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Clinical research

Decreasing one-year mortality and hospitalization rates for heart failure in Sweden

Data from the Swedish Hospital Discharge Registry 1988 to 2000

Maria Schaufelberger[a]*, Karl Swedberg[a], Max Köster[b], Måns Rosén[b], Annika Rosengren[a]

[a] *Department of Medicine, Sahlgrenska University Hospital/Östra, Göteborg, Sweden*
[b] *Centre for Epidemiology, National Board of Health and Welfare, Stockholm, Sweden*

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KEYWORDS
Heart failure;
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Aims To investigate if improved treatment of coronary heart disease and hypertension, the major causes of chronic heart failure (CHF), in the last 20 years has had an impact on the incidence of CHF and survival.
Methods National Swedish registers on hospital discharges and cause-specific deaths were used to calculate age- and sex-specific trends and sex ratios for heart failure admissions and deaths. The study included all men and women 45 to 84 years old hospitalized for the first time for heart failure in 19 Swedish counties between 1988 and 2000, a mean annual population 2.9 million. A total of 156 919 hospital discharges were included.
Result In 1988, a total of 267 men and 205 women per 100 000 inhabitants (age adjusted) were discharged for the first time with a principal diagnosis of heart failure. After 1993 a yearly decrease was observed, with 237 men and 171 women per 100 000 inhabitants discharged during 2000. The 30-day mortality decreased significantly. The decrease in 1-year mortality was more pronounced in the younger age groups, with a total reduction in mortality of 69% among men and 80% among women aged 45–54 years. The annual decrease was 9% among men and 10% among women aged 45–54 years (95% CI −7% to −12% and −6% to −14% respectively) and 4% among men and 5% among women (95% CI −4% to −5% for both) aged 75–84 years.
Conclusion The decrease in incidence and improved prognosis after a first hospitalization for heart failure coincides with the establishment of ACE-inhibitor therapy, the introduction of beta-blockers for treatment of heart failure, home-care programmes for heart failure, and more effective treatment and prevention of underlying diseases. Notwithstanding, despite considerable improvement, 1-year mortality after a first hospitalization for heart failure is still high.

* Correspondence to: Maria Schaufelberger, MD, Department of Medicine, Sahlgrenska University Hospital/Östra, S-416 85 Göteborg, Sweden. Tel: +46 31 343 40 00; Fax: +46 31 25 89 33
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E-mail address: maria.schaufelberger@hjl.gu.se (M. Schaufelberger).

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Introduction

The incidence of chronic heart failure (CHF) increases steeply with age,[1,2] and affects 1–2% of the population.[3] The prolongation of life expectancy is likely to have an impact on the incidence and prevalence of heart failure.[2] Hospital discharges for heart failure increased in Sweden and in the US between the early-1970s and the mid-1980s,[4,5] and CHF is a major cause for hospitalization in men and women above 65 years.[6] A diagnosis of CHF is associated with a serious prognosis, with an overall 5-year survival reported to be about 50%, and this prognosis has shown no major changes over the last 40 years.[1] Because CHF is both common and dangerous, CHF has a significant impact on health-care costs. The care of patients with CHF accounts for nearly 2% of the Swedish health-care budget.[7]

Several factors could influence incidence and prognosis of heart failure. Improved treatment of coronary heart disease and hypertension, the major causes of CHF, may lead to a reduction in the number of new cases.[1,8] New treatment modalities, including angiotensin-converting enzyme (ACE) inhibitors and beta-blockers, have been demonstrated to improve survival in selected study populations of patients with heart failure.[9,10] An estimate of the impact of this treatment on study populations suggests a reduction of about 50% in annual mortality.[10] However, these studies included only patients with decreased systolic function and, accordingly, excluded patients with heart failure and preserved systolic function. Partly because of this selection, women formed only about 20% of the study populations.

With respect to mortality, the report from Scotland by MacIntyre et al. based on hospital discharge data from 1986 to 1995, suggested an age-adjusted decrease in mortality.[11] Other studies have also shown a decreasing mortality trend in wider populations.[12,13] Sweden, like Scotland, has a well-developed person-based registration system for hospital discharges and cause-specific deaths. In order to assess potential effects of changes in treatment modalities for hypertension and heart disease on mortality in patients with heart failure, we analysed temporal trends in 30-day and 1-year mortality in patients hospitalized for the first time for heart failure in Sweden in the period from 1988 to 2000. We also estimated trends in the incidence of first time hospitalization for heart failure.

