Challenges for Patients Dying of Heart Failure and Cancer

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Running Title: End of Life Challenges for Patients with Heart Failure & Cancer

Word Count: 3,077/4000 words

Keywords: palliative care, hospice, heart failure, cancer, end of life care, prognosis, financial burden

Abstract (249/250 words)

Background: Hospice and palliative care (PC) were originally implemented for patients dying of cancer, both of which continue to be underused in patients with heart failure (HF). The objective of this study was to understand the unique challenges faced by patients dying of HF compared to cancer.

Methods: We assessed differences in demographics, health status and financial burden between patients dying of HF and cancer from the Health and Retirement Study.

Results: The analysis included 3,203 individuals who died of cancer and 3,555 individuals who died of HF between 1994 and 2014. Compared to patients dying of cancer, patients dying of HF were older (80 years vs. 76 years), had poorer self-reported health, and had greater difficulty with all activities of daily living (ADLs) while receiving less informal help. Their death was far more likely to be considered unexpected (39% vs. 70%) and they were much more likely to have died without warning or within 1-2 hours (20% vs. 1%). They were more likely to die in a hospital or nursing home than at home or in hospice. Both groups faced similarly high total healthcare out of pockets costs ($9,988 vs. $9,595, p=0.6) though patients dying of HF had less wealth ($29,895 vs. $39,008), thereby experiencing greater financial burden.

Conclusion: Compared to patients dying of cancer, those dying from HF are older, have greater difficulty with ADLs, are more likely to die suddenly, in a hospital or nursing home rather than home or hospice, and had worse financial burden.

Clinical Perspective:

- *What is new:* Patients with heart failure at the end of life experience worse disability, caregiver support, and financial burden, compared to patients with cancer. Their deaths were also much likely to be considered unexpected by their caregivers, and were more often likely to occur in a hospital or nursing home versus home or hospice.

- *Clinical Implications:* Clinicians should be aware that their patients with heart failure may face greater financial burden, disability and have lesser caregiver support at end of life. Many patients may not be aware of the seriousness of their heart failure condition, leading to a death from heart failure being unexpected. Improved prognostic communication and disease awareness is critical to patients receiving goal-concordant care at end of life.

Introduction

Heart failure (HF), a chronic, progressive, and debilitating condition, is a leading cause of hospital admissions amongst older Americans.[1] Palliative care (PC) is a specialty and a philosophy of care that prioritizes patients' quality of life and care concordant with patients' goals and values. PC was historically developed and implemented for patients dying of cancer and patients with cancer are most likely to use services such as hospice at the end of life.[2,3] While PC is appropriate for patients with serious illness regardless of prognosis, particularly patients with HF,[4] PC continues to be underutilized in patients with HF even at end of life. Some factors that lead to the underuse of PC includes unpredictable disease trajectory, difficulty in prognostication, discordance between clinician-predicted and patient-predicted prognosis, lack of cardiologist training in primary palliative care, poor care coordination and lack of programs specifically designed to meet the needs of patients with HF.[2]

Understanding differences between patients dying of HF and cancer is important, since these differences may point to distinct needs and challenges which in turn may influence access to palliative and hospice care. For example, in a national registry, patients with cardiovascular disease were older than cancer patients at time of initial referral to PC.[5] Therefore, to better understand the specific challenges faced by patients dying of HF, which could inform the design of curriculums and programs tailored to provide high-quality EOL care to these patients, we assessed differences in demographics, health status, ability to perform ADLs/IADLs and financial burden between patients dying of HF and cancer from the nationally representative Health and Retirement Study (HRS).

Methods

The study population included individuals surveyed in the nationally representative HRS who died from cancer or HF between 1994 and 2014. The HRS is a longitudinal cohort study of a representative sample of US adults, over the age of 50, who were interviewed biennially since 1992. The survey was conducted by the University of Michigan with funding support from the National Institute on Aging. The data are publicly avialble and freely available for researchers to analyze. It contains more than 37,000 individuals with an average response rate of ~87% across the study period. The survey collects data on demographics, income, assets, employment, retirement, health, disability, cognition, health insurance, health expenditure and end-of-life. The study oversamples African American and Latino populations and the cohort includes community dwelling individuals. Due to its in-

depth and unique interviews, the HRS provides a valuable multidisciplinary data source that can be used to study different aspects of aging. The data were publicly available and deidentified and therefore institutional review was not sought per HHS regulation 45 CFR 46.101(c).

The study population was identified through exit interviews. This interview was conducted after a participant's death with the respondent identified from a close social network of the deceased and contains information about the participant's end-of-life circumstances and death. The majority of respondents in exit interviews (88.3%) were closely related to the deceased participant. The exit interview was completed for almost all survey participants who died, ranging from 74.6% in 1994 to 92.1% in 2014. It contains information on participants' place of death, cause of death, health care utilization in the final year of life, health status, disability, out-of-pocket (OOP) expenses, insurance status and social support.

Data from exit interviews was merged with core interviews to better characterize participants' circumstances. Health conditions indicated if the participant had the disease before death. Difficulty with activities of daily living (ADL) and instrumental activities of daily living (IADLs) and help received were analyzed. The ADLs include dressing, walking across a room, bathing, eating, getting in and out of bed, and using the toilet. The IADLs include preparing hot meals, shopping for groceries, using the telephone and taking medications.

