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Confirmation of a Heart Failure Epidemic: Findings From the Resource Utilization Among Congestive Heart Failure (REACH) Study

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OBJECTIVES The purpose of this study was to create an automated surveillance tool for reporting the incidence, prevalence and processes of care for patients with heart failure.

BACKGROUND Previous epidemiologic studies suggest that the increasing prevalence of heart failure is a consequence of improved survival coupled with minimal changes in disease prevention. Developing new, efficient methods of assessing the incidence and prevalence of heart failure could allow continued surveillance of these rates during an era of rapidly changing treatments and health care delivery patterns.

METHODS Using administrative data sets, we created a definition of heart failure using diagnosis codes. After adjustment for patients leaving our health system or death, we derived the incidence, prevalence and mortality of the population with heart failure from 1989 to 1999.

RESULTS A total of 29,686 patients of all ages, 52.6% women and 47.4% men, met the definition of heart failure. Mean ages were 71.1 ± 14.5 for women and 67.7 ± 14.4 for men, $p < 0.0001$. Race proportions were 50.5% white, 44.6% African American and 4.9% other race. Incidence rates were higher in men and African Americans across all age groups. There was an annual increase in prevalence of 1/1,000 for women and 0.9/1,000 for men, $p = 0.001$ for both trends.

CONCLUSIONS Through the feasible and valid use of automated data, we have confirmed a chronic disease epidemic of heart failure manifested primarily by an increase in prevalence over the past decade. Our surveillance system mirrors the results of epidemiologic studies and may be a valid method for monitoring the impact of prevention and treatment programs. (J Am Coll Cardiol 2002;39:60–9) © 2002 by the American College of Cardiology

Previous cross-sectional studies from large data sets have shown increases in the point prevalence of congestive heart failure (CHF) in the U.S. and Europe since the 1970s (1–7). Prospective cohort studies have identified age, coronary artery disease, valvular disease and poorly controlled hypertension as major determinants of CHF (8,9). However, selection biases for entry into prospective cohort studies and randomized trials limit generalizability due to underrepresentation of African Americans, women and the elderly (10). Recent analyses of the National Health And Nutrition Examination Survey (NHANES) II have evaluated cross-sectional data with future follow-up to generate CHF point prevalence estimates of 1.04% by subject self-report and 1.78% by clinical evaluation, including chest X-ray, in the U.S. population between the ages of 25 and 75 (6,7). All of these sources of information taken together, however, are inadequate to evaluate the impact of CHF on integrated health systems, which provide both acute and chronic care on a long-term basis. The purpose of this investigation, the Resource Utilization Among Congestive Heart Failure (REACH) study, was to demonstrate the feasibility of creating an information infrastructure to report the epidemiology of CHF and its impact on resource utilization within an integrated health system.

METHODS

Setting. Henry Ford Hospital is a 903-bed tertiary care center located in the Detroit metropolitan area and receives patients whose care is provided primarily within Henry Ford Health System (HFHS), a vertically integrated, mixed model managed care organization (MCO), which includes urban and suburban satellite clinics in Southeast Michigan (11). The HFHS maintains a data warehouse comprised of administrative, clinical and encounters tables. Approximately 85% of HFHS patients are aligned to the Henry Ford Medical Group, a 1,000-physician multispecialty

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Abbreviations and Acronyms

CHF	= congestive heart failure
DRG	= diagnosis related group
HAP	= Health Alliance Plan
HFHS	= Henry Ford Health System
ICD-9-CM	= 9th International Classification of Diseases, Clinical Modification
MCO	= managed care organization
NHANES	= National Health And Nutrition Examination Survey
NYHA	= New York Heart Association
REACH	= Resource Utilization Among Congestive Heart Failure study

group and receive the majority, if not the entirety, of their care within HFHS. Health Alliance Plan (HAP), the primary MCO for HFHS, maintains comprehensive administrative tables for encounters within HFHS and hospitals nationwide. This setting provided an opportunity to develop search strategies to identify and follow patients with medical conditions of interest over time.

Case definitions. An index case of CHF was defined as an aligned patient who had accumulated at least two outpatient encounters (emergency department, urgent care or clinic) or one hospitalization coded for CHF. The 9th International Classification of Diseases, Clinical Modification (ICD-9-CM) codes for CHF used were previously validated in CHF case findings and included the following: 428.XX, 398.91, 402.01, 402.11, 402.91, 404.00, 404.01, 404.03, 404.10, 404.11, 404.13, 404.90, 404.91, 404.93 (12,13). Of note, the codes 404.00, 404.10 and 404.90 were included to capture patients with combined heart and renal failure. Hospitalizations for CHF required diagnosis-related group (DRG) 127 or one of the above ICD-9-CM codes in the principal position. In addition, patients with ≥1 hospital discharge coded with DRG 124 and one of the ICD-9-CM codes in the preceding text in the principal diagnosis position were included. This included patients whose principal diagnosis was CHF but, because of a diagnostic catheterization during the stay were assigned to DRG 124 instead of 127. This search strategy excluded those patients whose only code for CHF was in the secondary position. For hospital admissions, DRG codes were assigned by professional coders and approved by the attending physician. During outpatient visits, the attending physician assigned the codes at the time of the encounter. Death was ascertained by death within an HFHS facility, death confirmed by State of Michigan Death Registry tapes or the National Center for Health Statistics Death Index. We observed a >99% vital status ascertainment after five or more years from an index year. Each patient had a unique medical record number that avoided double counting.

