

# Importance of heart failure as a cause of death

## Changing contribution to overall mortality and coronary heart disease mortality in Scotland 1979–1992

D. R. Murdoch, M. P. Love, S. D. Robb, T. A. McDonagh, A. P. Davie, I. Ford\*, S. Capewell†, C. E. Morrison† and J. J. V. McMurray

*Medical Research Council's Clinical Research Initiative in Heart Failure, \*Department of Biostatistics, †Department of Public Health, University of Glasgow, Glasgow, Scotland, U.K.*

**Aims** As heart failure is a syndrome arising from another condition, such as coronary heart disease, it is rarely officially coded as the underlying cause of death regardless of the cause recorded by the physician at the time of certification. We sought to assess the true contribution of heart failure to overall mortality and coronary heart disease mortality and to examine how this contribution has changed over time.

**Methods and Results** We carried out a retrospective analysis of all death certificates in Scotland between 1979 and 1992 for which heart failure was coded as the underlying or a contributory cause of death. From a total of 833 622 deaths in Scotland between 1979 and 1992, heart failure was coded as the underlying cause in only 1.5% (13 695), but as a contributory cause in a further 14.3% (126 073). In 1979, 28.5% of male and 40.4% of female deaths attributed to coronary heart disease (coded as the underlying cause of death) also had a coding for heart failure. In 1992 these percentages had risen significantly to

34.1% and 44.8%, respectively (both  $P < 0.001$ ). Mortality rates for heart failure as the underlying or contributory cause of death, standardized by age and sex, fell significantly over the period studied in all ages and in both sexes: by 31% in men and 41% in women  $< 65$  years and 15.8% in men and 5.1% in women  $\geq 65$  years, respectively ( $P < 0.01$  for all changes).

**Conclusions** Death from heart failure is substantially underestimated by official statistics. Furthermore, one third or more of deaths currently attributed to coronary heart disease may be related to heart failure and this proportion appears to be increasing. While the absolute numbers of deaths caused by heart failure remains constant, this study is the first to show that standardized mortality rates are declining.

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**Key Words:** Heart failure, mortality, death certification, coronary heart disease.

## Introduction

Chronic heart failure due to left ventricular systolic dysfunction is now recognised as a major and escalating public health problem<sup>[1,2]</sup>. The morbidity and costs of heart failure have been highlighted in a number of publications<sup>[2–4]</sup>. The true contribution of heart failure to overall mortality in the general population has not, however, been fully explored or appreciated<sup>[5–7]</sup>. Although heart failure is common and greatly reduces life expectancy, official statistics in countries such as the United Kingdom and United States of America attribute

a very small proportion of deaths to this syndrome<sup>[8,9]</sup>. For example, in England and Wales in 1989, heart failure accounted for only 0.8% of all male and 1.5% of all female deaths or 6790 out of a total of 576 872 deaths<sup>[8]</sup>. These numbers do not easily equate with the knowledge that heart failure afflicts 1 to 2% of the overall population, increasing to 7% in the over 75s, has an annual mortality rate of up to 20%, and that moderate or severe heart failure has an average survival of only approximately 2.5 years<sup>[10]</sup>. Furthermore, in the United Kingdom, heart failure accounts for approximately 120 000 hospitalizations annually<sup>[11,12]</sup>. As the case fatality rate during hospitalization is 20–30%, this would suggest that at least 24 000–36 000 deaths from heart failure should occur in the U.K. amongst hospital admissions alone<sup>[11,12]</sup>. How can such a discrepancy arise and what might the true contribution of heart failure to overall mortality really be?

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*Correspondence:* Dr David R. Murdoch, BMSc, MBChB MRCP(UK), MRC Clinical Research Initiative in Heart Failure, West Medical Building, University of Glasgow, Glasgow G12 8QQ, Scotland, U.K.

One explanation may be the way in which information from death certificates is coded for official statistics. For example, a patient who dies from heart failure, having previously had a myocardial infarction, a common scenario, will be coded as dying from coronary heart disease. This will be the case even if the certifying doctor recorded 'heart failure' as the underlying cause of death. This is one major reason why government records substantially underestimate the number of deaths related to heart failure. Another reason is the many official publications concentrate on 'premature' mortality, i.e. deaths occurring in persons 65 years or younger<sup>[13]</sup>. Most patients with heart failure are, of course, elderly. To obtain more accurate information on heart failure-related deaths, we have, therefore, undertaken a detailed analysis of all death certificates completed in Scotland between 1979 and 1992. Scotland has a population of 5.1 million and high prevalences of hypertension and coronary heart disease<sup>[14]</sup>.

