used to evaluate hospital readmissions for patients with HF, changes in functional status over a 3-month period after hospital discharge, and caregiver stress. This phase of the longitudinal study used data from the first data collection to evaluate a conceptual model composed of factors hypothesized as predictors of hospital readmission during the first 3 months after discharge. The patient's age, gender, physical health status, cognitive status, socioeconomic status, and functional status were assessed. Their caregivers were assessed for age, perceived health status, stress, depressive symptomatology, caregiver appraisal, socioeconomic status, and informal social support.

Sample

The convenience sample included 156 patient-caregiver dyads in northeastern Ohio. For inclusion in the study, the patients were ≥65 years of age, required some assistance with ADLs or IADLs, and were recently hospitalized with a primary diagnosis of HF. The caregivers were family members who lived in the same city as the patient and provided the majority of assistance. To have a more homogeneous sample, patients were excluded who received hospice benefits or received regularly scheduled treatments in the hospital. Because the objective of the study was to evaluate patients' risk of readmission, death was treated as a competing hazard, and patients who were otherwise unable to complete the study were treated as censored in the Cox proportional hazard analysis. Power analysis was originally used for evaluating 2 groups, a one-tailed test of significance, 80% power at $\alpha = 0.05$, and effect size of 0.5.[23] Because Rich et al[4] found a difference of 13.2% in hospital readmissions between the control and treatment groups, a medium effect size was used. Although 100 dyads would be required, 156 dyads were initially interviewed because of known attrition rates of HF patients. Three months later, 128 surviving dyads were re-interviewed, but the day of death for nonsurvivors was known. Nonsurvivorship (censoring) of 18% was because of nursing home placement (n = 5), death (n = 21) and moving from the area (n = 1).

Measures

Dependent variable. The dependent variable was the length of time, in days, between hospital discharge and first unplanned hospital readmission or mortality. Data was collected by chart review and self-report.

Demographic variables.

- Age of the caregivers and patients was measured in years by self-report.
- Medications, comorbidities, and ejection fraction were assessed with chart review.
- Symptomatology and diet were assessed through the patient's self-report.
- Socioeconomic status was reported as financial and educational status. Financial status was scored as "comfortable", "uncomfortable", or "unable to make ends meet." Education was recorded as on a continuum of less than high school to doctoral degree.
- Length of time spent in caregiving was assessed through the caregiver's self-report.
- Perceived health of the caregiver was self-rated as 4 (*excellent*), 3 (*good*), 2 (*fair*), or 1 (*poor*).
- Length of stay in hospital when first identified was assessed with a chart review.
- Use of home health care was recorded at the first interview as a dichotomous variable.

Predictor variables.

Patient variables:

- Severity of cardiac illness, the measure of physical status, was assessed using the New York Heart Classification as a guide.[5] The guide was developed to classify patients for severity of HF symptoms in Class I, II, III, or IV. In this study, these classifications were used to rank-order severity of illness. The patients were questioned about their ability to perform physical activity in relationship to fatigue, dyspnea, palpitations, and chest pain. Scores for each symptom category ranged from 1 to 4 depending on limitation of physical activity. The total score for "severity of cardiac illness" had a possible range of 4 to 16. Higher scores indicated more disease severity. For patients at risk of readmission in this sample, Cronbach α was 0.71.
- Blood pressure measurements were taken by the principal investigator (PI) and research as-

sistant with a standard sphygmomanometer consisting of an adult-sized cuff and an aneroid manometer.

