Impact of Comorbidity on Mortality Among Older Persons with Advanced Heart Failure

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BACKGROUND: Care for patients with advanced heart failure (HF) has traditionally focused on managing HF alone; however, little is known about the prevalence and contribution of comorbidity to mortality among this population. We compared the impact of comorbidity on mortality in older adults with HF with high mortality risk and those with lower mortality risk, as defined by presence or absence of a prior hospitalization for HF, respectively.

METHODS: This was a retrospective cohort study (2002–2006) of 18,322 age-matched and gender-matched Medicare beneficiaries. We used the baseline year of 2002 to ascertain HF hospitalization history, in order to identify beneficiaries at either high or low risk of future HF mortality. We calculated the prevalence of 19 comorbidities and overall comorbidity burden, defined as a count of conditions, among both high and low risk beneficiaries, in 2002. Proportional hazards regressions were used to determine the effect of individual comorbidity and comorbidity burden on mortality between 2002 and 2006 among both groups.

RESULTS: Most comorbidities were significantly more prevalent among hospitalized versus non-hospitalized beneficiaries; myocardial infarction, atrial fibrillation, kidney disease (CKD), chronic obstructive pulmonary disease (COPD), and hip fracture were more than twice as prevalent in the hospitalized group. Among hospitalized beneficiaries, myocardial infarction, diabetes, COPD, CKD, dementia, depression, hip fracture, stroke, colorectal cancer and lung cancer were each significantly associated with increased hazard of dying (hazard ratios [HRs]: 1.16–1.93), adjusting for age, gender and race. The mortality risk associated with most comorbidities was higher among non-hospitalized beneficiaries (HRs: 1.32–3.78).

CONCLUSIONS: Comorbidity confers a significantly increased mortality risk even among older adults with an overall high mortality risk due to HF. Clinicians who routinely care for this population should consider the

impact of comorbidity on outcomes in their overall management of HF. Such information may also be useful when considering the risks and benefits of aggressive, high-intensity life-prolonging interventions.

KEY WORDS: heart failure; mortality; comorbidity.

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INTRODUCTION

Heart failure (HF) is a serious progressive illness that is highly prevalent among older adults¹. Care for patients with advanced HF has primarily centered around treating and managing the HF^{2,3}; however, there is growing recognition of the need to consider comorbidity in treatment decision making³. Prior research has demonstrated the high prevalence of comorbidity among patients with HF overall⁴ and its association with increased mortality^{5–8}. Less is known about the comorbidity profile of patients who survive to the advanced stages of HF and its contribution to mortality. While several comorbidities have been shown to increase the risk of mortality among patients with a range of HF severity^{5–8}, the effect of comorbidity on mortality among patients with advanced HF has not been characterized. In cancer, a disease with high prognostic certainty, the impact of comorbidity on mortality decreases as the cancer progresses to advanced stages and becomes the primary determinant of mortality^{9–11}. Whether there is a similar decrease in the effect of comorbidity on mortality in the advanced stages of diseases with more variable and uncertain trajectories, such as HF, is unknown.

We used a Medicare database that identifies a wide range of chronic conditions to examine the relationship between comorbidity and mortality among subgroups of older adults with HF. Because this administrative database lacked physiologic markers to identify older adults with advanced HF, we used a history of HF hospitalization during 2002 to identify

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beneficiaries at high risk for future HF mortality. The purpose of the study was to 1) describe the prevalence of comorbidity and 2) examine the associations between comorbidity and mortality among older adults with HF with high mortality risk as compared to those with lower mortality risk.

METHODS

Design Overview

We conducted a retrospective longitudinal cohort study of Medicare beneficiaries with HF. Participants were selected from the Center for Medicare and Medicaid Services' Chronic Conditions Warehouse (CCW), a dataset containing beneficiary, assessment, and claims data for a 5% random sample of Medicare beneficiaries. The CCW includes 21 chronic condition variables updated annually indicating the presence of a condition as defined by evidence-based algorithms that specify 1) a minimum number and type of diagnoses/procedure codes, 2) occurring within a specific look-back period and 3) within certain care settings. Identification of HF is derived from the occurrence of at least one of the following International Classification of Diseases, Ninth revision (ICD-9) codes: 398.91, 402.01, 402.11, 402.91, 404.01, 404.11, 404.91, 404.03, 404.13, 404.9, or 428.xx, occurring within a 2-year period in either the inpatient or outpatient setting.

