Congestive Heart Failure in the Community

Trends in Incidence and Survival in a 10-Year Period

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Objective: To compare the incidence of congestive heart failure and the survival in patients with congestive heart failure in Rochester, Minn, in 1981 with that observed in 1991.

Methods: Population-based, descriptive epidemiological study with ecological and individual level comparisons over time. Olmsted County, Minnesota, where the Rochester Epidemiology Project provides passive surveillance of the population for health outcomes. All 248 patients fulfilled the Framingham criteria, 107 patients presenting with the new onset of congestive heart failure in 1981 and 141 patients in 1991. The community inpatient and outpatient medical records of all incident cases were reviewed to evaluate the presenting characteristics of patients at diagnosis.

Results: The incidence of congestive heart failure after adjustment for age and sex to the US population was not significantly different in the 1991 cohort compared with that in 1981 (3.0 per 1000 person-years; 95% confidence interval, 2.5-3.5 vs 2.8 per 1000 person-years; 95% confidence interval, 2.2-3.3; *P* = .55). The survival of patients with new diagnosis of congestive heart failure was similar in the 2 cohorts (*P* = .53). Survival adjusted for age, sex, and New York Heart Association functional class was not significantly different in patients with congestive heart failure in 1981 and 1991 (relative risk, 0.907; *P* = .55).

Conclusions: These data suggest that recent advances in management of cardiovascular disease, as used in the community, had not yet impacted incidence or survival of patients with congestive heart failure in the community during the 10-year study period. This highlights the need to continue efforts to ensure that advances in diagnosis and therapy are incorporated into the care of patients with congestive heart failure in the community.

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IT HAS been estimated that congestive heart failure (CHF) in the United States affects approximately 2.3 million individuals, with 400 000 new cases per year,[1] and causes 274 000 deaths per year.[2] Although data concerning CHF in the community are essential to evaluate the risk of CHF developing and the impact of care given to patients with CHF in a nonreferral setting, few population-based data are available regarding the incidence and the prognosis of CHF.[3-7]

The trend in incidence and survival of patients with CHF over time and the effects this may have on the prevalence of this disease are controversial. It has been postulated that the decrease of case-fatality rates from cardiovascular disease may lead to a higher incidence of CHF, especially in the elderly.[2] Conversely, some authors[8-10] hypothesize that by limiting myocardial infarction size with thrombolysis or revascularization (or both) and with the widespread use of antihypertensive therapy, a reduction in the incidence of CHF should be noted. However, the incidence has declined only modestly over 3 decades, as reported in the Framingham Study,[11] although this study predated the widespread use of angiotensin-converting enzyme (ACE) inhibitors[12-15] or thrombolysis. If incidence remains stable or increases, the prevalence of CHF may increase dramatically as the population ages.[16]

Because relatively limited data are available regarding secular trends in the occurrence and outcome of CHF in the community, this study was designed to compare the incidence of CHF and the survival in patients with CHF in the community of Rochester, Minn, in 1981 to that observed in 1991. Only cases of definite CHF that satisfied the Framingham criteria were included in this study. We

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METHODS

The population of Rochester was well suited for this study of CHF because comprehensive, linked-unit medical records are available for the residents and are accessible through a centralized index of diagnoses.[17] The central file of medical records compiled by the Rochester Epidemiology Project includes essentially all sources of medical care available to and used by the local population. These include the Mayo Clinic and the Mayo Medical Center Hospitals, the Olmsted Medical Center, the Olmsted Community Hospital, the University of Minnesota Hospitals, and the Veterans Affairs Hospitals in Minneapolis. Data from several small community hospitals in surrounding counties, from the one solo family practitioner in Rochester, and from local nursing homes are also indexed and added to the central data bank at the Mayo Clinic. Consequently, detailed information about the medical care provided to all residents of the community is available for study. This system ensures nearly complete case ascertainment for almost all major illnesses diagnosed among residents of Rochester. This index includes diagnoses made among outpatients seen in clinic and office consultations, emergency department visits, house calls, or nursing home care and diagnoses recorded among hospital inpatients and at death. The potential of this data system for population-based studies has been described previously.[18,19]