Data management. We applied the index case search definition to all aligned HFHS patients and all HAP patients beginning in the calendar year 1989. Among cases found in 1989, it was assumed that the ratio of index to prevalent cases was 1 to 1. For each subsequent year, index cases were queried for the presence or absence of any medical care delivered. If no activity was found, a search for death records from the three sources listed above was done. If death was not found, individuals were considered to be temporarily out of HFHS or HAP and were kept in a dataset for continued prospective resource utilization or death. If in a subsequent year, a patient was found to be active or dead, the prior year prevalence pool was amended to reflect the presence of that individual, thus accounting for patients who exited the HFHS. Patients with established CHF who entered the system were counted as index cases once the ICD-9-CM definition was met. Patients without CHF entering the system were counted in the denominator of HFHS patients for that year. Once declared an index case, CHF was considered irreversible and present until death. This methodology was unable to detect and confirm reversible cases of CHF including myocarditis, metabolic cardiomyopathies and cases where revascularization improved cardiac function to a degree where CHF could be considered cured. It was expected that these cases were sufficiently uncommon as to affect the main results.

Data validation. To check on the positive predictive value of the index case definition by ICD-9-CM coding, a case validation procedure was carried out. A 1% random sample, n = 271 (58.3% women, 41.7% men) of REACH subjects was taken, and chart abstraction was performed with explicit criteria applied by the Framingham and NHANES I definitions of CHF (7,10). A total of 172 (63.5%) subjects met the Framingham definition, and 151 (55.7%) subjects met the NHANES definition (score ≥3) of CHF. Of those who met any definition of CHF (n = 200, 73.8%), the mean ejection fraction was 42.5 ± 16.0%. Because both the Framingham and NHANES I definitions were designed for populations free of disease and not for active HFHS patients, a second validation procedure was carried out. Two physicians, one internist and one cardiologist, were given a portion of the sample comprised of patients under their care and performed chart abstraction for confirmation of CHF by chart notes, with classification according to the New York Heart Association (NYHA). Of the sample reviewed (n = 263, 44.1% women, 55.9% men), 82.9% of cases were confirmed to have CHF. Of those with validated CHF at the time of last clinical encounter, the proportions of NYHA classes were as follows: class I, 25.1%; class II, 36.1%; class III, 28.9% and class IV, 9.9%. Of those without CHF mentioned in the chart notes: 60.0% had dyspnea listed, and 85.0% had a primary cardiac diagnosis such as coronary artery disease, atrial fibrillation, prior cardiac surgery or structural heart disease. That is, while not having CHF explicitly listed in the chart, these patients received ICD-9-CM codes and had the cardiac substrate and associated findings to support the presence of CHF. Only 5.0% had no mention of cardiovascular disease in the chart notes. Most likely, this overestimation was counterbalanced by the previously described community underestimation of CHF

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Table 1. Age Structure of the Henry Ford Health System General Population Taken From a Random Sample (n = 3,195) of Enrollees in 1994, the Midpoint of REACH Time Frame

Age in Years	Women	Men	Total
0–9	60	73	133
10–19	28	30	58
20–29	64	39	102
30–39	80	73	153
40–49	75	64	139
50–59	55	65	120
60–69	59	53	112
70–79	61	42	103
80–89	43	18	61
90–99	14	4	18
100–109	1	0	1

Counts are expressed per 1,000 health system patients and rounded to the nearest whole number.
REACH = Resource Utilization Among Congestive Heart Failure study.

by hospitalization ICD-9-CM codes described in the Corpus Christi Heart Project (14). Thus, investigators felt that the study definitions and population characteristics would yield valid point estimates on the epidemiology of CHF, and statistical analysis of the entire population was undertaken.

Statistical analysis. Univariate statistics were reported as proportions or means, and comparisons were made with chi-square or analysis of variance, as appropriate. Incidence and prevalence were reported in terms of total number of HFHS patients for that given year. This adjusted for denominator change, which was small given the stability of the HFHS during the study period. Incident cases excluded those who had been identified in prior years. Prevalent cases included: 1) those identified in prior years who were active in the HFHS and alive, and 2) those who were inactive in that year but found to be dead or alive in future years. This prevented the problem of migrating patients changing either the numerator or denominator. Age- and gender-adjustment of rates was carried out using direct standardization to the 1994 (midpoint) age and gender structure of the HFHS population (Table 1). Cox regression was used to compare adjusted survival among groups of interest. Statistical significance was chosen at the alpha <0.05 level.

RESULTS

Baseline characteristics. Age, gender, race and insurance status for the 29,686 individuals identified with CHF are given in Table 2. Women comprised 52.6% of the study group and contributed similar mean person-months to REACH as men, 24.3 ± 15.4 mean person-months and 23.9 ± 13.8 mean person-months , $p = 0.2$, respectively. Likewise, African Americans and whites contributed similarly to the cohort, 24.6 ± 13.1 mean person-months and 24.8 ± 18.8 mean person-months, $p = 0.62$. The race group labeled "other" was comprised of women and men in the following categories: Hispanic, Native Americans, Asian, Middle Eastern and "unknown or unstated." Of note, the mean age of index cases was older for women than it was for men across all race groups by an average of 3.4 years. In addition, the types of insurance carriers were statistically different for women and men, with 10,106 (64.7%) and 8,293 (60%) having Medicare, parts A and B, listed as their primary forms of insurance, respectively, $p < 0.00001$. This reflected the older mean age of women and proportional increase in eligibility for Medicare. Of note, 38.0% of all patients in REACH had a non-Medicare primary form of insurance, predominately HAP, the HFHS's managed care organization. The HFHS denominator of individual patients consisted of 2,928,286 (57%) women and 2,209,057 (43%) men.

