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Comorbid Diabetes and End-of-Life Expenditures among Medicare Beneficiaries with Heart Failure

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Abstract

Background—Diabetes is associated with increased risk of mortality in heart failure. We examined the association of diabetes with expenditures, hospitalizations, and procedures among Medicare beneficiaries with heart failure during the last six months of life.

Methods and Results—In a 5% national Medicare sample, the prevalence of diabetes was 41.7% among 16,613 beneficiaries who died in 2007 with a diagnosis of heart failure. Diabetes was associated with higher expenditures during the last six months of life (mean $39,042 vs $29,003, p<0.001), even after adjusting for covariates, including age, gender, race, geographic location, comorbidities, and prior hospitalizations (cost ratio 1.08, 95% CI 1.05–1.12). For both diabetic and non-diabetic adults, over half of Medicare expenditures were related to hospitalization costs (mean $22,516 vs $15,721, p<0.001). When compared to their counterparts without diabetes, beneficiaries with diabetes had higher rates of hospitalization (adjusted incidence rate ratio (aIRR) 1.09, 95% CI 1.05–1.12) and days spent in the ICU.

Conclusions—Comorbid diabetes was common in heart failure and associated with higher expenditures, much of which was driven by increased rates of hospitalizations. Programs that focus on prevention of hospitalizations may reduce the substantial costs associated with heart failure near the end of life.

Introduction

Heart failure is associated with nearly $40 billion in direct costs and over one million hospitalizations annually in the United States. [1] Expenditures related to heart failure are particularly concentrated as individuals approach the end of life and have been increasing over time. [2, 3] During the last six months of life, heart failure is also associated with high

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Disclosures
None

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rates of other markers of resource utilization, including hospitalizations, intensive care unit stays, and cardiovascular procedures.[3]

Diabetes mellitus is common among heart failure patients and its prevalence has been increasing over the past two decades. [4, 5] The high rate of diabetes has clinical importance as comorbid diabetes is associated with increased risk of hospitalization and mortality among heart failure patients. [6] Diabetes may also promote additional expenditures in heart failure, although this association has not been evaluated during the high utilization period near the end of life. [2, 7] The purpose of this study was to examine the association between diabetes and resource utilization among Medicare beneficiaries with heart failure during the last six months of life.

Methods

Study Design

We used a 5% national sample of Medicare claims to develop a cohort of individuals with heart failure. Datasets used were the Medicare Provider Analysis and Review (MedPAR) file and the 5% denominator, outpatient, home health agency, hospice, and carrier files for the years 2005–2007.

We included Medicare beneficiaries who died in 2007 with a previous diagnosis of heart failure. Heart failure diagnosis was established with an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code of 428 listed either as a hospital discharge diagnosis or in at least two physician claims in the year preceding the last six months of life (i.e. the period of 18 months to 6 months prior to the time of death). Inclusion criteria included age greater than or equal to 67 and at least two years of continuous enrollment in Medicare prior to time of death. We excluded beneficiaries who were enrolled in a health maintenance organization, did not have continuous Medicare Parts A and B coverage, or lived outside the United States.

Exposure

The primary exposure was a diagnosis of diabetes in the year prior to the last six months of life. Individuals were considered to have diabetes if an ICD-9-CM code of 250.xx was listed in either a hospital discharge diagnosis or at least two physician claims between 18 and 6 months prior to the date of death.

Outcomes

The main outcome was resource utilization during the last six months of life. Medicare expenditures were calculated by summing expenditures of the individual files (inpatient, outpatient, skilled nursing facilities, home health, hospice and carrier files). We evaluated hospitalizations as both a total count and by relevant categories: heart failure related (primary discharge diagnosis code 402.X1, 404.X1, 404.X3, 428.XX), non-heart failure cardiovascular related (primary discharge diagnosis code 390 to 459 other than those listed for heart failure), or non-cardiovascular related (all other discharge codes). Intensive care unit (ICU) utilization was assessed as both a binomial variable, based on any ICU stay, and a count variable, equal to the number of days spent in the ICU during the last six months of life. A beneficiary was considered to have received hospice care if Medicare had covered at least one day of hospice services during the last six months of life. Finally, we measured whether beneficiaries had received certain procedures, including echocardiogram, cardiac catheterization, implantable cardioverter defibrillator (ICD), cardiac resynchronization therapy (CRT), dialysis, non-invasive ventilation, or mechanical ventilations. Procedures

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were identified using ICD-9-CM codes from inpatient files and current procedure manual (CPT) codes from carrier files.