Study Population

We began with all living CCW beneficiaries identified as having HF as of January 1st, 2001 ($n=241,254$). We excluded 1) beneficiaries age ≤ 65 years ($n=20,938$) to ensure that all included beneficiaries were at least 65 years of age during the lookback period; 2) beneficiaries who received care outside traditional fee-for-service Medicare at any point between January 1st, 2000 and December 31st, 2006 ($n=18,852$) and 3) beneficiaries with missing data during the study period ($n=334$). The final sample included 201,130 Medicare beneficiaries with HF.

In the absence of physiologic measures to identify patients with advanced HF¹², we used a single hospitalization for HF, identified as the primary discharge diagnosis, to identify beneficiaries at high risk for HF mortality. Considerable evidence points to the high mortality risk associated with hospitalization in this population^{13–17}, which is driven by both the stage of HF and also by factors independent of HF status, such as preferences for treatment, access to care, and psychosocial support. In order to maximize the likelihood of identifying beneficiaries with an *initial* decompensation of their HF, we defined the hospitalized group as beneficiaries with a HF diagnosis and at least one HF hospitalization in 2002, but no HF hospitalizations in

2001. We matched hospitalized beneficiaries on the date of their live discharge from their first hospitalization for HF in 2002 to non-hospitalized beneficiaries - those who had not had a HF hospitalization as of that date. Once matched, beneficiaries in the non-hospitalized group retained their classification throughout the study period regardless of subsequent hospitalizations. We matched 1:1 according to age and gender. If there were multiple matches, one was chosen at random. This process resulted in a final study population of 9,166 matched pairs ($n=18,322$). Matched pairs were followed from their match date in 2002 until either death or censorship as of December 31st, 2006. Date of death was ascertained through the CMS Denominator File.

To validate the ability of hospitalization to identify beneficiaries in our study at higher risk of mortality, we calculated 1-year Kaplan–Meier (KM) survival curves for the matched population of hospitalized and non-hospitalized beneficiaries ($n=18,332$) (Appendix Fig. 2). At the end of one year, approximately 34% of the hospitalized beneficiaries had died, compared to only 10% of non-hospitalized beneficiaries. Using Cox regression analysis we found a large increase in mortality risk associated with hospitalization (HR: 3.04; $p<0.0001$). To address the concern that the HF hospitalization may represent complications from or the progression of a comorbidity, we compared 1-year KM survival curves (Appendix Fig. 3) within a subset of matched hospitalized and non-hospitalized beneficiaries who had no comorbidities ($n=332$) and found a similarly increased mortality risk with hospitalization (HR: 3.94; $p<0.0001$).

Chronic Condition Measures

We examined 19 cardiac (myocardial infarction, atrial fibrillation, and ischemic heart disease) and noncardiac (dementia, cataracts, chronic kidney disease [CKD], chronic obstructive pulmonary disease [COPD], diabetes, depression, glaucoma, hip/pelvic fracture, osteoporosis, rheumatoid arthritis/osteoarthritis [arthritis], stroke, and cancer [female breast, colorectal, prostate, lung, endometrial]) comorbidities¹⁸. We included in our analyses all conditions that met the respective algorithm criteria for identification by the baseline study year 2002. Because these are chronic conditions, we considered them to be present from the time they were identified through the study period.

We examined both individual comorbidities and comorbidity burden, defined as the count of individual conditions. We grouped beneficiaries according to the distribution of comorbidities in the study sample: ≤ 2 , 3–4, and 5+ comorbidities.

Analysis

We used descriptive statistics to summarize demographic characteristics and number of comorbidities present among

the hospitalized and non-hospitalized groups. Because of the matched pairs design, we compared the percentages of individual comorbidities at baseline in the two groups using McNemar's test for equality of paired data.

We conducted longitudinal survival analyses using Cox regression models to determine the association of both individual comorbidities and comorbidity burden with mortality. In the models that used matched data, the Lin and Wei¹⁹ robust covariance matrix estimator was used to account for potential clustering induced by matching¹⁹. The proportional hazards assumption was tested in all regression models using the log-negative-log survival curve method.

We estimated the effect of comorbidity burden on mortality within the hospitalized and non-hospitalized groups in separate multivariable analyses adjusting for age, gender and race. We tested for the equality of the comorbidity burden hazard ratios for beneficiaries in each group by examining the entire cohort using a model that included an interaction term crossing comorbidity burden with hospitalization status.

