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Assessment of Cost and Health Resource Utilization for Elderly Patients With Heart Failure and Diabetes Mellitus

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Abstract

Background—Our aim was to examine the health resource utilization and cost of care associated with heart failure (HF) and diabetes mellitus (DM) for elderly Medicare enrollees.

Methods and Results—A retrospective case-control design was used to identify 4 groups of elderly patients with HF and DM (n = 498), HF only (n = 1089), DM only (n = 971), and no-HF and no-DM (n = 5438) using an administrative database of a large urban academic health care system. Demographic, diagnostic, health resource utilization, and cost (reimbursement) data were obtained from the Medicare claims database for the years 2000 and 2001. Disease states were identified by ICD-9 codes. Costs and health resource utilization were compared across the groups. The mean total costs were highest for the group with HF and DM ($32,676), and second highest for the HF only group ($22,230). In multivariable models that adjusted for potentially influential covariates, the group with HF and DM had a 3-fold increase in total cost compared with the group without DM and HF (relative total cost = 4.51, 95% confidence interval 3.82–5.31).

Conclusions—The presence of DM has a substantial influence on the costs for managing older patients with HF. An integrated approach to management may be needed.

Keywords

Heart failure; diabetes; cost; health resource utilization

Heart failure (HF) is a major cause or morbidity and mortality in older adults with an estimated prevalence of 10 million cases.[1] HF is considered as an epidemic with 550,000 new cases per year and is characterized by the American Heart Association as the only cardiovascular disease with increasing incidence, prevalence, and cost.[2] Diabetes mellitus (DM) is another chronic illness with an increasing prevalence, and older adults have the

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Disclosures

None.

highest prevalence of DM among any age group.[3] DM is an important contributor to HF, with prevalence rates among patients with HF typically between 20% and 30%.[4–9] DM is linked with HF not only because it is a major risk factor for coronary artery disease, but also through less well understood mechanisms such as advanced glycation end product accumulation, interstitial fibrosis of the heart muscle, autonomic neuropathy, and impaired glucose utilization.[10–16] DM in patients with HF contributes to increased risk of rehospitalization,[17] poor clinical outcomes,[1,4] and increased risk of mortality.[18–23]

Estimating the increased health care expenditures associated with the growing epidemic of HF among older adults is complicated because of multiple coexisting chronic medical conditions including DM. HF is the second most costly condition paid for by Medicare and DM is among the top 20 most costly conditions.[24] HF is often the end stage of heart disease and is associated with large health care expenditures.[25–27] DM in patients with HF not only has an immediate influence on costs in the year of diagnosis but also has a continuing influence on costs in subsequent years unlike other conditions such as myocardial infarction or stroke.[28] A further understanding of the major costs associated with HF and DM would lead to future studies on strategies for improving care for both conditions.

Our work differs from prior work in the following ways. First, many of the prior studies on health care expenditures focus on DM[29–31] or HF.[25,32,33] A smaller number has only mentioned the effects on cost of HF among the multiple complications of patients with DM[28,34–41] or the effects of DM among the multiple comorbidities influencing the costs of care for patients with HF.[34] Second, we are specifically interested in Medicare older adults, whereas most studies use different age ranges encompassing younger samples.[34] Third, we used a sample drawn from the United States that may differ in important ways from the samples drawn from other countries.[36,37,39,41] Thus, to our knowledge, no study has examined the costs of HF and DM in the United States specifically among older adults enrolled in Medicare.

Our aim was to examine the health resource utilization and cost of care associated with HF and a specific concurrent comorbid condition, DM, for older Medicare enrollees. The objective of this study was to report the incremental cost of DM when it cooccurs with HF. Our hypothesis was that DM in the context of HF increases the complexity of care and Medicare enrollees with HF and DM would use significantly more health-related resources leading to increased health care expenditures than would Medicare enrollees with HF or DM alone. We sought to understand both the magnitude and patterns of the health care expenditures among older Medicare enrollees with HF and DM in order gain a further understanding of the complex interplay of HF and DM.