- Cognition, defined as the mental processes by which knowledge is acquired, was assessed with the Mini-Mental State Examination (MMSE).[24] The MMSE requires 5 to 10 minutes to administer and concentrates on the cognitive aspects of mental functioning and excludes questions about mood. The MMSE is divided into 2 sections, the first addressing orientation (0-10), registration (0-3), attention (0-5), and recall (0-3). The second section addresses language skills including naming (0-2), repetition (0-1), 3-stage command (0-3), reading (0-1), writing (0-1), and copying (0-1). Test-retest reliability of the MMSE has been reported as 0.89 and 0.98 in a group of cognitively impaired patients when administered 28 days apart. Concurrent validity has been demonstrated with a significant correlation of 0.78 between MMSE scores and the Weschsler Adult Intelligence Scale.[23] For this study, Cronbach α was 0.84 for orientation, 0.63 for language, and 0.67 for the total score. For patients over 60 years of age, cognitive impairment is defined as a score less than 24.[8]
- Functional status was defined as the ability to perform personal self-care as needed daily. Functional status was measured with 6 items from the Index of ADL[25] and 7 items from the IADL,[26] on a scale of 0 to 2. Combined scores range from 0 to 26 with lower scores indicating fewer limitations in self-care and better functioning.
- In a sample of 334 hospitalized older adults, Lockery, Dunkle, Kart, and Coulton[27] found the reliability for the ADL Index was 0.82. The IADL Index had a high reproducibility coefficient of 0.96 and interrater reliability was 0.87.[26] The ADL Index demonstrated predictive validity by predicting future assistance needs and identifying elderly persons at high and low risk for functional problems.[25,28] Construct validity was supported with a significant correlation between the ADL index and amount of personal assistance required in other studies.[25] Concurrent validity has been demonstrated with a significant correlation between the Langley-Porter Physical Self-Maintenance Scale and the IADL Index.[26] For patients at risk of readmission in this sample, Cronbach α was 0.87 for IADLs, 0.84 for ADLS, and 0.91 for the combined score.

Caregiver variables.

- Perceived Stress, defined as events that threaten available resources,[29] was measured with the Perceived Stress Scale (PSS),[30] which assesses the degree to which situations are appraised as stressful. The PSS consists of 14 items with 7 items reversed scored. Subjects rated items on a 5-point Likert scale from 0 (*never*) to 4 (*very often*), with a possible range of 0 to 56. Lower scores indicated less perceived stress.
- Cohen et al[30] reported Cronbach α as 0.84, 0.85, and 0.86 for 3 samples and short-term, test-retest reliability as 0.85. Concurrent validity was established with a correlation of 0.76 between the PSS and the Center for Epidemiological Studies Depression Scale (CES-D). The PSS demonstrated strong predictive validity in relationship to health outcomes. For caregivers of patients at risk of readmission, Cronbach α was 0.83.
- Depressive symptomatology, defined as a state of sadness or inadequacy in response to stress with feelings of hopelessness, was measured with ratings on the CES-D.[31] The CES-D focuses on distress symptoms prevalent among nonpsychiatric populations during the past week. Subjects rated 20 items on a 4-point Likert scale from 0 (*rarely*) to 3 (*most or all of the time*), with a possible range of 0 to 60. The norm for depressive symptomatology for persons more than 60 years of age is 0 to 15, not depressed; 16 to 20, mild depression; 21 to 30, moderate depression; and $\geq$31, severe depression.[32] Ratings were summed for a total score with some items reverse scored, and higher scores indicated more depressive symptoms. Radloff[31] reported a high Cronbach α of 0.85 in a study of nonpsychiatric adults, and construct validity using the contrasted group approach was supported. Cronbach α for this study was 0.90.
- Caregiving appraisal, defined as the cognitive and affective evaluation and re-evaluation of the potential stressor, was measured with the caregiving satisfaction subscale of the Philadelphia Geriatric Center Caregiving Appraisal Scale.[20] Caregiver satisfaction addresses the uplifts or rewards such as being shown appreciation by the patient. For the satisfaction subscale, subjects rated 5 items on a 5-point Likert scale from 1 (*never*) to 5 (*nearly always*), with a

possible range of 5 to 25. Higher scores indicated a more positive appraisal of caregiving.

