Prevalence and Prognostic Significance of Heart Failure Stages

Application of the American College of Cardiology/American Heart Association Heart Failure Staging Criteria in the Community

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Background—Heart failure (HF) is a progressive disorder associated with frequent morbidity and mortality. An American Heart Association/American College of Cardiology staging classification of HF has been developed to emphasize early detection and prevention. The prevalence of HF stages and their association with mortality are unknown. We sought to estimate HF stage prevalence in the community and to measure the association of HF stages with mortality.

Methods and Results—A population-based, cross-sectional, random sample of 2029 Olmsted County, Minnesota, residents aged ≥45 years was identified. Participants were classified by medical record review, symptom questionnaire, physical examination, and echocardiogram as follows: stage 0, healthy; stage A, HF risk factors; stage B, asymptomatic cardiac structural or functional abnormalities; stage C, HF symptoms; and stage D, severe HF. In the cohort, 32% were stage 0, 22% stage A, 34% stage B, 12% stage C, and 0.2% stage D. Mean B-type natriuretic peptide concentrations (in pg/mL) increased by stages: stage 0=26, stage A=32, stage B=53, stage C=137, and stage D=353. Survival at 5 years was 99% in stage 0, 97% in stage A, 96% in stage B, 75% in stage C, and 20% in stage D.

Conclusions—The present study provides prevalence estimates and prognostic validation for HF staging in a community cohort. Of note, 56% of adults ≥45 years of age were classified as being in stage A (risk factors) or B (asymptomatic ventricular dysfunction). HF staging underscores the magnitude of the population at risk for progression to overt HF. (Circulation. 2007;115:1563-1570.)

Key Words: heart failure ■ epidemiology ■ prevention ■ ventricular dysfunction

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The prevalence of the proposed HF stages in the community has not been determined. The prognostic implications of such a classification are unknown. Our objectives were to (1) estimate the prevalence of HF stages in a population-based cohort of 2029 adults aged ≥45 years, (2) provide neurohumoral validation of the staging model by measuring the association between B-type natriuretic peptide (BNP) concentration and HF stages, and (3) determine the prognostic significance of HF stages.

Methods

The Mayo Foundation and Olmsted Medical Center Institutional Review Boards approved the present study, and subjects gave informed consent.

Study Setting

In 2000, 90% of the 112,255 residents of Olmsted County, Minnesota, were white, 81% were urban, and 11% were ≥65 years of age. Since 1966, the Rochester Epidemiology Project has maintained an infrastructure for conducting population-based research, including a unified and indexed medical record system for inpatient and outpatient care.1,4
Patients with structural heart disease that is strongly associated with the development of HF. Such patients have no identified structural or functional abnormalities of the pericardium, myocardium, or cardiac valves and have never shown signs or symptoms of HF.

**TABLE 1. Stages of HF**

<table>
<thead>
<tr>
<th>HF Stage</th>
<th>AHA/ACC Guideline Description</th>
<th>As Operationally Defined in the Present Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Patients at high risk of developing HF because of the presence of a condition strongly associated with the development of HF. Such patients have no identified structural or functional abnormalities of the pericardium, myocardium, or cardiac valves and have never shown signs or symptoms of HF.</td>
<td>Hypertension, diabetes mellitus, obesity, coronary artery disease (excluding myocardial infarction), without abnormal ventricular structure or function; SAS class I</td>
</tr>
<tr>
<td>B</td>
<td>Patients with structural heart disease that is strongly associated with the development of HF but without HF signs or symptoms</td>
<td>SAS class I with any of the following abnormalities: history of MI, systolic dysfunction, echocardiographically determined LVH, LV enlargement, ECG-determined LVH, DD, echocardiographic valvular heart disease, and LV regional wall-motion abnormality</td>
</tr>
<tr>
<td>C</td>
<td>Patients with current or prior symptoms of HF associated with underlying structural heart disease</td>
<td>LV structural or functional abnormality plus symptoms: stage C, had SAS class II to III symptoms but did not fulfill Framingham HF criteria; stage C, fulfilled Framingham criteria.</td>
</tr>
<tr>
<td>D</td>
<td>Patients with advanced structural heart disease and refractory symptoms of HF requiring specialized interventions</td>
<td>History of HF and SAS class IV functional status</td>
</tr>
</tbody>
</table>