The HRS collected information on various out-of-pocket (OOP) costs: hospital, nursing home, hospice, special facility, home care, doctor visits, dentist, and prescription drug costs. Beginning in Wave 10 (2010), an additional category captured any additional OOP medical expenditures that could not be assigned to any of the above-mentioned categories. The costs reflected OOP expenditures, excluding expenditures for prescription drugs, since the last interview (on average 2 years). Prescription OOP costs reflected expenses in the month prior to the interview. Total major medical expenses were the sum of OOP expenses for hospital stays, nursing home stays, hospice, doctor visits, prescription drugs, special facilities or services, in-home medical care, and other medical expenses not covered by insurance. Information regarding OOP expenses came from a harmonized HRS file, where information was imputed and harmonized by the data provider. If participants could not provide the exact amount, they were presented with a series of unfolding brackets to approximate the amount. This information was then used to derive imputed expenditure values. Using this method, the HRS minimizes the non-response rate. All costs were adjusted to 2010 dollars based on the consumer price index for the year of death.

Baseline sociodemographic and health status characteristics were compared between participants that died of cancer or HF. Pearson's chi squared test was used to compare categorical variables and ANOVA for continuous variables. The outcome variables of interest included (1) having a disability, defined as difficulty with any ADL or IADL, and (2) dying in hospital. We employed multivariable logistic regression analysis to assess factors associated with having a disability and dying in hospital for both cancer and HF patients. Two models were tested to assess predictors of the outcome variables in both groups. The first model included gender, age, racial background (White, Black/African-American and other), marital status, education level (lower than high school level, high school level, graduate level), body mass index (BMI) category (<18.5 kg/m^2 , <25 kg/m^2 , <30 kg/m^2 and >=30 kg/m^2), whether the patient smoked before death, census region (North-East, Midwest, South, East), and used dummy time variable to control for the trends in time in the dataset for each wave or visit. The second model included variables from the first model and controlled for the presence of the following comorbid conditions: hypertension, lung disease, diabetes, and arthritis. We were unable to include ethnicity in the regression models as there was insufficient representation of non-White Hispanic individuals (<50 across both patient groups) leading to unbalanced representation across race and ethnic backgrounds. Memory problem was also not included in the regression models as it had a significantly higher proportion of missing values (17%) compared to other conditions, leading to a reduction in the statistical power of the models.

All analyses were performed using STATA version 15.0 (STATA Corp., TX, USA).

Results

The analysis included 3,203 individuals who died of cancer and 3,555 individuals who died of HF between 1994 and 2014. Baseline characteristics of the two groups are shown in **Tables 1 and 2**. Compared to patients dying of cancer, patients dying of HF were older (mean age 80.0 years vs. 75.7 years), were less likely to smoke (13.2% vs. 19.7%), be married/partnered (40.2% vs. 50.1%) and college educated (26.3% vs. 32.6%) and were less wealthy ($29,895 vs. $39,008). HF decedents were less likely to have private insurance (38.9% vs. 44.1%) but more likely to have Medicare (89.5% vs. 81.2%), Medicaid (17.7% vs. 13.7%) and receive social security benefits (92.1% vs. 87.5%) (all p<0.05). (**Table 1, Figure 1)** No difference was noted in sex, race, ethnicity, and body mass index. Patients dying of HF had a slightly greater sum of comorbid conditions (2.9 vs. 2.8) and were more likely to have hypertension (68.8% vs. 57.6%), diabetes (31.4% vs. 22.0%) and arthritis

(64.4% vs. 58.6%), with no significant differences in lung disease or memory problems. **(Table 2)**

Compared to patients dying of cancer, HF decedents were more likely to report poor health (30.0% vs. 28.8%) and less likely to report excellent (3.6% vs. 4.4%) or very good health (10.9% vs. 14.3%) (p<0.001) before dying. In the last year of life, patients dying of HF had greater difficulty with walking, using the toilet, getting in and out of bed, taking medications, eating, dressing, preparing meals, bathing, shopping, and using the phone (all p<0.001). **(Table 3)** However, despite having greater deficits in both ADLs and IADLs, patients dying of HF were less likely to have someone help with ADLs (34.1% vs. 46.7%) or IADLs (34.8% vs. 58.6%) in the last year of life. However, they were more likely to report professional help with ADLs/IADLs in the last 3 months of life (24.2% vs. 18.6%) (all p<0.001). **(Table 3)**

Compared to patients dying of cancer, HF decadents were more likely to die in the hospital (36.0% vs. 28.2%) or nursing home (18.5% vs. 12.8%) and less likely to die at home (30.1% vs. 36.7%) or in hospice (3.7% vs. 11.6%) (p<0.001). Patients dying of HF were much more likely to have died with no warning or within 1-2 hours of warning (19.5% vs. 0.9%), or to have a duration of final illness of less than 1 day (9.6% vs. 2.0%), less than 1 week (15.1% vs. 7.1%) or 1 month (15.2% vs. 13.7%) and were much less likely to have an illness duration longer than 1 year (15.6% vs. 28.1%) (p<0.001). Death was expected by the family among 39.2% of patients who died of HF as opposed to 70.4% of those dying of cancer (p<0.001).

Total healthcare OOP costs were similar between patients dying of cancer and HF ($9,988.4 vs. $9,594.5, p=0.6) though there were some differences in the sources of OOP costs. **(Table 4)** Patients dying of HF had greater OOP costs from nursing homes ($4,347.8 vs. $1,492.6) while they had lower OOP costs from hospice ($34.6 vs. $117.7), doctor visits ($799.1 vs. $1,213.9), and outpatient surgery ($26.8 vs. $99.8) (all p<0.05).