Incidence and prevalence. The overall age- and gender-adjusted incidence and prevalence of CHF are given by one-year intervals in Figures 1 and 2. There was no secular trend observed for incidence. However, Figure 2 displays linear trends for an increase in the number of prevalent cases adjusted for the HFHS population with an average increase of 1.0/1,000 for women (3.7 to 14.3/1,000) and 0.9/1,000 for men (4.0 to 14.5/1,000), $p < 0.0001$ for both trends. This represented a tripling of prevalence over the 11-year study period.

Gender and race differences in incident cases by age grouping are shown in Figures 3 and 4. In REACH, men predominated in all incident age groups when adjusting for the denominator of all HFHS patients, $p < 0.0000001$ (Fig. 3). While African Americans comprised 44.6% of the study sample, the rates of new cases of heart failure were consistently higher among African American HFHS patients than they were for whites or other race groups, $p < 0.0000001$ (Fig. 4). The "other" race group, comprised mainly of those with "unknown or unstated" race, was relatively equally distributed among the age groupings.

Mortality. Case fatality rates for incident and prevalent cases are displayed in Figure 5. Mortality for 1999 index cases was checked through the first quarter of 2000. The case fatality rate per year, shown in Figure 5, displays an inception cohort effect. This means that some patients identified in 1989 to 1993 likely had a shorter lead time in the database until death since the true onset of CHF may have been before 1989. The average, overall case fatality rate per year was 17.1% and 15.1% for incident and prevalent cases, respectively, $p < 0.0000001$. The overall median survival was 4.2 (95% confidence interval: 4.1 to 4.3) years. The median survival was longer for women compared with men, 4.5 versus 3.7 years, $p < 0.00001$. Age-adjusted survival was also significantly better for women compared with men, $p < 0.0001$ (Fig. 6). In addition, age- and gender-adjusted mortality was the best for whites, intermediate for African Americans and least favorable for other race groups, $p < 0.0001$ (Fig. 7). Age at the time of diagnosis was a clear discriminator of gender- and race-adjusted survival as depicted in Figure 8. The five-year survival rate for those >85 years diagnosed with CHF was 20%.

Table 2. Age, Gender, Race and Major Insurance Carrier for 29,686 Patients With CHF in the REACH Study

Characteristics	Women	Men	p Value
Total n (incident and prevalent cases)	15,626 (52.6)	14,060 (47.4)	<0.0001
White, n = 14,945	7,692 (51.2% of n)	7,307 (48.8% of n)	<0.0001
Age	73.7 ± 13.3	69.2 ± 13.6	<0.0001
Total person-months	189,128.2	176,241.1	—
Mean person-months	25.0 ± 27.5	24.5 ± 27.6	0.32
Medicare A & B	5,154 (67.0)	4,257 (58.3)	<0.0001
Health Alliance Plan HMO	1,514 (19.7)	1,636 (22.4)	0.00005
Blue Cross Blue Shield	325 (4.2)	547 (7.5)	<0.0001
Other HMO	54 (0.7)	68 (0.9)	0.17
Commercial Insurance	113 (1.5)	193 (2.6)	<0.0001
Medicaid	113 (1.5)	107 (1.5)	0.96
Unknown	419 (5.4)	499 (6.8)	0.0003
African American, n = 13,121	7,182 (54.1% of n)	6,050 (45.9% of n)	<0.0001
Age	68.1 ± 15.1	65.6 ± 15.0	<0.0001
Total person-months	175,446.1	145,418.8	—
Mean person-months	24.8 ± 28.6	24.4 ± 27.9	0.41
Medicare A & B	4,470 (62.2)	3,619 (59.8)	0.005
Health Alliance Plan HMO	1,182 (16.5)	932 (15.4)	0.09
Blue Cross Blue Shield	310 (4.3)	425 (7.0)	<0.0001
Other HMO	310 (4.3)	259 (4.3)	0.99
Commercial Insurance	60 (0.8)	72 (1.2)	0.02
Medicaid	349 (4.9)	295 (4.9)	0.98
Unknown	501 (7.0)	448 (7.4)	0.37
Other race, n = 1,455	752 (51.7% of n)	703 (48.3% of n)	0.07
Age	73.7 ± 13.3	70.7 ± 14.0	<0.0001
Total person-months	9,275.5	9,236.0	—
Mean person-months	12.7 ± 20.9	13.5 ± 20.7	0.43
Medicare A & B	482 (64.1)	417 (59.3)	0.06
Health Alliance Plan HMO	100 (13.3)	113 (16.1)	0.13
Blue Cross Blue Shield	44 (5.9)	46 (6.5)	0.58
Other HMO	22 (2.9)	22 (3.1)	0.82
Commercial Insurance	9 (1.2)	13 (1.8)	0.31
Medicaid	24 (3.2)	28 (4.0)	0.42
Unknown	71 (9.4)	64 (9.1)	0.82

HMO = health maintenance organization; REACH = Resource Utilization Among Congestive Heart Failure study.

