Original Paper

The Relationship of Medication Regimen to Hospital Readmissions for Older Adults With Heart Failure

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The purpose of this part of a longitudinal study was to examine whether medication therapy for older adults with heart failure predicted days to readmission post-hospital discharge. Using a prospective, predictive design, a convenience sample included 127 older adults with heart failure who had been recently discharged from two hospitals in northeastern Ohio. One hundred five patients were prescribed diuretics, 49 angiotensin-converting enzyme inhibitors, 23 β blockers, and 47 digoxin. There were no significant differences between readmitted and nonreadmitted patients with regard to the use of the specific classes of cardiac medications. None of the specific classes of cardiac medications predicted the number of days between the initial hospital discharge and readmission 3 months later. The use of a small, non-probability sample and exclusion of variables limit the results of the study. Effective case management with teaching about heart failure must address changes involved with heart failure and the use of medication therapy. More research is needed about treatment protocols in various regions of the United States. (Prog Cardiovasc Nurs. 2004;19:141–148)

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Heart failure (HF) is a clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill with or eject blood.[1] HF remains a clinically challenging illness with increasing incidence and prevalence and a high risk of mortality from progressive muscle dysfunction.[2] At present, approximately 4.6 million people are living with HF; approximately 550,000 new cases of the disease occur each year.[3] Mortality reports estimate 260,000 deaths annually are related to HF with a 5-year mortality rate of approximately 50%.[2] The total expenditures for HF hospitalizations alone exceeds $23 billion annually.[4]

HF management consists of treatment by specific classes of medications[1]; however, researchers have demonstrated that the recommended guidelines for use of cardiac medications are underutilized.[5] Although repetitive hospitalizations are a major problem for patients with HF,[6] research about the relationship between medications for HF and hospital readmissions remains very limited. The purpose of the study was to examine whether medication therapy for older adults with HF predicted days to readmission post-hospital discharge.

PHYSIOLOGY OF HF

HF is a pathophysiological state wherein the heart is unable to pump blood and oxygen at a rate commensurate with the body's metabolic demands.[7] The body will respond to the increased adrenergic (sympathetic) tone by increasing heart rate and contractility to augment a compromised cardiac output, as well as increased vasoconstriction to preserve perfusion and blood pressure (BP). The glomerular filtration rate will decrease, causing the retention of sodium and water

with activation of the renin-angiotensin-aldosterone system (RAAS). Activation of the RAAS also leads directly to increased systemic vascular resistance to preserve the perfusion of vital organs.[7] Patients with HF have systolic and/or diastolic dysfunction characterized by low cardiac output, increased filling pressures, and decreased exercise capacity.[8] Although patients with low cardiac output may be asymptomatic,[7] those with preserved left ventricular systolic function may exhibit clinical symptoms such as fatigue, shortness of breath, and peripheral edema. Treatment for HF consists of an exercise and activity regimen, dietary modifications, and a specific medication plan. Therefore, the ultimate goal of therapy is to: 1) minimize or eliminate the underlying cause of HF; 2) decrease volume in the ventricles at end diastole and decrease the resistance the ventricle pumps against to reduce the heart's workload; and 3) increase contractility.[8]

STANDARD MEDICATION THERAPY

The recommended therapeutic medication regimen includes treatment with diuretics, angiotensin-converting enzyme (ACE) inhibitors, β blockers and digoxin.[1] Large-scale clinical trials have supported that even if patients have responded favorably to diuretics, physicians should initiate treatment with ACE inhibitors and β blockers in patients who can tolerate them. Treatment with digoxin can be initiated to reduce symptoms and enhance exercise tolerance.[1]