### Population Sampling and Data Collection

A random sample of Olmsted County residents aged 45 years of age on January 1, 1997, was identified. A population sampling fraction of 7% was applied within each gender and age-specific (5 years) stratum. Of the 4203 subjects invited, 2042 (49%) participated. Participation bias was evaluated: Medical record abstraction of 500 randomly selected participants and 500 randomly selected nonparticipants showed no difference in cardiovascular disease prevalence between the groups. The 2042 subjects in the present study cohort are the subject of previous publications. Thirteen participants were excluded from analysis due to indeterminate prior myocardial infarction status or missing information on Goldman Specific Activity Scale, which left 2029 subjects. Enrollment began January 1, 1997, and ended September 30, 2000. Each subject completed a self-administered questionnaire that included the Goldman Specific Activity Scale (SAS) and had a physical examination, 12-lead ECG, and echocardiogram. Medical records were abstracted by trained nurse abstractors, as described previously. The median length of participant medical record archive was 36 years. Confirmed HF was diagnosed if Framingham criteria were fulfilled. Diabetes was based on the presence of physician diagnosis and treatment in the medical record. Myocardial infarction and hypertension were diagnosed with criteria from the World Health Organization and the Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, respectively. Plasma BNP concentration was measured by the Biosite method.

### Determination of Symptoms and Functional Status

The Goldman SAS questionnaire was used to ascertain symptoms and their associated functional limitation. This self-administered questionnaire evaluates symptoms during 21 specific activities that have known metabolic equivalents (METS) of energy expenditure. It categorizes functional status into 4 ordinal classes: class I have known METS of energy expenditure. It evaluates symptoms during 21 specific activities that have known METS of energy expenditure. It categorizes functional status into 4 ordinal classes: class I (able to exercise at 2 to 5 METS; class II to III symptoms but did not fulfill Framingham HF criteria; stage C, fulfilled Framingham criteria. |

### Defining HF Stages

Using the proposed HF stages as a template, stage 0 was defined as healthy and without HF risk factors (Table 1). Stage A was defined by the presence of HF risk factors without cardiac structural or functional abnormality. Only risk factors that have been predictive of HF in longitudinal studies were used (hypertension, diabetes mellitus, obesity, coronary artery disease, and hypertension were diagnosed with criteria from the World Health Organization and the Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, respectively. Plasma BNP concentration was measured by the Biosite method.

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TABLE 2. Characteristics of the Cohort

<table>
<thead>
<tr>
<th>Stage</th>
<th>Stage A</th>
<th>Stage B</th>
<th>Stage C</th>
<th>Stage C1</th>
<th>Stage C2</th>
<th>Stage D</th>
<th>Total, n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td>339 (53)</td>
<td>216 (48)</td>
<td>346 (60)</td>
<td>151 (63)</td>
<td>132 (68)</td>
<td>19 (43)</td>
<td>2 (40)</td>
</tr>
<tr>
<td>Men</td>
<td>301 (47)</td>
<td>238 (52)</td>
<td>345 (60)</td>
<td>88 (37)</td>
<td>63 (32)</td>
<td>25 (57)</td>
<td>3 (60)</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0</td>
<td>0</td>
<td>55 (8)</td>
<td>42 (18)</td>
<td>23 (12)</td>
<td>19 (43)</td>
<td>4 (80)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>0</td>
<td>0</td>
<td>53 (12)</td>
<td>59 (9)</td>
<td>37 (15)</td>
<td>25 (13)</td>
<td>12 (27)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0</td>
<td>197 (43)</td>
<td>256 (37)</td>
<td>138 (58)</td>
<td>110 (56)</td>
<td>28 (63)</td>
<td>4 (80)</td>
</tr>
<tr>
<td>HF*</td>
<td>0</td>
<td>0</td>
<td>42 (9)</td>
<td>116 (17)</td>
<td>83 (33)</td>
<td>50 (26)</td>
<td>33 (75)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>0</td>
<td>0</td>
<td>309 (68)</td>
<td>234 (34)</td>
<td>112 (47)</td>
<td>93 (48)</td>
<td>19 (43)</td>
</tr>
<tr>
<td>BMI &gt;30 kg/m²</td>
<td>0</td>
<td>0</td>
<td>309 (68)</td>
<td>234 (34)</td>
<td>112 (47)</td>
<td>93 (48)</td>
<td>19 (43)</td>
</tr>
</tbody>
</table>