DISCUSSION

Changing heart failure epidemiology. We found that incidence rates of CHF were variable from year to year with no clear secular trend. However, we found a significant rise in prevalent cases from 1989 to 1999. Mortality rates were consistently higher for incident cases than they were for prevalent cases, presumably because only the healthiest patients survived long enough to enter the pool of prevalent patients. We attribute the rising prevalence in REACH to: 1) compilation methods and enhanced case identification with ICD-9-CM codes screened over a long time period, 2) inclusion of minorities with higher rates of CHF not captured in prior epidemiologic studies, and 3) improved survival among patients with CHF (15–17). Our findings are consistent with other studies in supporting the notion that the aging of the population and therapeutic advances are leading to an epidemic of CHF (2,6). The REACH study extends the observations of previous epidemiologic studies by showing that the prevalence pool is increasing at a rate of approximately 1.0/1,000 HFHS patients per year. While in our study sample, women were predominant (65.6%) in the group >85 years, but, when adjusting for the denominator of all HFHS patients, men consistently had higher incident rates yet poorer survival compared with women.

Incidence. Our incidence rates were consistent with the few epidemiologic sources of data on incidence through the 1990s (9,15,16). Framingham results during the 1980s reported an incidence of CHF among persons age ≥45 years of 4.7 cases/1,000 in women and 7.2 cases/1,000 in men (9). This is in contrast with REACH, where the denominator was HFHS patients of all ages and the annual incidence was 5.3/1,000 in women and 5.5/1,000 in men. Our finding of a male predominance in incidence confirms findings published from Framingham and other studies (9,17). However, there may be an underrepresentation of the problem of heart failure in men (5). Previous studies of asymptomatic left ventricular dysfunction have found men are twice as likely as women to have asymptomatic disease. In addition, CHF is more common in men when a clinical examination or echocardiography has been used to define the condition (2). Therefore, women may have been more

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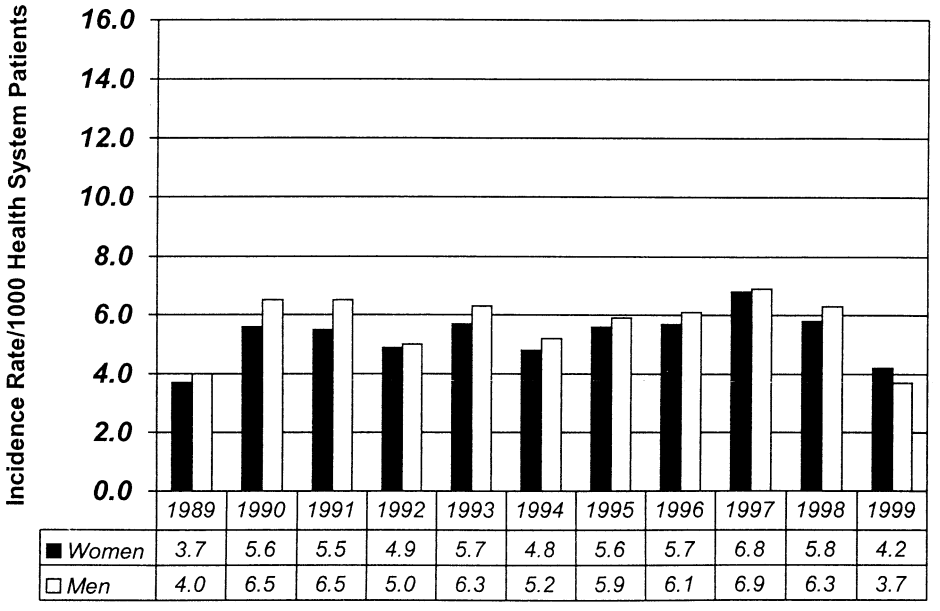
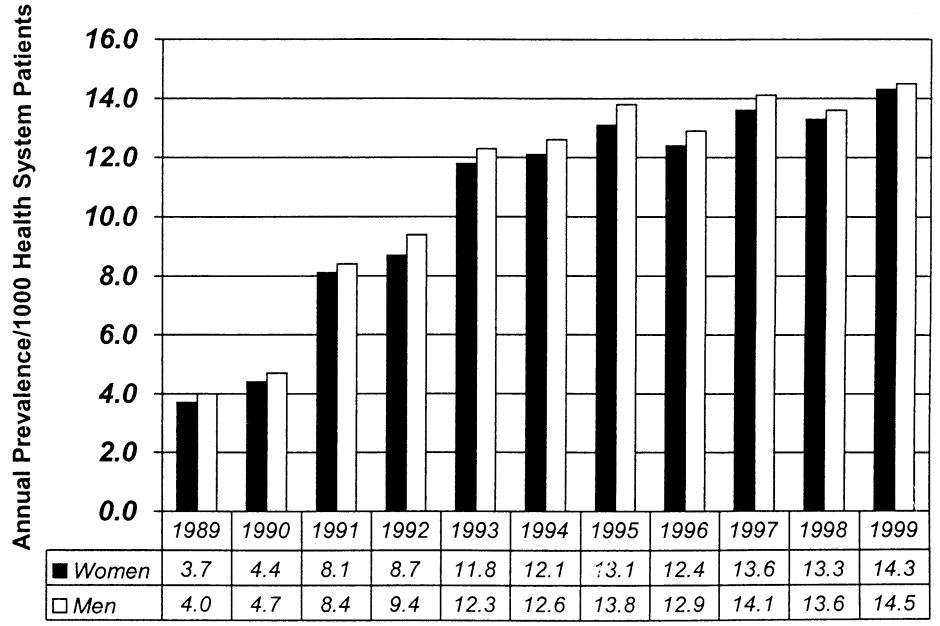


	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
■ Women	3.7	5.6	5.5	4.9	5.7	4.8	5.6	5.7	6.8	5.8	4.2
□ Men	4.0	6.5	6.5	5.0	6.3	5.2	5.9	6.1	6.9	6.3	3.7

Figure 1. Age- and gender-adjusted incidence of congestive heart failure in an integrated health system from 1989 to 1999. $p > 0.05$ for linear trend in both groups.

likely to manifest symptomatic CHF and, hence, be captured by the REACH methodology, which requires ICD-9-CM codes generated by face-to-face physician encounters or hospitalizations. The dominance of African Americans in incidence rates among HFHS patients confirmed earlier risk estimates from smaller studies (5). As previously shown, in general African Americans have a 50% to 75% excess rate of new heart failure as non-African Americans.