Methods

We studied first hospital admissions with a discharge diagnosis of heart failure in men and women aged 45 to 84 years old in the period from 1988 to 2000. In Sweden, virtually all hospitals that accept acute admissions are public and register principal and contributory diagnoses for all patients in the National Hospital Discharge Register. All Swedish citizens have a unique personal identification number (PIN). For the purpose of the present study, the PIN was used to link Swedish population records from 1984 to 1999 with data from the National Hospital Discharge Register and Cause of Death register for the same years. The Hospital Discharge Register has been in operation since the 1960s and has operated nationwide since 1987. In 1984, data were entered for all but five Swedish counties, out of a total of 19 counties. These counties included the three largest cities, Stockholm, Göteborg and Malmö, and comprised about 80% of the Swedish population. The study included all men and women 45 to 84 years old in the 19 counties, a mean annual population of 2.9 million, and the data is complete for the period from 1988 to 2000.

The International Classification of Diseases (ICD) used until 1986 was the ICD-8. The ICD-9 was used from 1987 to 1996 and the ICD-10 from 1997 on. The discharge codes applied were 427.00 (ICD-8), 428 (ICD-9), and I50 (ICD 10). Only first hospitalizations were investigated. In order to minimize bias from prior admissions, re-admissions after 4 years were treated as first admissions and information from the register for the years from 1984 to 1987 was used only to ensure that data on hospitalizations for each separate year from 1988 to 2000 was treated as uniformly as possible. Because of the high morbidity and mortality of heart failure, a censoring period of 4 years for any hospitalization for heart failure was considered adequate. Mortality from all causes within the first 30 days and within 365 days of the index admission was calculated up to 31 December 2001.

Validity of the registers

In the period from 1987 to 1996, a primary discharge diagnosis was lacking in 0.8% of all admissions to Swedish departments of internal medicine, including cardiology.[14] In a manual check of hospitalizations due to heart failure, acute myocardial infarction, or atrial fibrillation in two large hospitals in Göteborg less than 3% of hospitalizations had been missed by the national register.[15] The overall validity of diagnoses in the hospital discharge register was analysed in 1986 and 1990 by studying random samples of about 900 medical records. However, cardiovascular diseases like ischaemic heart disease, angina pectoris, and cerebrovascular disease were analysed, there was no specific analysis of heart failure; the percentages of false positives and false negatives were all below 4%.[16] In a more recent study of the validity of acute myocardial infarction based on the examination of 2065 medical records, the percentage of false positives and false negatives was estimated at 4.6% and 2.9% respectively.[14]

Statistical methods

All rates are person-based. We calculated age-adjusted first admissions with (a) a principal diagnosis of heart failure and (b) a diagnosis of heart failure in any diagnostic position, in addition to age- and sex-specific mortality in the first 30 days and in the first 365 days for patients hospitalized with heart failure as the principal diagnosis and in patients with heart failure in any diagnostic position. The age- and sex-specific annual change per cent in the 30-day and 365-day mortality was calculated, with 95% confidence intervals, on aggregated data using the logistic regression procedure in SAS software version 8. The respective mortality rates were used as the dependent variables in each calculation and the calendar year was used as the independent variable.

Calculations were made using the method of direct standardization and the population in 2000 was taken as the standard for the specific age intervals. The confidence limits for the standardized rates were obtained by a normal approximation of the gamma distribution, which the standardized rates were assumed to follow. Age was defined as age at admission.

The logistic regression model was chosen to summarize the irregular fluctuations (and overall decline) in rates with the aid of a single trend coefficient. This trend can be approximated by the coefficient of the year-variable (included as a continuous

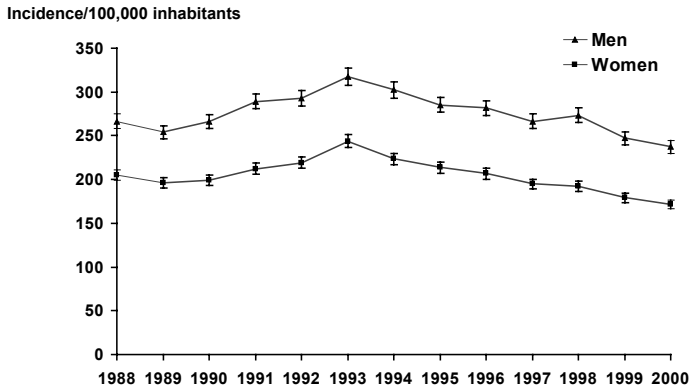

Fig. 1 Age-adjusted annual incidence (±95% confidence intervals) of first hospitalization with a principal diagnosis of heart failure in 19 Swedish counties over the period 1988 to 2000 in men and women.