Methods

Study Design and Data Sources

In this retrospective case-control study, we identified 1587 adults aged 65 years and older with a diagnosis of HF (ICD-9 402.01, 402.11, 402.91, 428.0, 428.1, 428.9) and 6409 adults age 65 years and older without a diagnosis of HF during the year 2000 from the administrative database of a large urban academic health care system. Principal or secondary diagnoses were used for both inpatient hospitalization and outpatient encounters. For outpatient encounters, a patient with 3 or more outpatient encounters with a diagnosis of HF was considered to have HF. All demographic, diagnostic, and health resource utilization data were obtained for the groups with and without a diagnosis of HF from the Medicare claims database for the years 2000 and 2001. The study was approved by the institutional review board.

Identification of Groups

The groups with and without a diagnosis of HF were further subdivided into those with and without a diagnosis of DM (ICD-9 250.00–250.93), leading to a total of 4 groups: HF and DM (n = 498), HF only (n = 1089), DM only (n = 971), and no-HF and no-DM or control group (n = 5438).

Outcome Variables

Health Resource Utilization and Cost—We obtained health resource utilization data and Medicare reimbursements (costs) for all care provided and paid for each person for the years 2000 and 2001. Data on inpatient costs, outpatient costs, inpatient pharmacy costs, length of stay, number of emergency room visits, number of inpatient admissions, number of outpatient visits, and number of diagnostic and lab procedures performed were obtained. The following Medicare claims files were used: MEDPAR inpatient care, Outpatient Standard Analytical Files, home health and hospice care, and carrier files. All costs for each person were aggregated across 2 years. Data on copayments, deductibles, and coinsurance paid by participants, and supplemental insurance and payments for other care such as ambulatory prescription pharmaceuticals were not available. Thus, this study applies to Medicare expenditures only.

Explanatory Variables

Important covariates are age, ethnicity, gender, and medical comorbidity. The Charlson comorbidity index is a medical record-based system whose integer scores from 1 to 10 represent increasing level of burden of illness.[42] Charlson comorbidity scores, excluding DM and/or HF points for the populations with a diagnosis of DM and/or HF, were calculated after study entry. We also examined the groups of older adults according to the presence of conditions considered to be microvascular or macro-vascular complications.[28,37,39,43,44] The conditions considered to be microvascular complications were: peripheral vascular disease (ICD-440.x, 443.9, 557.x), gangrene (785.4), foot ulcer (707.1x), amputation (895.x, 986.x, 897.x), retinopathy (362.01, 362.03, 362.04, 362.05, 362.06, 362.02, 362.29), macular edema (362.07, 362.53, 352.83), cataract (366.41), blindness (369.x), microalbuminuria (791.0), nephropathy (285.21, 403.01, 403.11, 403.91, 404.02, 404.12, 404.92, 538.x, 584.x, 585.x), and neuropathy (354.0-355.9, 337.1, 357.2, 358.1, 536.3, 713.5). The conditions considered to be macrovascular complications were: angina (413.x), myocardial infarction (410.x, 412), ischemic stroke (433.x1, 434.x1, 436, 437.1), and transient ischemic attack (435.9).

