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Risk Factors for Hospital Admission Among Older Persons With Newly Diagnosed Heart Failure

Findings From the Cardiovascular Health Study

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Objectives This study sought to identify risk factors for the occurrence of all-cause hospital admissions among older persons after heart failure diagnosis, and to determine whether geriatric conditions would emerge as independent risk factors for admission when evaluated in the context of other relevant clinical data.

Background Efforts to reduce costs in heart failure have focused on hospital utilization, yet few studies have examined how geriatric conditions affect the long-term risk for hospital admission after heart failure diagnosis. With the aging of the population with heart failure, geriatric conditions such as slow gait and muscle weakness are becoming increasingly common.

Methods The study population included participants with a new diagnosis of heart failure in the Cardiovascular Health Study, a longitudinal study of community-living older persons. Data were collected through annual examinations and medical-record reviews. Geriatric conditions assessed were slow gait, muscle weakness (defined as weak grip), cognitive impairment, and depressive symptoms. Anderson-Gill regression modeling was used to determine the predictors of hospital admission after heart failure diagnosis.

Results Of the 758 participants with a new diagnosis of heart failure, the mean rate of hospital admission was 7.9 per 10 person-years (95% CI: 7.4 to 8.4). Independent risk factors for hospital admission included diabetes mellitus (HR: 1.36; 95% CI: 1.13 to 1.64), New York Heart Association functional class III or IV (HR: 1.32; 95% CI: 1.11 to 1.57), chronic kidney disease (HR: 1.32; 95% CI: 1.14 to 1.53), slow gait (HR: 1.28; 95% CI: 1.06 to 1.55), depressed ejection fraction (HR: 1.25; 95% CI: 1.04 to 1.51), depression (HR: 1.23; 95% CI: 1.05 to 1.45), and muscle weakness (HR: 1.19; 95% CI: 1.00 to 1.42).

Conclusions Geriatric conditions are important, and potentially modifiable, risk factors for hospital admission in heart failure that should be routinely assessed at the time of heart failure diagnosis. (J Am Coll Cardiol 2013;61:635–42)

As the population has aged and survival with cardiovascular disease has increased, the number of older persons with heart failure has increased considerably over the past 20 years (1). Currently, 80% of patients with heart failure are age 65 years or older, and nearly 25% are age 80 years or

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Abbreviations and Acronyms

3MS = Modified Mini-Mental State Examination
ACE = angiotensin-converting enzyme
BMI = body mass index
CAD = coronary artery disease
CHS = Cardiovascular Health Study
DSST = Digit Symbol Substitution Test
NYHA = New York Heart Association

older (2). Costs associated with heart failure exceed $35 billion annually in the United States and are largely driven by hospital stays (3), yet relatively little is known about the long-term risk for hospital admission after heart failure diagnosis in older persons. Most studies have focused on the short-term (i.e., 30 days to 1 year) risk for hospital readmission after an initial hospital admission for heart failure. However, these short-term risk models have not fully characterized cumulative, lifetime hospital utilization after heart failure diagnosis, which is relevant from a public health perspective. Heart failure in older persons is often marked by recurrent episodes of clinical decompensation necessitating multiple hospital admissions. Furthermore, whereas geriatric conditions such as slow gait, muscle weakness, and cognitive impairment are emerging as important predictors of outcomes among older persons with cardiovascular disease (4–6), information about these conditions is not available in most heart failure registries, and their prognostic relevance for hospital admission in older patients with heart failure remains unclear.

To address these gaps in knowledge, the present study evaluated data from a population-based sample of persons age 65 years or older, with a follow-up period of up to 20 years after heart failure diagnosis. These data included a rich array of information, such as clinical heart failure assessments, laboratory evaluations, comorbid diseases, and objective assessments of several geriatric conditions. The goals were to identify risk factors for all-cause hospital admission among older persons after a new diagnosis of heart failure and to determine whether geriatric conditions would emerge as independent risk factors for admission when evaluated in the context of other relevant clinical data. This prognostic information may be used to assist in clinical decision making and to identify potential targets for intervention after heart failure diagnosis in older persons.

