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RESEARCH ARTICLE

Long-term survival and life expectancy following an acute heart failure hospitalization in Australia and New Zealand

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Aims Contemporary long-term survival following a heart failure (HF) hospitalization is uncertain. We evaluated survival up to 10 years after a HF hospitalization using national data from Australia and New Zealand, identified predictors of survival, and estimated the attributable loss in life expectancy.

Methods and results Patients hospitalized with a primary diagnosis of HF from 2008–2017 were identified and all-cause mortality assessed by linking with Death Registries. Flexible parametric survival models were used to estimate survival, predictors of survival and loss in life expectancy. A total of 283 048 patients with HF were included (mean age 78.2 ± 12.3 years, 50.8% male). Of these, 48.3% (48.1–48.5) were surviving by 3 years, 34.1% (33.9–34.3) by 5 years and 17.1% (16.8–17.4) by 10 years (median survival 2.8 years). Survival declined with age with 53.4% of patients aged 18–54 years and 6.2% aged ≥85 years alive by 10 years (adjusted hazard ratio [aHR] for mortality 4.84, 95% confidence interval [CI] 4.65–5.04 for ≥85 years vs. 18–54 years) and was worse in male patients (aHR 1.14, 95% CI 1.13–1.15). Prior HF (aHR 1.20, 95% CI 1.18–1.22), valvular and rheumatic heart disease (aHR 1.11, 95% CI 1.10–1.13) and vascular disease (aHR 1.07, 95% CI 1.04–1.09) were cardiovascular comorbidities most strongly associated with long-term death. Non-cardiovascular comorbidities and geriatric syndromes were common and associated with higher mortality. Compared with the general population, HF was associated with a loss of 7.3 years in life expectancy (or 56.6% of the expected life expectancy) and reached 20.5 years for those aged 18–54 years.

Conclusion Less than one in five patients hospitalized for HF were surviving by 10 years with patients experiencing almost 60% loss in life expectancy compared with the general population, highlighting the considerable persisting societal burden of HF. Concerted multidisciplinary efforts are needed to improve post-hospitalization outcomes of HF.

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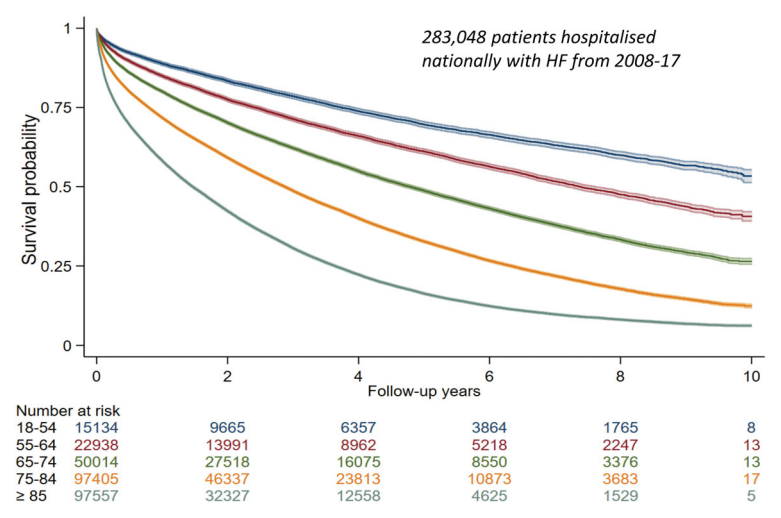
Graphical Abstract



Differences in long-term survival after an acute heart failure (HF) hospitalization across age groups in Australia and New Zealand.

Keywords Heart failure • Hospitalizations • Survival • Prognosis • Mortality • Outcomes

Introduction

Heart failure (HF) is a leading cause of hospitalizations and deaths globally. In developed countries, the prevalence of HF is estimated to be 1–4% and is projected to rise dramatically due to ageing populations.[1] Moreover, HF contributes to a disproportionate number of hospitalizations and is a common cause of hospital admission in older adults. Nevertheless, HF hospitalizations have significantly declined in developed countries.[1] For example, in Australia and New Zealand, HF hospitalizations have declined since the 1990s.[2] The decline in hospitalization have also been accompanied by a significant decline in 30-day[2,3] and 1-year mortality.[2] These improvements have been attributed to advances in HF care[4] that better address risk factors such as hypertension and diabetes, and availability of therapeutic options (both pharmacological and non-pharmacological) that improve survival,[5–7] particularly in those with reduced left ventricular ejection fraction.

Improvement in early mortality, however, has not been a consistent global finding with recent data from the United States suggesting potentially increasing early mortality.[8] A recent study from the United Kingdom also showed improvement in HF survival over time,[9] yet most of the improvement was observed in HF patients treated in the community with poor outcomes for hospitalized patients. Given the heterogeneity in outcomes reported across populations, whether such poor long-term outcomes are observed in other populations is uncertain especially given the improvements in early mortality observed in Australia and New Zealand. Unfortunately, much of our contemporary understanding of survival of hospitalized patients come from cohorts with relatively short outcomes times, typically up to 1 year[10–14] with a paucity of large-scale studies in the literature that examined survival beyond the first year.[2,15–17] These data are crucial for patients and caregivers seeking to better understand the impact of a HF hospitalization, and for clinical and population health efforts to further improve HF care and outcomes.