Data are presented as number of persons (column percent). BMI indicates body mass index.

*HF defined by Framingham criteria.

TABLE 3. Prevalence of HF Stages, Stratified by Age

<table>
<thead>
<tr>
<th>HF Stage</th>
<th>45–54 y</th>
<th>55–64 y</th>
<th>65–74 y</th>
<th>≥75 y</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>281 (46.9)</td>
<td>225 (36.0)</td>
<td>107 (20.9)</td>
<td>27 (9.3)</td>
<td>640 (31.5)</td>
</tr>
<tr>
<td>A</td>
<td>167 (27.9)</td>
<td>157 (25.1)</td>
<td>94 (18.3)</td>
<td>36 (12.3)</td>
<td>454 (22.4)</td>
</tr>
<tr>
<td>B</td>
<td>138 (23.0)</td>
<td>202 (32.3)</td>
<td>237 (46.2)</td>
<td>114 (39.0)</td>
<td>691 (34.1)</td>
</tr>
<tr>
<td>C</td>
<td>13 (2.2)</td>
<td>41 (6.6)</td>
<td>74 (14.4)</td>
<td>111 (38.0)</td>
<td>239 (11.8)</td>
</tr>
<tr>
<td>C1</td>
<td>9 (1.5)</td>
<td>32 (5.1)</td>
<td>65 (12.7)</td>
<td>89 (30.5)</td>
<td>195 (9.6)</td>
</tr>
<tr>
<td>C2</td>
<td>4 (0.7)</td>
<td>9 (1.4)</td>
<td>9 (1.8)</td>
<td>22 (7.5)</td>
<td>44 (2.2)</td>
</tr>
<tr>
<td>D</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>1 (0.2)</td>
<td>4 (1.4)</td>
<td>5 (0.2)</td>
</tr>
<tr>
<td>Total</td>
<td>599</td>
<td>625</td>
<td>513</td>
<td>292</td>
<td>2029</td>
</tr>
</tbody>
</table>

Data are presented as number of persons (column percent).

Mortality Data
In the Rochester Epidemiology Project, mortality data are collected by reviewing community medical records, death certificates, and obituary notices. Participants were assessed for mortality by November 1, 2004, at which time they were censored. This provided 11 210 person-years of follow-up (median 5.5 years) with 129 deaths. Active surveillance of the first 974 persons recruited to participate in follow-up identified no additional deaths.

Statistical Analysis
Categorical data are summarized as a percent of the group total with corresponding 95% CIs based on the normal approximation, and comparison between groups were based on the χ² test for association. Continuous variables are summarized as mean±SD, and comparisons between groups were based on ANOVA models. Post-ANOVA comparisons of continuous variables were based on the t test, but no adjustments for multiple comparisons were made. Time to death was summarized with the Kaplan-Meier estimate. Comparisons between groups were based on the log-rank test for univariate analyses and Cox proportional hazards regression models when adjusting for confounders such as age and gender. The assumption of proportional hazards was tested for the model, and no significant departure was found. Two-sided probability values <0.05 were considered significant.

