Heart Failure
Incidence, Case Fatality, and Hospitalization Rates in Western Australia Between 1990 and 2005

Tiew-Hwa Katherine Teng, MPH; Judith Finn, PhD, FRCNA; Michael Hobbs, MBBS, DPhil, FRACP; Joseph Hung, MBBS, FRACP

Background—We examined trends in incidence of first-ever (index) hospitalization for heart failure (HF), hospitalization rates, and 30-day and 1-year all-cause mortality subsequent to index hospitalization for HF.

Methods and Results—The Western Australia Hospital Morbidity Database was used to identify a retrospective population-based cohort with an index hospitalization for HF in Western Australia between 1990 and 2005. Risk-adjusted temporal trends in mortality were examined with the use of multivariable logistic regression models. Baseline period for comparison was 1990–1993. The cohort (n=19,342; mean age, 74.2±13.2 years; 51.3% men) was followed until death or end of 2006. During the period of 1990–2005, age-standardized rates (per 100,000) of index hospitalization for HF as a principal diagnosis decreased from 191.0 to 103.2 in men, with an annual decrease of 3.5%, and from 130.5 to 75.1 in women, with an annual decrease of 3.1%. Risk-adjusted odds ratio of death at 30 days decreased to 0.73 (95% CI, 0.65 to 0.81) based on nonelective admissions. Risk-adjusted odds ratio of 1-year mortality also decreased during the study period in both genders and across all age groups. The total number of HF hospitalizations increased, with nonelective admissions increasing by 14.9% (P for trend, <0.0001) during this period. However, age-standardized rates of nonelective HF hospitalizations decreased during the same period.

Conclusions—During the 16-year period studied, the incidence of index hospitalization for HF in Western Australia decreased steadily in both genders. However, hospitalizations for HF as a measure of health service use increased, despite decreasing rates, partly because of an aging population and improved HF survival. (Circ Heart Fail. 2010;3:236-243.)

Key Words: epidemiology  heart failure  survival

Heart failure (HF) is a chronic, debilitating, and progressive disease associated with significant mortality and morbidity.1,2 HF is primarily a disease of elderly persons, with both prevalence and incidence shown to increase steeply with age.3-5 With an aging population in many industrialized countries, there has been concern that HF is the next cardiovascular “epidemic,”5,6 especially given improvements in survival in patients with HF.7,8 Decreasing mortality after myocardial infarction,9 and the improved management and survival of patients with hypertension.10 However, little population-based evidence support this assertion, and because hospitalization costs constitute 70% of the total health expenditure attributable to HF,11 accurate estimates of the incidence of HF hospitalization is crucial for health service planning and policy development.

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The aim of our study was to examine the temporal trends in the incidence of first-ever (index) and any hospitalization for HF as a principal diagnosis and 30-day and 1-year all-cause mortality subsequent to index hospitalization for HF in Western Australia (WA) between 1990 and 2005.

Methods

Study Design and Data Sources
All patients hospitalized for HF between 1990 and 2005 in WA were included in this retrospective cohort study. In 2006, the resident population in WA was 1.96 million, with 12.0% aged ≥65 years. Three percent were indigenous people (Aboriginal and Torres Strait Islander), with Chinese (3%) being the largest non-European ancestral group. Most of the population (73%) lived within the capital city, Perth. Approximately 70% of the hospital beds in WA were in public hospitals.