Diuretics have been used to provide symptomatic relief from fluid overload and congestion associated with HF.[9] Diuretics can decrease circulating blood volume or preload to reduce venous congestion and improve the contractility of the failing heart.[7,9] Researchers have shown that: 1) diuretics produce symptomatic benefits more rapidly than any other drug for HF; 2) diuretics are the only drugs used for the treatment of HF that can adequately control fluid retention; 3) diuretics should not be used alone and should be combined with digoxin, an ACE inhibitor, and a β blocker; and 4) inappropriately low doses of diuretics will cause fluid retention, which can diminish the response to ACE inhibitors and increase the risk of treatment with β blockers.[1] However, long-term therapy with diuretics does not decrease mortality.[7]

ACE inhibitors reduce systemic vascular resistance, arterial pressure, and cardiac work and increase cardiac output.[9] ACE inhibitors aim to counteract neurohormonal activation through inhibition of the RAAS by blocking the ACE enzyme, decreasing angiotensin II-mediated vasoconstriction, and inhibiting the cardiac and vascular remodeling process.[3] Researchers reported that ACE inhibitors significantly decreased total overall mortality by 10%–30% and cardiovascular mortality by an even greater margin for patients with HF.[10]

The use of β blockers is based on the theory that blocking the maladaptive increase in adrenergic tone can be beneficial.[3] Studies have shown that adding β blockers in combination with ACE inhibitors can improve left ventricular function and survival rates in patients with HF due to either idiopathic or ischemic cardiomyopathy.[3,11] However, physicians should ensure that patients are not volume overloaded before a β blocker is initiated due to the risk of fluid retention with certain HF therapies.[1]

Digoxin may be used to reduce symptoms in patients who remain symptomatic despite receiving treatment with adequate doses of ACE inhibitors, β blockers, and diuretics.[1,12] However, digoxin should not be used to treat congestive HF patients with normal ventricular ejection fractions. Digoxin reduces a rapid ventricular rate associated with supraventricular tachyarrhythmia.[9] Digoxin exerts its effects in patients with HF by its ability to inhibit sodium-potassium adenosine triphosphate. Inhibition of this enzyme in cardiac cells results in an increase in the contractile state of the heart. For many decades, the benefits of digoxin in HF were ascribed exclusively to this positive inotropic action.[1] However, recent evidence suggests that digoxin inhibits certain enzymes in noncardiac tissues.

Recent studies have also demonstrated the benefits of adding other drug regimens to the standard therapy for treatment of HF.[1] Isosorbide dinitrate and hydralazine were initially combined because of their complementary dilating actions on peripheral blood vessels and are thought to also act at a biochemical and genetic level.[13] However, the use of hydralazine and isosorbide dinitrate frequently produced adverse reactions, and patients could not continue with treatment.[1] Angiotensin receptor blockers interfere with the renin-angiotensin system, however, trials showed better survival for patients treated with an ACE inhibitor than those treated with an angiotensin receptor blocker.[1,14] Other regimens suggest the use of aldosterone antagonists (spironolactone) or IV inotropic agents (milrinone) for patients with end-stage HF. The addition of spironolactone with ACE inhibitors reduced the risk of death and hospitalization, however, adverse reactions included hyperkalemia and gynecomastia in men.[15]

RELATIONSHIP OF PATIENT HEALTH TO PRESCRIBED MEDICATION REGIMEN

As persons age >65 years, the incidence and prevalence of HF increases dramatically.[4,6] A diagnosis of diabetes increases the likelihood of HF in patients without structural heart disease[1]; patients with atherosclerotic disease, which often accompanies aging and hypertension, are more likely to develop HF.[1] The New York Heart Association (NYHA) classification system has been widely used to quantify the degree

of limitations associated with HF and interventions needed to prevent or treat HF. Healthcare professionals use primary prevention strategies such as diuretics,[9] diabetic medications, and education to begin to treat poorly controlled hypertension and diabetes.[4] Secondary prevention strategies, such as the use of ACE inhibitors and β blockers, are used to manage those patients with a history of myocardial infarction and valvular heart disease who are more likely to be readmitted to the hospital.[6] Tertiary prevention includes the addition of digoxin and intensive home monitoring with home healthcare nursing.[4]