## Methods

### *Death certification in Scotland*

Scotland has adopted the international form of medical certification of cause of death. A physician completing a death certificate in Scotland is asked to describe the sequence of morbid conditions leading directly to death (Part I). The condition directly leading to death is recorded in Part I(a). If this condition is a complication or consequence of an underlying condition, this underlying condition is recorded next, i.e. Part I(b). If this in turn arose from another condition, this latter condition should in turn be recorded next, i.e. in Part I(c). The underlying or primary cause of death or the condition initiating the fatal sequence should, in this way, be recorded last, i.e. in Part I(b) or I(c). The second section (Part II) describes 'other morbid conditions which may have contributed to death but which were not involved in the fatal sequence'. Up to two further entries may be made in Part II of the certificate thus, in total, five entries may be made.

All death certificates are returned to the Registrar General for Scotland and coded according to the World Health Organisation International Classification of Diseases (the ninth revision, ICD9, was used throughout the period of this study)<sup>[15]</sup>. The ICD9 codes for an underlying cause of death (coded as 'Position 1') and up to three additional causes of, or contributors to, all deaths (coded as 'Positions 2-4') in Scotland are maintained on a database held at the General Register Office for Scotland. The underlying cause of death, as determined by the Registrar General, need not correspond to the order of entry by the completing physician on the death certificate. This is particularly true of heart failure where the pathological cause (e.g. coronary heart disease), is always sought and entered as the underlying cause of death. Indeed, the

Scottish Medical Certificate of Cause of Death specifically advises that 'heart failure' should not be recorded on the death certificate as the underlying cause of death.

### *Current analysis*

We obtained computerized records of all deaths in Scotland between 1979 and 1992 (latest completed records available at time of study) from the General Register Office in Edinburgh. We selected from these, for detailed analysis, all death certificates on which 'heart failure' was specified as either the underlying or a contributory cause of death. The ICD9 codes selected were: congestive heart failure (428.0), left heart failure (428.1), heart failure, unspecified (428.9), primary cardiomyopathy (425.4), alcoholic cardiomyopathy (425.5) and secondary cardiomyopathy, unspecified (425.9)<sup>[15]</sup>.

Data on the Scottish population, total (all cause) mortality, coronary heart disease mortality, and overall life expectancy was obtained from the yearly published report of the Registrar General for Scotland covering the years of study.

### *Statistical analysis*

Changes in numbers of deaths were compared using a chi-squared test. Age at time of death was compared using a two-sample t-test. Significance was taken at  $P < 0.05$ .

## Results

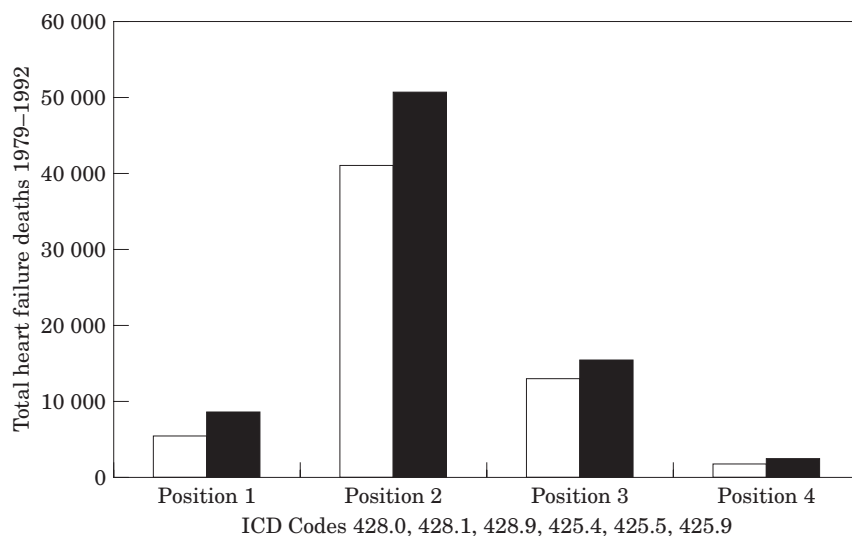
### *Death from heart failure as a proportion of all deaths*