Since the 1970s, the WA Hospital Morbidity Database (HMD) has recorded principal and secondary (up to 20) discharge diagnoses for all patients discharged from all 129 public and private hospitals in WA. The HMD routinely is linked to other administrative health data, such as the state death register.12 The WA HMD was used to identify those patients with any hospitalization for HF between 1990
and 2005. An index HF hospitalization was defined as the first admission for HF as a principal diagnosis during the study period, with no prior hospital admission for HF within a 10-year look-back period. Patients were followed until December 31, 2006, or death. The analyses were restricted to WA residents who were aged ≥20 years to minimize loss to follow-up. WA has a lower out-of-state migration than the national average (2.0% versus 3.7% per annum in 2003). The relative stability of the WA population has the advantage of reduced loss to follow-up.13

Definition of HF

The definition of HF was based on the International Classification of Diseases, Ninth Revision (ICD9) and Tenth Revision (ICD10) diagnostic codes. For the first-listed principal diagnosis of HF, ICD9 codes included 428x, 402.01, 402.11, 402.91, 404.1, 404.3, 425x, 518.4, 514, 391.8, and 398.91, and ICD10 codes included I50x, 111.0, 113.0, 113.2, 142x, J81, I10.8, I020.

We also examined a wider definition of index hospitalization for HF, which included HF as a secondary diagnosis with a principal diagnosis of a cardiovascular condition but excluding acute myocardial infarction (AMI) (ICD9 codes 411x—427x and 429x and ICD10 codes I24x—I48x and I51x). The majority of these secondary HF cases had a principal diagnosis of ischemic heart disease (IHD) with the exclusion of AMI (56.1%) or atrial fibrillation (AF) (35.4%). Unless specified otherwise, results are based on cases with a principal diagnosis of HF.

Definition of Comorbidities

A weighted Charlson Comorbidity Index14 was calculated for each person based on the ICD diagnostic codes recorded on HMD records within 5 years before the index hospitalization. A coexistent history of the following conditions was similarly identified: all IHD, AMI, AF, hypertension, diabetics, renal failure, chronic obstructive pulmonary disease, peripheral vascular disease, cerebrovascular disease, prior interventional procedures such as percutaneous transluminal coronary angioplasty (PTCA)/stenting, and coronary artery bypass graft (CABG).

Validity of the WA HMD

The validity of coding of HF in the WA HMD has been described previously.15 In a random sample of 1006 patients, a principal diagnosis of HF had a positive predictive value of 92.4% when compared with the Boston diagnostic criteria for definite HF and 98.8% for a combined possible and definite HF based on the Boston score.13 In the same random sample among patients who had an in-hospital echocardiogram (n = 537), 55.3% had preserved systolic function defined as left ventricular ejection fraction >40% or left ventricular systolic function described as normal or mildly impaired.16

Statistical Analysis

Index hospitalizations for HF during 1990–2005 were divided into 4 equal periods (1990–1993 [base period], 1994–1997, 1998–2001, and 2002–2005) for the purpose of descriptive analyses and comparing trends. Rates for each 5-year age group, gender, and each calendar year were calculated, with incident cases in that year as the numerator and the respective estimated WA population (≥20 years)17 at midyear (which approximates the person-years for a follow-up period of 1 year) as denominator. These rates were used to calculate overall and age-standardized rates for broad age groups, genders, and calendar periods and as input to Poisson regression for the assessment of significance of differences, trends, and gender-age interaction. Rates for each calendar period were computed based on the average of annual rates for the period. Annual age-standardized rates (ASR) per 100 000 were calculated by direct standardization method against the Australian 2001 population.17 Annual percent change was calculated based on mean rolling change for each year versus the prior year during the period of 1990–2005.

Multivariate risk-adjusted temporal trends in 30-day case fatality and 1-year mortality in patients who survived at least 30 days from initial date of index hospital admission for HF were examined for the total cohort and separately by gender using logistic regression, with odds ratios and their 95% CIs reported, and P<0.05 considered significant. Only covariates associated with outcome in a univariate manner (P<0.15) were entered into the multivariate analysis. Mortality trends were assessed using the Cochran-Armitage trend test. Poisson regression models were used to examine risk-adjusted rates and incidence rate ratios. The statistical analyses were performed with SAS version 9.1 and Stata 10.