Covariates

Age, gender, race, region, and end stage renal disease (ESRD) status were obtained from the Medicare denominator file; all other covariates were assessed using the claims files. Age was categorized into five groups: 67–74, 75–79, 80–84, 85–89, and ≥90. Race was categorized as white, black, or other. Comorbidities were considered to be present if listed between 18 and 6 months prior to date of death on one inpatient or two outpatient claims. Comorbid conditions were defined by ICD-9-CM codes based on the Clinical Classification System (CCS) developed by the Agency for Healthcare Research and Quality (AHRQ) and included chronic obstructive pulmonary disease (COPD), hypertension, kidney disease, cancer, dementia, cerebrovascular disease, coronary atherosclerosis, peripheral vascular disease, and depression. Prior hospitalizations were tabulated during the period of 18 to 6 months prior to date of death and categorized as no hospitalizations, 1–2 hospitalizations, and three or more hospitalizations.

Statistical Analysis

Baseline characteristics were compared between individuals with and without diabetes using chi-squared tests for categorical variables. Because continuous variables did not meet the normality assumption, they were compared among groups using the Wilcoxon rank sum test.

Utilization outcomes were presented as means with standard deviations for continuous variables and percentages for binary variables. Hospitalizations were evaluated both as a binomial outcome and as count. To study the relationship between diabetes and total expenditures, we calculated a cost ratio using a negative binomial regression model, since cost data were overdispersed. The cost ratio provided an estimate of the relative increase in expenditures related to presence of diabetes. [8] We also used a negative binomial regression model to estimate the incidence rate ratio for number of hospitalizations, number of hospitalization days, and number of ICU days for individuals with versus without diabetes. Binomial outcomes, including any hospitalization, any ICU admission, and procedures were compared between groups using a Poisson regression model with robust variance estimates [9, 10] to calculate prevalence ratios. We performed all regression analyses both unadjusted and adjusted for covariates, including age, gender, race, region, comorbidities, and prior hospitalization. Additionally, we calculated the cost ratio for diabetes among subgroups of beneficiaries who had and had not been admitted to the ICU.

We assessed the association between baseline characteristics with Medicare expenditures during the last six months of life among beneficiaries with comorbid heart failure and diabetes. Total expenditures were divided into quintiles among the cohort and unadjusted trends were calculated using chi-squared tests. Beneficiaries with diabetes were then divided into two groups based on median total expenditures. We used Poisson regression with robust variance to determine the association between baseline characteristics and presence in the higher expenditure group, after adjustment for covariates.

Statistical significance was pre-specified with an alpha level of 0.05 (two-tailed). Statistical analyses were performed using Stata 10 (Stata Statistical Software: Release 10, StataCorp, College Station, TX, 2007).

Results

Of the 16,613 Medicare beneficiaries with heart failure included in our study, 41.7% (n=6,922) had comorbid diabetes mellitus. Diabetes was associated with younger age, male

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gender, and black race (Table 1). As compared to beneficiaries without diabetes, individuals with diabetes were more likely to have other comorbid conditions, including COPD, hypertension, kidney disease, cerebrovascular disease, and depression. Beneficiaries with diabetes were more frequently hospitalized than beneficiaries without diabetes in the year prior to the last six months of life.

Total Medicare expenditures during the last six months of life averaged $10,039 higher for beneficiaries with diabetes versus those without diabetes (Table 2). For both groups, the majority of expenditures were related to inpatient costs, with inpatient costs representing a higher percentage of total expenditures among diabetic as compared to non-diabetic individuals (57.7% vs. 54.2%, $p<0.001$). Diabetes was associated with higher expenditures for inpatient, outpatient, skilled nursing, and home health services, but lower expenditures for hospice care. Although the higher expenditures among decedents with diabetes were attenuated in multivariate analysis, diabetes remained independently associated with an 8% increase in total expenditures. (Table 3) Diabetes was associated with similar increases in expenditures among subgroups of beneficiaries who had been admitted to the ICU (cost ratio 1.06; 95% CI 1.03–1.10) and those who had not had been admitted to ICU (cost ratio 1.07; 95% CI 1.02–1.12).

Individuals with diabetes experienced a mean of 0.6 more hospitalizations during the last six months of life, with over half of the additional hospitalizations due to non-cardiovascular causes. (Table 2) Diabetes was associated with a 3% increased of ever being hospitalized, a 9% increase in the rate of hospitalization, and a 14% increase in the number of hospitalization days, after adjustment for covariates (Table 3). Beneficiaries with diabetes spent 19% more hospital days in the ICU as compared to beneficiaries without diabetes. Conversely, diabetic individuals were 7% less like to use of hospice services during the last six months of life.