We examined the effect of individual comorbidities on mortality within the hospitalized and non-hospitalized groups using the same approach as for comorbidity burden. Comorbidities significantly associated with mortality in either group were included in a second multivariable regression that also adjusted for the presence of other comorbidities. Finally, we calculated age-stratified median survival for specific combinations of comorbidities that were the most prevalent and conferred the highest mortality risk among hospitalized beneficiaries in the multivariable analyses. Statistical significance was set at $P < 0.05$ for two-sided tests except for results reported in Table 2 for which a Bonferroni-corrected p -value of < 0.003 was considered statistically significant. All analyses were performed using SAS[®] statistical software (Version 9.2, SAS Institute, Cary, North Carolina).

RESULTS

Hospitalized beneficiaries had a median age of 81 years (IQR: 75–86) and were predominantly female (59%) (Table 1). Because of the matched study design, these characteristics were similar for non-hospitalized beneficiaries. At baseline, 16.5% of non-hospitalized beneficiaries and 42% of hospitalized beneficiaries had 5+ comorbidities. Median survival was 1.9 (IQR: 0.54, 4.4) years for hospitalized beneficiaries and 4.6 (IQR: 1.9, >5) years for non-hospitalized beneficiaries.

The majority of individual comorbidities, both cardiac and noncardiac, were significantly more prevalent among hospitalized beneficiaries than among non-hospitalized beneficiaries (Table 2). Burden of comorbidity was associated with a significantly increased hazard of dying among

Table 1. Baseline Characteristics of Study Cohort (n=18,332)

Characteristic	Hospitalized Beneficiaries (n=9166)		Non-hospitalized Beneficiaries (n=9166)	
Age, years, median (IQR)	81	(75–86)	81	(75–86)
Female, n (%)	5416	(59.1)	5416	(59.1)
Race/Ethnicity, n (%)				
White	7783	(84.9)	7915	(86.4)
Black	1026	(11.2)	825	(9.0)
Hispanic	179	(2.0)	204	(2.2)
Number of chronic conditions, median (IQR)	4	(3–5)	3	(2–4)
≤ 2 conditions, n (%)	1,342	(14.6)	4070	(44.4)
3–4 conditions	3,975	(43.4)	3,587	(39.1)
5+ conditions	3,849	(42.0)	1,509	(16.5)
Median Survival Time, years (IQR)	1.8	(0.54, 4.4)	4.6	(1.9, >5)

both groups. Having 3–4 comorbidities was associated with a 22% higher hazard of dying among AHF hospitalized beneficiaries and a 49% higher hazard of dying among NHF non-hospitalized beneficiaries, compared to having ≤2 comorbidities (Table 3).

Most comorbidities were associated with a significantly increased mortality risk among hospitalized beneficiaries (Table 4). For example, among cardiac conditions, myocardial infarction was associated with a 52% higher hazard of dying. Among noncardiac conditions, CKD was associated with a 62% and dementia with a 50% higher hazard of dying. The majority of comorbidities were associated with a significantly higher relative risk of mortality among non-hospitalized beneficiaries as compared to hospitalized beneficiaries. However, there was no significant difference in the mortality risk associated with ischemic heart disease,

Table 2. Prevalence of Individual Comorbid Conditions Among Hospitalized and Non-hospitalized Beneficiaries

Individual conditions, n (%)	Hospitalized Beneficiaries (n=9166)		Non-hospitalized Beneficiaries (n=9166)		p-value
Ischemic Heart Disease*	8,056	(87.9)	5,910	(64.5)	< 0.0001
Diabetes *	4,617	(50.4)	3,122	(34.1)	< 0.0001
COPD*†	4,263	(46.5)	1,866	(20.4)	< 0.0001
Atrial fibrillation*	4,110	(44.9)	1,884	(20.6)	< 0.0001
CKD*†	3,670	(40.0)	1,365	(14.9)	< 0.0001
Arthritis*	2,826	(30.8)	2,573	(28.1)	< 0.0001
Dementia*	2,266	(24.7)	2,000	(21.8)	< 0.0001
Cataracts*	2,007	(21.9)	2,520	(27.5)	< 0.0001
Depression*	1,960	(21.4)	1,213	(13.2)	< 0.0001
Osteoporosis	1,259	(13.7)	1,195	(13.0)	0.1559
Stroke *	1,224	(13.4)	845	(9.2)	< 0.0001
Glaucoma	906	(9.9)	982	(10.7)	0.0648
Myocardial infarction*	803	(8.8)	161	(1.8)	< 0.0001
Prostate Cancer	312	(3.4)	325	(3.6)	0.5903
Hip Fracture*	260	(2.8)	145	(1.6)	< 0.0001
Breast Cancer	131	(1.4)	167	(1.8)	0.0345
Lung Cancer*	131	(1.4)	83	(0.9)	0.0010
Colorectal Cancer	121	(1.3)	113	(1.2)	0.5978
Endometrial Cancer	11	(0.1)	9	(0.1)	0.6547