Methods

Study Population

The study population included Cardiovascular Health Study (CHS) participants with heart failure diagnosed after CHS enrollment. The objective of CHS was to identify factors associated with the onset of cardiovascular disease in older persons; however, potentially eligible participants with cardiovascular disease at the CHS screening visit were included. In 1989, 5,201 men and women age 65 years or older were enrolled into CHS from 4 communities across the United States, with an additional 687 African Americans recruited in 1992 to enhance minority representation. Potential CHS participants were identified from Medicare-eligibility lists. Persons who were wheelchair bound or receiving cancer or hospice treatment were excluded from CHS. Complete details on the inclusion/exclusion criteria have been previously reported (7).

Data Collection

In CHS, data about the development of heart failure and potential risk factors for hospital admission were collected every 12 months from 1989 to 1999 through in-person interviews and examinations, and hospital admissions through 2009 were ascertained. According to the CHS protocol, potential cases of incident heart failure were identified through 2 mechanisms: 1) hospital admission for heart failure, representing 85% of the new heart failure cases included in these analyses; and 2) self-report of a physician's diagnosis of heart failure (8). CHS criteria for heart failure required that a participant have a diagnosis of heart failure from a physician and be receiving medical treatment (e.g., a diuretic agent, an angiotensin-converting enzyme [ACE] inhibitor, or digitalis) for heart failure. The presence of cardiomegaly and pulmonary edema on chest x-ray, or evidence of left ventricular dysfunction by echocardiography or ventriculography, was used to support the diagnosis of heart failure. All potential cases of heart failure were adjudicated by an expert panel that reviewed all pertinent data from medical records. Participants entered the analysis at the time of the CHS study assessment (hereafter referred to as *baseline*) immediately after their heart failure diagnosis. However, because the objective of the present study was to identify risk factors for hospital admission that were present at the time of heart failure diagnosis, and because of the uncertainty about the duration of heart failure among prevalent cases in CHS, data from 275 CHS participants who had heart failure at the time of CHS enrollment were excluded from the present analysis.

Study Variables

Potential risk factors. DEMOGRAPHICS. Age was considered in 10-year categories. Sex, race (nonwhite vs. white), and highest level of education (<12th grade vs. 12th grade or higher) were also included in the analyses.

HEART FAILURE STATUS. Ejection fraction was classified as *depressed* (<45%) or *preserved* (≥45%) based on clinical studies of left ventricular function (echocardiography, nuclear, or catheterization data) performed at the time of hospital admission for heart failure diagnosis. New York Heart Association (NYHA) classification was ascertained through information obtained in participant interviews. ACE inhibitor and beta-blocker use was ascertained through participants' self-report and a medical record review.

BODY MASS INDEX. Based on previous work demonstrating associations of body mass index (BMI) with heart failure outcomes (9), BMI categories were selected to represent low

body weight (<18 kg/m^2), normal body weight (18 to 24.9 kg/m^2), overweight (25 to 29.9 kg/m^2), and obesity (>30 kg/m^2), using data obtained from physical examinations.

COMORBID DISEASES. Comorbid diseases were assessed according to CHS protocol (10) and included diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease, coronary artery disease (CAD), stroke, and anemia. Participants were considered diabetic if they reported a physician's diagnosis of diabetes mellitus, had a fasting serum glucose concentration of >126 mg/dl, had a serum glucose concentration of at least 200 mg/dl at 2 h on oral glucose tolerance test, or reported use of antidiabetic medications. Chronic kidney disease was ascertained through laboratory evaluation, with calculation of glomerular filtration rate, with a cutoff point of <60 ml/min. Chronic obstructive pulmonary disease was ascertained through self-report of a physician's diagnosis. Discharge summaries, medication use, cardiac enzyme levels, electrocardiograms, and brain imaging were reviewed by the CHS Cardiovascular Events Committee to classify all potential cases of CAD and stroke. The presence of anemia was ascertained through laboratory evaluation. A hemoglobin concentration cutoff point of <12 g/dl was used to indicate anemia in women, and a cutoff point of <13 g/dl was used in men.