Results
Prevalence of HF Stages
Participant characteristics are provided in Table 2. In the present study cohort, 640 persons (31.5%; 95% CI, 19.0% to 43.6%) were classified as having HF. Table 3 shows the prevalence of HF stages stratified by age.

To account for all subjects who described exertional dyspnea and fatigue (SAS score II to III), exercise capacity was classified as class I (exercise capacity 4 to 7 METS), class II (exercise capacity 2 to 7 METS), or class III (exercise capacity 0 to 2 METS). The authors had full access to the data and take full responsibility for its integrity. All authors have read and agree to the manuscript as written.
34.0%) were classified as normal (stage 0; Table 3). Stage A (HF risk factors) included 454 persons and accounted for 22.4% (95% CI, 20.6% to 24.2%) of the cohort. Stage B, with asymptomatic structure or function, comprised 691 persons and accounted for 34.1% (95% CI, 32.0% to 36.0%) of the cohort. Because stage B is a clinically silent group not likely to undergo clinical evaluation, we examined the range of asymptomatic abnormalities that resulted in stage B assignment: 60% (n = 364) had DD, 34% (n = 188) had LV enlargement, 5% (n = 36) had echocardiographically moderate or severe valvular heart disease, 24% (n = 133) had echocardiographic LVH, 10% (n = 66) had systolic dysfunction, 8% (n = 5) had a history of myocardial infarction, 7% (n = 51) had regional wall-motion abnormalities, and 2% (n = 16) had ECG LVH. Because 217 individuals entered stage B based only on DD, we further evaluated the impact of DD on stage B prevalence (Figure 1). Stage B prevalence decreased from 34% to 23% if only moderate or severe DD was considered as abnormal and remained 23% if DD was not considered as a stage B–qualifying abnormality. Fifty-eight subjects in stage B had physical signs of HF (edema, increased jugular venous pressure, or third heart sound) but not Goldman SAS class II to III symptom limitations that would classify them as stage C. This group had similar all-cause mortality to stage B subjects without physical signs of HF (data not shown) and were classified as stage B rather than stage C.

Stage C, which comprised 239 persons with symptomatic HF, accounted for 11.8% (95% CI, 10.5% to 13.3%) of the cohort. Within stage C, 195 persons were classified as early stage C1, with dyspnea and fatigue limitations on the SAS questionnaire but not meeting the Framingham HF criteria, which accounted for 9.6% (95% CI, 8.0% to 11.0%) of subjects. Forty-four stage C2 subjects (2.2%; 95% CI, 1.6% to 2.9%) met the Framingham HF criteria. Stage C1 subjects had fewer abnormalities of cardiac structure and function than stage C2 subjects (Table 4). Five stage D persons with end-stage HF represented 0.2% (95% CI, 0.1% to 0.6%) of the cohort.

The prevalence of stages B through D increased with advancing age (Table 3). The age distribution of HF stages was similar in men and women (data not shown).

**BNP Levels in HF Stages**

Mean plasma BNP concentration increased from stage 0 (26 pg/mL; CI 20 to 32 pg/mL) to stage A (32 pg/mL; 95% CI, 25 to 40 pg/mL), stage B (53 pg/mL; 95% CI, 47 to 59 pg/mL), stage C1 (117 pg/mL; 95% CI, 106 to 128 pg/mL), stage C2 (222 pg/mL; 95% CI, 199 to 245 pg/mL), and stage D (353 pg/mL; 95% CI, 279 to 428 pg/mL; P < 0.0001 by ANOVA). Post-ANOVA comparisons of BNP levels at each stage revealed that BNP was significantly (P < 0.05) greater in each successive stage from B through D. BNP in advanced stage C2 was significantly higher than mild C1. Stage 0 and stage A BNP levels were not different from each other but were significantly lower than BNP levels in stage B.