In this study, we examined survival up to 10 years following an acute HF hospitalization using nationwide data from Australia and New Zealand from 2008 to 2017 and examined patient factors associated with long-term survival. We also estimated the loss in life expectancy attributable to HF by comparing survival of patients with HF to that of the general population.

Methods

Data source

We used routinely collected hospitalization data from all public and most (80%) private hospitals from each Australian state and territory's Admitted Patient Collection and the equivalent New Zealand National Minimum Dataset (Hospital Events). Private hospital data were unavailable from South Australia, Northern Territory and Tasmania (which collectively contain about 10% of the Australian population) and from New Zealand. These datasets contain a standardized set of variables including patient demographic characteristics, date of admission and discharge, primary and up to 50 secondary diagnoses, all procedures performed and the patient's status at discharge. Diagnoses and procedures in both countries are coded as per the International Classification of Diseases, 10th revision Australian Modification (ICD-10-AM)

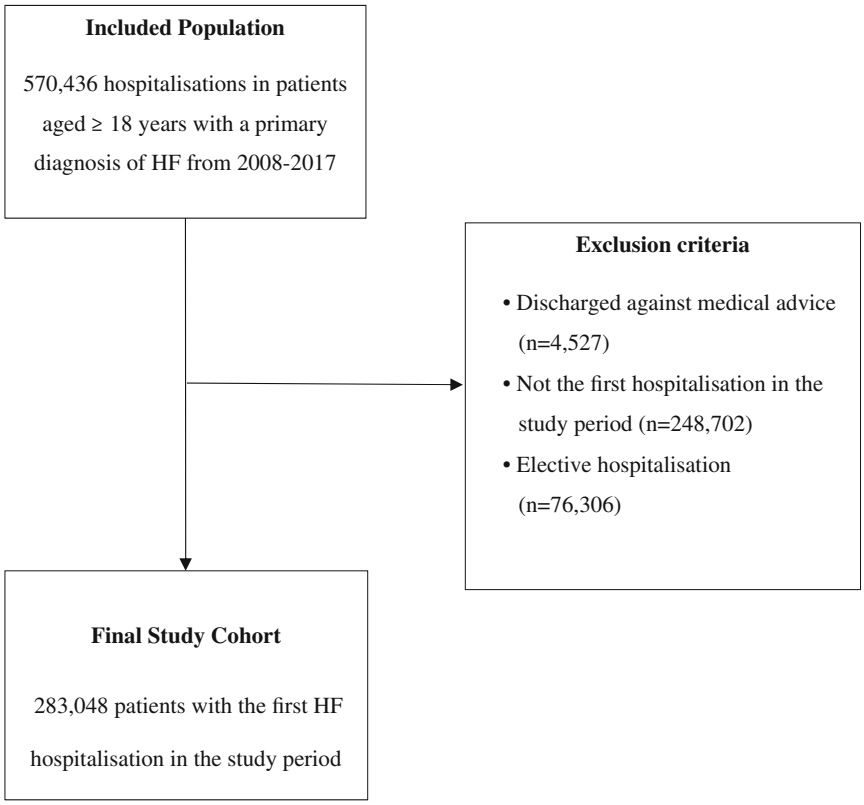


Figure 1 Patient selection flow diagram. HF, heart failure.

and the Australian Classification of Health Interventions, respectively. Prior studies have shown >85% accuracy of diagnoses and procedure coding[18] with a primary diagnosis of HF coded with high positive predictive value compared with medical records or a clinical diagnosis of HF.[19]

Study cohort

We included all patients aged >18 years hospitalized with a primary diagnosis of HF defined by ICD-10-AM codes I50.0–9 (Congestive HF), I11.0 (Hypertensive heart disease with congestive HF), I13.0 (Hypertensive heart and kidney disease with congestive HF), and I13.2 (Hypertensive heart and kidney disease with both congestive HF and kidney failure) from 2008–2017 inclusive. For patients with multiple hospitalizations for HF during the study period, only the first hospitalization was included. We excluded elective (planned) hospital encounters for HF (as these patients may not have acute HF), subsequent hospitalization for HF, or if the patient had discharged against medical advice.

Study outcome

The primary outcome was all-cause mortality. In Australia, all-cause mortality was captured by linking to Death Registries in each region. Linkages were performed by designated data-linkage units within each region by probabilistic matching using multiple patient identifiers with reported accuracy exceeding >99%.[20] In New Zealand, hospital encounters are linked nationally using a national unique patient identifier and all deaths are recorded in the National Minimum Dataset (Hospital Events). We also estimated the loss in life expectancy, which measures the number of life years lost due to a HF hospitalization, and estimated as the difference in the mean observed survival between the patients who had a HF hospitalization and the mean expected survival in the general population.[21]

Statistical analysis

Categorical data are presented as frequencies and percentages, normally distributed continuous variables as mean ± standard deviation and non-parametric data as medians and interquartile ranges (IQR). We used the Kaplan–Meier method to estimate crude survival with time to death calculated from the date of admission for the index HF hospitalization until the date of death. Patients surviving to 31 December 2017 were censored. The median follow-up time was defined as median time on study for those event-free at the end of follow-up. A flexible parametric survival model was used to identify patient factors associated with the risk of long-term mortality and reported as hazard ratios (HR) with 95% confidence intervals (CI). Patient factors considered included age, sex and comorbidities with the latter derived using the Condition Category classification system[22] which groups ICD-10-AM codes into 180 clinically significant conditions using selected secondary diagnosis codes from the index hospitalization, and primary and secondary diagnosis codes from all hospitalizations in the preceding 12 months.