Statistical Analysis

All data analysis was performed using SAS software, Version 9.1.[45] We examined the differences in demographics across 4 groups (HF and DM (n = 498), HF only (n = 1089), DM only (n = 971), and no-HF and no-DM or control group (n = 5438)) using χ^2 for binary variables and analysis of variance for continuous variables. Cost and health resource utilization were compared across the four groups. We used analysis of variance to compare means. To adjust for potentially influential covariates, regression models were fitted to the data. We analyzed the effects of cooccurring HF and DM on multiple outcomes such as health resource utilization and cost, after adjusting for age, gender, ethnicity, Charlson comorbidity score, and exposure months of observation. Because of the non-normal distribution, cost data and length of stay data was log transformed. In all regressions, PROC GENMOD (log link) for cost data and Poisson (zero-inflated) for count data (emergency room visits, surgical procedures, outpatient visits, and inpatient visits), the outcomes were modeled as a function of group (3 dummy variables, control group as reference group),[46] after adjusting for Charlson comorbidity score categories (2 dummy variables with Charlson comorbidity score of 0 as the reference category), age, gender, ethnicity, and exposure months of observation.[42] We needed to exponentiate the regression coefficients because the dependent variables were log transformed. Therefore, the interpretation of the exponentiated coefficients is the relative cost in PROC GENMOD (log link) models or relative count in Poisson models with the no-HF and no-DM group as the reference or control group. Goodness-of-fit was assessed for all multivariate models using scaled deviance and Pearson's χ^2 statistic. All costs (reimbursements) were adjusted to the 2009 values using 5% discount rate.

Results

Demographic and Clinical Characteristics

Comparison of demographic and clinical characteristics of the 4 study groups (HF and DM [n = 498], HF only [n = 1089], DM only [n = 971], and no-HF and no-DM or control group [n = 5438]) are displayed in Table 1. The HF and DM group and HF only group were the oldest (mean age = 79.0 years, standard deviation = 7.6 years and mean age = 81.4 years, standard deviation = 7.8 years, respectively), compared with the other 2 groups. The HF and DM group and DM only group had a somewhat higher proportion of African Americans. The DM only group had the highest proportion of women, although the difference did not reach statistical significance. The Charlson comorbidity score was higher for the HF and DM group, indicating that this group was relatively sicker. Patients in the HF and DM group and HF only group were more likely to have died than were patients in the DM only and no-HF and no-DM group.

Unadjusted Health Resource Utilization and Cost

Unadjusted comparisons of health resource utilization and costs across the 4 groups are displayed in Table 2. The annual data are aggregated across a 2-year follow-up period. There were significant differences in average health resource utilization and medical care costs across the four groups, as shown by the analysis of variance results (all P values ≤ .0001). The average total costs were highest for the HF and DM group ($32,676), and second highest for the HF only group ($22,230). For all groups, the cost of inpatient care accounted for a major portion of the Medicare total cost of care. Inpatient care costs accounted for 78.8% of total cost for HF and DM group, 84.3% the HF only group, 75.4% for the DM only group, and 76.4% for the no-HF and no-DM or control group.

The number of hospitalizations were significantly different between the 4 groups ($P < .0001$, Table 2). Compared with other groups, the average length of stay was longest for the HF and DM group (26.6 days, $P < .0001$). For both HF groups (HF and DM group and HF only group), mean length of stay was longer than that of the no-HF groups. The difference in mean number of surgical procedures was significant as well, with both HF groups (HF and DM group and HF only group) having the highest mean number of surgical procedures (Table 2).

Relative Health Resource Utilization and Cost

The results of PROC GENMOD log-link regressions for predicting costs and health resource utilization are presented in Table 3. The results for the total cost model indicate that the total costs of the HF and DM group were 4-fold higher in total cost compared with the group without HF and DM (relative total cost = 4.51, 95% confidence interval (CI) [3.82–5.31]), whereas the total costs of the HF only group were 3-fold higher compared with the group without DM and HF (relative total cost = 3.17, 95% CI [2.81–3.58]). Overall, the magnitude and direction of the results of the regressions for inpatient costs, outpatient costs, and inpatient pharmacy costs are consistent with the results of the total cost model. It is thus

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apparent that a diagnosis of DM in patients with HF exerted additional cost burden, compared with the control group (no-HF and no-DM).