Multivariable regression analysis revealed that being older than 70, unmarried, underweight, not having graduated high school, and having comorbidities such as lung disease, diabetes and arthritis were independently associated with having a disability in both patients with cancer or HF. **(Table 5)** Results were consistent across both models, with the effect being more pronounced in HF patients. Especially the impact of other comorbidities, such as lung disease, diabetes, or arthritis, was highly associated with the probability of having a disability in HF patients.

Among patients with cancer, those who were younger than 70, Black/African American, overweight, who smoked before death, who died more recently and who lived in the Northeast were all more likely to die in the hospital. This was consistent even after controlling for other comorbidities. On the other hand, patients with HF who were female, older than 70, married, died more recently and who lived in the Northeast were all more likely to die in the hospital. Among HF patients, comorbidities such as hypertension, lung disease and diabetes increased the likelihood of dying in hospital. Racial background was not a significant predictor of in-hospital death among HF patients in either model.

Amongst patients dying of HF, there were 670 (18.8%) who also had a history of cancer. Compared to those dying of HF, these patients with a history of cancer were of similar age, but were more likely to be male, White, married, have private insurance or Medicare, had greater wealth and were more likely to have a death that was expected. **(Table 1)** They were less likely to be on Medicaid, receive social security benefits. These patients dying of HF with a history of cancer were also more likely to have more comorbidities and report poor health. **(Table 2)** While there were no differences in ADLs or IADLs, patients dying of HF with a history of cancer were more likely to have someone help with ADLs and IADLs in their last year of life. **(Table 3)** No differences in OOP costs were noted. **(Table 4)**

Discussion

This analysis provides novel insights into the different challenges that patients dying of HF and cancer face in the last year of life. Compared to patients dying of cancer, patients dying of HF were older, poorer, had worse health status, had more comorbidities, and had greater difficulty with ADLs/IADLs. However, they reported receiving less help in the last year of life. Their death was more likely to be considered unexpected and they were much more likely to die in a hospital or nursing facility versus at home or in hospice. While both groups of patients faced significant financial burdens in the last year of life, HF patients had less wealth and were more likely to require government assistance. These findings have important implications for research and care delivery at the EOL for patients with HF.

These data build on previous studies that demonstrate the differences between patients dying of cancer and heart failure. Our study confirms previous findings that patients with HF are more likely to die in a medical facility such as a hospital or nursing home rather than at home or in hospice,[6,7] are more likely to have functional limitations and are less likely to use hospice.[8,9] This complexity of disease and function has direct implications for

prognostication and care coordination. In the last year of life, patients with HF are more likely to be admitted to the hospital for non-cardiovascular reasons than for HF exacerbation, with only 12% of hospitalizations being primarily related to HF.[10] Therefore, ideally, PC interventions for HF patients should be able to account for the multimorbid nature of the disease as well as higher prevalence of geriatric impairments such as frailty within this population. Partnering with geriatrics might be crucial for the development and implementation of PC programs for HF patients.

There is a body of literature to support the fact that in patients with cancer access to early palliative care can improve outcomes including earlier hospice referral which can in turn improve caregiver experience at and after EOL, decrease inpatient costs, and provide care where the patient/family prefer.[11,12] A major reason for the underutilization of PC in HF patients might be difficulties in prognostication in these patients. In cancer populations, accurate prognostic awareness correlates with less aggressive medical care at the end of life and improved caregiver outcomes.[13] The significant findings in this current analysis shows that most family members of patients who died of HF were not expecting death indicating a need for improved communication about disease expectations and highlighting clinicians' own uncertainty about prognostication in HF since the rates of actual sudden cardiac death have plummeted in recent years.[14]

While cancer patients are often seen in specialized centers and practices focused on one primary diagnosis, patients with HF have multiple care providers and locations, and therefore often experience fractured care. This can make prognostication in HF more challenging. Although both generalists and cardiologists tend to be inaccurate in their prognostic predictions, data is available to assist with HF prognosis.[15] The number of HF hospitalizations is a strong predictor of mortality in community HF patients with one study showing median survival after the first, second, third, and fourth hospitalization of 2.4, 1.4, 1.0, and 0.6 years, respectively.[16] A Danish study of HF patients older than 70 years showed an absolute 1 year mortality of 18% associated with outpatient diuretic intensification and a 22.6% mortality for patients with a HF hospitalization.[17] One simple approach that can be used in the clinical setting is the surprise question. In response to clinicians being asked if they would be surprised if a HF patient were to pass away within the next year, the response was significantly associated with all-cause mortality and had a sensitivity of 0.85 and specificity of 0.59 with a positive predictive value of 52% and a negative predictive value of 88%.[18]

Lack of prognostic communication throughout the disease process can lead to a disconnect between clinicians and patients and is also a significant contributor to the underutilization of PC in patients with HF. In a study from 2017 of cardiologists and patients with HF, cardiologists identified 69% of patients as high-risk for LVAD, transplant or death in the next year, while only 14% of patients considered themselves at risk of these outcomes at one year. The actual rate of high-risk events in this population was 38% at 13 months suggesting that patients greatly underestimate the risk of adverse outcomes from HF. [19]

Another novel aspect of this analysis is the presence of OOP cost data. While cancer patients have traditionally been thought of as being particularly burdened by rising health care costs, this analysis shows that patients dying of HF have largely equally high burden of OOP costs. This finding is particularly notable given that patients dying of HF had much lower wealth than patients dying of cancer. Considering that financial burden is largely defined as the ratio between costs and income or wealth,[20] this suggests that HF patients might be experiencing greater financial burden at the end of life. Given that previous work has shown that patients with atherosclerotic cardiovascular disease have greater financial burden than those with cancer,[21] these findings for HF patients at end of life build on that observation.