CHF INCIDENCE COHORT

The Rochester Epidemiology Project has identified 2 cohorts of residents of Rochester who were newly diagnosed as having CHF between January 1 and December 31 in 1981[17] and in 1991. The 1981 cohort included the cohort of Rodeheffer et al[17] (same criteria for selection and clinical assessment were used) but was extended to include subjects older than 75 years. This process identified all individuals with an initial diagnosis of CHF regardless of the setting in which a diagnosis was made. These cohorts included all individuals who were residents of Rochester at diagnosis of CHF and examined at the Mayo Clinic or any of the institutions with which the Rochester Epidemiology Project has linked medical records. At least 1 year of residence in Rochester before the diagnosis of CHF was required to be considered a resident of Rochester. This criterion is applied to minimize the potential for selection bias resulting from migration into Rochester because of illness.

The diagnosis of CHF was confirmed through a systematic review of the medical record. Only patients with definite CHF who fulfilled the Framingham criteria were included. Physicians' notes were examined for mention of major and minor criteria for CHF, according to Framingham criteria,[3] with minor modification. The major criteria were paroxysmal nocturnal dyspnea, orthopnea, abnormal jugular venous distention, rales, cardiomegaly, pulmonary edema, presence of a third heart sound, and central venous pressure of more than 16 cm H_2O. The minor criteria included edema, night cough, dyspnea on exertion, hepatomegaly, pleural effusion, tachycardia (>120 beats/min), and weight loss of 4.5 kg or more in 5 days (this finding was considered a major criterion if it occurred during therapeutic interventions for CHF). Individuals were assigned a diagnosis of CHF if 2 major criteria were present or, alternatively, if 1 major and 2 minor criteria were present concurrently. Clinical details at the time of diagnosis were obtained from the medical record. On the basis of the recorded history, patients were assigned to a New York Heart Association (NYHA) functional class. If the recorded history was not complete enough to allow such assignment, none was made. A random sample of 30 charts was reviewed in a blinded fashion by 2 independent observers (M.S. and C.M.T.) to test the reproducibility of criteria used for the diagnosis of CHF. The 2 observers had 100% agreement for the presence or absence of definite CHF.

Follow-up for analysis of survival was obtained through the comprehensive medical records and through the Survey Research Center at Mayo. For deceased patients, only the date of death was recorded; no effort was made to determine the cause of death. The presence of comorbid conditions was determined through review of the community medical records. Coronary artery disease was defined as the presence of a clinical diagnosis in the chart, or a positive result of a stress test, or coronary angiography with at least 1 vessel having a stenosis of more than 50%, or a clinical or an electrocardiographic diagnosis of myocardial infarction in the chart. A patient was considered to have hypertension if there was a clinical diagnosis in the chart, normal arterial blood pressure with ongoing antihypertensive therapy, or hypertension at diagnosis on 2 successive determinations with a systolic arterial blood pressure greater than 160 mm Hg or a diastolic arterial blood pressure greater than 90 mm Hg. The diagnosis of severe valve disease was based on angiographic or echocardiographic data. The criteria for idiopathic dilated cardiomyopathy were global left ventricular dilatation and impaired systolic function in the absence of a known cardiac or systemic cause.

STATISTICAL ANALYSIS

Continuous variables are expressed as mean ± SD. Group comparisons were based on Student t test or χ^2 test, as appropriate. Survival function estimates were derived by using the method described by Kaplan and Meier, and differences were tested with the log-rank test. Multivariate regression analysis was performed with the stepwise Cox proportional hazards model to identify independent predictors of survival. The candidate independent variables were age, sex, functional NYHA class, history of hypertension, history of coronary artery disease, history of valvular heart disease, history of dilated cardiomyopathy, history of smoking, history of diabetes, creatinine value, ACE-inhibitor treatment, and year of diagnosis (1981 vs 1991). The entry criterion in the multivariate analysis was $P<.15$, and $P<.05$ was considered significant.