Results

Patient Characteristics

Between 1990 and 2005, a total of 27 105 patients (52.2% men) were admitted with an index hospitalization for HF, and 71.4% (19 342) patients had a principal diagnosis of HF (Table 1). Women were older than men (mean age, 76.6 years versus 71.9 years; P<0.001). During the study period, the median age (77 years) of the patients with index hospitalization for HF did not change, although there was a significant change in the distribution of patients aged <65, 65 to 74, and ≥75 years (P<0.001) (Table 1).

Trends in Comorbidities

Almost 99% of the cohort had 1 or more comorbid conditions recorded (Table 1), the most common being hypertension (46.8%), IHD (32.5%) including AMI (13.4%), AF (27.3%), chronic obstructive pulmonary disease (25.6%), and diabetes (23.4%). Hypertension was more prevalent in women (48.5% versus 39.5%; P<0.0001), whereas IHD was predominant in men (35.3% versus 29.5%; P<0.0001). During the study period, we observed a decreasing prevalence in IHD, especially in AMI, but conversely an increasing prevalence of hypertension, diabetes, AF, renal failure, and rates of PTCA and CABG during the study period (Table 1).

Trends in HF Incidence Rates

The incidence rate of all index hospitalizations for HF as a principal diagnosis was higher in men than in women, with the overall ASR being 131.2 and 91.4 per 100 000 population, respectively (P<0.001), and with an overall rate of 111.3 per 100 000. The respective rates (per 100 000 population) in men during the period of 1990–2005, decreased from 191.0 to 103.2, with an annual decrease of 3.5%, and in women from 130.5 to 75.1, with an annual decrease of 3.1% (Figure). From 1994 onward, the annual decrease was steeper, being 4.1% in men and 3.4% per year in women.

If secondary diagnoses of HF were included, the overall ASR was 150.1 per 100 000 population, ≈35% higher than ASR based on a principal diagnosis of HF only. During the same study period, the ASR decreased from 224.6 to 143.2 in men and from 159.9 to 99.9 in women. Trend line gradients were similar irrespective of HF as a principal diagnosis or combined with a secondary diagnosis of HF.

For every advancing decade of age, we observed a 2- to 3-fold increase in ASRs of index hospitalization for HF in both men and women (Table 2). Nevertheless, decreases in ASRs occurred in both men and women across all age groups, with no significant difference between genders and no significant gender-age interaction (Table 2).
The overall crude cumulative mortality at 30 days and 1 year in patients with a principal diagnosis of HF were 9.5% and 26.7%, respectively, with no significant difference in mortality between men and women (Table 1). Notably, crude cumulative 30-day and 1-year mortality progressively decreased across all age groups during the study period (Table 1).

### Trends in Adjusted 30-Day and 1-Year Mortality
Multivariable analysis determined that age, AMI, renal failure, cerebrovascular disease, hypertension, AF, Charlson Comorbidity Index, and prior PTCA or CABG were significant independent predictors of 30-day mortality (all \(P<0.001\)). Predictors of 1-year mortality (in 30-day survivors) were age, gender, renal failure, Charlson Comorbidity Index, hypertension, diabetes, PTCA, and CABG (all \(P<0.01\)). Female gender was a significant independent predictor of 1-year mortality (odds ratio, 0.80; 95% CI, 0.73 to 0.87; \(P<0.001\)) but not for 30-day mortality.

After multivariate adjustment, we observed that the likelihood (odds ratio) of death at 30 days and 1 year after nonelective hospital admission for HF was significantly reduced in both genders in all time periods subsequent to 1990–1993 (baseline) (Table 3). Annual relative decrease in 1-year mortality in 30-day HF survivors, with a principal diagnosis, was 3.0% (95% CI, 2.1% to 4.0%; \(P<0.001\)). The annual relative mortality decrease
was similar at 3.1% (95% CI, 2.3% to 4.0%; \( P < 0.001 \)) if secondary HF diagnoses were included.

**Hospitalizations Involving HF**

The total number of hospitalizations and rates (per 100 000 population) of admissions for HF as a principal diagnosis in WA are summarized in Table 4. Overall total hospitalizations for HF increased by 4.2% in the last period (2002 to 2005) compared with baseline. There was a greater proportional increase in nonelective hospitalizations for HF (14.9%) during the same period (Table 4).