Prevalence. Our prevalence rates were consistent with prior cross-sectional studies, which suggested a rise in the prevalence of CHF in the U.S. when assessed at different time periods (NHANES I 1971 to 1974, NHANES II 1976 to 1980) (6,7). These time periods, however, almost certainly do not reflect the widespread use of vasodilators and beta-blockers, which have been shown to reduce CHF mortality. Hence, our finding of a sharp rise in prevalence through the 1990s represents new information pointing to a larger chronic disease epidemic on the basis of prevalence than has been previously described. We acknowledge that our methods report "prevalence" in the early years of data



	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
■ Women	3.7	4.4	8.1	8.7	11.8	12.1	13.1	12.4	13.6	13.3	14.3
□ Men	4.0	4.7	8.4	9.4	12.3	12.6	13.8	12.9	14.1	13.6	14.5

Figure 2. Age- and gender-adjusted prevalence and of congestive heart failure in an integrated health system from 1989 to 1999. For both men and women, the prevalence of congestive heart failure has tripled over the decade of the 1990s. $p < 0.0001$ for linear trend in women and men.

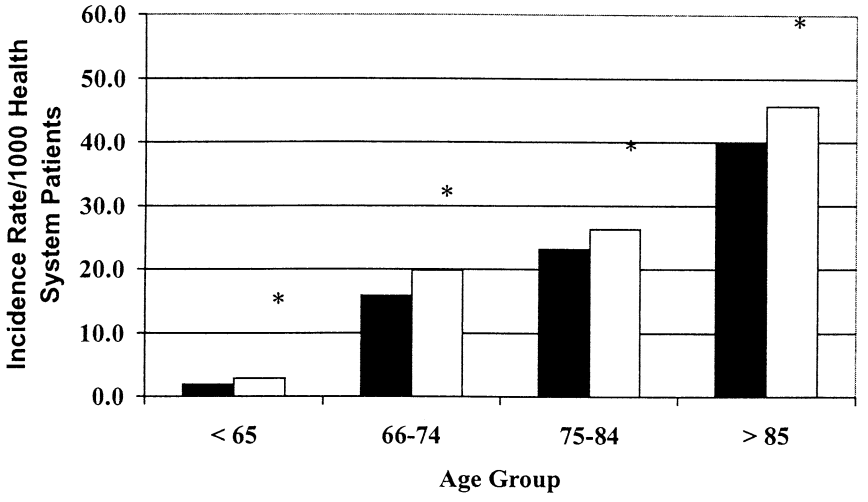


Figure 3. Incident cases of heart failure in men **(white bars)** and women **(black bars)** by age group in the Resource Utilization Among Congestive Heart Failure study (REACH). *p < 0.0000001 for all pairwise comparisons.

acquisition including 1989 as a starting point and up to approximately 1995 as a representation of cumulative incidence. It is only after all existing cases have been captured using ICD-9-CM codes that true prevalence can be appreciated. The reported, annualized point prevalence of CHF in REACH was 10.5/1,000 in women and 10.9/1,000 in men. This is considerably greater than the age-adjusted point prevalence of CHF reported from Framingham during the 1980s (7.7/1,000 in women and 7.4/1,000 in men) (9). Our findings suggest that the more comprehensive ICD-9-CM search algorithm and use of inpatient and outpatient encounters in REACH have overcome the underreporting of CHF prevalence in communities by the use of hospitalization discharge codes alone (14). In addition, prevalence estimates from Framingham represent a denominator of adults >45 years, unlike REACH, which used a denominator of HFHS patients of all ages (Table 3). Patients <45 years (n = 2,006 [6.8%]) were retained for two reasons: 1) to allow representation of younger individuals with CHF not included in prior epidemiologic studies, and 2) to provide a database for case finding of young patients with CHF in the HFHS for future studies. When compared with multiple large-scale epidemiologic studies of prevalence through the 1990s however, the prevalence found in our study is in line with the 9.0/1,000 to 15.0/1,000 rates reported (2,5,14,18,19).

Survival. The overall median survival for CHF in REACH was 4.5 versus 3.7 years for women and men, respectively. These survival times are longer than 3.2 and 1.7 years in women and men, respectively, previously reported in the 652 persons with CHF from the combined Framingham Heart and Offspring study cohorts (n = 9,405 denominator) (5). These differences should be noted in light of the similar mean ages at diagnosis in REACH (69.5 ± 14.5 years) and Framingham (70.0 ± 10.8 years) (5). However, one must consider that fully 39.7% and 12.7% of REACH patients developed CHF >75 years and >85 years, respectively. The median survival for those <65 years in REACH was six