Incidence rates were calculated as the observed number of cases divided by the age- and sex-specific person-years of observation. Estimates of the Rochester population at risk were derived from decennial census data for 1980 and 1990.[20] Rates were directly age and sex adjusted to the population of US whites in 1980. Ninety-five percent confidence intervals were constructed about the point estimates of incidence assuming a Poisson distribution.

Table 1. Clinical Characteristics of Patients With First Diagnosis of Congestive Heart Failure in 1981 and 1991＊

Characteristic	1981 (n = 107)	1991 (n = 147)	P
Mean ± SD age, y	75.0 ± 14.7	77.4 ± 11.7	.35
Age, >65 y	92 (86)	123 (84)	.77
Male	61 (57)	86 (59)	.53
History of smoking	50 (47)	40 (27)	.002
Diabetes mellitus	15 (14)	18 (12)	.71
Creatinine >115 µmol/L	32 (30)	50 (34)	.61
NYHA class†			
Mean ± SD	3.2 ± 1.4	2.7 ± 0.7	.001
I-II	30 (29)	60 (43)	.03
III-IV	72 (71)	80 (57)	.03
Cardiovascular disease			
CAD	62 (58)	76 (52)	.52
HTN	51 (48)	79 (54)	.19
VHD	7 (7)	9 (6)	.96
IDC	4 (4)	1 (1)	.99

＊Values are number (percentage) unless otherwise indicated. NYHA indicates New York Heart Association; CAD, coronary artery disease; HTN, hypertension; VHD, valvular heart disease; and IDC, idiopathic dilated cardiomyopathy.

†The NYHA functional class was able to be assessed in 102 patients in the 1981 cohort and 140 patients in the 1991 cohort.

Table 2. Incidence Rates of Congestive Heart Failure Adjusted to the US Population

|	Incidence Rate per 1000 Person-Years (SE/95% CI＊)		
Cohort	Male (Age Adjusted)	Female (Age Adjusted)	Total (Age and Sex Adjusted)
1981	3.7 (0.55/2.6-4.8)	2.1 (0.29/1.6-2.7)	2.8 (0.28/2.2-2.3)
1991	3.4 (0.45/2.5-4.2)	2.4 (0.27/1.8-2.9)	2.8 (0.24/2.3-3.3)

＊CI indicates confidence interval.

hypothesized that changes in the treatment of coronary artery disease and hypertension and the use of vasodilator therapy for CHF introduced during this time may have decreased the incidence of and mortality from this syndrome in the community.