*Statistically significant at Bonferroni-corrected $p < 0.003$;

†CKD = Chronic kidney disease; COPD = Chronic obstructive pulmonary disease

Table 3. Effect of Burden of Comorbidity on Mortality among Beneficiaries with Heart Failure*

Burden of Comorbidity	Adjusted Hazard Ratio (95% C.I.)		Interaction between Hospitalization status and comorbidity burden p-value
	Hospitalized Beneficiaries	Non-hospitalized Beneficiaries	
Low (≤ 2 conditions)	1.0 (Reference)	1.0 (Reference)	-
Medium (3–4 conditions)	1.22 (1.13, 1.31)	1.49 (1.39, 1.59)	0.0003
High (5+ conditions)	1.57 (1.44, 1.68)	2.35 (2.17, 2.54)	< 0.0001

*Adjusted for age, gender and race

diabetes, osteoporosis, or any of the cancers other than lung cancer, between the two groups. When adjusting for the presence of other conditions, the majority of comorbidities continued to confer a significant, albeit decreased, mortality risk among both groups of beneficiaries (Table 5).

Among hospitalized beneficiaries, CKD, COPD, and dementia conferred the highest mortality risk and were highly prevalent. Median survival was <1 year for hospitalized beneficiaries with CKD and dementia and <2 years for beneficiaries with other combinations of conditions (Fig. 1). In contrast, median survival for hospitalized beneficiaries without any of the three comorbidities was as high as 4.8 years for beneficiaries aged 66–75 years.

DISCUSSION

In this study of Medicare beneficiaries with HF, we used a single HF hospitalization to identify beneficiaries at a high risk of mortality compared to non-hospitalized beneficiaries. Both cardiac and noncardiac comorbidities were significantly more prevalent among hospitalized beneficiaries than among non-hospitalized beneficiaries. While the relative mortality risk associated with comorbidity was even higher

among non-hospitalized beneficiaries, both the overall burden of comorbidity and the majority of individual comorbidities were associated with increased mortality risk among hospitalized beneficiaries. The presence of CKD, dementia, myocardial infarction, and lung cancer each conferred $\geq 50\%$ increase in risk among hospitalized beneficiaries. Certain combinations of highly prevalent noncardiac comorbidities (e.g.: CKD and dementia) were associated with markedly reduced survival.

Our findings confirm the results of prior studies^{13–17} that hospitalization for HF identifies patients at high mortality risk. Multiple factors may contribute both to hospitalization and mortality risk in addition to severity of HF, including, socioeconomic status, psychosocial support, and preferences for treatment. If these factors were completely independent of HF status, it might be expected that the relative effect of comorbidity would be similar among both groups of beneficiaries. However, the finding that the relative association between comorbidity and mortality was lower among hospitalized beneficiaries than non-hospitalized beneficiaries suggests that a more advanced stage of HF was driving mortality in this group. Nonetheless, comorbidity continued to contribute to mortality risk among hospitalized beneficiaries.

Table 4. Hazard Ratios for Mortality by Comorbidity among Beneficiaries with Heart Failure*