The presence of wealth data is also novel, since wealth may be a more reliable marker to assess disparities among racial/ethnic groups than income.[22] This is in part because even when their incomes are similar, Black and Hispanic people have much lesser wealth than White people. Financial burden amongst patients with HF remains greatly understudied and will be an area that will benefit from greater investigation.

Our study has several limitations. The most recent cohort of the HRS died in 2014 and therefore there is a possibility that some of these findings may have changed in the interim. However, analyses from more recent registries point to similar trends.[4] Furthermore, HRS offers the deepest phenotyping of the burden faced by patients at EOL and a unique aspect of the database is that it includes bereaved caregiver interviews which offers considerable novel insight. HRS also lacked more in-depth data about comorbidities and about other aspects of end of life experience such as ICD shocks, etc.

In conclusion, patients with HF face many of the same challenges faced by patients with cancer at end of life. However, patients dying of HF face many unique challenges including a higher prevalence of disability and multimorbidity and possibly greater financial burden. Despite these challenges, HF patients are less likely to receive informal caregiver support. Furthermore, while 70% of caregivers of cancer patients felt the death was

expected, only 39% of caregivers of HF patients felt the same way, suggesting both suboptimal communication as well as greater difficulty in predicting outcomes in HF patients. These findings should inform the design of PC interventions and hospice programs designed specifically to meet the challenges that HF patients face.

Figure Legend:

Compared to Patients Dying of Cancer, Patients Dying of Heart Failure…

Cancer   Heart Failure

Are Older
Have Greater Difficulty with ADLs/IADLs
Are Less Likely to Receive Informal Help
Are More Likely to Die in Hospital or Nursing Home
Are Less Likely to Die in Home or Hospice
Experience Equally High Cost of Care but Have Less Wealth Leading to More Financial Burden
Are Much More Likely to Have A Death Perceived as Unexpected
Are No Different in Sex, Race or Ethnicity

Figure 1: Differences in Patients Dying of Cancer versus Heart Failure. Clip Art from Free Pik.

References:

1.   Agarwal MA, Fonarow GC, Ziaeian B. National Trends in Heart Failure Hospitalizations and Readmissions From 2010 to 2017. JAMA Cardiol 2021;6:952-6.

2.   Warraich HJ, Meier DE. Serious-Illness Care 2.0 - Meeting the Needs of Patients with Heart Failure. N Engl J Med 2019;380:2492-4.

3.   Cross SH, Kaufman BG, Quest TE, Warraich HJ. National Trends in Hospice Facility Deaths in the United States, 2003-2017. J Pain Symptom Manage 2021;61:350-7.

4.   Maqsood MH, Khan MS, Warraich HJ. Association of Palliative Care Intervention With Health Care Use, Symptom Burden and Advance Care Planning in Adults With Heart Failure and Other Noncancer Chronic Illness. J Pain Symptom Manage 2021;62:828-35.

5.   Warraich HJ, Wolf SP, Mentz RJ, Rogers JG, Samsa G, Kamal AH. Characteristics and Trends Among Patients With Cardiovascular Disease Referred to Palliative Care. JAMA Netw Open 2019;2:e192375.

6.   Chuzi S, Molsberry R, Ogunseitan A, et al. Trends in Place of Death for Cardiovascular Mortality Related to Heart Failure in the United States From 2003 to 2017. Circ Heart Fail 2020;13:e006587.

7.   Cross SH, Warraich HJ. Changes in the Place of Death in the United States. N Engl J Med 2019;381:2369-70.

8.   Lastrucci V, D'Arienzo S, Collini F, et al. Diagnosis-related differences in the quality of end-of-life care: A comparison between cancer and non-cancer patients. PLoS One 2018;13:e0204458.

9.   Warraich HJ, Wolf SP, Troy J, et al. Differences between patients with cardiovascular disease and cancer referred for palliative care. Am Heart J 2021;233:5-9.

10.   Madelaire C, Gustafsson F, Kristensen SL, et al. Burden and Causes of Hospital Admissions in Heart Failure During the Last Year of Life. JACC Heart Fail 2019;7:561-70.

11.   Wright AA, Keating NL, Balboni TA, Matulonis UA, Block SD, Prigerson HG. Place of death: correlations with quality of life of patients with cancer and predictors of bereaved caregivers' mental health. J Clin Oncol 2010;28:4457-64.

12.   Temel JS, Greer JA, Muzikansky A, et al. Early palliative care for patients with metastatic non-small-cell lung cancer. N Engl J Med 2010;363:733-42.

13.   Wright AA, Zhang B, Ray A, et al. Associations between end-of-life discussions, patient mental health, medical care near death, and caregiver bereavement adjustment. JAMA 2008;300:1665-73.

14.   Shen L, Jhund PS, Petrie MC, et al. Declining Risk of Sudden Death in Heart Failure. N Engl J Med 2017;377:41-51.

15.   Warraich HJ, Allen LA, Mukamal KJ, Ship A, Kociol RD. Accuracy of physician prognosis in heart failure and lung cancer: Comparison between physician estimates and model predicted survival. Palliat Med 2016;30:684-9.

16.   Setoguchi S, Stevenson LW, Schneeweiss S. Repeated hospitalizations predict mortality in the community population with heart failure. Am Heart J 2007;154:260-6.

17.   Madelaire C, Gustafsson F, Stevenson LW, et al. One-Year Mortality After Intensification of Outpatient Diuretic Therapy. J Am Heart Assoc 2020;9:e016010.