Table 1 Patient characteristics at presentation

Patient characteristic	Overall (n = 283 048)	18–54 years (n = 15 134)	55–64 years (n = 22 938)	65–74 years (n = 50 014)	75–84 years (n = 97 405)	≥85 years (n = 97 557)
Age, years (mean ± SD)	78.2 ± 12.3	45.7 ± 7.8	60.4 ± 2.8	70.3 ± 2.8	80.2 ± 2.8	89.5 ± 3.5
Male sex	143 812 (50.8)	9358 (61.8)	14 612 (63.7)	29 799 (59.6)	50 708 (52.1)	39 335 (40.3)
Presentation to private hospital	30 005 (10.6)	577 (3.8)	1309 (5.7)	3835 (7.7)	9824 (10.1)	14 460 (14.8)
Presenting region						
NSW/ACT	81 164 (28.7)	3349 (22.1)	5974 (26.0)	14 221 (28.4)	28 277 (29.0)	29 343 (30.1)
VIC	48 963 (23.3)	2498 (16.5)	4310 (18.8)	10 546 (21.1)	22 398 (23.0)	22 743 (23.3)
QLD	45 662 (16.1)	2665 (17.6)	3999 (17.4)	8403 (16.8)	15 186 (15.6)	15 409 (15.8)
SA/NT	20 150 (7.1)	1484 (9.8)	1756 (7.7)	3409 (6.8)	6778 (7.0)	6723 (6.9)
TAS	5322 (1.9)	181 (1.2)	404 (1.8)	1028 (2.1)	1966 (2.0)	1743 (1.8)
WA	22 244 (7.9)	1565 (10.3)	1964 (8.6)	3787 (7.6)	7377 (7.6)	7551 (7.7)
NZ	46 011 (16.3)	3392 (22.4)	4531 (19.8)	8620 (17.2)	15 423 (15.8)	14 045 (14.4)
Cardiovascular comorbidities						
Acute coronary syndrome	31 480 (11.1)	1355 (9.0)	2640 (11.5)	6052 (12.1)	11 265 (11.6)	10 168 (10.4)
Ischaemic heart disease	54 268 (19.2)	2366 (15.6)	5286 (23.0)	12 184 (24.4)	20 550 (21.1)	13 882 (14.2)
Hypertension	112 215 (39.6)	5415 (35.8)	9611 (41.9)	21 370 (42.7)	40 560 (41.6)	35 259 (36.1)
Congestive HF	77 864 (27.5)	5909 (42.4)	7362 (32.1)	14 829 (29.6)	26 467 (27.2)	23 297 (23.9)
Valvular and rheumatic heart disease	35 111 (12.4)	1956 (12.9)	2546 (11.1)	5804 (11.6)	12 553 (12.9)	12 252 (12.6)
Arrhythmia or conduction system disorder	60 558 (21.4)	2057 (13.6)	4057 (17.7)	10 930 (22.7)	23 270 (23.9)	20 244 (20.8)
Cerebrovascular diseases	8789 (3.1)	231 (1.5)	548 (2.4)	1455 (2.9)	3260 (3.3)	3295 (3.4)
Vascular disease	14 834 (5.2)	698 (4.6)	1220 (5.3)	3135 (6.3)	5662 (5.8)	4119 (4.2)
Other comorbidities						
Diabetes	86 856 (30.7)	4919 (32.5)	9830 (42.9)	20 918 (41.8)	31 802 (32.6)	19 387 (19.9)
Major and metastatic cancer	9645 (3.4)	254 (1.7)	773 (3.4)	2312 (4.6)	3872 (4.0)	2434 (2.5)
Chronic liver disease and cirrhosis	3540 (1.3)	452 (3.0)	666 (2.9)	990 (2.0)	1021 (1.0)	411 (0.4)
Chronic lung disease	13 332 (16.9)	1428 (9.4)	3881 (16.9)	10 515 (21.0)	18 644 (19.2)	13 332 (13.7)
Pneumonia	46 834 (16.6)	2130 (14.1)	3109 (13.6)	7266 (14.5)	16 441 (16.9)	17 888 (18.3)
Dialysis or renal failure	50 285 (17.8)	2388 (15.8)	3921 (17.1)	9314 (18.6)	18 539 (19.0)	16 123 (16.5)
Fluid and electrolyte disorders	49 259 (17.4)	2395 (15.8)	3671 (16.0)	8766 (17.5)	17 484 (17.9)	16 943 (17.4)
Anaemia and other haematological disorders	59 833 (21.1)	2732 (18.1)	4183 (18.2)	10 618 (21.2)	22 197 (22.8)	20 103 (20.6)
Psychiatric disorders	15 613 (5.5)	1267 (8.4)	1435 (6.3)	2977 (6.0)	5239 (5.4)	4695 (4.8)
Geriatric syndromes						
Dementia	15 201 (5.4)	33 (0.2)	117 (0.5)	915 (1.8)	5140 (5.3)	8996 (9.2)
Chronic skin ulcers	9881 (3.5)	360 (2.4)	676 (2.9)	1590 (3.2)	3333 (3.4)	3922 (4.0)
Protein-calorie malnutrition	24 587 (8.7)	737 (4.9)	1162 (5.1)	3192 (6.4)	8326 (8.5)	11 170 (11.4)
Incontinence, UTI and other urinary tract disorders	44 379 (15.7)	1179 (7.8)	2087 (9.1)	5950 (11.9)	15 750 (16.2)	19 413 (19.9)
Hemiplegia, paraplegia, paralysis, functional disability	13 502 (4.8)	538 (3.6)	1089 (4.7)	2384 (4.8)	4598 (4.7)	4893 (5.0)

Values are given as n (%), unless otherwise indicated.
ACT, Australian Capital Territory; HF, heart failure; NSW, New South Wales; NZ, New Zealand; QLD, Queensland; SA/NT, South Australia/Northern Territory; SD, standard deviation; TAS, Tasmania; UTI, urinary tract infection; VIC, Victoria; WA, Western Australia.