In unadjusted analysis, diabetes was associated with higher utilization of all procedures evaluated, including echocardiography, cardiac catheterization, implantable cardioverter defibrillator, cardiac resynchronization therapy, dialysis, and noninvasive and mechanical ventilation. However, after multivariate adjustment, only echocardiography and mechanical ventilation were independently associated with comorbid diabetes (Table 3).

Among individuals with comorbid heart failure and diabetes, a number of baseline characteristics were associated with Medicare expenditures. Beneficiaries who were of younger age, male gender, black race, or from Northeast region had lower expenditures in the unadjusted analysis (p-trend=0.03 for gender, p-trend <0.001 for age, race, and region). All comorbid conditions was associated with increased expenditures with the exception of dementia, which was associated with reduced Medicare expenditures (p-trend <0.01). After adjusting for all other covariates, younger age, region, prior hospitalizations, hypertension, ESRD, and absence of dementia remained strong predictors of increased expenditures among individuals with comorbid heart failure and diabetes (Table 4).

Discussion

In our nationally representative sample of Medicare beneficiaries with heart failure near the end of life, comorbid diabetes was present in 42% of decedents. This prevalence was similar to findings from a number of other contemporary studies of heart failure patients, in which diabetes prevalence has ranged from 20 to 45%. [3–5, 11–13] The presence of diabetes was associated with increased expenditures in Medicare during the last six months of life, primarily related to increases in hospitalizations and inpatient expenditures. We found diabetes to be associated with some, but not all, cardiovascular procedures, while

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beneficiaries with diabetes had higher rates of intensive care unit stays than beneficiaries without diabetes. Conversely, diabetes was associated with reduced hospice use.

We found that Medicare expenditures for beneficiaries with diabetes were on average $10,000 higher than those for their counterparts without diabetes in the last six months of life. Following adjustment for covariates, diabetes was associated with an 8% increase in total expenditures. This associated increase in expenditures was similar to results from a prior study of heart failure patients at a single hospital center, although the prior findings were aggregated over a two-year period and did not specifically evaluate end-of-life expenditures. [7] Similarly, other studies have found diabetes to be associated with increased expenditures following incident heart failure although have not examined the high cost period near the end of life. [2, 14] In a general Medicare population, diabetes was recently shown to be associated with a 16% increase in expenditures near the end of life. [15] We found diabetes to be associated with increased expenditures among a cohort of individuals with heart failure, a chronic disease known to be associated with high costs, particularly near the end of life. [16, 17]

In our study, diabetes was associated with increased hospitalization rates and days spent in the hospital. Previous studies have shown diabetes in heart failure to be associated with poor outcomes, including increased rates of hospitalizations and increased hospital length of stay. [6, 11] Nonetheless, comorbid diabetes has not consistently predicted hospitalization-related costs in adults with heart failure. [14, 18] We found that diabetes was associated with increased inpatient related expenditures in a cohort of Medicare decedents with heart failure. Furthermore, costs related to hospitalizations appeared to be the primary driver of increased total expenditures observed among beneficiaries with diabetes as compared to those without diabetes.

Our findings suggest that strategies to keep individuals with heart failure and diabetes out of the hospital may be a promising approach to reduce costs. Clinical trials have shown medical interventions including beta-blocker therapy and blockade of the renin angiotensin aldosterone system to be efficacious at reducing hospitalizations among individuals with both heart failure and diabetes. [19, 20] From a health delivery standpoint, close physician follow-up may be associated with lower rates of hospitalization among individuals with heart failure near the end of life. [21] Outpatient disease management programs have been shown to reduce hospitalizations in heart failure. [22] In particular, we found that certain demographic and clinical characteristics were associated with increased expenditures among Medicare beneficiaries with diabetes and heart failure. These characteristics, which included reduced age, race other than white, increased number of prior hospitalizations, and certain comorbidities, may be useful to help identify which patients may most benefit from intensive multi-disease management.

Our study focused on individuals near the end of life, a population for whom hospice care has been shown to reduce hospitalizations [23] and may reduce total expenditures, [24] although this has not been consistently shown. [25] While Medicare data does not include end of life preferences, more than one-third of beneficiaries in our study had chosen to enroll in hospice care, a notable finding given the older age and high rate of comorbidity of beneficiaries in this study. However, decedents with comorbid diabetes had lower rates of hospice use than their counterparts free of diabetes. Given the high rates of hospitalizations observed among beneficiaries with diabetes and heart failure coupled with the potential economic and non-economic benefits of palliative care, improvement in end of life discussions in this population might help reduce expenditures.