18.   Straw S, Byrom R, Gierula J, et al. Predicting one-year mortality in heart failure using the 'Surprise Question': a prospective pilot study. Eur J Heart Fail 2019;21:227-34.

19.   Ambardekar AV, Thibodeau JT, DeVore AD, et al. Discordant Perceptions of Prognosis and Treatment Options Between Physicians and Patients With Advanced Heart Failure. JACC Heart Fail 2017;5:663-71.

20.   Slavin SD, Khera R, Zafar SY, Nasir K, Warraich HJ. Financial burden, distress, and toxicity in cardiovascular disease. Am Heart J 2021;238:75-84.

21.   Valero-Elizondo J, Chouairi F, Khera R, et al. Atherosclerotic Cardiovascular Disease, Cancer, and Financial Toxicity Among Adults in the United States. JACC CardioOncol 2021;3:236-46.

22.   Pollack CE, Cubbin C, Sania A, et al. Do wealth disparities contribute to health disparities within racial/ethnic groups? J Epidemiol Community Health 2013;67:439-45.

Table 1: Baseline Characteristics and Differences Between Patients Dying of Cancer or Heart Failure (HF)						
		Cancer (N=3203)	HF (N=3555)	P Value	HF with hx of cancer (N=670)	P Value
Age (years)	Mean (SD)	75.7 (10.1)	80.0 (10.6)	<0.001	81.7 (9.01)	0.078
Sex	Male	1,670 (52.1%)	1774 (49.9%)	0.066	376 (56.1%)	<0.001
	Female	1533 (47.9%)	1781 (50.1%)		294 (43.9%)	
Race	White	2537 (79.2%)	2870 (80.7%)	0.249	577 (86.2%)	0.001
	Black	559 (17.5%)	567 (15.6%)		79 (11.8%)	
	Other	103 (3.2%)	113 (3.2%)		13 (1.9%)	
	Missing	0.1%	5 (0.1%)		1 (0.2%)	
Ethnicity	Non-Hispanic	3008 (93.9%)	3314 (93.2%)	0.254	635 (94.8%)	0.075
	Hispanic	191 (6.0%)	236 (6.6%)		34 (5.1%)	
	Missing	4 (0.1%)	5 (0.1%)		1 (0.2%)	
Body mass index	<18.5	204 (6.4%)	257 (7.2%)	0.165	54 (8.1%)	0.796
	18-25	1374 (42.9%)	1495 (42.1%)		294 (43.9%)	
	25-30	1049 (32.6%)	1077 (30.3%)		193 (28.8%)	
	>30	576 (18.0%)	726 (20.4%)		129 (19.3%)	
Smoked before death	Yes	630 (19.7%)	468 (13.2%)	<0.001	81 (12.1%)	0.325
	No	2555 (79.8%)	3060 (86.1%)		586 (87.5%)	
	Missing	18 (0.56%)	27 (0.8%)		3 (0.5%)	
Education	> HS level	1219 (38.1%)	1590 (44.73%)	<0.001	286 (42.7%)	0.187
	HS level	940 (29.4%)	1029 (29.0%)		205 (30.6%)	
	Some college	1044 (32.6%)	936 (26.3%)		170 (26.7%)	
	Missing	0 (0.0%)	0 (0.0%)		0 (0.0%)	
Married/partnered at death	Yes	1604 (50.1%)	1429 (40.2%)	<0.001	365 (54.5%)	<0.001
	No	1324 (41.3%)	1850 (52.0%)		305 (45.5%)	
	Missing	275 (8.6%)	276 (7.8%)		0 (0.0%)	
Private insurance	Yes	1412 (44.1%)	1384 (38.9%)	<0.001	284 (42.4%)	0.001
	No	1501 (46.9%)	1815 (51.1%)		312 (46.6%)	
	Missing	290 (9.05%)	356 (10.0%)		74 (11.0%)	
Medicare	No	570 (17.8%)	343 (9.7%)	<0.001	41 (6.1%)	<0.001
	Yes	2602 (81.2%)	3181 (89.5%)		627 (93.6%)	
	Missing	31 (1.0%)	31 (0.9%)		2 (0.3%)	
Medicaid	No	2706 (84.5%)	2853 (80.3%)	<0.001	556 (83.0%)	<0.001
	Yes	440 (13.7%)	629 (17.7%)		100 (14.9%)	
	Missing	57 (1.8%)	73 (2.1%)		14 (2.1%)	
Social Security Benefits	No	399 (12.5%)	281 (7.9%)	<0.001	65 (9.7%)	<0.001
	Yes	2804 (87.5%)	3274 (92.1%)		605 (90.3%)	
	Missing	0 (0.0%)	0 (0.0%)		0 (0.0%)	
Wealth ($)	Mean (SD)	$39,008 ($55,916)	$29,895 ($40,798)	<0.001	$34,060 ($41,654)	<0.001
Death expected	Expected	2254 (70.4%)	1392 (39.2%)	<0.001	322 (48.1%)	0.003
	Unexpected	586 (18.3%)	1783 (50.2%)		326 (48.7%)	
	Other	80 (2.5%)	96 (2.7%)		20 (3.0%)	
	Missing	283 (8.8%)	284 (8.0%)		2 (0.3%)	
Place of death	Home	1176 (36.7%)	1071 (30.1%)	<0.001	212 (31.6%)	0.237
	Hospital	904 (28.2%)	1278 (36.0%)		251 (37.5%)	
	Nursing home	410 (12.8%)	657 (18.5%)		138 (20.6%)	
	Hospice	372 (11.6%)	131 (3.7%)		36 (5.4%)	
	Other	64 (2.0%)	143 (4.0%)		33 (4.9%)	
	Missing	277 (8.7%)	275 (7.7%)		0 (0.0%)	

Univariable differences in baseline demographic data were assessed with the Pearson's chi squared for categorical variables and ANOVA was used for continuous variables. Last column (p-value) denotes difference between group that died of heart failure with and without prior cancer history.