GERIATRIC CONDITIONS. *Geriatric conditions* were defined as those that occur in older adults and that are typically multifactorial in etiology but not necessarily related to a specific disease (11). The 4 geriatric conditions assessed were impairments in muscle strength, gait speed, cognitive function, and psychological status. Geriatric conditions were classified as present or absent, as follows. Grip strength, an indicator of overall muscle strength (12), was measured in the dominant hand using a handheld dynamometer (13). *Weak grip* was defined as <28.5 kg in men and <18.5 kg in women (14). Gait speed was assessed by recording the time required to walk 15 feet at usual pace, and *slow gait* was defined as a gait speed of <0.8 m/s (15). Cognitive function was measured using the Modified Mini-Mental State Examination (3MS) (16) and the Digit Symbol Substitution Test (DSST) (17). The 3MS is an expanded version of the Folstein Mini-Mental State Examination, a widely used screening test for dementia (18). The DSST assesses several cognitive processes, including visual search, visual–motor coordination, and cognitive flexibility. As in previous CHS work (19), *cognitive impairment* was defined as a score <80 on the 3MS or a score <19 (which represents 1.5 SDs below the mean score for this age group) on the DSST. *Depression* was classified as a score of at least 8 on the (short-form) Center for Epidemiologic Studies–Depression scale (20), a self-reported measure of depressive symptoms experienced during the previous week.

All-cause hospital admissions. At the annual contacts, participants were asked about major illnesses and hospital admissions. Medical records were obtained for all reported hospital admissions. Medicare-utilization files were searched to ascertain hospital admissions that may have been missed. These procedures have been used in prior CHS work to ascertain hospital utilization (21). If the diagnosis of heart failure was made during a hospital stay, data from that event were not included in the outcome, as the present study evaluated the risk for hospital admission *after* heart failure was diagnosed.

Statistical Analysis

Characteristics of the study population at the time of heart failure diagnosis were described, and Anderson-Gill regression modeling (22) was used to evaluate the associations between the potential baseline risk factors and hospital admission. This technique allowed all hospital admissions to have been analyzed, in contrast to Cox modeling, which would have considered only the first admission. With the exception of age and sex, which were retained in the final models, factors were selected according to a hierarchical screening process to create a parsimonious, multivariate model (23). First, bivariate association between each factor and the outcome was evaluated. Only variables with a p value ≤0.30 were considered further. Next, the correlations among the remaining factors were sequentially evaluated with the Kendall correlation coefficient. Those with a correlation coefficient >0.3 may have resulted in collinearity; thus, a single risk factor was retained on the basis of clinical judgment and the strength of the association with the outcome. A backward selection method was used to evaluate the impact of each of the remaining risk factors on the overall model fit through a series of Anderson-Gill models. To assess each factor's contribution to the model fit, a chi-square distribution was used, with degrees of freedom equaling the number of parameters for the added factor, on the basis of the difference in the −2 log likelihood (LL) statistics between the models with and without the factor. After a separate model was fitted for each factor, the factor with the largest difference in −2 LL was added to the overall model. This process was continued iteratively until no factor significantly increased the model fit based on the −2 LL criterion. Participants were censored at the time of death. In supplementary analyses, the combined endpoint all-cause hospital admission or death was considered, using the same approach described for the endpoint all-cause hospital admission alone. To provide further understanding of the clinical impact of the independent risk factors, hospital admission rates (per 10 person-years) were calculated with and without each of the factors.

Risk-factor data that were missing from the baseline evaluation (i.e., at the CHS study visit immediately after heart failure diagnosis) were "carried forward" from the last available assessment (i.e., last observation carried forward [LOCF]). For ejection fraction, NYHA classification, and heart failure medication (ACE inhibitor and beta-blocker) use, the LOCF approach was not used because those values would have been expected to have changed substantially at

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Table 1 Baseline Demographic and Clinical Characteristics of the Study Patients (N = 758)

Age, yrs	79.7 ± 6.2
Age group	
65–<75 yrs	170 (22.4)
75–<85 yrs	417 (55.0)
≥85 yrs	171 (22.6)
Female	383 (50.5)
Nonwhite race	97 (12.8)
Education < high school	270 (35.8)
BMI group	
<18 kg/m^2	23 (3.0)
18–<25 kg/m^2	329 (43.5)
25–<30 kg/m^2	270 (35.7)
≥30 kg/m^2	135 (17.8)
Heart failure status	
Ejection fraction <45%	203 (43.2)
NYHA functional class	
I	22 (3.2)
II	462 (66.5)
III	173 (24.9)
IV	38 (5.4)
ACE inhibitor use	257 (40.7)
Beta-blocker use	99 (15.7)
Comorbid conditions	
Coronary artery disease	463 (61.1)
Chronic kidney disease	280 (37.1)
Diabetes mellitus	193 (25.5)
Stroke	125 (16.5)
COPD	112 (14.8)
Anemia	111 (14.7)
Geriatric conditions	
Slow gait	317 (41.8)
Weak grip	317 (41.8)
Depression	296 (39.1)
Cognitive impairment	264 (34.8)

Values are mean ± SD or n (%). All missing data <1%, with the exceptions of ejection fraction (37.9%), NYHA class (8.3%), and ACE inhibitors and beta-blockers (16.6% each). Percentages were calculated based on participants without missing data.