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Diabetes was associated with increased prevalence of comorbidities other than dementia. Among beneficiaries with diabetes, most comorbidities were associated with increased costs. Therefore, the association between diabetes and increased utilization may have been partially mediated by other conditions. Nonetheless, after adjustment for these covariates, diabetes was still associated with increased expenditures and hospitalizations.

Our study has several limitations. First, our use of diagnostic coding may have led to errors in misclassification, although we used a validated algorithm to define both heart failure [26] and diabetes. [27] Our reliance on claims data limited our ability to identify certain clinical factors that may have affected outcomes in our study, including markers of disease severity such as functional status, glycosylated hemoglobin, and ejection fraction. As a result of lack of data on ejection fraction, we were unable to characterize beneficiaries as having heart failure with preserved versus reduced ejection fraction. This distinction may have led to additional confounding. Nonetheless, some studies have found diabetes to be similarly prevalent in heart failure with preserved and reduced ejection fraction, [28, 29] so the difference in heart failure classification between beneficiaries with and without diabetes may have been small. The claims data did not allow us to fully evaluate differences in treatment uptake between beneficiaries with and without diabetes. In particular, we could not determine frequency of enrollment in disease management programs nor adherence to heart failure medications, both of which have been shown to be efficacious in heart failure patients. Claims were also limited to direct Medicare costs and thus our results do not reflect data on both direct and indirect costs to patients and their families. We did not have available patient reported outcomes or patient preferences, which are particularly important in end-of-life care. This study specifically addressed resource utilization near the end of life, a period often characterized by high intensity of care. Our findings of an association between diabetes and utilization may not be generalizable to beneficiaries with heart failure who are not in the last six months of life.

In conclusion, diabetes is common in heart failure near the end of life and associated with increased expenditures, hospitalizations, and other markers of utilization. Comorbid diabetes should be specifically considered in programs aimed at improving care and reducing unnecessary hospitalizations and costs for patients with heart failure.

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Table 1

Baseline characteristics of 16,613 Medicare beneficiaries with heart failure who died in 2007, by diabetes status.

Variable	No Diabetes (n=9,691)	Diabetes (n=6,922)	p
Age Category			<0.001
67–74	9.0	19.8	
75–79	11.3	18.0	
80–84	20.3	23.8	
85–89	25.9	22.1	
≥90	33.6	16.4	
Age, years, mean (SD)	85.8 (7.6)	81.8 (7.6)	<0.001
Female	59.8	54.1	<0.001
Race			<0.001
White	91.7	84.7	
Black	6.1	10.4	
Other	2.2	4.9	
Region			0.003
Northeast	21.3	22.9	
Midwest	27.2	27.0	
South	37.1	37.4	
West	14.4	12.7	
COPD	42.9	48.1	<0.001
Hypertension	76.4	86.8	<0.001
Kidney disease	23.6	40.2	<0.001
ESRD	2.9	9.3	<0.001
Cancer	17.6	17.7	0.83
Dementia	13.6	12.9	0.25
Cerebrovascular Disease	28.9	35.9	<0.001
Coronary Atherosclerosis	52.1	65.2	<0.001
Peripheral vascular disease	19.8	25.8	<0.001
Depression	17.1	19.2	0.001
Hospitalizations, 6–18 months prior to death			<0.001
None	34.2	23.2	
1–2	39.4	37.5	
≥3	26.5	39.3	
Hospitalizations, 6–18 months prior to death, mean (SD)	1.8 (2.1)	2.6 (2.7)	<0.001

In percentage points unless otherwise specified

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Table 2

Healthcare utilization among Medicare Beneficiaries with heart failure during the last 6 months of life, by diabetes status.

Variable	No Diabetes (n=9,691)	Diabetes (n=6,922)	p
Expenditures, $			
Total	29,003 (31,315)	39,042 (40,046)	<0.001
Inpatient	15,721 (25,329)	22,516 (33,146)	<0.001
Outpatient	1484 (3477)	2572 (5130)	<0.001
Part B	3324 (4377)	4790 (5515)	<0.001
Skilled nursing facility	3999 (7510)	4801 (8276)	<0.001
Home Health	1318 (2683)	1842 (3623)	<0.001
Hospice	3157 (6896)	2520 (6192)	<0.001
Hospitalizations			
Total	2.1 (2.2)	2.7 (2.5)	<0.001
Heart failure related	0.3 (0.8)	0.4 (0.9)	<0.001
Non-Heart Failure, CVD related	0.3 (0.7)	0.4 (0.8)	<0.001
non-CVD related	1.5 (1.8)	1.9 (2.0)	<0.001
Hospitalized, %	75.0	82.3	<0.001
Hospitalization days	26.1 (36.9)	34.7 (42.3)	<0.001
ICU admission, %	33.5	42.9	<0.001
ICU days	2.8 (7.3)	4.4 (9.9)	<0.001
Hospice, %	40.8	35.8	<0.001
Procedures, percent receiving			
Echocardiogram	43.4	51.7	<0.001
Cardiac Catheterization	3.2	5.1	<0.001
Implantable Cardioverter Defibrillator	0.8	1.3	0.002
Dialysis	4.2	11.2	<0.001
Cardiac Resynchronization Therapy	0.4	0.6	0.14
Non-invasive ventilation	4.1	5.2	0.001
Mechanical ventilation	10.7	16.3	<0.001