#### *Heart failure as the underlying or a contributory cause of death*

From 1979 to 1992 heart failure was coded as the underlying or a contributory cause of death in a total of 61 320 deaths in men (14.2% of a total of 432 109 male deaths), and 76 571 deaths in women (17.0% of a total of 451 516 female deaths), or 137 891 of a total of 883 622 deaths (15.6%) (Table 1). In contrast, heart failure was officially considered to be the underlying cause of death in a total of only 13 695 deaths overall (1.5% of a total of 883 622 deaths), i.e. coded in position 1 by the Registrar General. In all such cases 'heart failure' had been the only entry made on the death certificate. Most heart failure-related entries were coded in position 2 (Fig. 1). The distribution of coding positions for heart failure did not change significantly between 1979 and 1992. For men in 1979 heart failure was coded in position 1 in 6.7% of cases, in position 2 in 70.9% of cases, in position 3 in 19.6% of cases and in position 4 in 2.7% of cases. For women the proportions in these positions were 10.3%, 68.5%, 19% and 2.7%, respectively. In 1992 the

**Table 1** Deaths from heart failure, as the underlying or contributory cause of death, as a proportion of total (all cause) mortality in Scotland, 1979–1992, according to age at time of death

	Age	Total deaths (all causes)	'Heart failure' position 1	%	'Heart failure' positions 1–4 (inclusive)	%
Male	<65	131 098	950	0.7	11 372	8.7
	≥65	301 011	4321	1.4	49 948	16.6
	All ages	432 109	5271	1.2	61 320	14.2
Female	<65	81 959	466	0.6	6362	7.8
	≥65	369 557	7958	2.2	70 209	19.0
	All ages	451 516	8424	1.9	76 571	17.0
Total	<65	213 057	1416	0.7	17 734	8.3
	≥65	670 568	12 279	1.8	120 157	17.9
	All ages	883 625	13 695	1.5	137 891	15.6



**Figure 1** Positions in which heart failure was coded on official death records obtained from the General Register Office, Scotland. For official purposes, the underlying cause of death is that coded in position 1. □ = male; ■ = female.

respective figures for men were 9.9%, 63.2%, 23.2% and 3.7%; and for women were 12.2%, 62.5%, 21.4% and 3.8%, respectively.

In those <65 years, heart failure was coded as the underlying cause or a contributory cause of death in 17 734 deaths overall (8.3% of a total of 213 057 deaths), but the underlying cause in only 1416 deaths (0.7% of a total of 213 057 deaths) (Table 1).

#### *Absolute heart failure mortality by age and sex (1979–1992)*

In total, absolute numbers of annual deaths related to heart failure in Scotland did not change significantly between 1979 and 1992. In 1979, heart failure was coded as the underlying cause of or a contributor to death in a total of 4885 deaths in men (14.9% of a total of 32 884 male deaths) and 5796 in women (17.6% of a total of 32 863 female deaths), or 10 681 of a total of 65 747 deaths (16.2%). The corresponding figures for 1992 were

4309 in men (14.7% of a total of 29 334 male deaths) and 5535 in women (17.5% of a total of 31 603 deaths), or 9844 of 60 937 deaths (16.2%).

The total number of deaths related to heart failure in younger subjects did, however, decline from 1979 to 1992 (Table 2). This was particularly pronounced for those less than 65 years of age; from 996 in 1979 to 679 in 1992 in men, and from 608 to 344 in women. There was a corresponding increase in heart failure-related deaths in the very elderly (≥85 years), in both sexes, during this period (Table 2).

#### *Mortality standardized by age and sex 1979–1992*

Mortality rates for heart failure, standardized by age and sex, fell significantly between 1979 and 1992 in all

**Table 2** Total heart failure related mortality, heart failure related mortality rate standardized by age and sex, and change in heart failure related mortality rate in Scotland 1979–1992, according to age at time of death

		1979		1992		Change in rate %
		Number	Mortality rate (per 1000 pop)	Number	Mortality rate (per 1000 pop)	
Male	<65	996	0.45	679	0.31	-31.1
	≥65	3889	14.32	3630	12.05	-15.85
	65–74	1596	8.33	1273	6.56	-21.25
	75–84	1688	24.18	1636	18.08	-25.23
	≥85	605	59.90	721	43.70	-27.05
Female	<65	608	0.27	344	0.16	-40.74
	≥65	5188	11.62	5191	11.03	-5.08
	65–74	1292	4.85	938	3.74	-22.89
	75–84	2387	16.22	2258	13.68	-15.66
	≥85	1509	45.87	1995	36.60	-20.21
Total	<65	1604	0.36	1023	0.24	-33.33
	≥65	9077	12.64	8821	11.43	-9.58
	65–74	2888	6.31	2211	4.97	-21.24
	75–84	4075	18.77	3894	15.23	-18.86
	≥85	2114	49.16	2716	38.25	-22.19