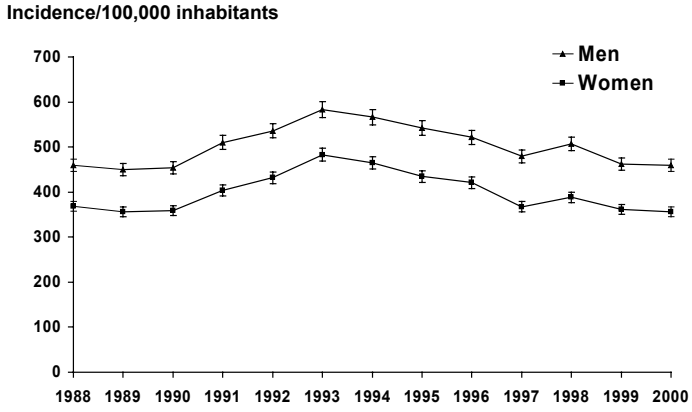

Fig. 2 Age-adjusted annual incidence of all first hospitalizations for heart failure in 19 Swedish counties over the period 1988 to 2000 in men and women.

variable) and was computed using the maximum likelihood method. The confidence intervals for the coefficients were computed assuming that these coefficients have an approximately normal distribution. In analogy with the standardized yearly admissions, we calculated the standardized fatality using the age-specific mortality of 2000 as the 'standard population'.

Results

Hospitalizations for heart failure as principal diagnosis

We identified a total of 156 919 first hospitalisations with a principal diagnosis of heart failure and 295 425 first hospitalizations with a discharge diagnosis of heart failure in any diagnostic position during 1988 to 2000. In 1988 a total of 267 men and 205 women per 100 000 inhabitants (adjusted for age) were discharged for the first time from the hospital with a principal diagnosis of heart failure. These figures increased until 1993, when 317 men and 244 women per 100 000 inhabitants (age adjusted) were discharged for the first time with a principal diagnosis of heart failure. Thereafter, a yearly decrease was observed for the rest of the study period, with 237 men and 171 women per 100 000 inhabitants discharged in 2000 (Fig. 1). More men than women were hospitalized for heart failure in all age groups throughout the whole study period (data not shown). Only 8% of men and 5% of women hospitalized for heart failure in 1988 were 64 years or younger (data not shown). The figures found in 2000 were similar.

Total hospitalizations for heart failure

Twice as many patients per 100 000 inhabitants were discharged for the first time for heart failure, irrespective of the position of the diagnosis, as were discharged for the first time with a principal diagnosis of heart failure (Fig. 2). The same trends were seen during the observation period when comparing all first discharges for heart failure with patients discharged for the first time with a principal diagnosis of heart failure. The incidence increased until 1993, after which there was a marked decrease in incidence among men and women in all the age groups studied, except men aged 45–54 years, which showed no decrease after 1993 (data not shown).

Mortality of patients with a principal diagnosis of heart failure

The 30-day mortality decreased during the study period in men and women pertaining to all age groups (Table 1).

Table 1 Thirty-day mortality after a first hospitalization with a diagnosis of heart failure in 19 Swedish counties over the period 1988 to 2000 in men and women 45 to 84 years, by sex and age