Values are mean (SD) unless otherwise specified

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Table 3

Association of diabetes with healthcare utilization among Medicare beneficiaries with heart failure during the last 6 months of life.

Outcome	Comparison Ratio* for Diabetes vs. No Diabetes	
	Unadjusted	Adjusted†
	Prevalence Ratio	
Any Hospitalization	1.10 (1.08–1.11)	1.03 (1.01–1.04)
Heart Failure Hospitalization	1.25 (1.18–1.32)	1.11 (1.04–1.17)
Cardiovascular Hospitalization	1.18 (1.14–1.23)	1.04 (1.00–1.08)
Non-Cardiovascular Hospitalization	1.12 (1.10–1.15)	1.05 (1.02–1.07)
ICU Stay	1.28 (1.23–1.33)	1.07 (1.03–1.11)
Hospice	0.88 (0.84–0.91)	0.93 (0.90–0.97)
Echocardiogram	1.19 (1.15–1.23)	1.04 (1.01–1.08)
Cardiac Catheterization	1.60 (1.38–1.86)	1.03 (0.88–1.20)
Implantable Cardioverter Defibrillator	1.61 (1.19–2.17)	1.03 (0.76–1.40)
Dialysis	2.67 (2.36–3.00)	1.08 (0.99–1.18)
Cardiac Resynchronization Therapy	1.40 (0.90–2.18)	0.94 (0.60–1.46)
Noninvasive Ventilation	1.26 (1.09–1.45)	1.05 (0.90–1.21)
Mechanical Ventilation	1.52 (1.40–1.64)	1.09 (1.00–1.18)
	Cost Ratio	
Total Expenditures	1.35 (1.30–1.39)	1.08 (1.05–1.12)
	Incident Rate Ratio	
Hospitalization Rate	1.26 (1.23–1.30)	1.09 (1.05–1.12)
Hospitalization Days	1.33 (1.26–1.40)	1.14 (1.09–1.20)
ICU Days	1.61 (1.48–1.74)	1.19 (1.09–1.29)

*Represents prevalence ratios for bivariate outcomes, cost ratios for cost outcomes, and incident ratios for repeated outcomes

†Adjusted for age, gender, race, geographic location, hospitalizations in the prior year, and comorbidities, including COPD, hypertension, kidney disease, cancer, dementia, cerebrovascular disease, coronary atherosclerosis, peripheral vascular disease, and depression

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Table 4

Association of baseline characteristics with higher than median expenditures during the last 6 months of life, among 6,922 Medicare beneficiaries with comorbid heart failure and diabetes.

Characteristic	Adjusted* Relative Risk
Age Category	
67–74	1 [Reference]
75–79	1.03 (0.97–1.09)
80–84	1.00 (0.95–1.07)
85–89	0.92 (0.96–0.99)
≥90	0.72 (0.66–0.79)
Female	1.03 (0.98–1.08)
Race	
White	1 [Reference]
Black	1.20 (1.13–1.28)
Other	1.09 (1.00–1.20)
Region	
Northeast	1 [Reference]
Midwest	0.89 (0.84–0.95)
South	0.90 (0.85–0.96)
West	0.92 (0.85–1.00)
COPD	1.05 (1.00–1.10)
Hypertension	1.30 (1.17–1.44)
Kidney disease	1.04 (0.99–1.10)
ESRD	1.49 (1.41–1.57)
Cancer	1.12 (1.06–1.19)
Dementia	0.88 (0.82–0.95)
Cerebrovascular Disease	1.06 (1.01–1.11)
Coronary Atherosclerosis	1.16 (1.09–1.22)
Peripheral Vascular Disease	1.04 (0.99–1.09)
Depression	1.02 (0.96–1.07)
Hospitalizations, 6–18 months prior to death	
None	1 [Reference]
1–2	1.15 (1.07–1.25)
≥3	1.37 (1.26–1.49)

* Adjusted for all other variables in table