ACE = angiotensin-converting enzyme; BMI = body mass index; COPD = chronic obstructive pulmonary disease; NYHA = New York Heart Association.

the time of heart failure diagnosis. For those variables, missing values were retained as distinct categories.

All statistical tests were 2-tailed, and $p < 0.05$ was considered to have indicated statistical significance. All analyses were conducted using SAS software version 9.2 (SAS Institute Inc., Cary, North Carolina).

Results

Study Population

During the study period, 758 CHS participants were newly diagnosed with heart failure and were included in the present analysis. As shown in Table 1, the mean age at the time of heart failure diagnosis was 79.7 years. Most participants were white, about one-third had a <12th-grade education, and nearly one-fifth were obese. The majority of the cohort had preserved ejection fraction, and 30.3% were NYHA functional class III or IV. ACE inhibitors were being used in 40.7% of participants, and beta-blockers, in 15.7%. As would be expected in a heart failure cohort, CAD was the most common comorbid condition, followed by chronic kidney disease and diabetes mellitus. Geriatric conditions were common, with muscle weakness, slow gait, cognitive impairment, and depression all present in approximately 40% of the cohort. (In comparison, at the time of enrollment into CHS, the mean age of the study participants [N = 5,888] was 72 years, and 57.6% were female. CAD was present in 19.4% and 22.8% of patients were diabetic and 4.2% had a history of stroke. Muscle weakness was present in 20% of participants; slow gait, in 22.1%; cognitive impairment, in 13.2%; and depression, in 21.5%.)

Hospital admission after heart failure diagnosis. A total of 2,395 hospital admissions occurred during a median follow-up of 3.4 years (IQR: 1.8 to 5.9 years). By the end of the follow-up period (2009), 75% of the participants had died. As shown in Figure 1, the number of hospital admissions per participant ranged from 0 (in 14% of the cohort) to 56, with the median of 3.4 (IQR: 1.8 to 5.9). The mean rate of hospital admission was 7.9 per 10 person-years (95% CI: 7.4– to 8.4). Among participants with preserved ejection fraction, the rate of hospital admissions was somewhat lower, 7.0 per 10 person-years (95% CI: 6.6 to 7.4).

Hospital admission and mortality over the study period. Shown in Table 2 are hospital-admission and mortality rates over the 20-year study period. The group whose heart failure was diagnosed between 1990 and 1994 had a greater rate of hospital admissions across the study period compared with the group whose heart failure was diagnosed between 1995 and 1999 ($p < 0.001$). The rate of hospital admissions (among all participants) was generally stable across the follow-up period, with an increase in years 6 to 10 compared with years 1 to 5 and then a decrease in years 11 to 20. The mortality rate was slightly higher in the group whose heart failure was diagnosed between 1995 and 1999 than in the

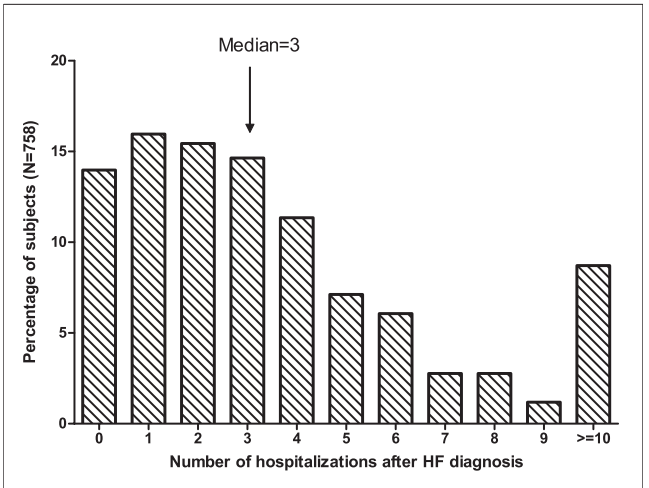

Figure 1 Median Number of Hospital Admissions Per Person After Heart Failure Diagnosis

Table 2 Hospital Admission and Mortality Rates (95% CI) After Heart Failure Diagnosis per 10 Person-Years