- Construct validity was established by finding that increased caregiver satisfaction, resulting from the provision of care, explained a decrease in caregivers' depressive symptoms, and concurrent validity was established by significant correlations between caregiving satisfaction and relationship to the impaired person.[20] Cronbach α for caregiving appraisal was 0.67. Cronbach α for this study was 0.86.
- Informal social support, defined as activities that are provided or anticipated to be provided by families and friends, was measured with the tangible subscale rating from the Modified Inventory of Socially Supportive Behaviors Scale.[33] The tangible subscale reflects instrumental activities such as receiving a loan of money or an object. Subjects rated 9 items on a 4-point Likert scale from 1 (*never*) to 4 (*very often*), with a possible range of 9 to 36. Higher scores indicated more support.
- Evidence of predictive validity was supported with finding that social support buffered the impact of bereavement on depressive symptoms in older adults.[33] A theoretically meaningful 3-factor orthogonal solution supported construct validity, and Cronbach α for tangible informal social support was 0.66.[33] Cronbach α for this study was 0.92.

Procedure

After research proposals were submitted to institutional review boards at the participating university and the institutional review boards at 2 large metropolitan hospitals in northeastern Ohio, permission was granted to conduct the study. Families meeting criteria were identified with the assistance of the clinical nurse specialists on medical and cardiac telemetry floors before hospital discharge of the patient. The PI explained the study briefly to the patient and/or caregiver and gave each a letter explaining the study. If the patient and/or caregiver was interested in participating, the PI obtained their phone number and called soon after discharge for the first interview.

At the first meeting, within 7 to 10 days of hospital discharge, the patients and their caregivers signed consent forms indicating their willingness to participate. The caregivers completed their interview schedule about stress, depressive symptoms, social support and appraisal while the PI administered the cognitive exam to the patient, questioned them about their ADLs, and assessed their blood pressure. At the end of the 3-month data collection period, the families were reinterviewed. Hospital readmissions for the 3-month period and the number of days from hospital discharge to first readmission were verified by the PI with a chart review.

Estimation method. The analysis of hospital readmission over the 3-month interval posed 2 major problems: the follow-up interview could occur just before a hospital readmission, so persons at high risk of readmission would be misclassified (censored), and individuals diagnosed with heart disease were at risk of mortality as well as readmission (competing risks). Therefore, we used Cox proportional hazard models to accommodate the censoring of information and account for the competing risk.[22] The analysis allowed 2 types of events to occur following the first hospital discharge interview: a hospital readmission or a mortality transition. The 2 hazard models were estimated separately. The timing of failure for each of these events was conditional on the other event not occurring, and was hypothesized to reflect the aforementioned sets of variables (patient and caregiver characteristics and before home care use). For each outcome, observations were treated as censored if the event did not occur by reinterview or if a competing event occurred. Patients lost to moves or to long-term care were treated as right censored in both models; their tiny numbers did not allow separate analyses.

The Cox model, a partial likelihood model, differentiates functions of time (not parameterized) and predictors (covariates), and the procedure discards the information pertaining to time and a small amount of the information pertaining to the covariates but returns unbiased coefficients. The reported estimates are the (conditional) hazard of an event for a person relative to others in the sample. This method assumes that the odds of an event are proportional for each subgroup and that the odds remain constant over time (for example, that readmission is twice as likely to occur for one group vs another over the time period); empirical tests for assumption violations are reported in this article. The regression estimates were obtained from the PHREG procedure, using SAS software[22].

Descriptive Results

Sample characteristics. For demographic characteristics, the patients who survived in the commu-

Table I
Description of patient/caregiver dyads at risk of readmission versus mortality (n = 149*)