A flexible parametric survival model was also used to estimate the expected life expectancy, the observed life expectancy, and loss in life expectancy,[21] with predictors of long-term survival included as covariates. The expected survival was estimated based on the available life tables of the general population matched for age, sex and region.[23,24] Due to possible variations in expected life expectancy across subgroups, the proportion of life lost was also calculated by dividing the estimated years of life lost by the expected life expectancy.[25] A two-sided p-value <0.05 was indicative of statistical significance. All analyses were performed using Stata version 16.1 (StataCorp, College Station, TX, USA).

Ethical approval

Human Research Ethics Committee of Australian states and territories provided ethical approval to undertake the study with a waiver of

Table 2 Number of deaths and median survival among heart failure patients

Participants	*n*	Died, *n* (%)	Median survival, years (95% CI)[a]
Overall	283 048	168 866 (59.7)	2.81 (2.79–2.84)
Male	143 812	85 297 (59.3)	2.79 (2.76–2.82)
Female	139 236	83 569 (60.0)	2.84 (2.81–2.87)
18–54 years	15 134	4171 (27.6)	N/A[b]
55–64 years	22 938	8470 (36.9)	7.38 (7.19–7.61)
65–74 years	50 014	23 753 (47.5)	4.78 (4.69–4.87)
75–84 years	97 405	60 481 (62.1)	2.87 (2.84–2.91)
≥85 years	97 557	71 991 (73.8)	1.47 (1.44–1.49)

CI, confidence interval; N/A, not available.
[a]Defined as the time taken for survival probability to reach 50%.
[b]Median survival not reached at the end of follow-up for those aged 18–54 years.

informed consent to use de-identified patient data as listed in the online supplementary *Appendix S1*. De-identified data from New Zealand is obtained under a data user agreement with the New Zealand Ministry of Health.

Results

A total of 570 436 consecutive HF hospitalizations met our inclusion criteria (*Figure 1*). Of these, we excluded (not mutually exclusive): (i) 4527 where the patient had discharged against medical advice; (ii) 248 702 subsequent HF hospitalizations (the first HF hospitalization were retained as the index presentation); and (iii) 76 306 elective hospitalizations. The final cohort consisted of 283 048 unique patients.

Patient characteristics

The mean age of the cohort was 78.2 ± 12.3 years with 68.9% aged ≥75 years (*Table 1*). Overall, male and female patients were evenly distributed. Cardiovascular and non-cardiovascular comorbidities were prevalent. The most common cardiovascular comorbidities were hypertension (39.6%), congestive HF (27.5%), arrhythmias (21.4%), ischaemic heart disease (19.2%), and valvular and rheumatic heart disease (12.4%). Diabetes (30.7%), anaemia (21.1%), renal failure (17.8%), fluid and electrolyte disorders (17.4%), and chronic lung disease (16.9%) were the most common non-cardiovascular comorbidities.

When patients were compared by age (*Table 1*), older patients were more likely to be female (38.2% in those aged 18–54 years vs. 60% in those aged >85 years) and were more likely to receive care at a private hospital. The proportion of patients with prior HF declined with increasing age while the proportion with arrhythmias and other conduction system disorders increased. Other cardiovascular comorbidities were similar across age groups. Non-cardiovascular comorbidities such as chronic lung disease, renal failure, anaemia, and fluid and electrolyte disorders were prevalent across all age groups while geriatric syndromes expectedly increased with age (*Table 1*). Patients who died during the follow-up period were generally older and had more cardiac and non-cardiac comorbidities compared with those that survived (online supplementary *Table S1*).

Long-term survival after a heart failure hospitalization

There were 711 666 person-years of follow-up, with a median follow-up time in patients surviving to end of follow-up of 2.88 (IQR 1.21–5.53) years. During the follow-up period, 168 866 (59.7%) patients died with a median follow-up time to death of 1.11 years (IQR 0.25–2.78) and a median survival time of 2.81 years (*Table 2*). The incidence rate of death was highest in the first 3 months after the HF hospitalization (667.9 per 1000 person-years, *Table 3*) and remained high during the first year. The high early incidence of death corresponded to a rapid decrease in the observed survival with an overall survival of 70.5% (95% CI 70.4–70.7) by 1 year, 48.3% (48.1–48.5) by 3 years, and 34.1% (33.9–34.3) by 5 years. The subsequent decline was more gradual with the incident rate of death declining to 150.0 per 1000 person-years between years 5 to 10 (*Table 3*) with a 17.1% (16.8–17.4) survival by 10 years (*Figure 2A*). The overall observed survival was comparable between male and female patients (*Figure 2B*), although survival was worse among male patients in older age groups (online supplementary *Figure S1*).

