Incidence and Prevalence of Heart Failure in Elderly Persons, 1994-2003

Lesley H. Curtis, PhD; David J. Whellan, MD, MHS; Bradley G. Hammill, MS; Adrian F. Hernandez, MD, MHS; Kevin J. Anstrom, PhD; Alisa M. Shea, MPH; Kevin A. Schulman, MD

Background: Recent analyses have presented conflicting evidence regarding the incidence and prevalence of heart failure in the United States. We sought to estimate the annual incidence and prevalence of heart failure and associated survival in elderly persons from January 1, 1994, through December 31, 2003.

Methods: We conducted a retrospective cohort study of 622,789 Medicare beneficiaries 65 years or older who were diagnosed as having heart failure between 1994 and 2003. The main outcome measures were incidence and prevalence of heart failure and survival following a heart failure diagnosis.

Results: The incidence of heart failure declined from 32 per 1000 person-years in 1994 to 29 per 1000 person-years in 2003 (P < .01). Incidence declined most sharply among beneficiaries aged 80 to 84 years (from 57.5 to 48.4 per 1000 person-years, P < .01) and increased slightly among beneficiaries aged 65 to 69 years (from 17.5 to 19.3 per 1000 person-years, P < .01). Although risk-adjusted mortality declined slightly from 1994 to 2003, the prognosis for patients diagnosed as having heart failure remains poor. In 2002, risk-adjusted 1-year mortality was 27.5%, more than 3 times higher than for age- and sex-matched patients.

Conclusions: Although the incidence of heart failure has declined somewhat during the past decade, modest survival gains have resulted in an increase in the number of patients living with heart failure. Identifying optimal strategies for the treatment and management of heart failure will become increasingly important as the size of the Medicare population grows.

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THE IMPACT OF HEART FAILURE ON PUBLIC HEALTH IS SUBSTANTIAL. Heart failure affects nearly 5 million people in the United States, and more than 300,000 die each year as a result of the disease.1 Heart failure is primarily a disease of elderly persons and, consequently, places a significant and growing economic burden on the Medicare program. From 1984 to 2002, hospitalizations for heart failure among people 65 years or older increased by more than 30%.2

Recent analyses of community-based cohorts have presented conflicting pictures of heart failure in the United States. Data from the Framingham study suggest that the incidence of heart failure may be declining among women but not men, whereas survival may be improving slightly among both women and men.3 In contrast, an analysis of data from Olmsted County, Minnesota, implied that the incidence of heart failure has remained stable during the past 20 years in both men and women and that men and patients 70 years or younger have experienced disproportionate gains in survival.4 More recently, an increase in incidence was observed in an elderly, community-based, managed care population from the early 1970s through the early 1990s, with improved survival among men but not women.5

Estimates of the incidence and prevalence of heart failure in elderly persons translate directly into projections of resource use for the Medicare program, so accurate estimates are essential. Furthermore, documenting trends in incidence and prevalence helps policy makers and professional societies evaluate the impact, if any, of programs designed to improve cardiovascular health. Using claims data from a 5% sample of Medicare beneficiaries, we undertook a study to examine the annual incidence and prevalence of heart failure and associated survival by age and sex from January 1, 1994, through December 31, 2003.

Methods

Data Sources

Data are from the Medicare inpatient, outpatient, and carrier standard analytic files (a 5%
national sample) and the corresponding denominator files. The inpatient files contain institutional claims for facility costs covered under Medicare part A, and the outpatient files contain claims by institutional outpatient providers (e.g., hospital outpatient departments and ambulatory surgery centers). Available data elements include beneficiary, physician, and hospital identifiers; admission and discharge dates; and International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes. The carrier files contain noninstitutional provider claims for services covered under Medicare part B. Unique patient identifiers, dates of service, and ICD-9-CM diagnosis codes are among the variables included in the files. The denominator files contain beneficiary identifiers, dates of birth, sex, race/ethnicity, dates of death, and information about program eligibility and enrollment.

We obtained all files for 1991 through 2003 from the Centers for Medicare & Medicaid Services. We eliminated invalid records and limited the analysis to persons 65 years and older living in the United States.

The institutional review board of the Duke University Health System approved the study.

PATIENTS

We included beneficiaries for whom a diagnosis of heart failure (ICD-9-CM code 428.XX, 402.X1, or 404.X3) was reported on a single inpatient claim. This approach has greater than 95% specificity for the diagnosis of heart failure.8,9 We also included beneficiaries for whom a heart failure diagnosis appeared on at least 3 carrier or outpatient claims for services provided on different days within 20 consecutive months.9,10 We reasoned that elderly patients with heart failure who were cared for exclusively as outpatients were likely to be seen at least once every 6 to 7 months.