Variable	Characteristics of sample dyads at risk of hospital readmission (n = 128)		Characteristics of sample dyads censored due to mortality (n = 21)	
	Patients No. (%)	Caregivers No. (%)	Patients No. (%)	Caregivers No. (%)
Age (y)				
<30	-	2 (1.6)	-	0 (0)
31-45	-	14 (10.9)	-	2 (9.5)
46-60	-	25 (19.5)	-	2 (9.5)
61-75	48 (37.5)	55 (43)	7 (33.3)	10 (47.6)
76-92	80 (62.5)	37 (28.9)	14 (66.7)	8 (38.1)
Sex				
Women	64 (50.0)	95 (74.2)	8 (38.1)	14 (66.7)
Men	64 (50.0)	33 (25.8)	13 (61.9)	7 (33.3)
Race				
White	114 (89.1)	114 (89.1)	17 (81.0)	17 (81.0)
Black	13 (10.1)	13 (10.1)	2 (9.5)	2 (9.5)
Asian	1 (0.8)	1 (0.8)	1 (4.7)	1 (4.8)
Other			1 (4.7)	1 (4.7)
Marital status				
Single	2 (1.6)	9 (7.0)	0 (0.0)	0 (0.0)
Married	86 (67.2)	107 (83.6)	16 (76.2)	18 (85.7)
Divorced	5 (3.9)	10 (7.8)	0 (0.0)	2 (9.5)
Widowed	35 (27.3)	2 (1.6)	5 (23.8)	1 (4.8)
Relationship				
Spouse	79 (61.7)	79 (61.7)	13 (61.9)	13 (61.9)
Child	35 (27.3)	35 (27.3)	6 (28.6)	6 (28.6)
Daughter in law	2 (1.6)	2 (1.6)	0 (0.0)	0 (0.0)
Other relative	12 (9.4)	12 (9.4)	2 (9.5)	2 (9.5)
Education				
Less than high school	55 (43.0)	25 (19.5)	9 (42.9)	4 (19.0)
High school graduate	47 (36.7)	54 (42.3)	6 (28.6)	12 (57.1)
Some college	8 (6.3)	19 (14.8)	4 (19.0)	3 (14.3)
College	18 (14.0)	30 (23.4)	1 (4.8)	2 (9.6)
Perceived health				
Excellent	5 (3.9)	27 (21.1)	1 (4.8)	5 (23.8)
Good	40 (31.2)	61 (47.7)	4 (19.0)	10 (47.6)
Fair	54 (42.2)	5 (28.1)	6 (28.6)	5 (23.8)
Poor	29 (22.7)	1 (3.1)	10 (47.6)	1 (4.8)

*Seven dyads censored for reasons other than mortality not included.

nity to finish the study (n = 128) were not significantly different from those who did not. However, they had better cognition (t = 3.13, P = .00), and had better functional status (t = −3.87, P = .00) than those who did not finish the study (n = 28). Table I reports the characteristics of persons who were not treated as censored because of mortality or dropout. Their average age was 77.3 (± 6.1), range 65 to 92 years. These patients were equally divided with 64 men and 64 women in the sample. The majority were white (89%), were married (67%), had at least a high school education (57%), were retired (88%), and were comfortable in making ends meet (79%).

Table II
Patient/caregiver characteristics: Nonreadmission (n = 71) versus readmission (n = 57) in subsample at risk of hospital readmission

Variable	Not readmitted (n = 71)	Readmitted (n = 57)	*P*
Patient			
Age	77.79 (± 6.3)	76.79 (± 5.9)	.75
Severity of cardiac illness	7.85 (± 3.1)	7.40 (± 2.8)	.25
Systolic pressure	127.38 (± 23.4)	127.07 (± 22.1)	.70
Diastolic pressure	67.31 (± 10.9)	65.68 (± 9.3)	.80
Cognition	26.90 (± 4.8)	26.19 (± 3.9)	.72
Functional status	8.21 (± 6.3)	8.84 (± 5.8)	.51
Number of heart medications	4.56 (± 1.7)	4.68 (± 1.7)	.77
Caregiver			
Age	65.49 (± 14.48)	63.88 (± 14.8)	.52
Perceived stress	16.75 (± 9.2)	16.18 (± 8.3)	.55
Depressive symptoms	11.86 (± 9.1)	10.87 (± 8.5)	.86
Caregiving appraisal	21.41 (± 4.0)	21.51 (± 3.5)	.65
Informal social support	25.75 (± 8.7)	25.54 (± 8.3)	.44

None of the variables significantly differs.