Survival declined with increasing age; 53.4% (51.3–55.4) of those aged 18–54 years were surviving at 10-years compared with 12.4% (11.8–12.9) of those aged 75–84 years and worse for patients older than 85 years whose median survival time was 18 months and only 6.2% (5.9–6.5) of this age group survived up to 10 years (*Graphical Abstract* and *Figure 2C*). Patients with a prior history HF had worse survival compared with those without a history of HF (online supplementary *Figure S2*).

Presentation characteristics associated with long-term survival

Age, sex, presenting region, and 21 comorbidities were independently associated with long-term survival (*Figure 3*). Increasing age (HR 4.84; 95% CI 4.65–5.04, $p < 0.01$) for those aged ≥85 years

Table 3 Incidence rate of death per 1000 person-years and 95% confidence intervals at various time periods post-discharge

	Time interval post-discharge					
	0–3 months	3–6 months	6–12 months	1–2 years	2–3 years	3–5 years	5–10 years
Overall	667.9 (661.5–674.3)	295.1 (290.6–299.6)	225.0 (222.0–228.0)	195.1 (192.9–197.3)	185.0 (182.5–187.5)	174.0 (171.8–176.3)	150.0 (147.6–152.5)
Male	662.1 (653.3–671.0)	294.3 (288.0–300.7)	229.3 (225.1–233.5)	200.0 (196.9–203.2)	183.2 (179.7–186.8)	170.3 (167.3–173.4)	144.8 (141.4–148.2)
Female	673.9 (664.8–683.0)	295.9 (289.6–302.5)	220.5 (216.3–224.8)	190.1 (187.0–193.2)	186.8 (183.2–190.4)	177.8 (174.6–181.0)	155.5 (151.9–159.1)
18–54 years	224.8 (209.8–240.8)	98.0 (87.9–109.1)	77.1 (70.5–84.3)	63.5 (58.9–68.4)	59.9 (55.0–65.2)	60.1 (56.0–64.5)	50.3 (46.3–54.5)
55–64 years	298.6 (284.4–313.5)	142.5 (132.4–153.3)	107.5 (101.0–114.4)	92.0 (87.3–96.8)	82.5 (77.7–87.7)	77.5 (73.6–81.7)	83.3 (78.9–88.0)
65–74 years	412.9 (401.4–424.7)	197.8 (189.5–206.5)	143.5 (138.2–148.9)	132.0 (128.0–136.0)	121.2 (116.9–125.7)	122.0 (118.3–125.9)	126.1 (121.8–130.6)
75–84 years	621.1 (610.8–631.6)	281.6 (274.2–289.2)	219.2 (214.2–224.2)	193.8 (190.1–197.5)	194.0 (189.7–198.4)	198.4 (194.4–202.4)	202.5 (197.5–207.6)
≥85 years	1033.9 (1020.1–1047.8)	453.3 (443.3–463.5)	357.0 (350.1–364.0)	319.8 (314.4–325.4)	323.2 (316.3–330.2)	316.1 (309.4–323.1)	240.6 (232.2–249.1)

compared with those aged 18–54 years and male sex (HR 1.14; 95% CI 1.13–1.15, $p < 0.01$) were associated with a higher risk of death. Patients from the Australian state of Tasmania (HR 1.25; 95% CI 1.20–1.29, $p < 0.01$) and New Zealand (HR 1.26; 95% CI 1.24–1.28, $p < 0.01$) had an elevated adjusted hazard of long-term death compared to New South Wales/Australian Capital Territory. Patients from the Australian state of Victoria (HR 0.71; 95% CI 0.70–0.72, $p < 0.01$) had the lowest adjusted hazard of death (*Figure 3*).

Cardiovascular comorbidities, particularly prior congestive HF (HR 1.20; 95% CI 1.18–1.22, $p < 0.01$), valvular/rheumatic heart disease (HR 1.11; 95% CI 1.10–1.13, $p < 0.01$), vascular disease (HR 1.07; 95% CI 1.04–1.09, $p < 0.01$) and acute coronary syndrome (HR 1.06; 95% CI 1.04–1.08, $p < 0.01$) were associated with an elevated risk of long-term death. Non-cardiovascular comorbidities were also associated with poorer long-term survival with metastatic cancer (HR 2.29; 95% CI 2.24–2.35, $p < 0.01$), chronic liver disease (HR 1.88; 95% CI 1.80–1.96, $p < 0.01$), chronic lung disease (HR 1.29; 95% CI 1.28–1.31, $p < 0.01$) and dialysis or renal failure (HR 1.24; 95% 1.22–1.26, $p < 0.01$) having the strongest association. Similarly, geriatric syndromes commonly associated with frailty such as dementia (HR 1.62; 95% CI 1.59–1.65, $p < 0.01$), protein-calorie malnutrition (HR 1.24; 95% CI 1.22–1.26, $p < 0.01$) and chronic ulcers (HR 1.34; 95% CI 1.31–1.38, $p < 0.01$) were associated with a higher risk of long-term mortality.

Loss in life expectancy and proportion of life lost

In absolute terms, on average, 7.3 years of life expectancy was lost due to HF compared with the general population (*Table 4*). The loss in life expectancy gradually decreased with older age, from 20.5 years for patients aged 18–54 years to 2.9 years for those aged ≥85 years. In proportional terms, there was an overall 56.6% loss in life expectancy compared to the general population and exceeded 50% for all age groups. The proportion of life lost was most pronounced among those aged 65–74 years (59.6%). Male patients had a higher absolute (9.1 vs. 5.5 years) and relative (60.6% vs. 50.8%) loss in life expectancy compared with female patients.