RELATIONSHIP OF TREATMENT TO HOSPITAL READMISSIONS

Researchers have reported variations in how medications for HF are prescribed and that these medications are often underprescribed.[16-19] Michalsen, Konig, and Thimme[18] found that ACE inhibitors were underused; nearly 20% of patients did not receive a diuretic, and only 7% received a β blocker. De Geest et al.[17] reported that 77% of patients on a geriatric ward received ACE inhibitors as compared with 100% on a cardiology floor. Diuretics were prescribed significantly more to geriatric patients, β blockers were significantly prescribed more often to patients admitted to cardiology, and digitalis was equally prescribed between the two groups. Tsuchihashi et al.[19] reported that at hospital discharge, diuretics were administered to 77% of the patients, ACE inhibitors to 54%, β blockers to 18%, and digoxin to 52%.

Patients with HF are frequently readmitted to the hospital because of exacerbation of their symptoms. The 3–6 month readmission rate is reported to be as high as 30%–50%.[6,19] Researchers found associations between advanced age, prior hospital admission, the severity of illness and medical comorbidity, and hospital readmission.[19] Additional predictors for exacerbation of HF and the need for readmission include uncontrolled hypertension, noncompliance with treatment regimen, and inadequate treatment before hospital admission.[18,20] According to Michalsen et al.,[18] 54.2% of hospital admissions could be regarded as preventable with how medications are prescribed as a precipitating factor. McDonald et al.[21] and Jong et al.[22] found that readmission for HF was lower for cardiologists as compared with family practitioners,[22] however, Foody et al.[23] found in a very large nationwide study of HF patients (n=25,869) that only 43% of patients were treated by a cardiologist during a hospitalization and 25% had a cardiologist as their attending physician.

Research about the association between HF medications and hospital readmissions is very limited. McDonald et al.[21] reported that the routine use of a high dose of ACE inhibitors before hospital discharge eliminated hospital readmission for a group of 70 patients with systolic dysfunction 1 month post-hospital discharge. Tsuchihashi et al.[19] found that there were no significant differences between those patients readmitted and not readmitted with regard to the specific classes of cardiac medications, however, they did not examine whether these classes of drugs predicted hospital readmissions. This segment of a longitudinal study about predictors of hospital readmissions for patients with HF addressed the following hypothesis: Specific classes of heart medications will predict days to readmission post-hospital discharge.

METHODS

Design

A prospective, predictive design was used to evaluate hospital readmissions for patients with HF. Data was used from a longitudinal study that evaluated predictors of hospital readmissions for patients with HF.[24]

Sample

The convenience sample included 127 patients living in rural and urban areas of northeastern Ohio. For inclusion in the study, the patients were ≥65 years of age, required some assistance from caregivers with activities of daily living or instrumental activities of daily living, and were recently hospitalized with a primary diagnosis of systolic HF. To have a more homogeneous sample, patients were excluded who received hospice benefits or received regularly scheduled treatments in the hospital.

Measures

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

The demographic and predictor variables included:

- *Age* was measured in years by self-report.
- *Perceived health* of the patient was rated by the caregivers as 4 “excellent,” 3 “good,” 2 “fair,” or 1 “poor.”
- *Medication and comorbidities* were assessed by chart review. The principal investigator (PI) was interested in the prescribed medical regimen including diuretics, ACE inhibitors, β blockers, and digoxin.
- *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 a doctoral degree.
- *Use of home health care* was recorded at the first interview as a dichotomous variable.
- *BP* measurements were taken by the PI or the research assistant with a standard sphygmomanometer consisting of an adult-sized cuff and an aneroid manometer.

- *Severity of cardiac illness* was assessed using the NYHA as a guide.[25,26] A questionnaire was developed for this study using the classifications to rank-order functional limitations from HF that also may signify 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 category range from 1–4. The total score for "severity of illness" had a possible range of 4–16. Higher scores indicated a more severe form of HF. Bennet et al.[26] reported that the NYHA is a valid measure of functional status for HF. For this sample, Cronbach's α was 0.71.
- *Length of stay in hospital* when first identified was assessed by chart review.