ages and both sexes (Table 2). Reductions were most pronounced in those <65 years, of 31.1% (chi-square=53.6,  $P<0.001$ ) in men, and 40.7% (chi-square=65.8,  $P<0.001$ ) in women. The corresponding reductions in those ≥65 years were 15.8% (chi-square=56.7,  $P<0.001$ ), and 5.1% (chi-square=11.0,  $P<0.01$ ), respectively. The reductions in mortality rates in men and women were immediately apparent and became more marked over the period of study (Figs 2(a,b)).

#### *Heart failure related deaths as a proportion of deaths due to coronary heart disease*

In 1979, 28.5% of male and 40.4% of female deaths attributed to coronary heart disease also had a heart failure coding. In 1992, these percentages had risen significantly to 34.1 (chi-square=70.3,  $P<0.001$ ) and 44.8 (chi-square=70.3,  $P<0.001$ ), respectively (Fig. 3). This increase was particularly marked in subjects older than 65 years at the time of death; 34.2 to 39.1% in men (chi-square=35.1,  $P<0.001$ ) and 43.6 to 47.2% (18.3,  $P<0.001$ ) in women.

#### *Age at time of death from heart failure*

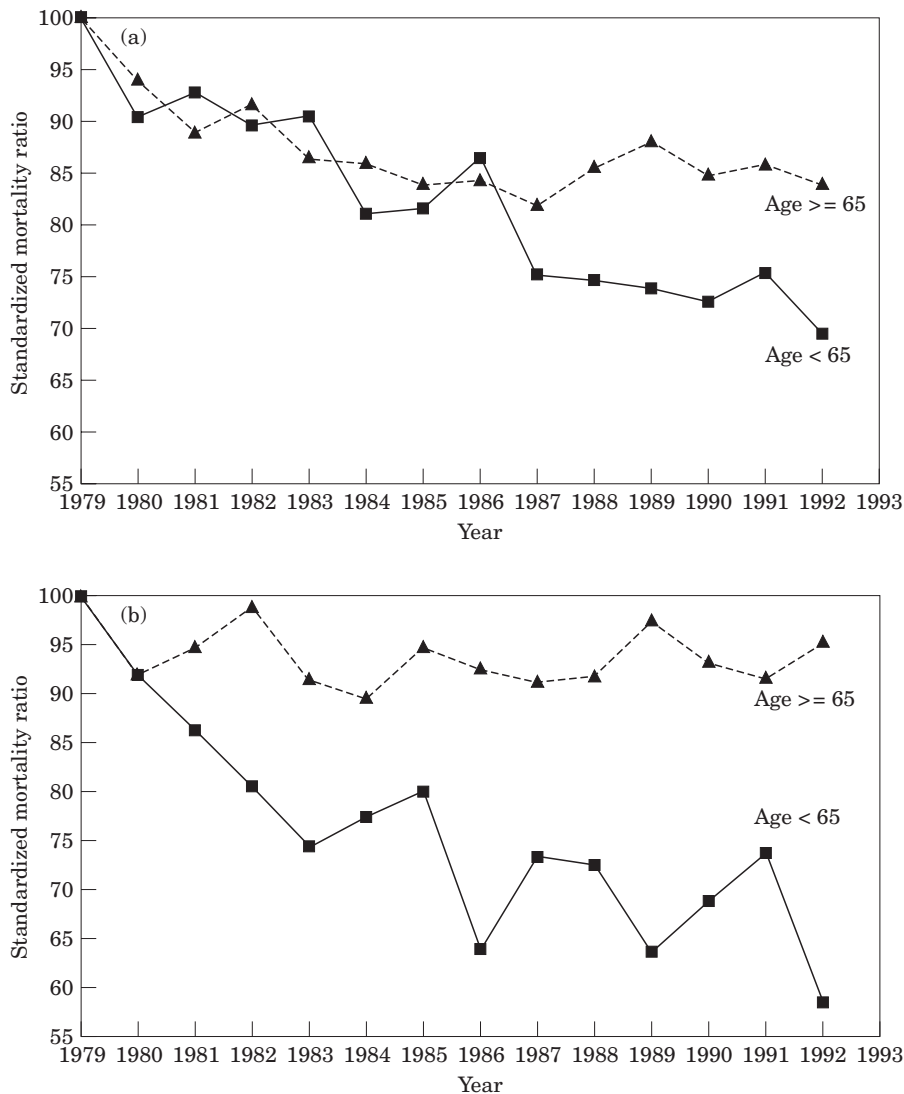
The mean age at time of death caused by or related to heart failure increased significantly from 72.4 years in 1979 to 76.6 years in 1992 in men ( $P<0.001$ ), and from 77.6 to 80.3 ( $P<0.001$ ) years in women, increases of 2.3 years and 2.7 years, respectively (Fig. 4). During the same time period, overall life expectancy at age 65 years