Characteristics of Risk Set for Hospital Readmission Among Community Survivors

Patient. Fifty-six (44%) of the patients at risk of readmission were readmitted to the hospital within a 3-month period. For those readmitted to the hospital, the mean number of days between admissions within 7 to 10 days after discharge and 3 months after discharge was 35.57 (± 26.7), range 1 to 90.

The average number of readmissions during the 3-month period of data collection was 0.66 (± 0.90), range 1 to 4. The average length of stay for the hospital admission in which these subjects were initially identified was 5.45 (± 3.62), range 1 to 22 days. In addition, those patients who were readmitted to the hospital (n = 57) did not differ significantly from those patients who were not readmitted (n = 71) for the study variables (see Table II).

The patients were prescribed an average of 5 (± 1.7) cardiac medications ranging from 0 to 8. Twenty-eight (22%) were prescribed medication for depression and seven (5%) were prescribed medication for anxiety. The patients reported having multiple comorbidities (see Table III): diabetes (42%), hypertension (33%), arteriosclerotic heart disease (30%), history of myocardial infarction (25%), history of bypass surgery (24%), stroke (14%), chronic obstructive pulmonary disease (13%), renal disease (7%), history of cancer (6%), or atrial fibrillation (4%). A chart review indicated that ejection fraction ranged from 15% to 60% with a mean of 36% (n = 47). Upon patient response to questions about the severity of their cardiac illness according to the New York Heart Classification, they were grouped as follows: Class I (n = 19), Class II (n = 35), Class III (n = 31), and Class IV (n = 43). In the assessment

Table III
Comorbidities of 128 patients with heart failure

Comorbidities	n	%
Diabetes	54	42
Hypertension	42	33
Ateriosclerotic heart disease	38	30
History of myocardial infarction	32	25
History of bypass surgery	31	24
Stroke	18	14
Chronic obstructive pulmonary disease	17	13
Renal disease	9	7
History of cancer	8	6
Atrial fibrillation	5	4

of severity of cardiac illness, of those patients (n = 56) who were readmitted, 36 (64%) complained of some degree of shortness of breath at the first interview, and 45 (80%) had some degree of fatigue. In addition, of those patients readmitted, 15 (27%) complained of heart palpitations and 9 (16%) complained of chest pain.

Furthermore, the patients were questioned about increased edema, cough, and weight gain post hospital discharge. Fifty-nine (46.1%) reported increased edema in their lower extremities, 46 (36%) experienced a cough on a regular basis and only 19 (14.8%) noticed any weight gain. Although 109 (85%) of the patients were prescribed a low salt diet, only 82 (64%) of these reported following the diet daily. Ninety-nine per cent of the patients reported taking their medications as prescribed. Sixty-nine (54%) of the subjects had home care at the first interview.

See Table II for comparison of means for study variables for readmission versus non-readmission. For the total sample, severity of cardiac illness was moderate with a mean of 7.62 (± 2.9). Systolic blood pressure was within normal limits with a mean of 127 (± 22.75), range 84 to 190 mm, and diastolic blood pressure was within normal limits with a mean of 66.6 (± 10.2), range 40 to 100 mm. Ninety-eight of the patients (76.6%) had systolic pressure that was equal to 140 mm or less, and 120 patients (93.7%) had diastolic pressures 90 mm or less. Cognitive assessment scores had a mean of 26.6 (± 4.43), range 2 to 30. Eighty-one percent of the patients scored >24 on the MMSE indicating that overall cognitive function in this sample was good. Functional status scores for the total sample had a mean of 8.4 (± 6.1) indicating minimal impairment in providing self-care.

Caregiver. The average age for the caregivers was 64.8 (± 14.6), range 16 to 86. The majority of the caregivers were women (74%), were white (89%), were spouses (62%), were married (84%), and had a least a high school education (80%). Although all of the caregivers did not live with the patients, they reported that they had been helping the patient for an average of 4.3 (± 5.7) years and averaged 10.2 (± 8.8) hours per day helping with IADLs or ADLs. The majority were financially comfortable (79%), somewhat satisfied with help from family and friends (43%), reported good health (48%), and had no physical problems helping the patient (74%). The caregivers who finished the study (n = 128) did not significantly differ on the study variables from those who did not finish the study (n = 28).