Table 2: Health Status of Individuals Dying of Cancer and Heart Failure (HF)						
		Cancer (N=3203)	HF (N=3555)	P Value	HF with hx of cancer (N=670)	P Value
# of conditions before death	*Mean (SD)*	2.75 (1.45)	2.93 (1.39)	<0.001	3.94 (1.54)	<0.001
	Missing	433 (13.5%)	437 (12.3%)		0 (0.0%)	
High blood pressure	No	1,330 (41.5%)	1071 (30.1%)	<0.001	185 (27.6%)	0.132
	Yes	1844 (57.6%)	2445 (68.8%)		465 (69.4%)	
	Missing	29 (0.9%)	39 (1.1%)		20 (3.0%)	
Diabetes	No	2477 (77.3%)	2417 (68.0%)	<0.001	461 (68.8%)	0.611
	Yes	705 (22.0%)	1116 (31.4%)		205 (30.6%)	
	Missing	21 (0.7%)	22 (0.6%)		4 (0.6%)	
Lung disease	No	2585 (80.7%)	2869 (80.7%)	0.881	498 (74.3%)	0.001
	Yes	603 (18.8%)	663 (18.7%)		158 (23.6%)	
	Missing	15 (0.5%)	23 (0.7%)		14 (2.1%)	
Arthritis	No	1290 (40.3%)	1241 (34.9%)	<0.001	220 (32.8%)	0.052
	Yes	1877 (58.6%)	2289 (64.4%)		437 (65.2%)	
	Missing	36 (1.1%)	25 (0.7%)		13 (1.9%)	
Memory problem	No	1721 (53.7%)	1854 (52.2%)	0.233	279 (41.6%)	0.698
	Yes	938 (29.3%)	1114 (31.3%)		209 (31.2%)	
	Missing	544 (17.0%)	587 (16.5%)		182 (27.2%)	
Self-reported health before death	Excellent	142 (4.4%)	128 (3.6%)	<0.001	24 (3.6%)	0.008
	Very good	458 (14.3%)	386 (10.9%)		57 (8.5%)	
	Good	758 (23.7%)	837 (23.5%)		132 (19.7%)	
	Fair	918 (28.7%)	1131 (31.8%)		226 (33.7%)	
	Poor	922 (28.8%)	1068 (30.0%)		230 (34.3%)	
	Missing	5 (0.2%)	5 (0.1%)		1 (0.2%)	
Duration of final illness before death	No warning, 1-2 hours	28 (0.9%)	692 (19.5%)	<0.001	119 (17.8%)	0.123
	< 1 day	63 (2.0%)	340 (9.6%)		63 (9.4%)	
	< 1 week	228 (7.1%)	537 (15.1%)		123 (18.4%)	
	< 1 month	438 (13.7%)	540 (15.2%)		120 (17.9%)	
	< 1 year	1,247 (38.9%)	561 (15.8%)		118 (17.6%)	
	> 1 year	899 (28.1%)	554 (15.6%)		116 (17.3%)	
	Missing	300 (9.4%)	331 (9.3%)		11 (1.6%)	
Notes: Univariable differences in baseline demographic data were assessed with the Pearson's chi squared. Last column (p-value) denotes difference between group that died of heart failure with and without prior cancer history.						