	Heart failure as the principal diagnosis				Heart failure in any diagnostic position			
	Age				Age			
	45–54	55–64	65–74	75–84	45–54	55–64	65–74	75-84
Men, 30-day mortality, %								
1988	13	9	13	20	13	12	15	21
1989	9	8	13	17	12	9	15	19
1990	8	11	12	19	7	12	14	20
1991	5	7	11	17	9	9	12	18
1992	7	8	11	16	8	10	13	17
1993	8	7	9	14	9	8	11	15
1994	6	6	8	14	7	7	10	15
1995	5	4	8	14	4	8	11	16
1996	4	5	8	13	8	8	10	14
1997	4	6	8	13	7	8	10	14
1998	4	6	9	13	4	7	9	14
1999	2	4	7	14	6	6	9	15
2000	4	5	7	14	5	6	10	15
% annual change 1988–2000	−10	−7	−6	−4	−7	−6	−5	−3
Lower 95% CI	−14	−9	−7	−4	−10	−7	−6	−4
Upper 95% CI	−6	−5	−5	−3	−5	−4	−4	−3
Women, 30-day mortality, %								
1988	15	13	12	16	17	12	13	16
1989	10	13	13	15	11	11	13	15
1990	18	12	13	15	13	10	14	15
1991	11	9	11	14	11	11	11	14
1992	8	7	10	13	11	8	11	14
1993	6	8	9	12	7	9	9	12
1994	7	7	7	10	7	8	8	11
1995	5	9	8	12	10	9	10	12
1996	4	7	9	11	6	7	10	12
1997	0	6	9	12	7	8	9	12
1998	3	7	8	11	6	7	7	12
1999	7	7	9	11	7	7	9	12
2000	4	6	8	12	7	7	8	12
% annual change 1988–2000	−13	−6	−5	−4	−7	−5	−5	−3
Lower 95% CI	−19	−9	−6	−4	−10	−7	−6	−4
Upper 95% CI	−7	−3	−3	−3	−5	−3	−4	−3

The decrease was more pronounced in the younger age-groups, with a yearly decrease of 10% among men and 13% among women aged 45–54 years compared to a 4% yearly decrease among both men and women aged 75–84 years (Table 1). The standardized case fatality rate decreased after 30 days in both men and women (Fig. 3A and B).

One-year mortality also decreased markedly in both men and women of all age groups (Table 2). Again, the decrease in 1-year mortality was more pronounced in the younger age groups, with a total reduction in mortality of 69% among men and 80% among women aged 45–54 years. The annual decrease was 9% among men and 10% among women aged 45–54 years and 4% among men and 5% among women aged 75–84 years (Table 2). There was a striking decrease in standardized case fatality rate of both men and women 1 year after a first admission for heart failure (Fig. 3A and B). No difference in the change in mortality was seen between men and women.

Mortality of all patients with a first hospitalization for heart failure

The relative 30-day and 1-year mortality was very similar among patients hospitalized for heart failure, irrespective of whether heart failure was the principal or secondary diagnosis. A trend toward a decrease in mortality was evident throughout the whole study period (Table 1 and Table 2).

Discussion

We investigated trends over time in hospitalizations for heart failure and the 30-day and 1-year mortality after first hospitalization for heart failure in patients aged 45–84 years in Sweden between 1988 and 2000. Hospitalizations for heart failure increased until 1993 in both men and women of all age groups, but have declined steadily

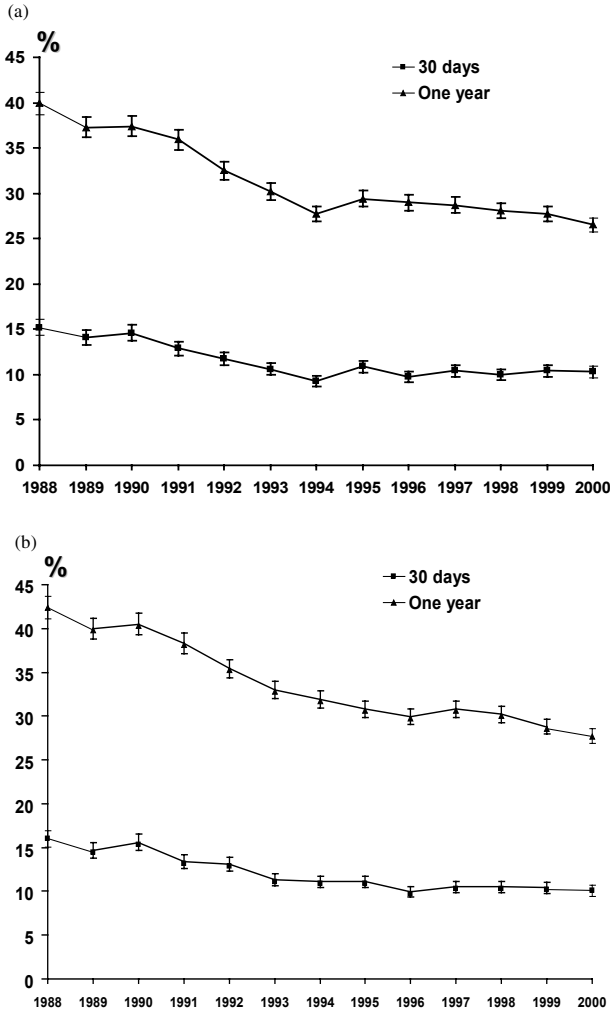

Fig. 3 (A) Standardized 30-day and 1-year case fatality rates (%) for all first hospital admissions with a principal diagnosis of heart failure in 19 Swedish counties over the period 1988 to 2000 in women. (B) Standardized 30-day and 1-year case fatality rates (%) for all first hospital admissions with a principal diagnosis of heart failure in 19 Swedish counties over the period 1988 to 2000 in men.