See Table II for comparison of means for study variables for readmission versus non-readmission. For the total sample, perceived stress was low with a mean of 16.5 (± 8.8). Depressive symptoms were low with a mean of 11.4 (± 8.8), range 3 to 46. Seventy-nine percent of the caregivers scored <16 on the CES-D indicating only a minority (21%) of caregivers reported depressive symptomatology. Caregiving appraisal was high with a mean of 21.5 (± 3.8), and informal social support was high with a mean of 25.7 (± 8.5).

Test of the Hypotheses

The results of the proportional hazard regression models partially supported the study hypotheses. See Model 1 in Table IV for the results for hospital readmissions. The interaction of greater severity of cardiac illness and greater functional impairment increased the risk of hospital readmission for patients with HF. However, the significant interaction of these 2 variables suggests that their influence on patient outcomes was not wholly independent. Increased caregiver informal social support significantly reduced the risk of hospital readmission for patients with HF (see Table IV). Although caregiver depression decreased the risk for hospital readmission, the interaction of stress and depression increased the risk for readmission ($P < .05$). Patient age, caregiver age (dummy as well as continuous polynomial indicators were nonsignificant); patient financial status and cognitive status, caregiver education and perceived health; or home health care did not significantly predict readmission. Other nonsignificant predictors included race, number of medications, number of previous hospitalizations, and caregiver relationship to patient (not shown; available on request).

Interactions of patient gender, patient age, patient cognitive status, patient functional status, caregiver age, informal social support, caregiver stress, and caregiver appraisal were tested in groups with all other model variables and were deleted in groups because of nonsignificance. Two separate groups of interactions pertaining to patient severity of cardiac illness and all of the other variables in the model, and to caregiver depression and all of the other variables in the model, significantly improved model fit in single clusters. When both clusters were added to the equation, the deletion of all of the interactions in both groups, with the exception of patient functional status, severity of cardiac illness, and caregiver stress and depression, did not lead to a deterioration of fit. Although greater severity of cardiac illness and greater functional impairment predicted higher hospitalization risk, the risk of hos-

Table IV
Cox proportional hazard models, competing outcomes: hospitalization, mortality

	Hazard of hospital admission			Hazard of mortality		
		95% Confidence Interval			95% Confidence Interval	
	Hazard Ratio	Low	High	Hazard Ratio	Low	High
Patient Characteristics at Baseline						
Age	0.971	0.924	1.021	0.994	0.884	1.117
Male	1.231	0.641	2.361	5.629*	1.320	23.993
Severity of illness	1.349*	1.010	1.803	0.611	0.360	1.038
Systolic	1.002	0.987	1.018	0.991	0.950	1.035
Diastolic Pressure	0.956*	0.915	0.998	0.901*	0.822	0.987
Cognition	0.977	0.884	1.080	0.896	0.759	1.057
Functional Status	1.388‡	1.153	1.670	0.866	0.629	1.193
High School Graduate	0.510	0.255	1.020	0.580	0.098	3.426
Functional Status*Severity of Cardiac Illness	0.962†	0.939	0.986	1.027*	1.000	1.056
Caregiver Characteristics at Baseline						
Age	1.013	0.991	1.037	1.020	0.969	1.074
Informal Social Support	0.933†	0.889	0.981	0.998	0.898	1.110
Stress	0.979	0.921	1.039	1.163*	1.022	1.322
Depression	0.882*	0.778	0.999	0.533†	0.355	0.799
Appraisal	0.996	0.919	1.080	1.075	0.874	1.323
High School Graduate	1.239	0.597	2.574	0.451	0.063	3.200
Poor/Fair Perceived Health	0.681	0.307	1.513	0.483	0.081	2.874
Stress*Depression	1.005*	1.001	1.008	1.01†	1.006	1.027
Health Care Utilization at Baseline						
Home Health Care Use	0.580	0.196	1.717	2.995	0.171	52.295
Non-Proportional Hazard Parameters						
Home Health Care*Time	1.039*	1.011	1.068	0.979	0.900	1.016
Functional Status*Time	0.997†	0.995	0.999	1.008*	1.000	1.066
Survival time 75th percentile	74 days	60	90	-	-	
(Kaplan-Meier 50th percentile	36 days	30	60	-	-	-
Statistics) 25th percentile	16 days	14	30	43 days	21	63
Model-2 Log likelihood	369.890			93.6		
Model Chi Square	40.08†			56.29‡		
df	20			20		