To specify disease onset (“incident diagnosis”), we used the earlier of the following: (1) the date of the earliest inpatient heart failure diagnosis or (2) the date of the third outpatient or carrier heart failure diagnosis. To be considered an incident case, a beneficiary had to have at least 12 prior months in which no claim listed heart failure as a diagnosis. Once identified as having heart failure, patients remained in the disease cohort for the remainder of the analysis but were excluded from subsequent analyses of incidence rates. Patients were included in the prevalence cohort if they met the diagnostic criteria for heart failure by December 31 of each year.

STATISTICAL ANALYSIS

We used Poisson regression models to calculate age-adjusted incidence and prevalence from 1994 through 2003. We fit separate models by sex and age category (i.e., men or women aged 65-69, 70-74, 75-79, 80-84, or ≥89 years). In the sex-specific models, we included admission and discharge dates, which imposed the same age distribution across all years. We calculated standard errors assuming a Poisson error distribution. We applied semiparametric weighted estimators to adjust the incidence and prevalence rates for censoring that arises when beneficiaries switch to managed care.11 The method inversely weights the uncensored observations by their estimated probability of not being censored. This method has performed well in finite samples, even in the presence of heavy censoring.11 We used a Cox proportional hazards model to model the censoring distribution as a function of age, sex, race/ethnicity, and geographic region.

We examined characteristics of patients in the incident cohort. Categorical variables are presented as frequencies, and continuous variables are presented as means (SDs). We identified comorbid conditions using the approaches described by Birman-Deych et al7 and Quan et al.12 Specifically, we searched all inpatient, outpatient, and carrier claims for 365 days preceding the date of incident diagnosis for evidence of cerebrovascular disease (ICD-9-CM codes 436.34 and 430.X-438.X), chronic obstructive pulmonary disease (416.8, 416.9, 490.0-490.5, 506.4, 508.1, and 508.8), coronary heart disease (410.X-414.X, 429.2, and V45.81), dementia (290.x, 294.1, and 331.2), diabetes mellitus (250.x), hypertension (401.x-405.x and 437.2), metastatic disease (196.x-199.x), peripheral vascular disease (403.0, 437.3, 440.x, 441.x, 443.1-443.9, 471.1, 537.1, 557.9, and V43.4), or renal disease (403.01, 403.11, 403.91, 404.02, 404.036, 404.12, 404.13, 404.92, 404.93, 582.x, 583.0-583.7, 585.x, 586.x, 588.0, V42.0, V45.1, and V56.x).

To test the statistical significance of changes over time, we used linear regression for continuous variables and χ² tests of trend for categorical variables.

We used a Cox proportional hazards model to examine survival trends during the 10-year study period, adjusting for age at incidence and year of diagnosis. In addition, we examined age-adjusted survival by sex and by source of incident diagnosis (inpatient vs outpatient). We calculated 30-day, 1-year, and 5-year unadjusted and risk-adjusted mortality using logistic regression models that controlled for age at incidence, race/ethnicity, comorbidities in the 12 months preceding diagnosis, and whether the date of incidence was determined based on inpatient or outpatient claims. The risk-adjusted mortality rate provides an estimate of what the annual mortality rate would have been if the mix of patients were identical over time. To calculate the risk-adjusted mortality rate, we divided the observed mortality rate by the expected mortality rate and multiplied that ratio by the overall observed mortality rate. We calculated upper and lower confidence limits using the method described by Shwartz et al.13 We fit separate regressions by sex and age category and overall for each mortality end point. Finally, we used standardized mortality ratios to compare the observed number of deaths within 1 year of heart failure incidence with the expected number of deaths computed from the Medicare 5% sample by year, sex, and age category. We used SAS statistical software, version 8.2, for all analyses (SAS Institute Inc, Cary, North Carolina).

RESULTS

INCIDENCE

In a nationally representative 5% sample of Medicare beneficiaries, 622,786 patients were diagnosed as having heart failure between 1994 and 2003. Incidence declined slightly, from about 32 per 1000 person-years to 29 per 1000 person-years (P < .01). Incidence among men surpassed incidence among women each year by approximately 10 cases per 1000 person-years. Incidence among both men and women decreased (Table 1). Temporal trends in age-specific incidence exhibited different patterns (Figure 1). Among beneficiaries aged 65 to 69 years, incidence increased from 17.5 to 19.3 per 1000 person-years (P < .01). Incidence among beneficiaries aged 75 to 79 years decreased from 37.6 to 32.8 per 1000 person-years, whereas incidence among beneficiaries aged 80 to 84 years decreased from 57.5 to 48.4 per 1000 person-years (P < .01 for both). Similarly, among beneficiaries 85 years and older, incidence decreased from 92.6 to 80.8 per 1000 person-years (P < .01). Within age categories, patterns were consistent for men and women (data not shown).