Age-specific rates of nonelective admissions for HF in both genders and in all age groups were lower in the last versus baseline period (Table 4). ASR (per 100 000) for nonelective admissions decreased similarly in both genders, particularly when compared with the period of 1994–1997 when rates of emergent HF admission seemed to have peaked (Table 4). Irrespective of the decreases in ASR, the age-specific rate of HF hospitalizations for age group $\geq$75 years was 4.0-fold higher than in age group 65 to 74 years and 55.2-fold compared with the age group <65 years.

**Discussion**

Our principal findings are 3-fold. First, the incidence of first-ever hospitalization for HF as a principal diagnosis or combined principal and secondary diagnoses in WA decreased between 1990 and 2005, consistent with studies from other developed countries. Second, there has been a sustained decrease in 30-day case fatality and 1-year adjusted mortality for HF during this 16-year period, which corresponded to the era of evidence-based treatments for HF. Third, the overall number of hospitalizations has increased, with a greater magnitude of increase for nonelective admissions, particularly in the age group $\geq$75 years; however, age-standardized hospitalization rates for HF have decreased.

**Trends in Incidence of Index Hospitalization for HF**

As shown in previous studies, we found that HF is primarily a disease of elderly persons with a median age of 77 years. Although men tended to be younger than women when admitted for the first time with HF, the greater female longevity meant that women predominate in the age group $>$75 years. Our study also confirms that the incidence of hospitalization for HF increases steeply with age. For every decade increase in age, we observed a 2- to 3-fold increase in incidence rates. Given that the segment of the WA population that is aged $\geq$65 years has increased by 40.4% during the period of 1990–2005, trends in incidence of new HF admis-

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**Table 2. Age-Standardized Rates of Index Hospitalization for HF as a Principal Diagnosis per 100 000 Based on Age Group, Gender, and Calendar Period**

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<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
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<tr>
<td>&lt;65 y</td>
<td>27.00</td>
<td>26.92</td>
<td>24.11</td>
<td>27.47</td>
<td>+1.7</td>
</tr>
<tr>
<td>65–74 y</td>
<td>425.54</td>
<td>344.18</td>
<td>284.00</td>
<td>237.81</td>
<td>-44.1</td>
</tr>
<tr>
<td>$\geq$75 y</td>
<td>1286.76</td>
<td>1010.63</td>
<td>865.57</td>
<td>780.03</td>
<td>-39.4</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>&lt;65 y</td>
<td>16.87</td>
<td>14.62</td>
<td>15.34</td>
<td>14.93</td>
<td>-11.5</td>
</tr>
<tr>
<td>65–74 y</td>
<td>285.07</td>
<td>231.23</td>
<td>193.45</td>
<td>152.42</td>
<td>-46.5</td>
</tr>
<tr>
<td>$\geq$75 y</td>
<td>1037.56</td>
<td>818.21</td>
<td>704.46</td>
<td>632.44</td>
<td>-39.0</td>
</tr>
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</table>

There is a concern about a potential epidemic of HF due to an aging population and improvements in survival of patients with HF and after myocardial infarction.\(^5\)\(^6\) The major finding of our study is that during the study period, age-standardized incidence rates of index hospitalizations for HF decreased by \(\approx 40\%\) in both genders, and the largest decreases were seen in

<table>
<thead>
<tr>
<th>Period</th>
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<th>Women</th>
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<tr>
<td>1990–1993</td>
<td>239</td>
<td>239</td>
</tr>
<tr>
<td>1994–1997</td>
<td>194</td>
<td>174</td>
</tr>
<tr>
<td>1998–2001</td>
<td>185</td>
<td>169</td>
</tr>
<tr>
<td>2002–2005</td>
<td>168</td>
<td>168</td>
</tr>
</tbody>
</table>