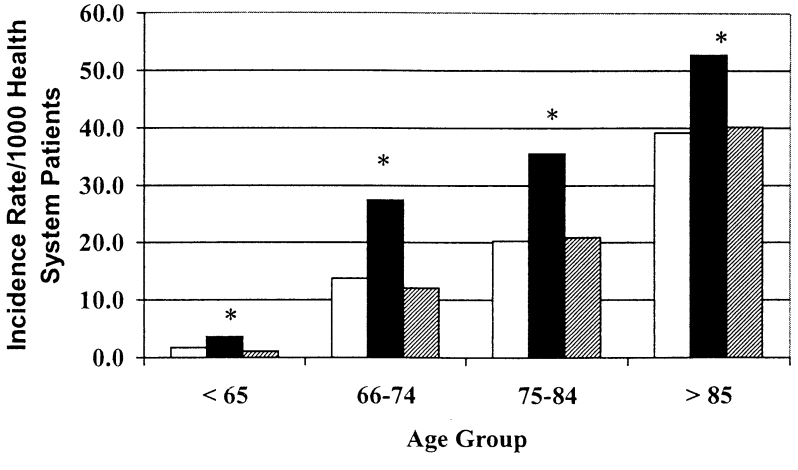


Figure 4. Incident cases of heart failure in race groups by age group in the Resource Utilization Among Congestive Heart Failure study. *p < 0.0000001 for African American **(black bars)** versus white **(white bars)** or other race **(striped bars)** groups.

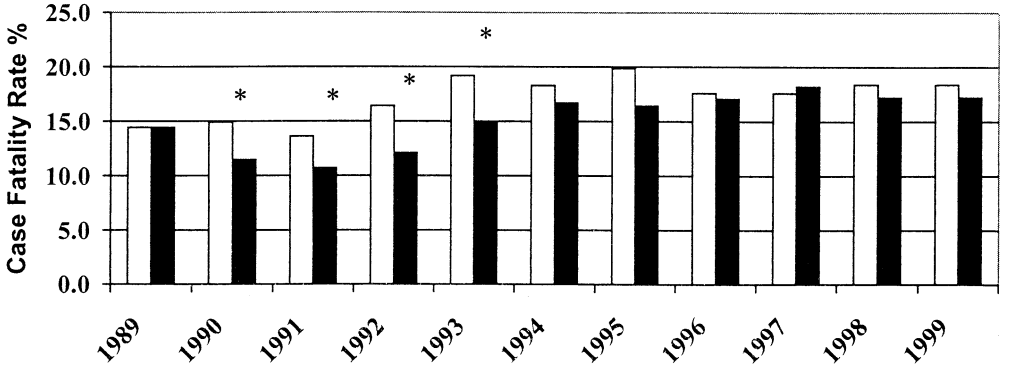


Figure 5. Case fatality rate per year among incident **(white bars)** and prevalent **(black bars)** cases in the Resource Utilization Among Congestive Heart Failure study. The higher mortality among incident cases relative to prevalent cases before 1994 most likely represents lead-time bias in the index case ascertainment algorithm. *$p < 0.01$.

years. This is longer than previously reported in Framingham and other epidemiologic studies, supporting the case that improved therapies for myocardial infarction are creating more cases of CHF and that improved treatment of CHF is prolonging the survival of these patients (5,20–22). Alternatively, differences in case definitions in REACH and other studies may have accounted for the survival differences seen. The annual case fatality rates of 17.1% and 15.1% in incident and prevalent cases in REACH are much lower than the 23% to 50% mortality rates reported from studies of recently hospitalized patients with CHF (17,23). This is likely due to the fact that REACH included patients identified as outpatients, with lesser degrees of CHF and, hence, is more reflective of the true annual mortality rate of this condition.

Study limitations. We acknowledge that there are multiple limitations to our study. Using ICD-9-CM codes as the basis for a definition of CHF does not equate to the stringent criteria used in Framingham, NHANES or the opinion of clinicians as demonstrated and discussed in our data validation section. Hence, our study is hampered by misclassification bias. This bias is almost certainly nondif-