Table 2 shows characteristics of patients with incident heart failure in each year. Most patients with inci-
The rate of increase in prevalence moderated over time, reflecting declining incidence and relatively steady mortality rates. The proportion of beneficiaries with a heart failure diagnosis grew from 90 per 1000 in 1994 to 120 per 1000 in 2000, and remained at about 120 per 1000 through 2003.

MORTALITY

Unadjusted and risk-adjusted mortality declined slightly (Table 4). Between 1994 and 2003, risk-adjusted 30-day mortality decreased by more than 5%, from 13.0% to 12.6% for men and from 11.5% to 10.8% for women (Figure 2). Risk-adjusted 1-year mortality decreased by 5%, from 28.9% to 27.5%. Risk-adjusted 5-year mortality declined by 3% from 1994 to 2003, from 67.5% to 64.9% for men and from 61.7% to 60.2% for women. Median survival following incident diagnosis was 2.9 years, and was higher for women than for men (3.1 vs 2.7 years; P < .01). Risk-adjusted mortality was markedly higher among incident cases identified based on an inpatient claim, compared with those identified based on 3 outpatient claims (Figure 3). Patients with heart failure had markedly higher mortality than expected, based on the expected number of deaths computed from the 5% sample by year, sex, and age category. The 1-year standardized mortality ratio was approximately 3.3 throughout the study period; the 5-year standardized mortality ratio was approximately 1.7.

PREVALENCE

The prevalence cohort increased steadily from approximately 140 000 to approximately 200 000 (Table 3). Prevalence among men exceeded prevalence among women in each year. By 2003, nearly 130 per 1000 men had a heart failure diagnosis, compared with 115 per 1000 women. The rate of increase in prevalence moderated over time, reflecting declining incidence and relatively steady mortality rates. The proportion of beneficiaries with a heart failure diagnosis grew from 90 per 1000 in 1994 to 120 per 1000 in 2000, and remained at about 120 per 1000 through 2003.

MORTALITY

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In a nationally representative sample of nearly 3 million Medicare beneficiaries, we found a modest decline in the incidence of heart failure among both men and women from 1994 to 2003. Incidence increased among patients aged 65 to 69 years, but declined among patients 75 years or older. Survival improved among both men and women, although risk-adjusted mortality was consistently lower for women. Although the prevalence of heart failure increased from 1994 to 2003, the rate of increase slowed, reflecting declining incidence and relatively steady mortality. To our knowledge, this is the largest study of the incidence and prevalence of heart failure in the United States.

Perhaps most striking is the modest but steady decline in the annual incidence of heart failure among both
men and women. In contrast, the Framingham study reported no change in incidence among men and a decrease in incidence among women between the periods 1950 through 1969 and 1990 through 1999. Data from Olmsted County suggested stable incidence between 1979 and 2000. Several factors may contribute to these differences. First, the size of our data set allowed us to calculate annual incidence with a high degree of precision. In previous analyses, data were aggregated over the years in which we observed declining rates, possibly obscuring a slight downward trend. Moreover, the period during which the decline is most apparent (January 1, 1998-December 31, 2003) is only partially represented in the other analyses.

Second, the patterns observed in the Olmsted County and Framingham studies may not generalize to the national Medicare population. Both cohorts were almost exclusively white, Framingham study participants may have had better access to health care, and Olmsted County residents tended to have more education and higher income than the general US population. Third, the decline in incidence is most notable among individuals 75 years or older. Although the Framingham and Olmsted County studies included elderly persons, the sample sizes may not have been large enough to detect a downward trend or to affect overall incidence. The decline in incidence in the older age groups contrasts with findings of a recent analysis of an el-

Table 2. Characteristics of Patients With Incident Heart Failure in the Medicare 5% Sample, 1994-2003

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<td>78.4 (7.9)</td>
<td>78.4 (7.9)</td>
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<td>78.3 (7.9)</td>
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<td>28.3</td>
<td>29.2</td>
<td>30.3</td>
<td>31.0</td>
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a Data are given as percentages unless otherwise indicated. bPercentages may not total 100 because of rounding.

Table 3. Prevalence of Heart Failure in the Medicare 5% Sample by Sex and Year

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<th>Year</th>
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<td>1996</td>
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<tr>
<td>2001</td>
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a Data are given as number (rate). Rates shown are per 1000 eligible Medicare beneficiaries. P<.01 for females, males, and the overall group for all years.
derly, community-based, managed care population, in which age- and sex-adjusted incidence rates increased from 10.0 to 11.3 per 1000 person-years between the periods 1970 through 1974 and 1990 through 1994. The lack of temporal overlap between the 2 analyses makes it difficult to determine whether the findings are truly inconsistent.