PROCEDURE

The institutional review boards at the participating university and two hospitals in northeastern Ohio granted permission to conduct the study. Patients meeting the criteria were identified with the assistance of the clinical nurse specialists on medical and cardiac telemetry floors before hospital discharge. The PI explained the study briefly to the patient at the hospital and gave a letter explaining the study. If patients were interested in participating, the PI obtained their phone numbers and called soon after discharge for the first interview in their homes.

At the first meeting, within 7–10 days of hospital discharge, the patients signed consent forms indicating their willingness to participate. At the end of the 3-month data collection period, the patients were reinterviewed in their homes. Hospital readmissions for the 3-month period and the number of days from hospital discharge to readmission were verified by the PI with a chart review.

DESCRIPTIVE RESULTS

Sample Characteristics

One hundred fifty-six subjects participated in the initial interview, however, an attrition rate of 18% was due to mortality (n=21), nursing home placement (n=5), missing data about medications (n=2), and relocation (n=1). The medications (diuretics, ACE inhibitors, β blockers, and digoxin) prescribed for the patients who finished the study did not differ significantly from those who died or who required nursing home placement. Those patients who died were significantly older than those who finished the study (t=2.5, p=0.01,) but severity of illness was not significantly different. Age and severity of illness did not differ significantly between those participants who required nursing home placement and those who finished the study.

The average age of the 127 patients who finished the study was 77.3 (±6.1), range 65–92 years. These patients were almost equally divided with 64 men and 63 women in the sample. The majority were white (89%), married (67%), had at least a high school education (57%), were retired (88%), and reported that their income was sufficient for their needs or daily life (79%). Forty-two percent of the caregivers reported the patients' health as fair. See Table I for demographic characteristics about these patients and whether they were readmitted to the hospital based upon these characteristics. With the Mann-Whitney U test, formal education was the only significant characteristic in relationship to hospital readmission. Patients with more formal education had fewer hospital readmissions (m place=53.75, U=1414.000, p<0.01).

The patients reported having multiple comorbidities: diabetes (42%), hypertension (33%), arteriosclerosis (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%). Systolic BP ranged from 84–190 mm Hg with a mean within normal limits of 127 mm Hg (±22.64), and diastolic BP ranged from 40–100 mm Hg, with a mean within normal limits of 66.7 mm Hg (±10.2). Severity of cardiac illness was moderate, with a score ranging from 3–16, mean of 7.6 (±2.96).

According to responses about severity of illness, the patients were grouped according to the NYHA as follows: class I (n=19); class II (n=35), class III (n=30), and class IV (n=43).The patients were prescribed an average of five (±1.7) cardiac medications, ranging from 0–8. Seventy-eight (61.4%) indicated that they were able to take their medications without help. A review of medications indicated that 105 patients (82.7%) were prescribed diuretics, 48 (37.8%) ACE inhibitors, 23 (18%) β blockers, and 47 (37%) digoxin. Forty patients (32%) were prescribed a combination of diuretics and ACE inhibitors, and eight patients (6%) were prescribed a combination of ACE inhibitors and β blockers. Twenty-one (17%) patients were prescribed more than one diuretic. Only two (1.6%) patients were prescribed the combination regimen of diuretics, ACE inhibitors, β blockers, and digoxin. See Figure 1 for the percentages of patients taking medications.

The four medications in the treatment regimen were compared with comorbidities, patient age, and severity of cardiac illness. Renal disease was significantly related to the use of diuretics (intracellular Phi=0.41, p<0.001) and digoxin (Phi=0.04, p<0.05). ACE inhibitors were significantly related to having a past history of myocardial infarction (Phi=0.01, p=0.023), but β blockers were not significantly related to the comorbidities. Patient age was significantly related to the use of ACE inhibitors (r=–0.19, p<0.05). The other three medications were not significantly related to patient age or severity of cardiac illness.