COMORBIDITY	Adjusted Hazard Ratio (95% C.I.)		Interaction between hospitalization status and condition
Cardiac Conditions	Model 1: Hospitalized Beneficiaries	Model 2: Non-hospitalized Beneficiaries	Model 3: P-Value
Myocardial infarction	1.52 (1.40, 1.66)	2.23 (1.82, 2.73)	0.0025
Ischemic Heart Disease	1.08 (1.00, 1.17)	1.10 (1.04, 1.17)	0.5891
Atrial fibrillation	0.99 (0.94, 1.04)	1.34 (1.25, 1.43)	< 0.0001
Noncardiac Conditions	Model 1: Hospitalized Beneficiaries	Model 2: Non-hospitalized Beneficiaries	Model 3: P-Value
Lung Cancer	1.93 (1.57, 2.37)	3.78 (2.86, 4.98)	0.0075
Endometrial Cancer	1.73 (0.67, 4.52)	2.11 (1.11, 4.00)	0.7282
CKD [†]	1.62 (1.54, 1.70)	1.98 (1.83, 2.14)	0.0021
Dementia	1.50 (1.43, 1.60)	2.19 (2.05, 2.34)	< 0.0001
Hip Fracture	1.33 (1.16, 1.51)	1.93 (1.60, 2.33)	0.0003
Colorectal Cancer	1.29 (1.06, 1.56)	1.27 (0.98, 1.65)	0.978
COPD [†]	1.28 (1.22, 1.34)	1.90 (1.77, 2.03)	< 0.0001
Stroke	1.21 (1.13, 1.29)	1.64 (1.50, 1.80)	< 0.0001
Depression	1.18 (1.11, 1.25)	1.51 (1.40, 1.64)	< 0.0001
Diabetes	1.16 (1.11, 1.22)	1.32 (1.24, 1.41)	0.25
Breast Cancer	1.12 (0.90, 1.41)	1.17 (0.94, 1.46)	0.8548
Prostate Cancer	1.01 (0.89, 1.15)	1.06 (0.92, 1.24)	0.8823
Osteoporosis	0.97 (0.90, 1.03)	1.02 (0.94, 1.12)	0.068
Arthritis	0.88 (0.84, 0.93)	0.97 (0.91, 1.04)	0.0008
Glaucoma	0.79 (0.73, 0.86)	0.84 (0.77, 0.92)	0.0793
Cataracts	0.73 (0.69, 0.77)	0.78 (0.73, 0.83)	0.1456

*Adjusted for age, gender and race

[†]CKD = Chronic kidney disease; COPD = Chronic obstructive pulmonary disease

Table 5. Adjusted Hazard Ratios for Mortality by Comorbidity among Beneficiaries with Heart Failure*

COMORBIDITY	Adjusted HR (95% C.I.)	
Cardiac Conditions	Model 1: Hospitalized Beneficiaries	Model 2: Non-hospitalized Beneficiaries
Myocardial Infarction	1.44 (1.32, 1.57)	1.64 (1.31, 2.04)
Ischemic Heart Disease	1.00 (0.93, 1.09)	0.94 (0.88, 1.00)
Atrial Fibrillation	-	1.30 (1.22, 1.40)
Noncardiac Conditions	Model 1: Hospitalized Beneficiaries	Model 2: Non-hospitalized Beneficiaries
Lung Cancer	1.86 (1.52, 2.28)	3.58 (2.63, 4.89)
CKD [†]	1.57 (1.49, 1.65)	1.77 (1.63, 1.92)
Dementia	1.44 (1.36, 1.52)	1.91 (1.77, 2.05)
Colorectal Cancer	1.39 (1.16, 1.67)	-
COPD [†]	1.24 (1.19, 1.31)	1.70 (1.58, 1.82)
Hip Fracture	1.24 (1.08, 1.42)	1.44 (1.17, 1.76)
Stroke	1.10 (1.02, 1.18)	1.23 (1.11, 1.36)
Depression	1.06 (0.99, 1.12)	1.13 (1.04, 1.24)
Diabetes	1.04 (0.99, 1.09)	1.22 (1.15, 1.31)
Arthritis	0.87 (0.83, 0.92)	-
Glaucoma	0.79 (0.73, 0.86)	0.87 (0.79, 0.95)
Cataracts	0.74 (0.70, 0.78)	0.81 (0.75, 0.87)
Endometrial Cancer	-	1.07 (0.45, 2.55)

* Adjusted for age, gender, race, and other comorbid conditions. Cells with no results indicate non-significant association with mortality in analyses unadjusted for the presence of other conditions (See Table 4)

[†]CKD = Chronic kidney disease; COPD = Chronic obstructive pulmonary disease

Our findings support the conclusion that comorbidity continues to confer a significant risk of mortality among persons with advanced HF. This conclusion stands in contrast to the relationship between comorbidity and mortality among patients with cancer, whereby the mortality risk associated with comorbidity in the early stages of cancer drops markedly and becomes non-significant in the advanced stages⁹⁻¹¹. Several mechanisms may be responsible for the persistent deleterious effects of comorbidities in advanced HF. Conditions that share pathophysiology or risk factors with HF may contribute to mortality by interacting with and

exacerbating the course of HF²⁰. Conditions unrelated to HF may confer a competing effect on mortality because of the variable trajectory of HF. Alternatively, there is growing evidence that conditions traditionally considered to be unrelated to HF, such as depression²¹ and cognitive impairment²², may be pathophysiologically related to HF. Further examination of the effect of comorbidity on mortality in the advanced stages of these diseases, and the mechanisms by which comorbidity affects mortality, is warranted.