Discussion

Our large contemporary national cohort of patients hospitalized for HF in Australia and New Zealand revealed only 17% survived to 10 years following their HF hospitalization. The prognosis was poor for patients older than 75 years who represented nearly 70% of all hospitalizations, with a median survival time of 2.87 years for those aged 75–84 years, and only 18 months for those older than 85 years. In addition, the projected proportional reduction in life expectancy compared to the general population was striking, exceeding 50% for all age groups and translating to a projected 20.5 years shortened lifespan in those aged 18–54 years. While cardiovascular comorbidities such as prior HF worsened prognosis, we also found non-cardiovascular comorbidities were common

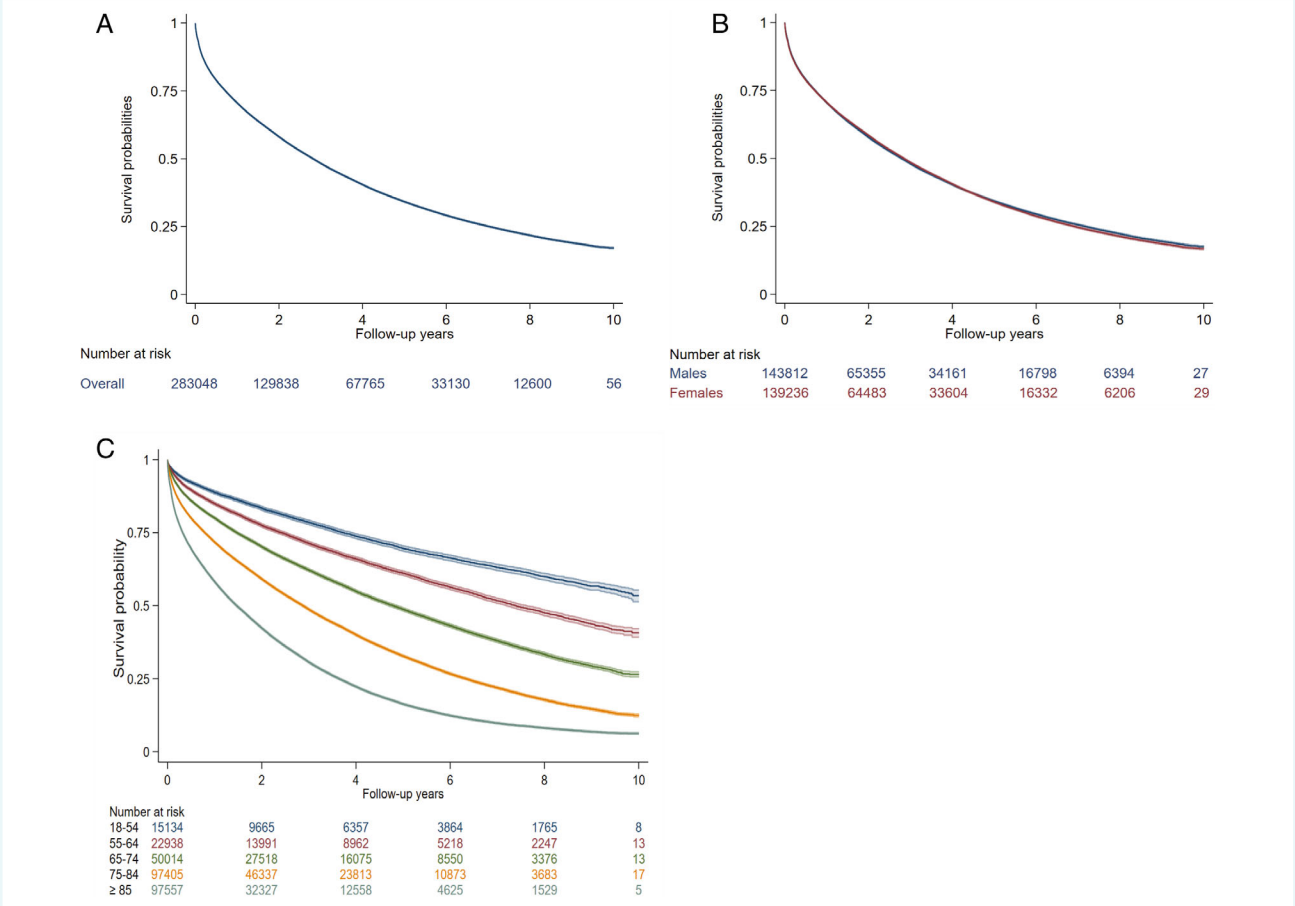


Figure 2 Long-term survival following a heart failure hospitalization (*A*) in the overall cohort, (*B*) by sex, and (*C*) by age group.

across all ages and were associated with poor survival highlighting the challenges faced in improving the prognosis of these patients who often have multimorbidity. Collectively, these solemn findings shed light on the poor prognosis of patients hospitalized for HF and reinforce the need for concerted, multidisciplinary strategies to improve HF outcomes.