The results of regression models for predicting number of emergency room visits, inpatient visits, outpatient visits, and length of stay are also displayed in Table 3. The HF and DM group reported a 3.99 times higher number of emergency room visits (relative number of emergency room visits = 3.99, 95% CI [3.68–4.33]) compared with the group without HF and DM. Also, the HF and DM group had a 2.07 times higher number of inpatient visits compared with the group without HF and DM (relative number of in-patient visits = 2.07, 95% CI [1.93–2.22]), and the length of stay of the HF and DM group was longer compared with the group without HF and DM (relative length of stay = 2.49, 95% CI [2.18–2.86]). Overall, the HF and DM group was associated with a multifold increase by all measures of health resource utilization and the overall pattern of health resource utilization is consistent with the results of costs as also reported in Table 3. Goodness-of-fit appeared satisfactory using scaled deviance and Pearson's χ^2 statistic with coefficients ranging from 1 to 3.4.

Discussion

HF and DM are the 2 most common chronic illnesses among elderly and can have a significant impact on quality and quantity of life of the elderly. The economic burden associated with multiple chronic illnesses is complex and multifaceted. Elderly patients with HF often present with other chronic illnesses such as DM that influence health resource utilization and cost. The principle finding of our investigation was that the presence of DM has a substantial influence on the costs for managing older patients with HF. The findings of this retrospective study are as follows. 1) Direct of cost of HF alone and DM alone was higher than the control group, the group without HF and DM. 2) Beyond the diagnosis of HF, a cooccurring diagnosis of DM is accompanied by substantial increases in all medical care, mainly inpatient care. 3) Cooccurring DM for HF patients may also lead to longer inpatient stays, perhaps as a result of medical and surgical complications. 4) A diagnosis of DM for HF patients leads to an additional cost burden. 5) Finally, a diagnosis of DM in the context of HF should be followed by reevaluation of the person's health status, medical needs, and care.

Before discussing our findings, the results must first be considered in the context of some potential study limitations. First, our study was retrospective and based on administrative claims data with all the limitations common to the use of administrative data sets.[47,48] Our data are from a large university health system and therefore are limited by the geographic characteristics of the study sample. The patients may not be representative of patients receiving care in other settings. Second, we have excluded data from ambulatory prescription pharmaceuticals, which are an important contributor to health care expenditures for HF and DM. Our analysis focuses on direct medical costs from the perspective of a large health care system, whereas patient out-of-pocket costs, direct nonmedical costs, and indirect costs were excluded. Third, we used ICD-9 codes to assess for comorbidity and therefore there is the potential for miscoding and misclassification bias. Fourth, because claims data were only available for a limited period of time for each patient, it was not possible to determine the length of time from diagnosis for HF and DM, thus this is cost of prevalence only. Fifth, we did not obtain clinical data through chart review. There was no measure of HF severity and we could not distinguish between systolic and diastolic heart failure. In addition, our investigation is a descriptive cost analysis only because we do not have specific information on outcomes such as ejection fraction and hemoglobin A_{1c}. Finally, Medicare enrollees represent an older segment of the US population and so our results cannot be generalized to younger patients.

Nonetheless, despite limitations our results deserve attention because we attempted to further characterize the costs associated with HF and DM among enrollees in Medicare. An understanding of the magnitude of the increased cost of HF in the context of DM has clinical potential as a model for the complexities associated with care for multiple chronic medical conditions among older adults. The cost and management of patients with multiple chronic conditions is a challenge for the health care system. Cost-of-illness studies are often the first step in formal economic evaluations and can help policy decisions concerning resource allocation decisions. Cost-of-illness studies provide an important resource for future cost-effectiveness modeling and other types of economic research. Incremental cost of illness is the added costs of care attributable to a specific diagnosis when compared to persons without the index disease adjusting for comorbid conditions, as well as patient demographics. The incremental cost-of-illness measure enhances our understanding of the specific cost influence of DM in patients with HF.