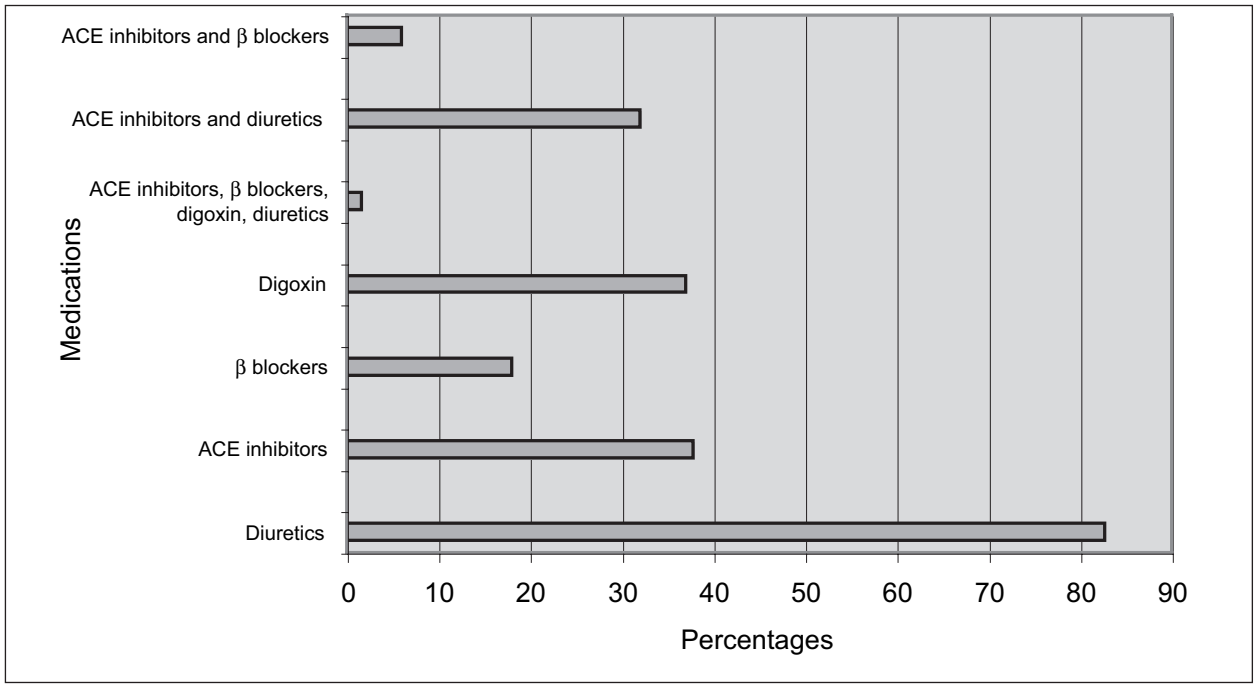

Figure. Percentages of patients prescribed daily medications. ACE=angiotensin-converting enzyme

One of the patients who received the regimen of four drugs was readmitted once during the 3-month interval. The total number of medications taken in the combination medication regimen was not significantly different (t=1.5, p=0.14) between those readmitted (M=1.89) and those not readmitted (M=1.65). There were no significant differences between readmitted and non-readmitted patients with regard to the use of the specific classes of cardiac medications, severity of cardiac illness, and comorbidities**.** See Table I for a comparison of medications and comorbidities to hospital readmissions.

The average length of hospital stay when first identified was 5.4 days (±3.64), range of 1–22. Fifty-six (44%) of the patients were readmitted to the hospital within 3 months post-hospital discharge. The average number of days between the first and second hospital readmission was 35.4 (±26.8), range of 1–90. Sixty-seven (53%) of the patients received home health care post-hospital discharge. The correlations between systolic pressure and diastolic pressure (r=0.48, $p \leq 0.01$) and systolic pressure and days between readmission (r=0.17, $p \leq 0.05$) were significant. The correlations between severity of cardiac illness and patient age (r=–0.19, $p \leq 0.05$) and patient health (r=0.28, $p \leq 0.01$) were significant. Those participants with less severity of cardiac illness perceived their health as better; however, patients who were younger reported greater severity of cardiac illness than those who were older. The correlation among patient age, patient health, days between readmissions, total number of medications in the 4-medication regimen, and length of first admission were not significant.