Prior studies have shown a consistent improvement in early survival of patients hospitalized with HF in Australia and New Zealand.[3] Wasywich *et al.*[2] reported a decline in 30-day mortality from 15.2% to 9.3%, and 12-month mortality from 39.0% to 28.1% in New Zealand from 1998 to 2008 and we showed a continued decline in 30-day mortality from 12.5% to 8.1% in Australia and New Zealand from 2010–2015,[3] suggesting ongoing improvement in survival post-hospitalization. We extend the literature by reporting contemporary national survival of up to 10 years post-hospitalization. Prior cohorts from New Zealand (1988–2008)[2] and Western Australia (1990–2005)[17] have also reported 5-year mortality of 52% and 54.1%, respectively, in the most recent periods. Despite reported improvement in early mortality in this population, our observed 1-, 5- and 10-year survival of 71.1%, 49.2% and 17.1% (corresponding to cumulative mortality of 28.9% at 1 year, 50.8% at 5 years and 82.9% at 10 years) showed little improvement and remains well below survival of 89.3%, 78.9% and 59.7% at 1, 5, and 10 years recently reported in a meta-analysis of patients with HF treated in the community.[26] While national studies of HF outcomes are sparse, and direct comparisons are challenging due to differing methods and population characteristics, our 5-year mortality is higher than the 43% mortality recently reported from Denmark[15] but comparable with the less than 20% 10-year survival reported for hospitalized patients in the UK.[9] Collectively, despite the reported improvement in early mortality in Australia and New Zealand, the long-term survival of hospitalized patients remains poor and considerably worse than those treated in the community.

Several factors may explain the persistently poor long-term survival despite advances in HF care and reported improvement in early outcomes. Our cohort is considerably older than the previously described populations[2,15–17,27] and increasing age is well known to be associated with higher rates of comorbidities and higher risk of death.[28] Any survival gains with evidenced-based interventions may be countered by this increasingly elderly population resulting in a lack of a net survival gain. Several studies have also shown a progressive temporal decline in rates of hospitalizations for HF.[28–31] While this suggests improvements in prevention and treatment of HF

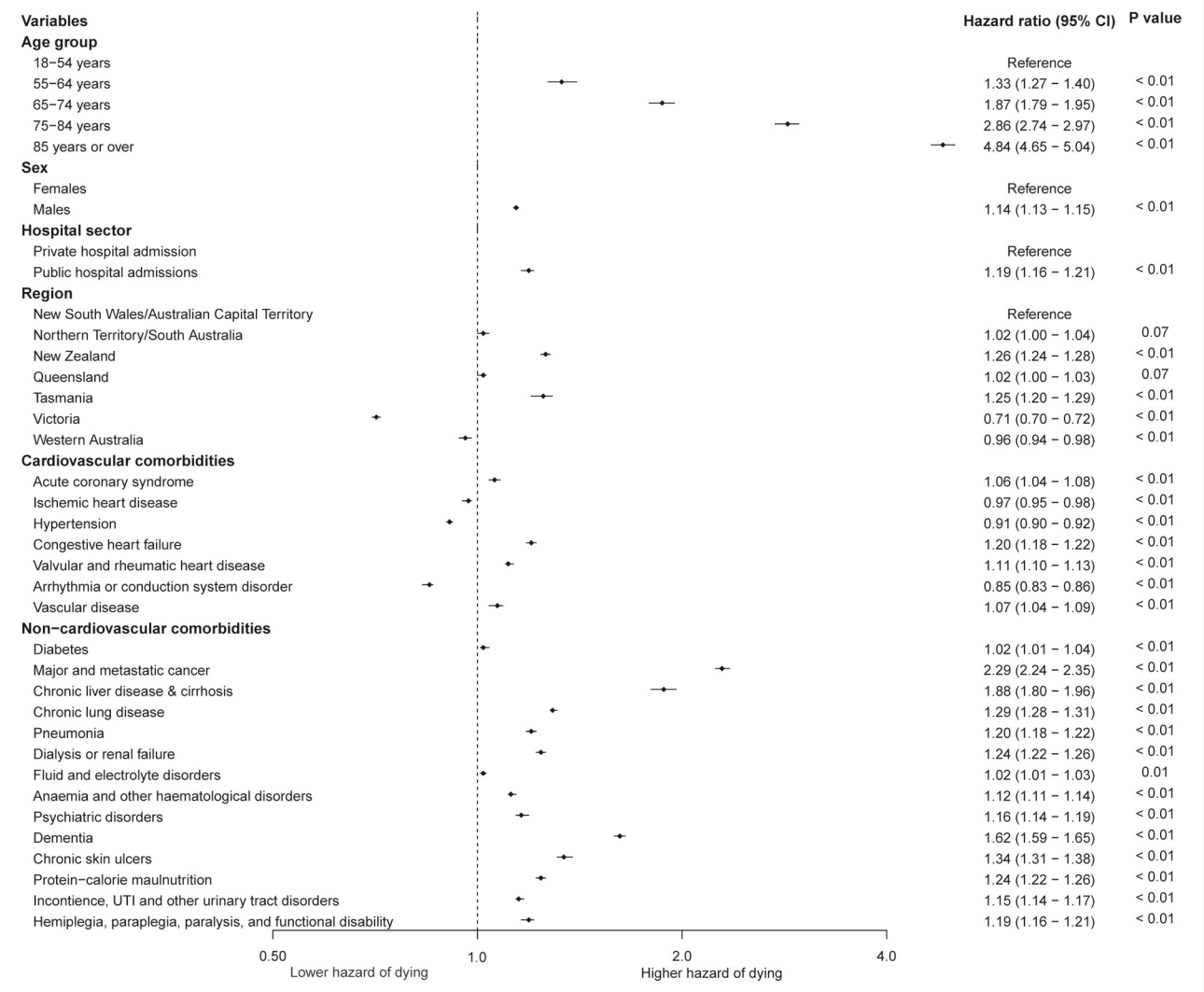


Figure 3 Risk factors independently associated with long-term mortality in heart failure patients. CI, confidence interval, UTI, urinary tract infection. The X-axis is in logarithmic scale.