**Survival Analysis**

HF stages were associated with progressively worsening 5-year survival rates (Figure 2): stage 0 98.9% (95% CI, 98.0% to 99.0%), stage A 97.0% (95% CI, 94.3% to 98.8%), stage B 95.7% (95% CI, 94.2% to 97.3%), stage C (C1 + C2)
74.6% (95% CI, 68.9% to 80.4%), early stage C, 78.0% (95% CI, 72.0% to 84.0%), advanced stage C, 60.0% (95% CI, 40.0% to 75.0%), and stage D: 20.0% (95% CI, 15.0% to 55.0%). HF stages A through D were associated with progressively increasing all-cause mortality hazard ratios (HRs) compared with stage 0, both with (Table 5) and without (results not shown) adjustment for age and sex. Deterioration from stage B to C and from stage C to D was associated with significant incremental increases in HR: stage B versus A, HR = 1.7 (95% CI, 0.9 to 3.3; P = 0.1); stage C versus B, HR = 9.6 (95% CI, 6.8 to 13.6; P < 0.0001); and D versus C, HR = 5.3 (95% CI, 1.9 to 12.1; P = 0.004). Cox proportional hazards analysis, stratified by gender, showed that men had a higher HR than women at any stage and a 4- to 6-fold higher risk in stages B and C (Table 6).

Discussion

This study applies ACC/AHA HF staging in a community population to clarify our understanding of the burden of ventricular dysfunction and HF in adults >45 years of age. The analysis provides a coherent cross-sectional picture of HF from its preclinical risk factors to its advanced manifestations in a single uniformly evaluated, randomly selected, population-based cohort. Although 32% of subjects were healthy (stage 0), 22% carried the burden of HF risk factors (stage A), 34% demonstrated asymptomatic abnormalities of cardiac structure or function (stage B), and 12% manifested structural and functional abnormalities and overt HF symptoms (stages C and D). HF stages were associated with progressively increasing plasma BNP concentration and progressively higher 5-year mortality rates.

HF as a Progressive Condition

Longitudinal studies show that cardiac injury causes progressive chamber remodeling. Incremental chamber size and decreased ventricular function lead to symptomatic HF, with its attendant morbidity and mortality. Early diagnosis and intervention are advocated to prevent disease progression.

Stage A: HF Risk Factors

The selection of HF risk factors to define stage A was intentionally conservative. Risk factors prospectively demonstrated to predict incident cases of HF were used: hypertension, diabetes mellitus, obesity, and coronary artery disease. Inclusion of less rigorously established risk factors would have further increased the size of stage A at the expense of stage 0. Even so, the presence of HF risk factors in 22% of persons highlights the number of persons in whom risk factor management is indicated.

Stage B: Asymptomatic Cardiac Dysfunction

The magnitude of stage B prevalence depends on the cardiac structure and function abnormalities used to select persons for this category and on the criteria chosen to distinguish asymptomatic from symptomatic persons. Only echocardiographic abnormalities shown to predict incident HF cases or mortality were chosen: increased LV mass, LVEDD, LV DD, or decreased EF. Inclusion of other echocardiographic parameters could have further increased the relative size of stage B. To be considered asymptomatic, subjects had to be SAS class I, indicating the ability to perform activities requiring ≥7 METS of exercise capacity without fatigue or dyspnea limitations.

A 34% prevalence of stage B symptomatic ventricular dysfunction among persons ≥45 years of age suggests the size of the population in whom early identification of abnormal ventricular structure and function may be important. This HF stage also describes a group in whom clinical trials of early pharmacological intervention for systolic and diastolic dysfunction are appropriate.