The finding that comorbidity confers a significant mortality risk among older adults hospitalized with HF

Figure 1. Age-stratified median survival times by combinations of comorbid conditions among hospitalized beneficiaries.

highlights the importance of using comorbidity information to guide treatment decision-making for this population. Patients in the advanced stages of HF are candidates for intensive interventions aimed at reducing HF mortality³. The increased mortality risk associated with comorbidity suggests that patients with particular comorbidities may derive only a limited survival benefit from such interventions. Although HF guidelines acknowledge the need to consider comorbidity in the treatment decision-making process for persons with advanced disease, little empiric evidence exists to help guide providers in using comorbidity information to inform decision-making. A recent study modeling the maximum benefit of implantable cardiac defibrillators (ICDs) found that CKD and dementia identified patients with particularly poor survival even when assuming all sudden cardiac deaths to be preventable by an ICD²³. We extend these findings among a population-based cohort by identifying comorbidities that are highly prevalent, and when present in combination, contribute to markedly reduced survival among older adults with advanced HF. Future work examining if and how certain combinations of comorbidities might provide prognostically useful information to help guide care will be relevant.

Our analyses have several limitations. Because claims databases typically do not contain clinical information, we lacked data to characterize the severity and impact of comorbidity. While it is possible that beneficiaries with advanced HF also have more advanced comorbidities, an association between comorbidity severity and mortality would only strengthen our conclusion that comorbidity continues to confer a significant mortality risk in advanced HF. Although we were unable to measure psychosocial factors that may have influenced hospitalization, the finding that the relative mortality attributable to comorbidity was lower among hospitalized beneficiaries provides support that the stage of HF was driving mortality in this group rather than these unmeasured factors. Overall health status is not available through administrative data, and it is possible that comorbidity may have served as a proxy for better health. Specifically, we found that cataracts conferred a protective effect among both groups of beneficiaries; however, cataracts may have been coded when they were removed, and beneficiaries with better overall health may be more likely to be deemed suitable for cataract surgery. The use of administrative data for estimating the prevalence of conditions is at risk for underestimating the true burden of disease²⁴. We believe that our use of the CCW, specifically designed to mitigate the risk of underestimation through the use of evidence-based algorithms to indicate the presence of a disease, facilitated the accurate reporting of disease prevalence in our sample. Because we defined conditions as present once the algorithm criteria were met we may have over-reported the prevalence of cataracts since cataracts can be cured. We were unable to distinguish

between systolic and diastolic HF. As prior evidence indicates that some comorbidities confer greater mortality risk among patients with diastolic versus systolic HF²⁵, our mortality estimates might be impacted by the proportions of patients in our study cohort who had either type of HF.

Our findings highlight the significant impact that comorbidity, particularly noncardiac disease, has on increasing mortality even among those who are hospitalized with HF and are at overall high mortality risk. To the extent that these patients represent individuals with advanced heart failure, these findings challenge the assumption that as HF progresses into advanced stages, it becomes the primary determinant of outcomes. A model of care that focuses primarily on managing HF may not be adequate for this population; instead, our findings support a shift towards an expanded care model that considers the impact of coexisting illnesses in increasing mortality, addressing quality of life, and determining appropriate treatment interventions, even among patients with advanced disease. Future research should examine the potential mechanisms by which comorbidity affects mortality in patients with HF – by contributing to the severity of HF or by providing a competing mortality risk – to help clinicians better target their care and treatment approach.

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APPENDIX

Below are Figure 2 and Figure 3.

Figure 2. The 1-year Kaplan–Meier survival curves of hospitalized and non-Hospitalized beneficiaries (n=18,332).

Figure 3. The 1-year Kaplan–Meier survival curves of hospitalized and non-Hospitalized beneficiaries with no comorbid conditions (n=332).