Year at Diagnosis	1–5 Yrs After Diagnosis			6–10 Yrs After Diagnosis			11–20 Yrs After Diagnosis		
	n*	Hospital Admission, %	Mortality, %	n*	Hospital Admission, %	Mortality, %	n*	Hospital Admission, %	Mortality, %
1990–1994	283	7.9 (7.4–8.4)	1.3 (1.1–1.5)	144	10.1 (9.3–11.0)	1.7 (1.4–2.1)	60	7.7 (6.5–9.0)	2.2 (1.7–3.0)
1995–1999	475	7.4 (7.0–7.9)	1.5 (1.4–1.8)	141	7.5 (6.6–8.4)	1.9 (1.5–2.4)	25	6.0 (3.4–10.5)	2.5 (1.0–6.0)
Total	758	7.6 (7.3–8.0)	1.4 (1.3–1.4)	285	9.0 (8.4–9.7)	1.8 (1.5–2.1)	85	7.5 (6.4–8.8)	2.3 (1.7–3.0)

*Number of participants at the beginning of the time period.

group whose heart failure was diagnosed between 1990 and 1994, but these differences achieved statistical significance only at years 1 to 5. As would be expected, the overall mortality rate increased over the study period ($p < 0.001$).

Risk factors for hospital admission after heart failure diagnosis. As shown in Table 3, several characteristics were associated with hospital admission on bivariate analysis. Race, BMI, ACE inhibitor use, and CAD did not meet the bivariate p value criterion ($p < 0.30$) and were not considered further. None of the potential risk factors were excluded because of collinearity. On multivariate analysis, independent risk factors for hospital admission were diabetes mellitus (HR: 1.36; 95% CI: 1.13 to 1.64), NYHA class III or IV (HR: 1.32; 95% CI: 1.11 to 1.57), chronic kidney disease (HR: 1.32; 95% CI: 1.14 to 1.53), slow gait (HR: 1.28; 95% CI: 1.06 to 1.55), depressed ejection fraction (HR: 1.25; 95% CI: 1.04 to 1.51), depression (HR: 1.23; 95% CI: 1.05 to 1.45), and muscle weakness (HR: 1.19; 95% CI: 1.00 to 1.42). Missing categories of ejection fraction, NYHA, ACE inhibitor use, and beta-blocker use were not significantly associated with hospital admission.

Hospital admission rates (per 10 person-years) with and without each of the independent risk factors are shown in Figure 2. The presence of depression was associated with a 23% increase in hospital admission rate (i.e., the group without

Table 3 Risk For All-Cause Hospital Admission, by Baseline Characteristic

Characteristic	Bivariate Model		Multivariate Model*	
	Hazard Ratio (95% CI)	p Value	Hazard Ratio (95% CI)	p Value
Age group				
65–<75 yrs	Reference		Reference	
75–<85 yrs	1.05 (0.86 to −1.28)	0.666	0.96 (0.81 to 1.15)	0.655
≥85 yrs	1.33 (1.04 to −1.71)	0.022	1.20 (0.94 to 1.53)	0.139
Female	0.98 (0.83 to −1.14)	0.765	0.89 (0.77 to 1.03)	0.124
Nonwhite race	1.09 (0.86 to −1.39)	0.475	—	—
Education <12th grade	1.18 (1.00 to −1.40)	0.048	1.12 (0.96 to 1.31)	0.146
BMI group				
<18 kg/m^2	1.17 (0.76 to −1.81)	0.470	—	—
18–<25 kg/m^2	Reference		—	—
25–<30 kg/m^2	0.93 (0.78 to −1.10)	0.393	—	—
≥30 kg/m^2	1.05 (0.83 to −1.34)	0.675	—	—
Heart failure status				
Ejection fraction <45%	1.32 (1.07 to −1.62)	0.010	1.25 (1.04 to 1.51)	0.019
NYHA functional class III/IV	1.37 (1.14 to −1.65)	<0.001	1.32 (1.11 to 1.57)	0.001
Not taking ACE inhibitor	1.05 (0.87 to −1.27)	0.616	—	—
Not taking beta-blocker	1.23 (0.98 to −1.55)	0.076	1.21 (0.99 to 1.46)	0.059
Comorbid conditions				
Diabetes mellitus	1.42 (1.17 to −1.74)	<0.001	1.36 (1.13 to 1.64)	0.001
Chronic kidney disease	1.31 (1.11 to 1.55)	0.002	1.32 (1.14 to 1.53)	<0.001
Stroke	1.27 (1.03 to −1.56)	0.024	1.15 (0.95 to 1.38)	0.149
COPD	1.16 (0.94 to −1.44)	0.164	—	—
Anemia	1.16 (0.92 to −1.45)	0.210	—	—
Coronary artery disease	1.09 (0.92 to 1.29)	0.317	—	—
Geriatric conditions				
Slow gait	1.49 (1.24 to −1.80)	<0.001	1.28 (1.06 to 1.55)	0.010
Cognitive impairment	1.33 (1.14 to −1.56)	<0.001	—	—
Depression	1.33 (1.13 to −1.56)	<0.001	1.23 (1.05 to 1.43)	0.010
Weak grip	1.21 (1.02 to 1.44)	0.030	1.19 (1.00 to 1.42)	0.050