in the community, patients who are hospitalized are increasingly likely to represent a selected and sicker subgroup with a poorer prognosis. While 30-day mortality has improved, 30-day unplanned readmission rates remain high at 22% with little improvement over time.[3] Thus, improvement in early survival may not lead to sustained improvements in health in this cohort of patients. Lastly, the utilization of evidence-based HF management is associated with improved survival,[32] yet data from Australia and New Zealand and globally consistently show that evidence-based medications, device therapies and HF management programmes are under-used or not optimized according to best practice clinical guidelines.[33–35] Optimizing the use of guideline-directed HF care may offer opportunities to improve long-term survival.

We also extend the literature by estimating the loss in life expectancy attributable to HF. Loss in life expectancy is a widely used measure that summarizes the societal impact of a condition and is useful in to interpret longevity in cohorts of older adults who may have reduced survival simply because of their age. We found that hospitalized HF patients, on average, had 7.3 years of life lost attributable to their condition. In proportional terms, we found 50–60% loss in life expectancy irrespective of age group or sex compared with the general population. While for older adults, this equated to a moderate loss in life in absolute terms, for those aged 18–54 years (mean age 49 years), this equated to approximately two decades of life lost – a sobering statistic that highlight the societal impact of HF in younger patients. The latter is of concern because young adults form a small but growing proportion of patients with HF.[1] Indeed, cardiovascular and non-cardiovascular comorbidities were highly prevalent among younger adults in our cohort, and younger patients with HF are known to have readmission rates that often exceed those seen in older adults.[36] Thus, even in young adults, once HF is of

Table 4 Expected and observed life expectancy, loss in life expectancy and proportion of expected life lost among heart failure patients in Australia and New Zealand

Population	Expected life expectancy	Observed life expectancy (95% CI)	Loss in life expectancy (95% CI)	Proportion of life lost (95% CI)
Overall	12.9	5.6 (5.5–5.8)	7.3 (7.2–7.5)	56.6 (55.4–57.7)
Age				
18–54 years	38.7	18.2 (17.5–18.8)	20.5 (19.9–21.2)	53.0 (51.3–54.7)
55–64 years	26.8	11.5 (11.1–11.9)	15.3 (14.9–15.6)	57.1 (55.7–58.4)
65–74 years	18.1	7.3 (7.1–7.5)	10.8 (10.6–11.0)	59.6 (58.5–60.6)
75–84 years	10.4	4.4 (4.3–4.5)	6.0 (5.9–6.1)	57.5 (56.5–58.5)
≥85 years	5.5	2.6 (2.5–2.6)	2.9 (2.9–3.0)	53.1 (52.1–54.0)
Sex				
Male	15.1	5.9 (5.8–6.1)	9.1 (8.9–9.3)	60.6 (59.4–61.7)
Female	10.7	5.3 (5.2–5.4)	5.5 (5.3–5.6)	50.8 (49.6–51.9)

CI, confidence interval.

sufficient severity to warrant hospitalization, it carries a guarded prognosis.

Our observations highlight the challenges faced in further improving the prognosis. As expected, cardiovascular comorbidities such as prior HF, valvular and rheumatic heart disease and acute coronary syndromes increased the risk of long-term mortality although the size of the effect was modest (HR <1.2 for all). Importantly, these patients had a range of other comorbidities that were associated with long-term survival with HRs that often exceed the effects size observed for cardiovascular comorbidities. These included dementia, malnutrition, chronic skin ulcers and incontinence, which are likely to be markers of advanced HF and frailty. Due to the multimorbid nature of HF, a multidisciplinary approach consisting of comprehensive clinical evaluation and management of complex comorbidities is likely necessary to further improve survival.[37] A proportion of very high-risk patients such as those at extremes of age and those with advanced comorbid conditions such as dementia, end-stage liver disease and cancer, may also benefit from advanced care planning such as end-of-life pathways and palliation.[38]

Few limitations should be considered when interpreting our findings. Not all private hospitals provided data although acute HF care in Australia and New Zealand are mainly provided by public hospitals. Our study used hospital administrative records which do not record potential factors that may impact long-term prognosis including left ventricular ejection fraction, medications prescribed at discharge, and lifestyle behaviours such as smoking. Prior studies have shown that socioeconomic status may impact survival, although patient-level socioeconomic data are not recorded in administrative data. Nevertheless, using administrative data provides the only feasible method for long-term follow-up of patients across the population. For patients with multiple HF hospitalizations in the study period, we selected the first hospitalization. As a result, the cohort may include a greater proportion of patients with *de novo* HF and fewer patients with pre-existing HF.

Conclusion

Despite significant advances in HF care and improvement in early mortality, the long-term prognosis following HF hospitalizations remains poor with less than 20% surviving by 10 years. These patients also experienced almost 60% loss in life expectancy compared with the general population highlighting the considerable societal burden. Concerted multidisciplinary efforts in prevention and treatment are needed to improve post-hospitalization outcomes for patients with HF.

Supplementary Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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