A unique aspect of the present study is the ability to include a graded measurement of diastolic function in the definition of stage B. Recent studies have shed light on the substantial contribution that DD plays in HF with preserved EF, the prognostic significance of diastolic HF, and the increasing proportion of HF patients who manifest primarily diastolic HF. The current ACC/AHA criteria reflect an increased recognition of the role of DD in the evolution of HF, and a comprehensive HF staging scheme is enhanced if it can take into account the role of DD in the progression to HF with normal EF.
Stage C: Overt HF
To be classified as stage C, subjects had to have abnormality of LV structure or function and score as class II to III on the Goldman SAS (functional limitation from dyspnea or fatigue at an exercise level of 2 to 7 METS). The 12% prevalence of stage C is considerably higher than the prevalence of overt HF previously reported in population cohorts, including this one, that have used a clinical definition such as the Framingham criteria to identify HF.13,16,19 In the present study, application of the Framingham criteria (stage C2) identified 2.2% of the population, a prevalence comparable to other studies of HF prevalence in this age range.5,16,19 However, in recognition of persons with echocardiographic ventricular dysfunction who have functional limitation from fatigue or dyspnea but do not yet fulfill the Framingham criteria, the present study included all persons with ventricular dysfunction who were Goldman SAS class II to III in its definition of stage C symptomatic HF. This broader definition of symptomatic HF identified a larger group, stage C1, which accounted for 9.6% of the population. The validity of this broader definition of symptomatic HF is borne out by the doubling of plasma BNP from stage B (53 pg/mL) to stage C1 (117 pg/mL). There is also a substantial decrease in 5-year survival between stage B and stage C1 (from 96% to 78%), which suggests that C1 subjects with ventricular dysfunction and functional limitation who do not yet fulfill the Framingham HF criteria should be considered to have overt HF.

Plasma BNP and HF Stages
Plasma BNP concentrations have been shown to be associated with LV dysfunction and to have independent prognostic value for hospitalization and mortality events.36 In the present study, plasma BNP concentrations rose incrementally and significantly from HF stages A through D, providing a neurohormonal correlate across the stages.

Association of HF Stages With Mortality
Five-year survival decreased most sharply at the transition from stage B asymptomatic LV dysfunction to stage C symptomatic HF, from 96% to 75%. Stage B was a significant mortality predictor in an unadjusted model and continued to be a significant predictor after adjustment for sex; however, after adjustment for age, it lost statistical significance, which implies a strong association between stage B abnormalities and age.

Clinical Implications
The development of stage B is associated with increased mortality risk in men. Transition from stage B to stage C1 is associated with a 5-fold increase in mortality risk in both men and women, which suggests that the development of even mild exercise limitations portends a significant increase in risk. These findings underscore the importance of identifying persons as early as stage B (asymptomatic), and certainly at stage C1 (mildly symptomatic), for early diagnosis and intervention.

Strengths and Limitations
The strengths of the present study include its randomly selected population-based sample, the availability of medical records with a 36-year median length of archive, uniform collection of cross-sectional data, and standardized echocardiographic measurements. A unique strength is the Doppler-echocardiographic assessment of diastolic function. The use of the Goldman SAS for classification of functional status impairment based on a series of specific questions reduces bias that may result from an unstructured interview technique such as the New York Heart Association HF classification. In our attempt to use only HF risk factors prospectively proven to be predictive of HF, we may have generated an excessively conservative prevalence estimate of stage A. Future studies may need to include more clinical or echocardiographic risk factors if they are prospectively proven to be independent predictors of HF.

The cross-sectional nature of the study limits the ability to eliminate survivor bias, to assess time-dependent changes, and to make cause-effect inferences. Long-term follow-up will be necessary to fully assess the risk of progression from stage A to stage C. The small number of stage D subjects limits the power to make meaningful observations about end-stage HF. Owing to the small number of deaths, the mortality risk ratio CIs are wide, which indicates a relative lack of power for sex-specific mortality analysis.