*Model is adjusted for year of heart failure diagnosis (1990 to 1999).
Abbreviations as in Table 1.

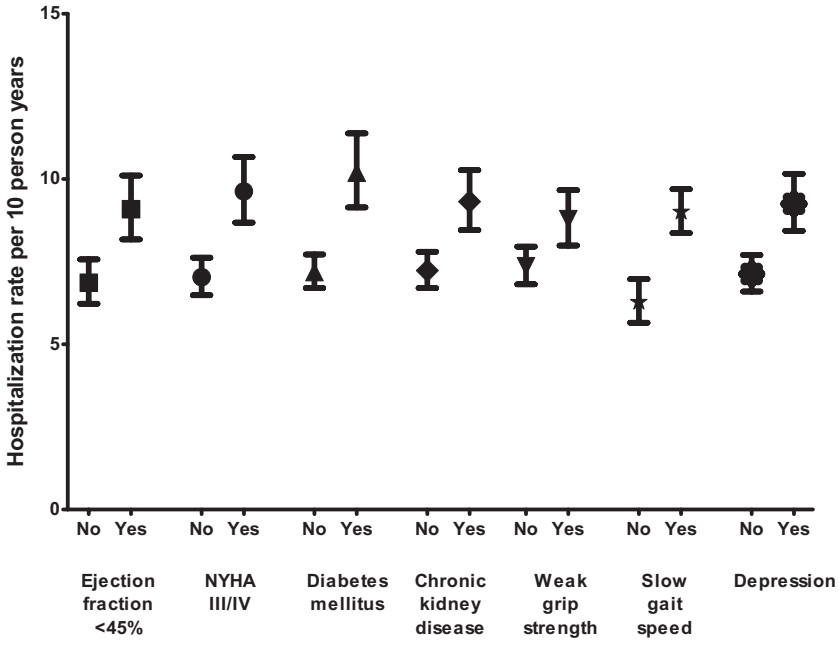

Figure 2 Rates of Hospital Admission Per 10 Person-Years, With and Without Independent Risk Factors

Bars represent 95% confidence intervals.

depression had 7.13 hospital admissions per 10 person-years compared to 9.26 in the group with depression). Similarly, slow gait was associated with a 30% increase in hospital admission rate, and muscle weakness, with a 16% increase. The presence of diabetes mellitus was associated with a 29% increase; chronic kidney disease, with a 22% increase; depressed ejection fraction, with a 25% increase; and NYHA functional class III or IV, with a 27% increase.

Results from analyses that considered hospital admission or death as a composite endpoint were similar to those from analyses that considered hospital admission alone. On multivariate analysis, diabetes mellitus (HR: 1.36; 95% CI: 1.13 to 1.63), chronic kidney disease (HR: 1.33; 95% CI: 1.15 to 1.53), NYHA class III or IV (HR: 1.32; 95% CI: 1.12 to 1.57), depressed ejection fraction (HR: 1.26; 95% CI: 1.04 to 1.51), slow gait (HR: 1.31; 95% CI: 1.08 to 1.58), depression (HR: 1.22; 95% CI: 1.05 to 1.43), and muscle weakness (HR: 1.19; 95% CI: 1.00 to 1.42) were independently associated with hospital admission or mortality.

Discussion

In this cohort of community-living older persons, 3 geriatric conditions, namely muscle weakness, slow gait, and depression, emerged as independent risk factors for hospital admission after heart failure diagnosis, even when other relevant demographic, social, and clinical factors were considered. Other independent risk factors included depressed ejection fraction, NYHA class III or IV, diabetes mellitus, and chronic kidney disease.