RESULTS

In Rochester 248 patients fulfilled the study criteria: 107 patients presented with the new onset of CHF in 1981 and 141 patients in 1991. The median follow-up for these patients was 1061 days (25th percentile, 303; 75th percentile, 2355) and 1233 days (25th percentile, 409; 75th percentile, 1804) for the 1981 and 1991 cohorts, respectively. Follow-up was available on all patients. Clinical characteristics of new cases of CHF in the 2 cohorts are summarized in **Table 1**. Patients in the 1991 cohort were less symptomatic at diagnosis and fewer had a history of smoking compared with patients in the 1981 cohort. In 7 patients of the 1991 cohort and 5 of the 1981 cohort, the functional class was indeterminate. Coronary artery disease, hypertension, valvular disease, and cardiomyopathy were present in compa-
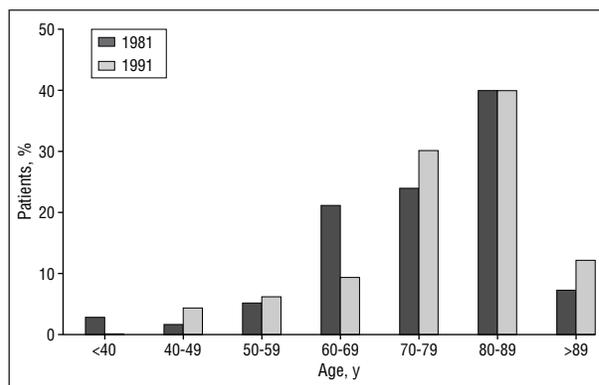
Figure 1. Age distribution of patients with congestive heart failure in 1981 and 1991 cohorts in Rochester, Minn.
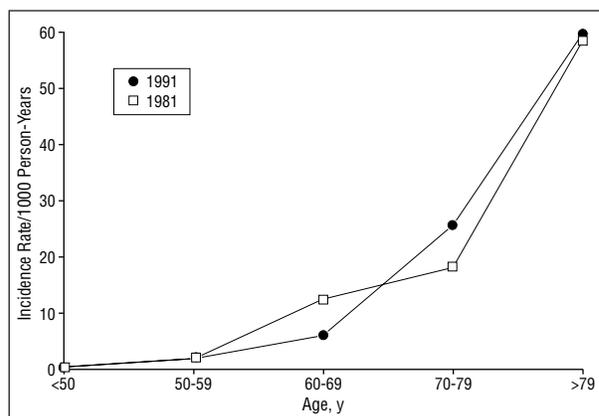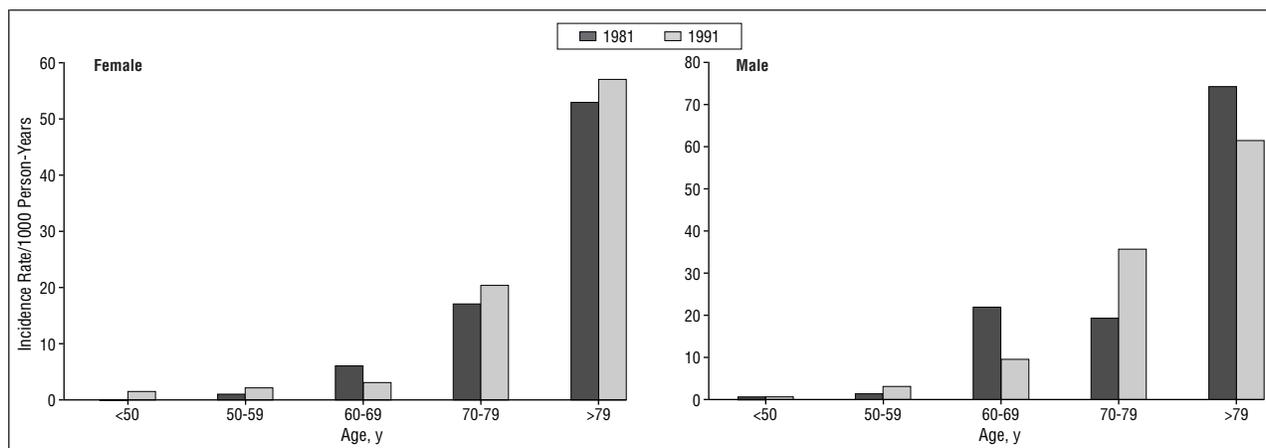

Figure 2. Incidence rates by age of patients with congestive heart failure in 1981 and 1991 cohorts in Rochester, Minn.

rable percentages in the 1981 and 1991 cohorts. The age distribution of patients with CHF in 1981 and 1991 is shown in **Figure 1**. In both cohorts there was a dramatic increase in the number of patients with CHF at older ages. However, 82% of patients of the 1991 cohort were 70 years or older compared with 71% of the 1981 cohort (P = .06). Therapy with ACE inhibitors was present after the initial diagnosis of CHF in 41% of patients in the 1991 cohort and in 0% of patients in the 1981 cohort.

INCIDENT CASES WITH CHF

The incidence rates of the 2 cohorts are reported in **Table 2**. The total incidence rate of CHF, after adjustment for age and sex, did not differ in the 1991 cohort compared with the 1981 cohort. In both cohorts, men had a higher age-adjusted incidence rate of CHF compared with women. The incidence rates by age of the 2 cohorts are shown in **Figure 2**. There was an exponential increase in incidence rate with advancing age in both cohorts. Two infants (<1 year old) with CHF were not included in the assessment of incidence rate or prognosis of the 1981 cohort. The incidence rates by sex and age are shown in **Figure 3**. Among men, the incidence rate increased dramatically in both cohorts, starting at the seventh decade of life. In women this increase was delayed until the eighth decade of life.