Test of the Hypothesis

Multiple regressions were used to evaluate whether diuretics, ACE inhibitors, β blockers, digoxin, and the total number of prescribed heart medications predicted days to readmission post-hospital discharge. The hypothesis was not significant (R^2=0.02, F=0.41, p=0.84). None of the variables were significant predictors of days to readmission. Table II describes the regression analysis with all of the variables entered.

Additional Findings

Logistic regression was used to evaluate whether diuretics, ACE inhibitors, β blockers, and digoxin predicted mortality for the patients sampled. None of these variables were significant. Only the use of ACE inhibitors approached significance (p=0.085).

DISCUSSION

According to Aronow,[9] diuretics are the first-line therapy for treatment of HF in older adults. Contrary to the findings of Michalsen et al.,[18] the patients sampled for the present study took diuretics more than any other drug for HF. Renal disease was significantly related to the use of diuretics and digoxin. ACE inhibitors were significantly used by those patients with a history of myocardial infarction, but β blockers were not related to comorbidities. Diuretics, ACE inhibitors, β blockers, and digoxin were prescribed in the same proportion for this sample as those patients studied by Tsuchihashi et al.[19] Although 58% of the patients studied had marked limitations in physical activity, only 38% were prescribed ACE inhibitors, 18% were prescribed β blockers, and

Table I. Comparison of Readmitted (n=56) and Non-Readmitted Patients (n=71)

Variable	Readmitted Number (%)	Non-Readmitted Number (%)
Age (y)		
65–75	24 (43)	24 (34)
76–79	13 (23)	19 (27)
80–85	15 (27)	19 (27)
86–92	4 (7)	9 (12)
Sex		
Women	29 (52)	34 (48)
Men	27 (48)	37 (52)
Race		
White	48 (86)	65 (92)
Black	8 (14)	5 (7)
Asian	0	1 (1)
Marital		
Single	1 (2)	1 (1)
Married	37 (66)	49 (69)
Divorced	1 (2)	4 (6)
Widowed	17 (30)	17 (24)
Education		
Less than high school	32 (57)	22 (31)
HS graduate/GED	17 (30)	30 (42)
Some college	3 (5)	5 (7)
Graduate, technical training	0	6 (9)
Bachelor's degree	2 (4)	5 (7)
Master's degree	1 (2)	1 (1)
Doctoral or beyond	1 (2)	2 (3)
Medications		
Diuretics	47 (84)	58 (82)
ACE inhibitors	25 (45)	23 (32)
β blockers	9 (16)	14 (20)
Digitalis	25 (45)	22 (31)
Comorbidities		
Diabetes	27 (48)	27 (38)
Hypertension	26 (46)	33 (46)
Arteriosclerosis	20 (38)	18 (25)
Myocardial infarction	14 (25)	18 (25)
Bypass surgery	16 (29)	15 (21)
Stroke	8 (14)	10 (14)
COPD	8 (14)	8 (12)
Renal disease	4 (7)	5 (7)
Cancer	3 (0.05)	5 (0.07)
Atrial fibrillation	1 (0.02)	4 (0.06)

HS=high school; GED=graduate equivalency degree; ACE=angiotensin-converting enzyme; COPD=chronic obstructive pulmonary disease

6% were prescribed a combination of ACE inhibitors and β blockers. A possible reason for these findings is the underestimation of the seriousness of HF by general practitioners who continue to treat the majority of HF patients who reside in the community.[17] Older adults with HF frequently have multiple comorbidities that are treated with other medications, and treatment by cardiologists is more expensive.[16,23]