*$P < .05$ †$P < .01$ ‡$P < .001$

pital readmission significantly declined if the patient had poorer cardiac status and poorer functional status.

It is important to understand the results of the readmission equation in the context of a competing risk for patients' mortality. Model 2 in Table IV elucidates the relationship between patient functional status, severity of cardiac illness, mortality, and readmission. The interaction of poor severity of cardiac illness and poor functional status significantly increased the hazard of mortality and reduced the risk of hospital readmission. However, the risk of patient readmission and of patient mortality was significantly higher when caregivers experienced higher depression and higher stress levels at the baseline interview (Models 1 and 2).

A test for the proportionality of risk (hazard) over time found that the assumption should be rejected.

The risk of readmission increased over time for patients in this study who used home health care at baseline. The risks of readmission decreased and of mortality increased for those with poorer functional status. However, the inclusion of these effects in the final model adjusts for the nonproportionality assumptions; coefficients are unbiased. Log Likelihood tests of Model fit show that the theoretically important variables contained in Models 1 and 2 significantly improve model fit as compared to respective intercept-only models. Also, χ^2 tests show that different models are required to parameterize readmission and mortality risks (LR 94.20, 20 df; the sum of the −2 Log Likelihoods in Table IV are subtracted from an all-types-combined −2 Log Likelihood of 558.69). The median hospital readmission time for the sample was 36 days, with a 95% confidence interval of 30 to 60 days. Less than half of the sample died in the 3-month interval; the probability of an individual dying in less than 43 days was less than .25.

DISCUSSION

Consistent with the findings of other researchers,[1,3,4] 44% of the patients were rehospitalized during the 3-month period. Among patients who were readmitted to the hospital, 64% complained of shortness of breath and 80% complained of fatigue at the first interview. Anecdotal data indicated that another cause of readmission was exacerbation of multiple chronic health problems.

Data immediately post hospital discharge were used for hypotheses testing. Results of hypotheses testing indicated that patient's severity of cardiac illness and functional health status and caregiver pyschosocial and informal support factors influence hospital readmission during 3 months post hospital discharge. Because only 46% reported increased edema and only 15% noticed any weight gain, this sample of patients was not exhibiting signs of fluid overload at the time of the first interview. Factors that measure a patient's change in condition, rather than a measure of the absolute level of the patient's status, may be even better predictors of hospital readmission.[12]

Since many chronically ill older adults who are impaired in ADLs and IADLs reside in nursing homes, functional status was high for this sample of community dwelling elderly. Functional status and severity of cardiac illness appear to have been accurate indicators of health in spite of reliance on patient and/or self-report of functioning. Whereas some findings indicate that older adults overestimate their health, other studies have suggested an underestimation of perceived health problems by certain older adults.[34]

Although Cacciatore et al[8] found that the risk of cognitive impairment was 1.96 times greater for persons with HF when certain factors were controlled, the cognitive status of patients in this sample was high and did not predict hospital readmissions. Possibly, the MMSE was not the appropriate tool to assess cognition in this sample of patients since it measures dementia rather than subtle cognitive impairment. Another measure of cognitive function, such as the Neurobehavioral Cognitive Status Exam[35] that assesses multiple domains of cognitive functioning or the Clock Drawing Test that requires comprehension of time concepts and constructional and visuospatial skills, could be used.[36] Contrary to the findings of Rich et al,[4] systolic blood pressure was not a significant predictor of hospital readmission. A possible reason for this finding is that Rich et al's[4] sampling criteria included patients in which HF was either precipitated by an acute myocardial infarction or systolic blood pressure ≥200 mm Hg. Patients sampled in this study did not meet this criteria and were assessed soon after hospital discharge when their blood pressure was stabilized.