Cumulative 1-y mortality in 30-day survivors from index admission\(^\S\)

<table>
<thead>
<tr>
<th>Period</th>
<th>Men</th>
<th>Women</th>
</tr>
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<tbody>
<tr>
<td>1990–1993</td>
<td>376</td>
<td>342</td>
</tr>
<tr>
<td>1994–1997</td>
<td>382</td>
<td>291</td>
</tr>
<tr>
<td>1998–2001</td>
<td>358</td>
<td>309</td>
</tr>
<tr>
<td>2002–2005</td>
<td>314</td>
<td>292</td>
</tr>
</tbody>
</table>

Table 3. Long-Term Trends in 30-Day Case Fatality and 1-Year Mortality in 30-Day Survivors for Men and Women for the Period of 1990–2005, Adjusted for Multiple Covariates (Nonelective Index HF Cases With a Principal Diagnosis Only)

<table>
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</thead>
<tbody>
<tr>
<td>Total Elective (planned)</td>
<td>14 568</td>
<td>15 000</td>
<td>15 348</td>
<td>15 176</td>
<td>60 092</td>
<td>+4.2</td>
</tr>
<tr>
<td>Total Nonelective (emergency)</td>
<td>3810</td>
<td>2865</td>
<td>2326</td>
<td>2819</td>
<td>11 820</td>
<td>−26.0</td>
</tr>
<tr>
<td>Age-standardized rate for all nonelective admission for HF</td>
<td>10 758</td>
<td>12 135</td>
<td>13 022</td>
<td>12 357</td>
<td>48 272</td>
<td>+14.9</td>
</tr>
<tr>
<td>Males Elective (planned)</td>
<td>299.93</td>
<td>317.17</td>
<td>294.31</td>
<td>248.60</td>
<td>282.67</td>
<td>−17.1</td>
</tr>
<tr>
<td>Males Nonelective (emergency)</td>
<td>228.19</td>
<td>223.16</td>
<td>218.93</td>
<td>176.44</td>
<td>206.86</td>
<td>−22.7</td>
</tr>
<tr>
<td>Females Elective (planned)</td>
<td>71.78</td>
<td>65.37</td>
<td>58.38</td>
<td>59.23</td>
<td>63.03</td>
<td>−17.5</td>
</tr>
<tr>
<td>Females Nonelective (emergency)</td>
<td>852.36</td>
<td>908.88</td>
<td>751.90</td>
<td>626.00</td>
<td>757.29</td>
<td>−26.6</td>
</tr>
<tr>
<td>In men</td>
<td>2435.62</td>
<td>2696.71</td>
<td>2645.28</td>
<td>2122.86</td>
<td>2410.40</td>
<td>−12.8</td>
</tr>
<tr>
<td>In women</td>
<td>595.39</td>
<td>571.28</td>
<td>504.15</td>
<td>352.96</td>
<td>488.36</td>
<td>−40.7</td>
</tr>
<tr>
<td>≥75 y</td>
<td>2136.97</td>
<td>2123.26</td>
<td>2110.67</td>
<td>1724.85</td>
<td>1974.77</td>
<td>−19.3</td>
</tr>
</tbody>
</table>

\(^\dagger\)Last period (2002–2005).
\(^\ddagger\)Last period−base period/base period.

Table 4. Hospitalizations and Hospitalization Rates (per 100 000 Population) for HF as a Principal Diagnosis in WA Between 1990 and 2005
the age group ≥65 years (Table 2). Similar trends in first hospitalization for HF have been reported, most recently from Scotland (1986–2003),7 Sweden (1987–2000),18 Canada (1994–2000),20 and England (1993–2001).19 Taken together, these studies suggest that the incidence of new hospitalizations for HF has peaked and has been steadily decreasing since the 1990s.