Figure 3. *Incidence rates by sex (left, female; right, male) and age of patients with congestive heart failure in 1981 and 1991 cohorts in Rochester, Minn.*
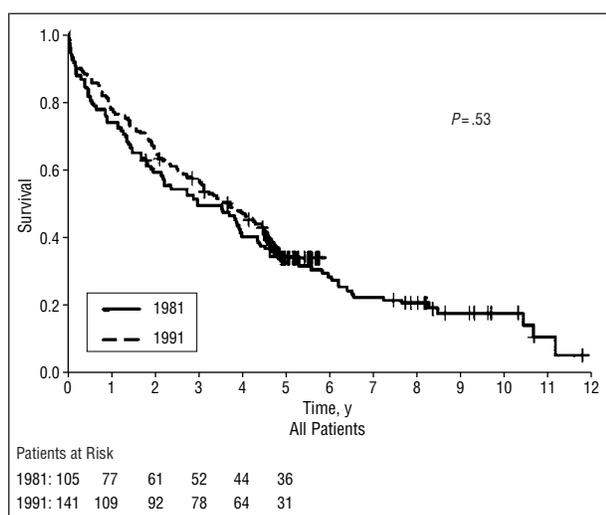
Figure 4. *Overall survival of patients with congestive heart failure in 1981 and 1991 cohorts in Rochester, Minn.*

PROGNOSIS

The survival of patients with a new diagnosis of CHF was poor in both cohorts. Only 79% and 85% remained alive 6 months after diagnosis, 72% and 77% at 1 year, and 34% and 33% at 5 years in the 1981 and 1991 cohorts, respectively. Overall survival was similar in the 2 cohorts (*P* = .53) (**Figure 4**). Survival adjusted for age, sex, and NYHA functional class was not significantly different in patients with CHF in 1981 and in 1991 (relative risk, 0.907; *P* = .55). Survival among women and men was similar in both cohorts (men, *P* = .23; women, *P* = .78; **Figure 5**). In the multivariate analysis, independent predictors of mortality were as listed in **Table 3**. Age and creatinine concentration greater than 115 µmol/L were negative predictors of long-term survival. Hypertension tended to be an independent positive predictor of survival. Sex, NYHA functional class, presence of coronary artery disease, valvular disease, idiopathic dilated cardiomyopathy or diabetes, history of smoking, and use of ACE inhibitors were not found to be independent predictors of mortality.

COMMENT

In this study, we report on the incidence and prognosis of patients with definite CHF in the community over time. These data indicate that the incidence of CHF was unchanged over a 10-year period in this well-defined community population. Furthermore, survival of patients with a new diagnosis of CHF in the same community was not significantly different over time. This stability in the incidence and prognosis of CHF occurred despite advances in the diagnosis and treatment of cardiovascular disease and CHF thought to have the potential for an impact on the epidemiology of this disease.