has shown a more modest increase of only 1.5 years in men (from 76.7 to 78.2 years), and 1.2 years in women (from 80.7 to 81.8 years).

## Discussion

This study shows that official statistics potentially greatly underestimate the contribution of heart failure to population mortality. In Scotland, over the period 1979–1992, heart failure was considered to be the underlying cause of death in 1.5% of all fatalities, i.e. officially coded in position 1 by the Registrar General. It is, however, important to remember that in an unknown, but probably substantial number of cases, heart failure was recorded as the underlying cause of death by the certifying physician before official re-classification. The importance of heart failure is further diminished if only 'premature' mortality is considered, i.e. deaths in subjects <65 years. Here heart failure was considered to be the underlying cause of death in only 0.7% of all fatalities. When heart failure entries coded in positions 2–4 are also considered, the picture changes dramatically. This analysis suggests that heart failure may cause or contribute to as much as 15.6% of all deaths overall and 8.3% of deaths <65 years. Clearly the possibility that heart failure entries coded in the lower death certificate positions may be subject to clinical uncertainty and inaccuracy must be considered especially for positions 3 and 4.

The most frequent form of recoding likely with heart failure-related deaths is the transfer of heart failure from the underlying cause to a contributing cause of death (i.e. from position 1 to 2) and coronary heart disease from a contributing cause to the underlying

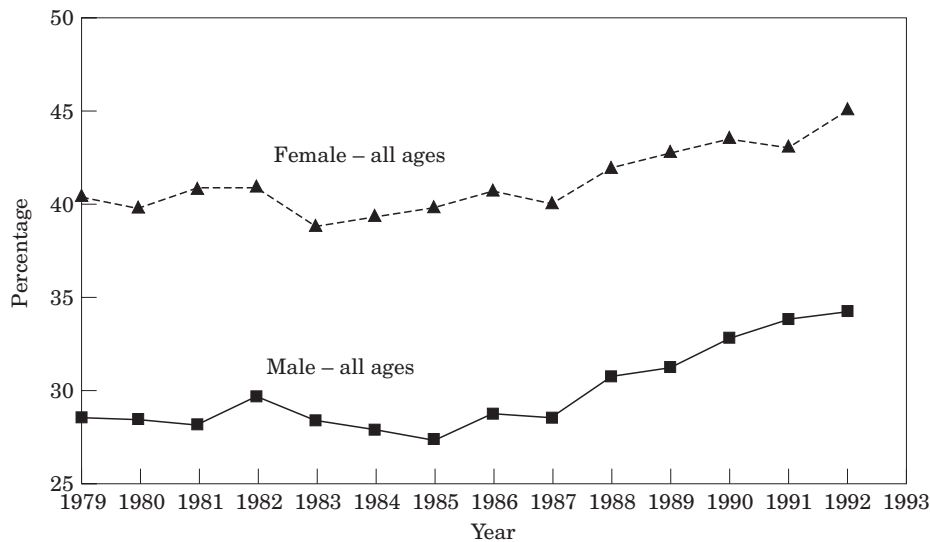


**Figure 2** Standardized mortality ratios for heart failure related death in Scotland 1979–1992 (1979=100). (a)=male deaths; (b)=female deaths.