Consistent with the findings of others,[6,19] 44% of participants discharged from the hospital with HF were

Table II. Summary of Hierarchical Regression for Variables Predicting Days to Readmission

Predictor Variables	β	*t* Value	*p* Value
Diuretics	0.126	1.30	0.20
ACE inhibitors	0.025	0.27	0.79
β blockers	0.000	−0.00	0.99
Digitalis	0.031	0.33	0.74
Total medications used for heart failure	−0.03	−0.24	0.81

R^2=0.02; *df*=5,121; *F*=0.41; *p*=0.84; ACE=angiotensin-converting enzyme

readmitted within a 3-month period. Furthermore, similar to the findings of Tsuchihashi et al.[19] and Vinson et al.[6] there were no significant differences between participants readmitted and not readmitted with regard to the use of specific classes of cardiac medications. Severity of illness, comorbidities, and functional status were not significantly different between patients who were readmitted and not readmitted, however, with more formal education, patients had fewer hospital readmissions. Perhaps those persons with higher education complied with their medication and treatment protocol better because of increased knowledge and/or finances.

Results indicated that for the patients in this study, none of these drugs were significant predictors of the number of days between the initial hospital discharge and next hospital readmission or mortality. Possible reasons for lack of significance for hypothesis testing include compliance with medication, knowledge about the drugs, failure to seek medical attention when symptoms occurred, and availability of social support systems.[8,20] According to Bennet et al.[20] and Michalsen et al.,[18] noncompliance with medication and sodium restrictions for HF contributes to sodium retention and volume overload that precipitates decompensation and hospital readmissions. Non-compliance with medication may be related to the high cost of prescription drugs for HF and other comorbidities, poorer mental health, lack of adequate discharge planning, and/or the number of medications and side effects from the medications.[6,27,28] Mitchell et al.[27] found mismanagement of prescription medications to be widespread. Patients either had difficulty obtaining their medication or managing the costs. Side effects such as a cough from ACE inhibitors, incontinence from diuretics, or hypotension affect "when and how" patients take their medications. Although patients reported that they had sufficient income for daily living, the ability to pay for medications may have influenced the results of the study. Furthermore, the variation of severity of HF contributed to the need for different treatment plans. Patients with more abnormalities face a worse prognosis regardless of treatment.

LIMITATIONS

A major limitation of the study is the use of a small, non-probability sample that limits the ability to generalize the findings. The sample was further self-selected because of attrition and lack of diversity in race and educational status. Many patients with HF are assessed on an outpatient basis and were not included in the study.

Limitations may also be due to exclusion of important variables. Adherence to the prescribed medication regimen should have been measured. Since the source of provision of treatment was not documented, differences in hospital readmissions and use of cardiac medications could not be assessed based upon utilization of cardiologists, general physicians, or nurse practitioners.

CONCLUSION

HF is a clinical syndrome that affects millions of Americans; each year, thousands of new cases are diagnosed. Although the treatment of hypertension has been shown to reduce the risk of incidence of HF by 50%,[29] those persons who are diagnosed with HF experience an unpredictable progression of symptoms. Consequently, effective case management of HF must address each of the many changes involved in this complex syndrome. Nurses need to spend time before hospital discharge teaching patients and their caregivers about the different categories of medications that are used to treat HF. Home healthcare nurses can follow up this initial teaching to ensure that patients comply with the treatment program and are able to access their prescribed medications.

Further studies should examine compliance with medication, diet, and education about early recognition of symptoms of HF. Since researchers have shown that medications for HF are under-prescribed, nurses can take the first step in increasing awareness among primary care providers about the guidelines for the use of HF medications, which can be done by presenting findings about medication use to groups of family practice physicians at local, regional, and national meetings. Since the cost of medications to treat HF continues to be a serious issue,[4] nurses can educate patients and their caregivers about programs that have been implemented to defray some of these costs.

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