since 1993. We also found a significantly lower 30-day and 1-year mortality after the first hospitalization for heart failure in both sexes, irrespective of age. The same development was apparent for all first hospitalizations for heart failure regardless of whether heart failure was the principal or secondary diagnosis. Thus, heart failure seems to have more impact on prognosis than any other diagnosis.

We only investigated patients aged 45–84 years. Younger patients were excluded due to the low number below 45 years of age hospitalized each year and older patients were excluded due to the high prevalence of concomitant diseases.

In the US and Scotland, hospitalization rates for heart failure remained unchanged or increased in both men and women from the mid-1980s to the mid-1990s.[8,17–19] However, in Scotland the incidence of hospitalizations of patients with heart failure as a principal diagnosis decreased between 1993 and 1996 in women and from 1994 and 1996 in men,[8] which concurs with our findings. Recently, a decrease in the age-adjusted incidence of heart failure in women, but not men, age 65–74 years old between 1950 and 1999 was reported in the Framingham study.[13] A decrease in mortality among patients diagnosed with heart failure was observed in the US and Scotland in the 1980s and first half of the 1990s, but the decrease was less marked than the decrease seen in our investigation.[11–13]

Treatment of underlying diseases

Hypertension is a major underlying cause of CHF.[4,20] Patients treated for hypertension or with a systolic blood pressure above 160 mmHg or diastolic blood pressure above 90 mmHg have a two-fold greater risk of developing heart failure.[15,21] A decline in the prevalence of hypertension in the population[22,23] and increased use of antihypertensive drugs may have affected the incidence of heart failure.[24]

Treatment of myocardial infarction underwent major changes during the study period, starting with the widespread acceptance of thrombolytic therapy around 1988,[25] which may have reduced the frequency of long-term complications, including heart failure. As a counterpoint, increased survival after myocardial infarction might have left more surviving patients with myocardial damage that could progress to heart failure. During the last two decades the incidence of myocardial infarction has decreased in Sweden,[14] probably due, at least in part, to a reduction in the levels of risk factors.[22] In addition, there are some indications that myocardial infarctions are becoming smaller.[26]

Treatment of heart failure

In the last 10–15 years several treatment modalities have been demonstrated to improve symptoms, reduce hospitalization rates, and decrease mortality due to heart failure in selected study populations. The first study showing the positive prognostic effect of ACE-inhibitors was published in 1987.[27] The use of ACE inhibitors became more widespread in the decade after the publication of SOLVD 1991 and other major survival trials.[9,28] As can be extrapolated from the 12-year experience of the SOLVD trial, ACE-inhibitors can prolong life by 3 to 4 years.[29] However, national surveys of patients with heart failure suggest that ACE inhibitors are prescribed much less often than would be expected. In the recently published IMPROVEMENT study only two-thirds of Swedish primary care physicians stated that they would prescribe ACE inhibitors to 50% or more of their patients with CHF.[30]

The beneficial effect of the administration of beta-blockers after myocardial infarction was first reported in 1981–1982 and the use of beta-blockers in CHF has slowly gained wider acceptance in Sweden since the first report of improved survival with these drugs.[31] While the important factor in the early 1990s was to continue beta-blocker therapy post myocardial infarction, the full benefit of this treatment in CHF was not established until

Table 2 One-year mortality after a first hospitalization with a diagnosis of heart failure in 19 Swedish counties over the period 1988 to 2000 in men and women 45 to 84 years, by sex and age