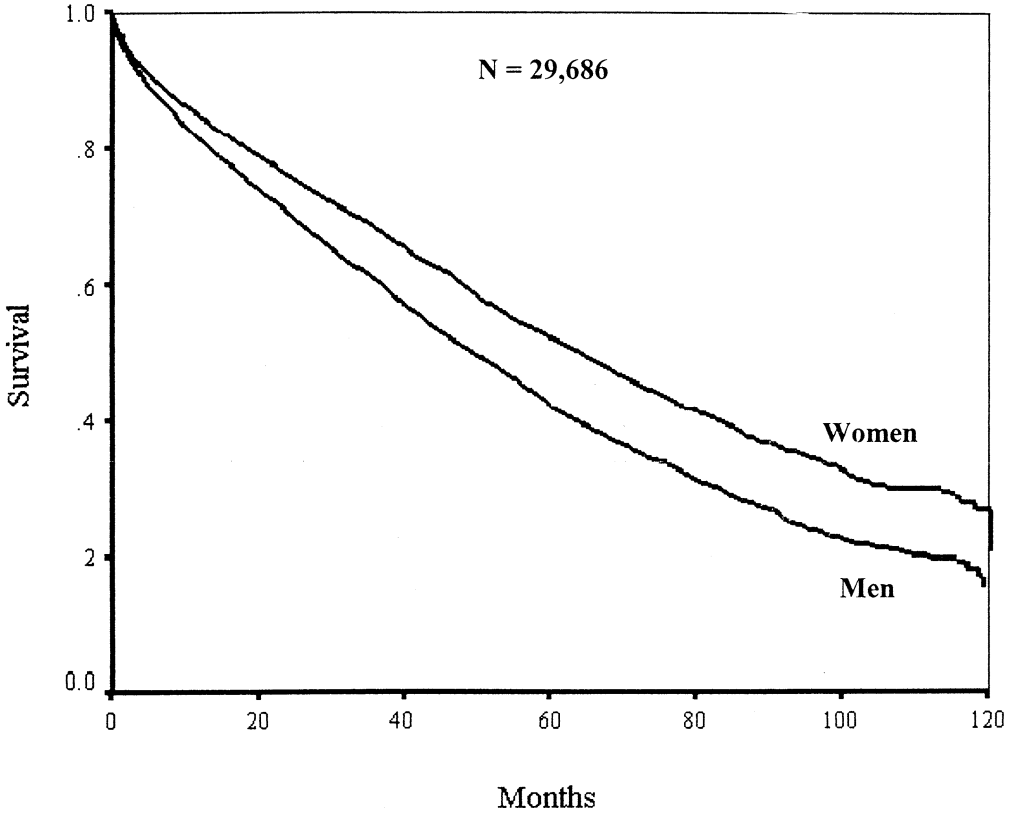


Figure 6. Age- and race-adjusted mortality for men and women with congestive heart failure in an integrated health system, 1989 to 1999. $p < 0.0001$.

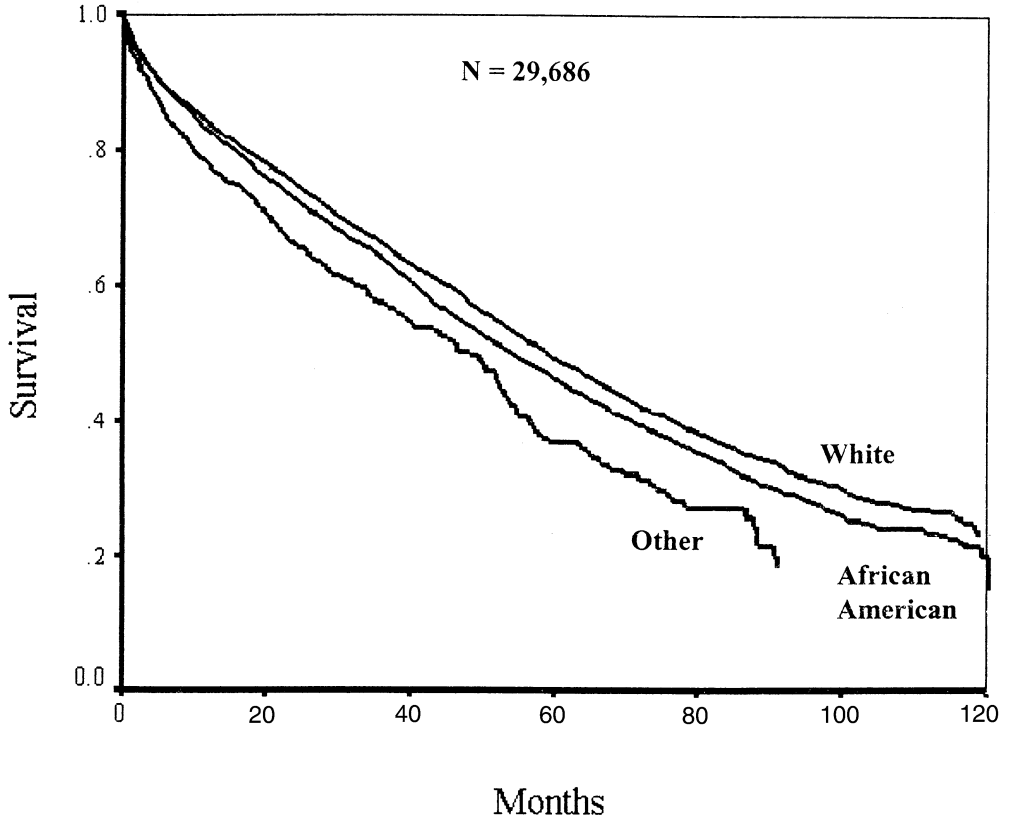


Figure 7. Age- and gender-adjusted mortality by race for patients with congestive heart failure in an integrated health system, 1989 to 1999. *$p < 0.0001$ for all pairwise comparisons.

ferential and would bias any analytic conclusion to the null hypothesis. For example, a null hypothesis could be that prevalence is not changed over time. Our methods indicate that any bias towards this null makes the case for a rise in prevalence even stronger. It is possible that prevalent cases were counted as incident cases if there was a prolonged period (several years) without encounters coded for CHF prior to 1989; however, this incidence-prevalence bias is unlikely to affect point estimates in later years given the reported survival duration in our study. It was also possible that a differential exit of CHF or healthy patients from the system who remain alive could shift the denominator and change both incidence and prevalence rates. Another source of bias would be a secular trend over time for the HFHS to take in patients with greater comorbidities or recruit more patients with CHF. The HFHS started a cardiac transplant service in 1985 and maintained it throughout the study period with no change in numbers of heart failure specialists and no change in the approximately 15 annual transplants performed. Furthermore, we are unaware in any shift in case-mix within the HFHS and acknowledge this is an area worthy of future study. Our study did not have the resources to evaluate full decision statistics including the negative predictive value of the ICD-9-CM code algorithm. An example evaluation would call for a random chart review of 5,000 HFHS charts to yield an expected 100 patients with and 4,900 without CHF, respectively (assuming a point prevalence of ≤2%). Random sample sizes smaller than 5,000 would likely inflate the negative predictive value because of the low point prevalence of CHF in the HFHS population. Extrapolation of our results may be limited by the relatively high (20.9%) managed care component of the study sample. Conversely, having a mixed population of fee-for-service, managed care, Medicaid and underinsured patients is the strength of REACH not seen in other epidemiologic studies. Generalizability to the U.S. or Western European countries is limited due to the high proportion of African Americans in our sample. Conversely, REACH represents the largest cohort of African Americans with CHF in the medical literature today, which adds to the observations taken from small numbers of African Americans in cross-sectional and cohort studies (5,13,15,23).