Why would these geriatric conditions predict hospital utilization among older persons with newly diagnosed heart failure? In the case of slow gait, walking places demands on multiple organ systems, including the cardiovascular, pulmonary, nervous, and musculoskeletal systems. Slow gait may reflect physiological dysfunction in one or more of these systems. Grip strength is a reliable indicator of overall muscle strength (24), and therefore may similarly reflect overall physiological reserve. Poor health status may result in depressive symptoms, which may, in turn, negatively affect patients' self-care (including adherence with medications and follow-up appointments), creating a vicious cycle.

Because muscle weakness, slow gait, and depressive symptoms are potentially modifiable, they should be routinely assessed in older persons with newly diagnosed heart failure. As with other geriatric conditions, however, these factors fall outside the conventional disease-oriented model of clinical medicine (25); thus, they may be overlooked in the care of older persons with newly diagnosed heart failure, particularly when they are subtle (26–28). Modification of physical impairments and depressive symptoms is challenging but may improve outcomes in older patients with cardiovascular disease. Exercise training improves gait speed, aerobic fitness, and quality of life in patients with heart failure and may reduce the risks for hospital admission and mortality (29,30). Recent work demonstrated that both exercise and antidepressant treatment in depressed patients with CAD resulted in improvement in depressive symptoms and cardiovascular biomarkers (31). In addition to serving as

targets for intervention, the presence of these geriatric conditions signals a high-risk group that may benefit from services such as nursing and pharmacy support. Whether the assessment and management of geriatric conditions actually improves heart failure outcomes should be examined in future work.

The findings from the present study add valuable information for understanding the determinants of hospital utilization after heart failure diagnosis in older persons. The duration of follow-up allowed a more complete assessment of hospital admission than is available from previous heart failure studies. Previous work that has included a similar duration of follow-up in persons newly diagnosed with heart failure (32) has not focused on an older population or included information about geriatric conditions, which emerged as important risk factors of hospital admission in the present analyses. Detailed medical record review supplemented self-reported information for several comorbid conditions, enhancing the validity of the data. There was no attrition for reasons other than death, further strengthening the validity and generalizability of the results. The generalizability of the results is also enhanced by the fact that the CHS data were collected from a representative sample of white and African-American community-living older persons from across the United States.

Of note, the use of ACE inhibitors and beta-blockers was not significantly associated with hospital admission. The high prevalence of heart failure with preserved ejection fraction in the present study sample provides one explanation of this finding. Additionally, most hospital admissions in older patients with heart failure are due to non–heart failure related causes (32), which these medications would not be expected to affect.

Although heart failure primarily affects older persons, current heart failure guidelines do not incorporate routine assessment or management of geriatric conditions. Underscoring the relative inattention to geriatric conditions, even current quality indicators developed specifically for older patients, such as the Assessing Care of Vulnerable Elders (ACOVE) measures for heart failure, do not include the assessment of these conditions (33). The present results provide strong justification for developing strategies to routinely screen for and manage these conditions at the time of heart failure diagnosis. Through such interventions, it may be possible to reduce the burden of hospital stays among older persons newly diagnosed with heart failure, thereby improving their quality of life while reducing health care costs.

Study limitations. This study had several potential limitations, which should be considered when interpreting the results. Data were collected beginning in 1989; heart failure management has certainly changed since that time, and it is possible that the risk factors for hospital admission have changed. However, hospital admissions through 2009 were ascertained, thereby including up to 20 years of follow-up, which would not have been possible with a later baseline date. Participants were censored at the time of death; therefore, the results may have underestimated the magnitude of the risk associated with some strong risk factors for both death and hospital admission (e.g., CAD), particularly as the observed mortality rate was high (75%). Although the presence of comorbid conditions was accounted for, it could not be assessed whether the associations between geriatric conditions and hospital admission were attenuated after adjustment for severity and duration of comorbid conditions. Finally, the mean age of the study participants was 79.7 years, which is certainly older than participants included in most heart failure registries. However, the age of the study participants was well-suited to the objective of examining the prognostic importance of geriatric conditions in older patients with heart failure.

Conclusions

Based on the findings from the present analysis of data from patients with newly diagnosed heart failure, geriatric conditions are important risk factors for all-cause hospital admission; these risk factors should be routinely assessed at the time of heart failure diagnosis.

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