INCIDENCE OF CHF IN THE COMMUNITY

Data from death certificates have indicated an increase in CHF in the US population in the last decades.[2] Moreover, the number of hospital discharges for CHF has increased from 1976 to 1986 in the United States,[21] and rates of initial hospitalizations for CHF were higher in 1993 than in 1986 among older men and women.[8] However, these data may be affected by some limitations such as changes in criteria for the diagnosis of CHF,[21] a lower threshold for classifying elderly patients as having CHF,[2] and the difficulty in determining whether CHF was a contributing cause or the primary cause of death.[9,22] In this study, which used the same diagnostic criteria for CHF in 2 different periods, the incidence of CHF in the community did not change over time. Numerous explanations for this finding may be postulated. Patients with CHF in the 1991 cohort tended to be older, which probably reflects the aging population. Decreased acute myocardial infarction case-fatality rates and improved survival among subjects with angina pectoris may have led to an increase in the number of patients with left ventricular dysfunction at risk for CHF in the community, especially in those aged 65 years or older.[23,24] Treated patients with hypertension who escape death from cerebrovascular events may still suffer progressive myocardial damage and remain at risk for CHF.[2,24] Conversely, some authors[10] have suggested that incidence should decline with primary and secondary prevention of coronary events, treatment of hypertension,[25] and myocardial salvage during ag-
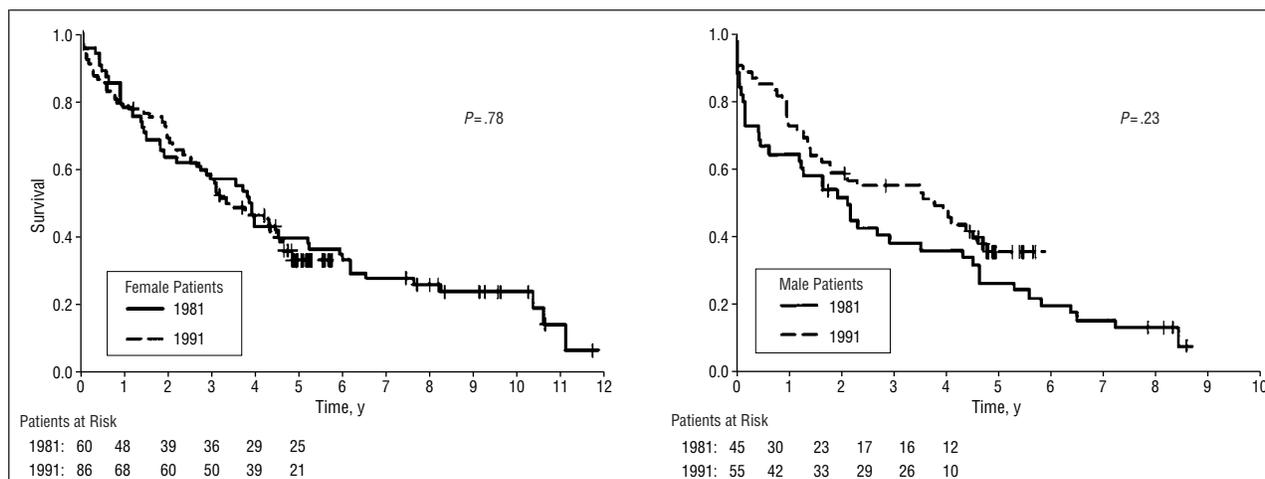
Figure 5. *Survival among female (left) and male (right) subjects with congestive heart failure in 1981 and 1991 cohorts in Rochester, Minn.*

<table>
<tr><th colspan="4">Table 3. Multivariate Logistic Regression Analysis for Predictors of Survival*</th></tr>
<tr><th>Predictor</th><th>RR</th><th>95% CI</th><th>P</th></tr>
<tr><td>Age per year</td><td>1.047</td><td>1.02-1.07</td><td>.001</td></tr>
<tr><td>Creatinine >115 µmol/L</td><td>1.649</td><td>1.07-2.54</td><td>.023</td></tr>
<tr><td>Hypertension</td><td>0.682</td><td>0.45-1.04</td><td>.075</td></tr>
</table>

RR indicates relative risk; CI, confidence interval.

gressive treatment of myocardial infarction.[9,10,26,27] Early therapeutic intervention with ACE inhibitors can delay or prevent the onset of CHF with left ventricular dysfunction, but these studies had not been published in 1991 and thus were unlikely to have affected care of patients with ventricular dysfunction in the community.[15,28]

The absence of a change in incidence in the 10-year period is probably related to the cumulative effects of these factors, which may balance each other so as to lead to a stable incidence over this 10-year period. Alternatively, the lack of a change in incidence may reflect the lag time between the development of new therapies, their use in the community, and their impact on the natural history of this syndrome.[10] Our results suggest also that patients in the recent period are being identified earlier because patients of the 1991 cohort were less symptomatic compared with those of the 1981 cohort. This finding may be related to an increased awareness by physicians of the symptoms and signs of CHF. Surprisingly, this does not appear to be related to improved survival, as would be expected owing to lead-time bias.[29]

SURVIVAL IN PATIENTS WITH CHF IN THE COMMUNITY

Although the mortality rate for coronary artery disease has dramatically decreased during recent decades,[26,27] our results indicate that survival of patients with CHF after adjustment for age, sex, and NYHA class remained stable during the 1980s. The Framingham Study reported that survival was not different after the onset of CHF during 40 years of follow-up.[4] In a previous study[30] on idiopathic dilated cardiomyopathy in a referral population,

we found that survival in the symptomatic patients (NYHA class III-IV) did not differ between patients diagnosed in 1982-1987 and patients diagnosed in 1976-1981, but we reported an improved survival rate in less symptomatic patients (NYHA class I-II), suggesting that improvements in the diagnosis and therapy had affected the natural history of this form of cardiac disease, often associated with CHF.