Caregiver age, stress, depressive symptomatology, informal social support, and appraisal have rarely been studied in relationship to hospital readmissions. The caregivers sampled reported a moderate amount of stress, low depressive symptoms, and positive caregiving appraisal. Although less than half of the caregivers were satisfied with help from family and friends, their informal social support was high in this study, and this high level of support reduced the risk of hospital readmission. In addition, combined high levels of stress and depression among caregivers in this study increased the risk of hospital readmission. These findings are consistent with those of others who found that less tangible forms of social support such as money or health care equipment predicted hospital readmission.[15] Furthermore, these findings, that patients' poor cardiac and functional health status precipitates readmissions, are consistent with those of Beach[37] who found that caregivers considered hospitalization of family members when they were no longer physically able to handle the responsibility of providing care. The results of the study may also be influenced by the patient's motivation to comply with the medical regimen and the amount and quality of home care.[38] The assessment of perceived

stress is highly subjective, and varies according to daily demands on the caregiver.

Limitations

Many of the limitations of the study resulted from sampling that could affect generalizability of the findings. Refusal to participate was not recorded. Anecdotally, refusals were due to caregivers' feelings of stress and being overwhelmed, and some patients avoiding interruption of their schedules by another visit from a nurse. Nonsampling bias and self-selection occurred from patient/caregiver refusal to participate in the study and inability to contact the caregivers after patient discharge. Many patients with HF were not included in the study because they were evaluated on an outpatient basis or were routinely hospitalized for intravenous medications such as dobutamine.

Limitations of the study may also be related to measurement issues. The measurement of severity of cardiac illness may not have been completely accurate because of reliance on patient report. The low sensitivity of the MMSE for mild cognitive deficits may have affected its ability to predict hospital readmissions. Socioeconomic status could have included more specific information about monthly income and health insurance.

CONCLUSION

The readmission rate for patients with HF remains high and the majority of variables measured in this study were not significant predictors of hospital readmissions. However, key predictors that did predict readmission were the interaction of severity of patient cardiac illness and functional status, interaction of caregiver depression and stress, and caregiver informal social support. The mechanisms underlying patient health status deserve further study. Because physical and psychosocial factors appear to affect readmission independently, whereas others are interactive, nurses need to assess changes in patients' ability to provide self-care in addition to changes in their cardiac status. Nurses should assess the caregivers' ability to psychologically cope with this progressive illness and continue to offer resources that could moderate their stress and depressive symptoms.

Although these patients reported a fairly high compliance with their low sodium diets and took medications as prescribed, dietary compliance is a daily challenge and a tendency to please the researcher may have existed. Researchers have found that contributing factors for readmission are excessive sodium retention leading to fluid volume overload and not adhering to prescribed medication regimen.[39] Future studies should comprehensively address diet restrictions and how to improve medication compliance. Patients and their families could be followed with phone interviews at more frequent intervals post hospital discharge to assess the patient's dietary intake.

The patient's socioeconomic status could have affected the probability of hospital readmissions. Fethke et al[12] found a positive relationship between high income and the probability of readmission at 6 weeks, but the probability of readmission was higher for patients with low income after one year. Although socioeconomic status was not significant in the analysis, further studies of hospital readmission of patients with HF could examine both income and available insurance.

As healthcare costs increase and funding for follow-up by home care nurses decreases, it is important for researchers to continue to evaluate predictors of readmissions of patients with HF. Although this study did not suggest that certain patient and caregiver factors were related to hospital readmissions, others may be worthy of further study. Secondary data analysis could compare differences between subjects in the various New York Heart Classifications.

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