In comparison with other international studies with HF as a principal diagnosis only, our study showed annual percentage decreases of 3% to 4% in both genders, similar to the Scottish HF7 and the Swedish HF18 studies from around 1994 onward (Figure A and B). The Scottish and the Swedish HF studies were both large population studies similarly based on hospital administrative data. Although comparison of the ASRs ideally should be based on a common standard population for the same set of weights to be applied in the calculation across populations, this was not within the scope of our study. However, the most important observation is that the incident trends of first hospitalizations for HF have steadily decreased in Australia, Scotland, and Sweden since the early 1990s. We also found the same downward incident trends for HF even when we used a broader definition of HF, which included HF as a principal or secondary diagnosis. A potential limitation to assessing temporal trends in incidence is that HF may be more readily diagnosed now, but if anything, this tendency would weigh against the observed trend for decreasing incidence.

Although these results based on new hospitalizations for HF are encouraging, they do not capture the incidence of new HF cases in the clinic setting. The few studies that have attempted to assess the longitudinal incidence of both inpatient and outpatient cases of HF have provided equivocal results.5,8,21 The Framingham Heart study reported a significant decrease in age-adjusted incidence of HF in women but not in men between 1950 and 1999.8 However, another community-based study from Olmsted County, Minnesota, showed that the incidence of HF has not decreased between 1979 and 2000 for either gender, although survival after onset of HF improved.21 A recent study involving the use of administrative (Medicare) data for 622,786 inpatients and outpatients with HF aged ≥65 years in the United States reported a modest decrease in incidence in both genders between 1994 and 2003.4 These results at least suggest that the incidence of new HF in the community is not increasing and that better care and preventive treatment in the community may translate to a lower caseload of incident hospitalizations for HF.

Comorbidities

HF is a highly heterogeneous condition with several underlying causes that affect its epidemiology.1–3 In line with previous studies, we found that IHD and hypertension were the predominant comorbidities associated with HF, with IHD more prevalent in men and hypertension in women. Although we are not able to fully elucidate the change in contributory risk factors to HF over time, we found that the prevalence of AMI decreased steadily during the study period. With the decreasing incidence and severity of AMI over time22–24 and the decreased risk of HF after AMI,23 the contribution of AMI to the burden of HF might diminish, which seems to be reaffirmed in our study, particularly in men who are more likely afflicted by IHD.25 Conversely, we found that the prevalence of risk factors for HF, including hypertension, diabetes, renal failure, and AF, increased during the study period, which along with the aging population demographics provides a note of caution with respect to future population trends in HF.

Trends in Mortality

We showed that 30-day and 1-year crude and adjusted mortality decreased during the study period in both genders and in all age groups, despite an increasing age and comorbidity burden of our HF cohort (Table 3). Although reported crude 1-year mortality rates after new HF have varied across populations, studies from Scotland,7 England,19 and Sweden18 have similarly reported improvements in 1-year survival around the same time period as our study.

As with the observed reductions in incident hospitalizations for HF, it is difficult to be certain of the reasons for the improved survival. The use of angiotensin-converting enzyme inhibitors became widespread in the beginning of the 1990s, and subsequently, β-blockers and aldosterone antagonists increasingly were used in the later periods.26–28 In a separate study involving a random sample of our HF cohort (n = 944), we confirmed a high prescription rate of angiotensin-converting enzyme inhibitors and an increasing prescription rate of β-blockers and aldosterone antagonists after index hospitalization for HF during the period of 1996–2006.16 Discharge prescription of an angiotensin-converting enzyme inhibitor or a β-blocker was independently associated with an improved 1-year survival in this cohort.16 Jhund et al7 also found that prescribing rates for prognostic HF therapies increased from 1997 to 2003 in association with their observed decrease in case-fatality rates among hospitalized patients with HF in Scotland. In the same era, secondary prevention treatments of IHD also have improved with increasing use of antiplatelet drugs, lipid-lowering agents (statins), angiotensin-converting enzyme inhibitors, and coronary artery revascularization procedures after AMI.29,30 We observed that the rate of coronary artery revascularization procedures increased during the period, and PTCA and CABG were both strong independent predictors of improved survival after hospital admission for HF. Finally, it is important to note that despite the encouraging trend in case-fatality, the overall prognosis for hospitalized patients with HF remains poor, with almost one quarter of patients dying by 1 year.