The overall decline in incidence may reflect improvements in the treatment of hypertension and cardiovascular disease. In the Cardiovascular Health Study,14 treatment of hypertension in elderly persons increased from 66% in 1990 to 81% in 1999. Similarly, control of hypertension among patients aged 40 to 59 years increased from 28.9% to 41.6% between the periods 1988 through 1991 and 1999 through 2000.15 Other studies have documented increases in the use of aspirin,16-18 β-blockers,16-18 lipid-lowering agents,17,18 and angiotensin-converting enzyme inhibitors16-18 for cardiovascular disease, although overall rates remain suboptimal.

Mortality declined only slightly during the study period, and the prognosis for patients with heart failure remains poor. Nearly 30% died within 1 year of incident diagnosis, and more than 60% died within 5 years. Moreover, mortality was much higher than expected. The stability of the standardized mortality ratios over time suggests that the modest survival gains were not limited to patients with heart failure but were experienced in the overall Medicare population. These findings are consistent with earlier reports3,4,19 and highlight the challenge of effectively treating heart failure in elderly persons. Clinical trials have demonstrated survival gains associated with treatments for heart failure,20-24 but elderly patients are
Comorbidities in the 12 months before heart failure incidence increased throughout the study period. The prevalence of hypertension and diabetes mellitus at baseline increased markedly, likely reflecting real increases in the prevalence of these conditions\(^{29,30}\) and increases in their coding.\(^{31}\) Accompanying increases in the prevalence of cerebrovascular disease, chronic obstructive pulmonary disease, peripheral vascular disease, and kidney disease in the incident cohort suggest that the complexity of newly diagnosed heart failure cases is increasing as well.

Our findings suggest that the prevalence of heart failure approached 121 per 1000 Medicare beneficiaries by 2003, or more than 4 million beneficiaries. Although the increase has slowed in recent years, absolute numbers will continue to increase as the Medicare population grows. The number of elderly Medicare beneficiaries may exceed 50 million by 2020.\(^{2}\) Even if the prevalence of heart failure remains stable at 120 per 1000, more than 6 million Medicare beneficiaries will have heart failure by 2020. Identifying cost-effective strategies for managing the disease will become increasingly important as the size of the Medicare population grows.

Our study has some limitations. First, estimates of incidence from a claims-based algorithm are not directly comparable to estimates based on medical record review and may yield higher rates.\(^{32}\) Second, coding of diseases and conditions is not always accurate and changes over time.\(^{31}\) Such changes could affect patterns of incidence and prevalence over time. Similarly, our estimates of incidence and prevalence may be artificially high if Medicare financial incentives encourage the coding of heart failure.\(^{33}\) However, the steady declines we observed in relative and absolute incidence suggest that “up-coding” may not have been problematic during this period. In addition, claims data do not include information about left ventricular function, so it is not possible to determine whether the observed trends reflect changes in systolic heart failure, diastolic heart failure, or both.

Finally, claims data were not available from the period before participants were eligible for Medicare, so incidence among beneficiaries aged 65 to 69 years may be artificially high if heart failure diagnoses before enrollment were incorrectly classified as incident on enrollment. Moreover, claims data are not available during periods of managed care coverage. To help account for patients without continuous fee-for-service coverage, we applied greater weight to patients with continuous fee-for-service coverage. The size of the weight depended on the age, sex, and race/ethnicity of the patient and on the geographic region in which the patient lived (ie, patients in managed care were represented by patients with claims and similar demographic characteristics). As a result, patients with complete fee-for-service coverage living in regions with high managed care penetration were weighted more heavily.

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Correspondence: Lesley H. Curtis, PhD, Center for Clinical and Genetic Economics, Duke Clinical Research Institute, PO Box 17969, Durham, NC 27715 (lesley.curtis@duke.edu).

Author Contributions: Dr Curtis had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Curtis and Whellan. Acquisition of data: Curtis and Shea. Analysis and interpretation of data: Curtis, Whellan, Hammill, Hernandez, Anstrom, and Schulman. Drafting of the manuscript: Curtis and Whellan. Critical revision of the manuscript for important intellectual content: Curtis, Whellan, Hammill, Hernandez, Anstrom, and Schulman. Statistical analysis: Curtis, Hammill, and Anstrom. Obtained funding: Curtis, Whellan, and Hernandez. Administrative, technical, and material support: Shea and Schulman. Study supervision: Curtis and Whellan.

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Medicare claims are the only national longitudinal source of data regarding heart failure in the United States. Because most patients with heart failure are elderly, Medicare claims data are highly representative of the population with heart failure. Moreover, the size of the data set allowed us to generate precise estimates even for relatively small cohorts (eg, beneficiaries aged ≥85 years). The analysis provides strong evidence that heart failure remains an important clinical finding in the Medicare population, affecting more than 1 in 10 beneficiaries. Although incidence has declined somewhat during the past decade, modest survival gains have resulted in more patients living with heart failure. Identifying optimal strategies for the treatment and management of heart failure will become increasingly important as the size of the Medicare population grows.