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**TABLE 6. Cox Proportional Hazard Analysis of All-Cause Mortality for CHF Staging in Men and Women**

<table>
<thead>
<tr>
<th></th>
<th>Deaths/Persons in Stage, n</th>
<th>HR* (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6/238</td>
<td>1.9 (0.5–6.9)</td>
<td>0.32</td>
</tr>
<tr>
<td>B</td>
<td>25/345</td>
<td>4.0 (1.3–11.9)</td>
<td>0.0110</td>
</tr>
<tr>
<td>C</td>
<td>37/88</td>
<td>26.0 (8.9–75.9)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>C1</td>
<td>24/63</td>
<td>22.0 (7.3–66.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>C2</td>
<td>13/25</td>
<td>38.4 (12.1–121.9)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>D</td>
<td>3/3</td>
<td>60.4 (12.8–286.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>A</td>
<td>7/216</td>
<td>1.6 (0.5–4.9)</td>
<td>0.42</td>
</tr>
<tr>
<td>B</td>
<td>8/346</td>
<td>0.9 (0.3–2.7)</td>
<td>0.84</td>
</tr>
<tr>
<td>C</td>
<td>31/151</td>
<td>6.6 (2.6–16.5)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>C1</td>
<td>23/132</td>
<td>5.5 (2.1–14.1)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>C2</td>
<td>8/19</td>
<td>14.7 (4.9–44.3)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>D</td>
<td>2/2</td>
<td>48.7 (9.3–254.9)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

*Each stage compared with stage 0 HF. Results of the model adjusted for age, sex, stage, and interactions between age and sex with stage. The interaction between sex and stage was significant (P=0.0293). Individual testing indicated that most of the sex differences came from differences in responses between male and female stage B (P=0.0466) and stage C (P=0.0494) patients.
Retrospective assignment of HF stage classification to participants could lead to misclassification. However, because data were collected prospectively, without knowledge of the forthcoming ACC/AHA staging definitions, class assignment bias was avoided.

This predominantly white cohort includes only persons ≥45 years of age, so conclusions cannot be generalized to the entire US population. Participation bias has been evaluated: Medical record abstraction of a random selection of 500 participants and 500 invited nonparticipants showed no difference in cardiovascular disease. However, 5-year all cause mortality was 94% among participants and 87% among nonparticipants, which suggests an element of participation bias.

Conclusions

This study shows that the proposed classification of HF into stages A through D is conceptually, biohormonally, and prognostically sound. The high prevalence of stages A and B and the worsening prognosis associated with progression to stage C signal a need for the development of diagnostic and treatment strategies to prevent progression from asymptomatic ventricular dysfunction to symptomatic HF.

Acknowledgment

We thank Tammy S. Burns for expert manuscript preparation.

Sources of Funding

This study was supported by grants from the Public Health Service (National Institutes of Health [NIH] HL 555902 to Dr Rodeheffer, NIH AR30582 to Dr Jacobsen, NIH HL 62381 to Dr Redfield, and NIH HL 36634 to Dr Burnett) and by the Mayo Clinic Foundation.

Disclosures

None.

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Prevalence of CHF Stages in the Community


**CLINICAL PERSPECTIVE**

Heart failure (HF), a major form of cardiac disease associated with high morbidity and mortality, is increasing in prevalence. The American Heart Association and American College of Cardiology proposed the concept of heart failure staging to emphasize the progression from HF risk factors to asymptomatic cardiac dysfunction to clinically overt HF. The prevalence of HF stages in the community is unknown. This cross-sectional, population-based, community study of 2029 persons ≥45 years old provides prevalence estimates for HF stages: 22% of persons had risk factors for HF (stage A), 34% had asymptomatic abnormalities of cardiac structure/function (stage B), 12% had HF symptoms associated with abnormalities of cardiac structure/function (stage C), and 0.2% had end-stage HF (stage D). HF stages were associated with a progressive increase in plasma B-type natriuretic peptide concentration and with progressively severe 5-year mortality rates. In total, 56% of adults ≥45 years of age have HF risk factors or asymptomatic cardiac dysfunction and constitute a target population for HF prevention efforts. Longitudinal community studies will be necessary to clarify the rate of progression through the HF stages and to assess the impact of prevention and treatment strategies on HF progression.