Hospitalizations

The absolute number of index hospital admissions for all HF as a principal diagnosis increased during the study period in tandem with the aging population, particularly for nonelective hospitalizations. Several reports have confirmed the increased number of hospitalizations attributed to HF,4,31 and as such, HF may present a growing problem on a global scale.1

However, when expressed as standardized rates, the hospitalization rates for HF in both genders actually steadily decreased from a peak around 1994–1997 (Table 4). The observed decrease during the study period is consistent with
other local studies\textsuperscript{2,3} and those from Scotland\textsuperscript{4} and Canada.\textsuperscript{20} It is encouraging to note that despite the increase of 40.4\% in the WA population aged $\geq65$ years during the study period, nonelective hospitalization rates that are less affected by admission thresholds have decreased. Notably, the age-specific rates of nonelective admissions in the age group 65 to 74 years, who pose the greatest burden in the future, had the most significant decrease.

It seems unlikely that the decrease in overall hospitalization rates was due to changing admission thresholds in WA hospitals because the mean Boston score (as a measure of severity of HF) was unchanged throughout the period in our validation study.\textsuperscript{19} Decreases in hospitalization rates also could be a reflection of better treatment of patients with HF in the community, leading to fewer hospitalizations, although this could not be ascertained from this study.

**Strengths and Limitations**

Our study has a number of strengths and limitations. We have previously determined that a principal diagnosis of HF in the WA HMD had a high positive predictive accuracy in a random sample of 1006 patients.\textsuperscript{15} Uptake of evidence-based pharmacotherapies for HF could not be assessed for the whole cohort, although increasing use of proven pharmacotherapies during the study period was confirmed in a random sample of the cohort.\textsuperscript{16} In addition, we lack information on left ventricular function for the whole cohort, although in the random sample of patients with HF as a principal diagnosis, similar outcomes between patients with and without left ventricular systolic dysfunction had been observed.\textsuperscript{16} A potential disadvantage of the 10-year look-back period is that we may not be able to track new residents who have lived in WA $<10$ years. On the other hand, WA has a low out-of-state migration (2.0\% per annum according to 2003 population statistics\textsuperscript{35}). Our study, similar to all hospital-based studies, may be biased by changes in coding practices or case-mix classification. In addition, we were not able to examine changes in the incidence and prevalence of HF in the community; however, because hospitalization cost is the main cost driver for HF, the hospital-based perspective undertaken longitudinally is crucial to healthcare planning. We also have shown that an HF definition based solely on it as a principal diagnosis may underestimate the caseload of HF attributable to cardiovascular conditions, such as IHD, in which HF may be indicated as a secondary diagnosis.

**Clinical Implications**

Despite the decreasing incidence of index hospitalizations for patients with HF, the total number of hospitalizations and the burden related to HF will continue to increase in the future due to the aging of the Australian population and improved survival associated with better interventions and treatments. These findings, therefore, have major implications for future healthcare costs and service planning for HF.

**Acknowledgments**

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**Disclosures**

None.

**References**


**CLINICAL PERSPECTIVE**

There is concern of a growing epidemic of heart failure (HF) due to an aging population in most countries. We examined temporal trends in the incidence of first-ever (index) hospitalization for HF as a principal diagnosis, hospitalization rates, and 30-day and 1-year all-cause mortality subsequent to index hospitalization for HF in Western Australia between 1990 and 2005. We found that age-standardized hospitalization rates for new HF decrease in both genders and in all age groups during the study period, as did the adjusted risk of death at 30 days and at 1 year, which is consistent with findings in other countries. Overall number of HF hospitalizations increased, however, because of aging of the Australian population and improved HF survival. These findings have major implications for future healthcare costs and health service planning for HF.
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