Study implications. The REACH study adds to current insights into the epidemiology of CHF in the following ways: 1) it demonstrated a feasible, automated, "turn-key" methodology that may be replicated by other health systems; 2) it included information on CHF across all age ranges and was not restricted to those >65 years (e.g., studies from Medicare data); 3) it comprised CHF cases identified on an in-patient and outpatient basis and, hence, was more useful in describing the global aspects of the problem than studies of hospitalized patients only; 4) it included a large proportion of African Americans not previously captured in U.S. or European epidemiologic

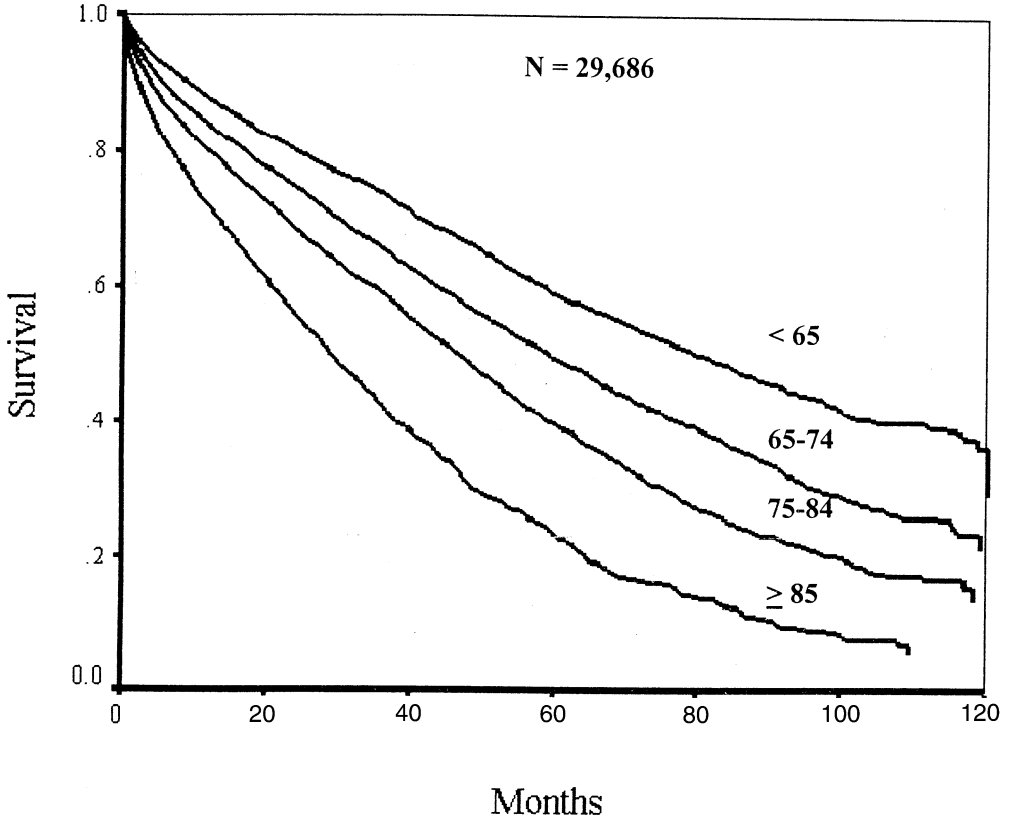


Figure 8. Age-stratified mortality, adjusted for gender and race, for patients with congestive heart failure in an integrated health system, 1989 to 1999. Age is taken at the time of diagnosis of heart failure. $p < 0.0001$ for all pairwise comparisons.

studies or randomized trials; and 5) although this will require validation, REACH presumably included patients with both systolic and diastolic dysfunction forms of CHF and, hence, is expected to be a more complete description of the full spectrum of CHF outcomes than those from randomized trials of left ventricular dysfunction alone (2,24–27).

Conclusions. We conclude that, by use of ICD-9-CM codes and automated sources of data, the epidemiology of CHF can be described within health systems. Through the 1990s, there has been a growing epidemic of CHF prevalence captured by ICD-9-CM codes. Aging of the U.S. population almost certainly is the most important factor in this evolving epidemic. Consistent with studies from earlier decades, men have higher incidence rates but poorer survival. Women now predominate the CHF prevalence pool and appear to present with CHF at older ages. The CHF epidemic extends to African Americans, who have significantly higher rates of new onset CHF and suffer a poorer long-term survival compared with whites. The techniques of identifying incident and prevalent cases in REACH may provide an important tool for cost-effectively evaluating the impact of new treatments on large populations of patients.

Table 3. Age Structure of the REACH-CHF Population From 1989 to 1999

Age in Years	Women	Men	Total
0–9	0	0	0
10–19	0	0	0
20–29	4	5	9
30–39	13	14	27
40–49	32	38	70
50–59	52	64	116
60–69	102	112	214
70–79	162	139	301
80–89	127	86	213
90–99	33	15	48
100–109	1	1	2

Counts are expressed per 1,000 REACH patients and rounded to the nearest whole number.
REACH = Resource Utilization Among Congestive Heart Failure.

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