	Heart failure as the principal diagnosis				Heart failure in any diagnostic position			
	Age				Age			
	45–54	55–64	65–74	75–84	45–54	55–64	65–74	75–84
Men, 1-year mortality, %								
1988	23	31	38	49	27	30	38	48
1989	24	29	37	45	26	28	37	45
1990	19	30	36	47	23	29	36	47
1991	19	27	33	45	19	25	32	44
1992	21	23	31	41	19	24	31	40
1993	18	20	27	40	19	21	28	39
1994	17	18	27	38	16	19	28	37
1995	11	15	26	38	13	18	26	38
1996	12	18	25	36	16	17	26	36
1997	16	19	25	37	16	21	26	37
1998	12	18	26	37	12	17	25	36
1999	8	15	24	36	12	16	25	37
2000	9	15	22	35	9	16	24	36
% annual change 1988–2000	−9	−8	−6	−4	−9	−7	−6	−4
Lower 95% CI	−12	−9	−7	−5	−10	−8	−6	−5
Upper 95% CI	−7	−7	−6	−4	−7	−6	−5	−4
Women, 1-year mortality, %								
1988	31	30	33	43	35	29	33	41
1989	22	29	33	40	22	27	30	39
1990	33	25	34	40	25	27	32	38
1991	24	26	30	39	23	24	28	37
1992	19	23	28	35	24	24	26	33
1993	15	21	25	33	16	21	25	32
1994	16	17	22	31	20	18	22	30
1995	18	21	23	33	20	21	24	31
1996	15	18	25	32	14	18	24	30
1997	14	17	24	32	18	18	22	30
1998	13	20	23	31	15	18	21	30
1999	13	16	22	31	18	18	21	29
2000	8	16	22	30	14	16	22	29
% annual change 1988–2000	−10	−6	−5	−5	−7	−6	−5	−4
Lower 95% CI	−14	−8	−6	−5	−10	−7	−6	−5
Upper 95% CI	−6	−4	−4	−4	−4	−5	−4	−4

1999.[10] However, only 13% of Swedish primary care physicians would prescribe beta-blockers to more than 50% of patients with heart failure.[30]

Intensive home-care programmes have optimized treatment and made patients with heart failure more knowledgeable about their disease. This has been shown to diminish re-hospitalizations and mortality.[32] It is not known if improved management in primary care prevents first-time hospitalization for heart failure.

In this study, only hospitalized patients were investigated. Less severely ill patients who were managed in an outpatient setting were not included. The decreased mortality in the study population may not be representative of all patients with heart failure. Less symptomatic patients die suddenly more often than from progressive heart failure,[33] and the effective treatment modalities introduced during the study period have probably produced symptomatic improvement in patients and thus curtailed hospitalizations. The evolution in mortality among non-hospitalized patients is not known.

Co-existing factors

Diagnostic instruments changed during the study period. More widespread use of echocardiography may lead to earlier identification of milder cases, thereby increasing incidence while improving survival.[34] However, it is unlikely that mildly symptomatic patients would have been admitted on the basis of echocardiographic findings alone. In 1997 15% of Swedish hospitals used echocardiography in all cases, 73% in most cases, and 12% in selected cases, according to a survey made by the Swedish Society of Cardiology.[35] Our mortality data are from hospitalized patients and there is no evidence that patients with milder forms of heart failure are hospitalized more often today than in 1988. On the contrary,

the number of hospital beds in departments of internal medicine in Sweden has declined markedly since 1992. As a consequence, the threshold for admitting patients may have risen. Furthermore, as the incidence of hospitalizations for heart failure has decreased, there is no evidence to support the notion that a shift towards the hospitalization of patients with milder cases is responsible for improved survival.

Limitations

One limitation of our study is that the diagnosis of heart failure could not be validated. However, the diagnosis of left heart failure by clinical examination has been validated in several studies. After a review of the literature, Badgett and co-workers found that clinical examination had a sensitivity of 62% and specificity of 76% for detecting increased filling pressure, and a sensitivity of 85% and specificity of 66% for detecting decreased ejection fraction.[36] A similar database in Scotland was recently validated with respect to the accuracy of ICD coding and found to be 90% accurate overall.[37]

It has not been possible to analyse the actual prescription of medication in this database. Consequently, the impact of pharmacological therapy on the changes observed can only be speculated.

Conclusion

Mortality after a first hospitalization for heart failure has decreased markedly in Sweden during the last decade, particularly in younger patients. Since 1993, first hospitalizations have also decreased. This improvement coincides with the establishment of ACE-inhibitor therapy, the introduction of beta-blockers for the treatment of heart failure, home-care programmes for heart failure, and more effective treatment and prevention of underlying diseases. Notwithstanding, despite considerable improvement, the 1-year mortality after a first hospitalization for heart failure is still high. On the other hand, the full benefits of widespread treatment with beta-receptor blockers and spironolactone were probably not achieved in this investigation.

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