Both the Framingham Study and the study on idiopathic dilated cardiomyopathy had a low percentage of patients treated with an ACE inhibitor because this drug has been commercially available only since 1983. However, in our study, despite the use of ACE inhibitors in more than 40% of patients in the 1991 cohort period, we did not observe changes in survival rates. Again, different mechanisms for this observation can be postulated. A 15% to 20% reduction in mortality has been reported with the use of ACE inhibitors, but when this improvement is averaged for the entire population treated, it results in a mean increase in survival of less than 6 months.[10] Moreover, limited data are available on the impact of ACE inhibitors on survival in elderly patients (>75 years), who represent 69% of our cohort with CHF, although the CONSENSUS I (Cooperative North Scandinavian Enalapril Survival Study) trial in NYHA class IV patients included elderly patients and demonstrated an improvement in short-term survival with drug therapy.[13] The lack of an impact of ACE-inhibitor therapy on survival in this study may be related to the low percentage of patients treated as well as to inadequate dosing and duration of therapy, neither of which was addressed in this study.

Although an extensive comorbidity assessment was not performed in our study, there were no differences in the prevalence of diabetes or renal dysfunction in 2 cohorts, and fewer patients in the 1991 cohort smoked. Nonetheless, the possibility that factors other than CHF influenced mortality primarily in both cohorts cannot be excluded.

LIMITATIONS

Our study was a retrospective cohort analysis and has the inherent limitations of this design. The incidence rate of CHF may have been underestimated as a result of the in-

sensitivity of the Framingham criteria for the detection of early manifestations of CHF, especially in elderly subjects.[31] Some patients may not have fulfilled study criteria for CHF because the physician may not have recorded specific symptoms or signs of CHF since they were considered synonymous with CHF. The incidence of CHF as defined in the study may have been affected by changes in documentation practices between the study periods. Such changes could affect the number of patients with suspected CHF who would meet the study criteria. Patients were identified from medical records; therefore, they had to have sufficient symptoms to seek medical care. However, although the incidence rates may have been underestimated, these factors should have affected incidence similarly in 1981 and 1991, because we compared 2 cohorts in the same community, with the same case ascertainment methods and the same diagnostic criteria.

This study was also limited by the small size of the Rochester population. In 1981, fewer than 8000 Rochester residents were older than 55 years and were at risk for development of CHF. This limitation is reflected in the wide confidence intervals about the point estimates of incidence and prevalence.

Finally, this study may be limited in its generalizability. The population of Rochester is predominantly white; no blacks or Asians were identified among the patients with CHF. In addition, the socioeconomic profile of the city of Rochester is primarily middle to upper-middle class. Nevertheless, this population has been used to assess incidence and prevalence of several diseases.[18,19,32]

The care of patients with CHF uses a large portion of this country's health care resources.[33] The well-recognized shift in the age distribution of our population and the higher incidence of CHF in the elderly engender alarm concerning the economic burden of this syndrome.[24] Even a stable incidence of CHF translates into increasing prevalence as the population ages. The lack of any evidence suggesting that recent advances in management of cardiovascular disease have as yet impacted on incidence or survival of patients with definite CHF is disappointing. As every adequately powered study that has examined the effect of ACE inhibition in patients with symptomatic heart failure has demonstrated a beneficial effect on survival, the current data suggest that more aggressive use of these agents must be implemented in the community to realize the beneficial effects of these agents on survival of patients with CHF in the community. Further close observation is needed to ensure that advances in diagnosis and therapy of cardiovascular disease have a favorable impact on CHF in the community.

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