Table 3: Help Received with ADLs & IADLs for Individuals Dying of Cancer or Heart Failure (HF)						
Difficulty in year prior with:		**Cancer N=3203**	**Heart failure N=3555**	**P Value**	**HF w/ hx of cancer (N=670)**	**P Value**
Walking across a room	Yes	553 (17.3%)	1076 (30.3%)	<0.001	200 (29.9%)	0.868
	No	2622 (81.9%)	2435 (68.5%)		465 (69.4%)	
	Missing	28 (0.9%)	44 (1.2%)		5 (0.8%)	
Toilet	Yes	390 (12.2%)	673 (18.9%)	<0.001	131 (19.6%)	0.619
	No	2770 (86.5%)	2832 (79.7%)		530 (79.1%)	
	Missing	43 (1.3%)	50 (1.4%)		9 (1.3%)	
Getting in and out of bed	Yes	405 (12.6%)	748 (21.0%)	<0.001	146 (21.7%)	0.724
	No	2781 (86.8%)	2780 (78.2%)		520 (77.6%)	
	Missing	17 (0.5%)	27 (0.8%)		4 (0.6%)	
Taking medications	Yes	258 (8.1%)	602 (16.9%)	<0.001	114 (17.0%)	0.884
	No	2630 (82.1%)	2605 (73.3%)		500 (74.6%)	
	Missing	315 (9.8%)	348 (9.8%)		56 (8.4%)	
Eating	Yes	311 (9.7%)	530 (14.9%)	<0.001	102 (15.2%)	0.963
	No	2874 (89.7%)	3000 (84.4%)		565 (84.3%)	
	Missing	18 (0.6%)	25 (0.7%)		3 (0.5%)	
Dressing	Yes	613 (19.2%)	1095 (30.8%)	<0.001	193 (28.8%)	0.252
	No	2571 (80.3%)	2434 (68.5%)		474 (70.8%)	
	Missing	19 (0.6%)	26 (0.7%)		3 (0.5%)	
Preparing hot meals	Yes	570 (17.8%)	1075 (30.2%)	<0.001	194 (29.0%)	0.383
	No	2587 (80.8%)	2439 (68.6%)		469 (70.0%)	
	Missing	46 (1.4%)	41 (1.2%)		7 (1.0%)	
Bathing	Yes	577 (18.0%)	1112 (31.3%)	<0.001	207 (30.9%)	0.791
	No	2609 (81.5%)	2418 (68.0%)		460 (68.7%)	
	Missing	17 (0.5%)	25 (0.7%)		3 (0.5%)	
Shopping for groceries	Yes	758 (23.7%)	1331 (37.4%)	<0.001	243 (36.3%)	0.339
	No	2396 (74.8%)	2183 (61.4%)		420 (62.7%)	
	Missing	49 (1.5%)	41 (1.2%)		7 (1.0%)	
Using telephone	Yes	333 (10.4%)	733 (20.6%)	<0.001	136 (20.3%)	0.698
	No	2621 (81.8%)	2509 (70.6%)		480 (71.6%)	
	Missing	249 (7.8%)	313 (8.8%)		54 (8.1%)	
Someone helped with ADLs in the last year	Yes	1495 (46.7%)	1211 (34.1%)	<0.001	312 (46.6%)	0.002
	No	43 (1.3%)	145 (4.1%)		212 (31.6%)	
	Missing	1665 (52.0%)	2199 (61.9%)		146 (21.8%)	
Someone helped with IADLs in the last year	Yes	1877 (58.6%)	1238 (34.8%)	<0.001	344 (51.3%)	0.008
	No	144 (4.5%)	440 (12.4%)		267 (39.9%)	
	Missing	1182 (36.9%)	1877 (52.8%)		59 (8.8%)	
Professional helped with IADLs/ADLs in the final 3 months	Yes	597 (18.6%)	860 (24.2%)	<0.001	189 (28.2%)	0.826
	No	1986 (62.0%)	1513 (42.6%)		326 (48.7%)	
	Missing	620 (19.4%)	1182 (33.3%)		155 (23.1%)	
Last column (p-value) denotes difference between group that died of heart failure with and without prior cancer history.						

Table 4: Healthcare Out-of-Pocket (OOP) Costs of Individuals Dying of Cancer and Heart Failure (HF)								
Cost category	Cancer (n=3,203)		Heart Failure (N=3,555)		P Value	HF w/ hx of cancer (N=670)		P Value
	N (%)	Mean (SD)	N (%)	Mean (SD)		N (%)	Mean (SD)	
Hospital OOP	2,116 (66%)	$3,151.6 ($26,303.7)	2217 (62%)	$1,875.3 ($21,717.2)	0.081	492 (73%)	$985.0 ($3,345.3)	0.273
Nursing Home OOP	2,116 (66%)	$1,492.6 ($9,509.2)	2,217 (62%)	$4,347.8 ($18,913.7)	<0.001	492 (73%)	$4,001.0 ($17,457.9)	0.363
Hospice OOP	2,928 (91%)	$117.7 ($1,082.6)	3281 (92%)	$34.6 ($608.5)	<0.001	670 (100%)	$48.87 ($730.5)	0.393
Doctor visits OOP	2,928 (91%)	$1,213.9 ($8,111.2)	3281 (92%)	$799.1 ($7,476.4)	0.037	670 (100%)	$656.4 ($2,362.8)	0.220
Drugs OOP	2,928 (91%)	$2,893.9 ($7,780.8)	3,281 (92%)	$2,998.6 ($7,795.5)	0.597	670 (100%)	$3,240.6 ($7,404.0)	0.292
Spec facility & home care OOP	812 (25%)	$228.7 ($1,5359)	1064 (30%)	$545.6 ($6,375.2)	0.166	178 (27%)	$1,290.7 ($12,661.3)	0.789
Special facility OOP	2,116 (66%)	$425.2 (3,184.3)	2,217 (62%)	$365.0 ($1,840.8)	0.443	492 (73%)	$526.8 ($2,323.8)	0.110
Home care OOP	2,116 (66%)	$530.8 ($7,598.7)	2,217 (62%)	$304.3 ($3,135.5)	0.196	492 (73%)	$570.0 ($4,733.2)	0.071
Other med exp OOP	2,928 (91%)	$428.6 ($2,806.8)	3,281 (92%)	$329.8 ($3,081.6)	0.189	670 (100%)	$373.8 ($2,333.7)	0.064
Outpatient surgery OOP	898 (28%)	$99.8 ($648.0)	812 (23%)	$26.8 ($297.7)	0.003	209 (31%)	$14.5 ($85.5)	0.317
Dental OOP	898 (28%)	$333.2 ($1,145.5)	812 (23%)	$283.3 ($1,077.7)	0.355	209 (31%)	$455.3 ($1,632.2)	0.661
Total major medical expenses OOP	2,928 (91%)	$9,594.5 ($30,280.9)	3,281 (92%)	$9,988.4 ($30,852.6)	0.612	670 (100%)	$9,804.6 ($20,238.4)	0.564
Help from others OOP	2,233 (70%)	$212.7 ($1,426.8)	2,626 (74%)	$385.1 ($3,851.3)	0.050	567 (85%)	$252.6 ($1,840.1)	0.579