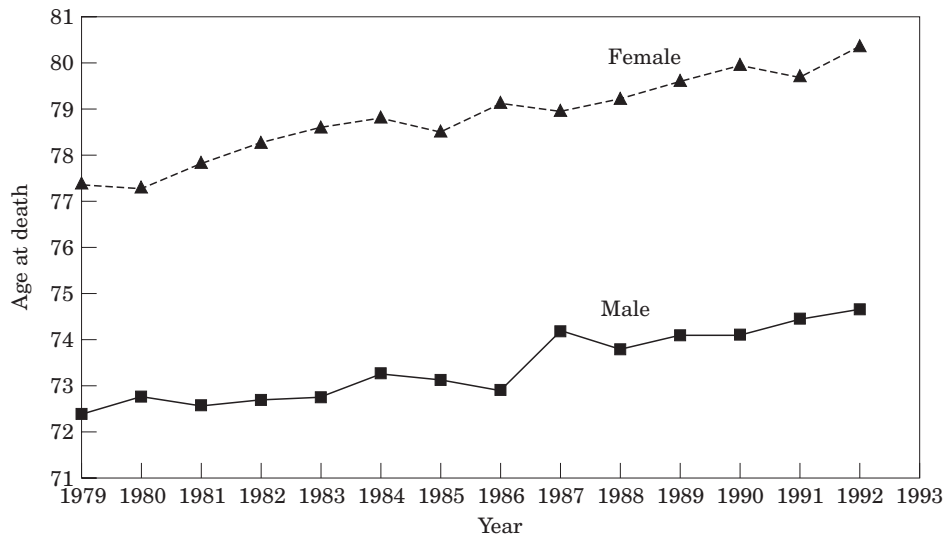
cause of death (i.e. from position 2 to 1). Indeed, we found that the majority of heart failure entries were coded in position 2 by the Registrar General and the vast majority of these had coronary heart disease in position 1. As a consequence of this, the importance of heart failure as a terminal manifestation of coronary heart disease may clearly be underestimated. We therefore examined the proportion of deaths due to coronary heart disease that also had a heart failure code. We found that 30–40% of coronary heart disease deaths may have been heart failure-related. This proportion is in keeping with the knowledge that most cases of heart failure are now caused by coronary heart disease and that heart failure carries a very poor prognosis in contrast to coronary heart disease associated with preserved left ventricular systolic function<sup>[10,16]</sup>.

A second objective of this study was to examine changes in heart failure-related mortality over time. We

found a striking reduction in the age standardized mortality rates for heart failure in Scotland between 1979 and 1992 and a corresponding substantial increase in the age of death from heart failure. It is always difficult to explain temporal changes of this sort. Recording biases, social and environmental factors may all play a role. It is, however, possible that developments in treatment might have contributed to the changes observed, although such speculation must be treated with caution. For example, the decline in mortality rate was apparent from the start of the period of analysis suggesting, perhaps, the influence of anti-hypertensive therapy<sup>[17]</sup>. From the mid-1980s, however, the mortality rate appeared to plateau in older men indicating perhaps, the consequences of modern treatments of acute myocardial infarction<sup>[7,18]</sup>. This would be in keeping with the increasing proportion of coronary heart disease deaths related to heart failure (Fig. 2). The increasing



**Figure 3** Heart failure related deaths as a proportion (%) of deaths due to coronary heart disease in Scotland 1979–1992.



**Figure 4** Age at time of heart failure related death (years) in Scotland, 1979–1992.

age at death in patients with heart failure is consistent with effective anti-hypertensive therapy and post-MI treatments delaying the onset of heart failure and angiotensin converting enzyme inhibitors extending life in patients with established heart failure<sup>[19]</sup>.

### Study limitations

This study, inevitably, has a number of limitations. Today heart failure is recognized to be an important clinical problem much more so than in 1979. It is, therefore, possible that heart failure is recorded more frequently on death certificates. It is unlikely, however, that such a change will have influenced coding in positions 1 and 2 (i.e. where heart failure is either the direct cause or a major contributor to death) and, overall, the

proportion of heart failure-associated deaths with the heart failure coded in positions 1–4 did not change in the period studied. A second limitation is that of diagnostic accuracy. It is well known that many patients diagnosed as having heart failure do not have left ventricular systolic dysfunction. Patients without left ventricular systolic dysfunction have a better prognosis. This difficulty in diagnosis has been more widely appreciated in recent years than in 1979. It is, therefore, likely that any diagnostic bias will have led to certification of higher rather than lower risk patients over the period of study.

### Conclusions

In summary, this study suggests that heart failure is a much greater contributor to both total mortality and



premature mortality in the general population than previously realized. One-third or more of coronary heart disease deaths may also actually be related to heart failure, and this proportion appears to be increasing. This is also the first study to show a fall in heart failure mortality and increase in age at death in the population, suggesting that effective cardiovascular treatments may have had a beneficial effect over the past two decades. More recent therapeutic interventions may, however, result in increasing numbers of patients surviving acute myocardial infarction and other manifestations of coronary heart disease to ultimately develop and die from heart failure.

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