From waves 3-5, respondents were asked about OOP spending in four categories: (1) hospital and nursing home costs; (2) doctor, dentist, and outpatient surgery costs; (3) average monthly prescription drug costs; and (4) home health care and special facilities or services costs. Beginning in Wave 6, the number of categories expands to eight: (1) hospital costs; (2) nursing home costs; (3) doctor visits costs; (4) dentist costs; (5) outpatient surgery costs; (6) average monthly prescription drug costs; (7) home health care and (8) special facilities costs. Beginning in Wave 10, a ninth category seeks to capture any additional out-of-pocket medical expenditures that cannot be assigned to any of the other categories. Information regarding OOPs comes from harmonized HRS file, so information was imputed and harmonized by data provider. Total major medical expense was the sum of reported or imputed out-of-pocket expenses for hospital stays, nursing home stays, hospice, doctor visits, drug expenses, special facilities or services, in-home medical care, and other medical expenses not covered by insurance. Last column (p-value) denotes difference between group that died of heart failure with and without prior cancer history.

Table 5: Multivariable predictors of having a disability or dying in the hospital for patients dying of cancer or heart failure																
	Probability of having disability								Probability of dying in hospital							
	Cancer patients				Heart failure patients				Cancer patients				Heart failure patients			
	N=2617		N=2691		N=2919		N=3001		N=2051		N=2897		N=3149		N=3235	
Independent variable	RRR	P-value	RRR	P-value	RRR	P-value	RRR	P-value	RRR	P-value	RRR	P-value	RRR	P-value	RRR	P-value
Female	1.17	*0.077*	1.17	*0.066*	1.54	*<0.001*	1.60	*<0.001*	0.87	*0.148*	0.87	*0.112*	1.19	*0.036*	1.20	*0.022*
Age>70	1.73	*<0.001*	1.65	*<0.001*	2.03	*<0.001*	1.96	*<0.001*	0.67	*<0.001*	0.69	*<0.001*	1.23	*0.062*	1.19	*0.099*
Race (Ref=White)																
Black/African-American	1.15	*0.234*	1.04	*0.718*	0.93	*0.554*	0.92	*0.487*	2.07	*<0.001*	2.12	*<0.001*	1.07	*0.544*	1.12	*0.259*
Other	1.40	*0.167*	1.30	*0.263*	0.83	*0.429*	0.79	*0.308*	1.55	*0.063*	1.56	*0.053*	1.19	*0.425*	1.16	*0.488*
Married																
Yes	0.83	*0.033*	0.82	*0.024*	0.63	*<0.001*	0.66	*<0.001*	1.24	*0.022*	1.15	*0.113*	1.30	*0.002*	1.31	*<0.001*
Education (Ref=below HS)																
High School (HS)	0.58	*<0.001*	0.56	*<0.001*	0.63	*<0.001*	0.62	*<0.001*	1.02	*0.861*	0.99	*0.891*	1.16	*0.099*	1.13	*0.179*
College	0.52	*<0.001*	0.51	*<0.001*	0.69	*<0.001*	0.68	*<0.001*	1.13	*0.266*	1.10	*0.372*	1.08	*0.418*	1.03	*0.750*
BMI (Ref=BMI<18.5)																
<25	0.41	*<0.001*	0.36	*<0.001*	0.51	*<0.001*	0.54	*0.001*	1.26	*0.236*	1.28	*0.183*	1.05	*0.729*	1.10	*0.512*
<30	0.34	*<0.001*	0.31	*<0.001*	0.37	*<0.001*	0.42	*<0.001*	1.47	*0.051*	1.56	*0.019*	1.18	*0.303*	1.28	*0.105*
>30	0.41	*<0.001*	0.39	*<0.001*	0.53	*0.002*	0.63	*0.018*	1.68	*0.014*	1.83	*0.003*	1.15	*0.411*	1.34	*0.070*
Smoking before death	0.90	*0.334*	0.90	*0.335*	0.77	*0.033*	0.73	*0.010*	1.20	*0.095*	1.27	*0.027*	1.12	*0.345*	1.08	*0.476*
Hypertension	0.94	*0.520*	-	-	1.05	*0.593*	-	-	1.19	*0.060*	-	-	1.24	*0.010*	-	-
Lung disease	1.39	*0.002*	-	-	1.53	*<0.001*	-	-	1.04	*0.706*	-	-	1.21	*0.048*	-	-
Diabetes	1.24	*0.042*	-	-	1.40	*<0.001*	-	-	1.01	*0.912*	-	-	1.30	*0.002*	-	-
Arthritis	1.46	*<0.001*	-	-	1.47	*<0.001*	-	-	0.99	*0.886*	-	-	1.08	*0.339*	-	-
Region (Ref=Northeast)																
Midwest	0.88	*0.323*	0.84	*0.165*	1.04	*0.746*	1.06	*0.630*	0.56	*<0.001*	0.57	*<0.001*	0.66	*<0.001*	0.68	*0.001*
South	0.90	*0.385*	0.87	*0.237*	1.03	*0.815*	1.05	*0.656*	0.69	*0.002*	0.71	*0.004*	0.94	*0.588*	0.95	*0.628*
West	0.75	*0.052*	0.72	*0.019*	0.97	*0.846*	0.94	*0.685*	0.61	*0.001*	0.62	*0.001*	0.67	*0.003*	0.66	*0.002*

Notes: Presented results are from multinomial logistic regression analysis. Results are presented as relative risk ratios (RRR), indicating percentage relative risk change for a unit increase in the observed variable compared to the referent group, holding other variables constant. For categorical variables, reference category is stated in the row label, otherwise the reference is the complementary category.