Understanding the major costs associated with DM in the context of HF would aid in determining a course of care that is both beneficial and cost-effective. Consistent with other studies on DM complications, inpatient treatment of older patients with DM and HF appears to be a significant contributor to the total costs.[37,39,40] The length of inpatient stay for persons with HF and DM was significantly longer, 26.6 days, compared with persons with HF only or DM only: 22.2 and 9.9 days, respectively. Even after adjustment for comorbid conditions, as well as patient demographics and exposure months of observation, the length of stay for patients with DM and HF was longer. DM worsens the prognosis of patients with HF and therefore the optimal management of both conditions is essential. HF is the single most common cause of hospitalizations in patients 65 years and older. Our results indicate that patients with HF and DM are at even greater risk of long inpatient stays and high inpatient costs. However, minimal data are available on the optimal management of DM in the context of HF, especially for patients with preserved systolic function.[1] More research is needed on the appropriate management of DM in the context of HF in order to improve both health and economic outcomes.

Our results have important implications for the clinical management of Medicare beneficiaries with multiple chronic illnesses. The current fee-for-service model may complicate the adoption of chronic care treatment models, and efforts to control spending will require changes in the way Medicare pays for services.[49] The prevalence of HF and DM continues to increase. The increased spending already required for the management of HF and DM supports the need to revise the Medicare payment system to allow for integrative care management. For example, because both disease outcomes have been shown to be improved by education and ambulatory care by specialized nurses,[50–52] future studies could examine the efficacy of these programs in patients with both HF and DM. Strategies integrating the care for HF and DM have the potential to avert hospital admissions and to reduce Medicare payments for hospital, skilled nursing facility, and home health care services.

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Table 1

Comparison of Demographic and Clinical Characteristics of the 4 Study Groups (n = 7996)

	HF + DM	DM Only	HF Only	No-HF + No-DM	
	n = 498	**n = 971**	**n = 1089**	**n = 5438**	***P* Value**
Sociodemographic variables					
Age (y), mean (SD)	79.0 (7.6)	77.8 (7.8)	81.4 (7.8)	78.8 (8.1)	<.0001
African American, n (%)	203 (40.8%)	380 (39.1%)	310 (28.5%)	1131 (20.8%)	<.0001
Women, n (%)	325 (65.3%)	650 (67.0%)	644 (59.1%)	3474 (63.9%)	.0785
Medical conditions					
Charlson score, mean (SD)	4.8 (3.3)	3.3 (2.8)	3.2 (3.0)	1.8 (2.4)	<.0001
% with at least 1 microvascular complication, n (%)	67 (13.5%)	47 (4.8%)	59 (5.4%)	28 (0.5%)	<.0001
% with at least 1 macrovascular complication, n (%)	41 (8.2%)	16 (1.6%)	61 (5.6%)	42 (0.8%)	<.0001
Died, n (%)	24 (4.8%)	16 (1.6%)	66 (6.1%)	125 (2.3%)	<.0001

DM, diabetes mellitus; HF, heart failure; SD, standard deviation.

Table 2

Comparison of Health Care Resource Utilization and Unadjusted Costs of the 4 Study Groups (n = 7996)

	HF + DM	DM Only	HF Only	No-HF + No-DM	
	n = 498	**n = 971**	**n = 1089**	**n = 5438**	***P* Value**
Health Care Resource Utilization					
Number of emergency room visits, mean (SD)	2.7 (2.2)	0.92 (1.3)	2.1 (2.1)	0.56 (1.5)	<.0001
Length of inpatient stay in days, mean (SD)	26.6 (30.7)	9.9 (19.2)	22.2 (27.1)	5.3 (12.9)	<.0001
Number of surgical procedures, mean (SD)	2.6 (3.4)	0.73 (1.5)	1.7 (2.4)	0.43 (1.0)	<.0001
Number of outpatient visits, mean (SD)	9.1 (9.4)	6.8 (6.9)	6.8 (7.5)	4.4 (5.4)	<.0001
Number of inpatient visits, mean (SD)	2.7 (1.8)	1.4 (0.9)	2.2 (1.5)	1.2 (0.57)	<.0001
Annual Costs					
Outpatient cost, mean (SD)	$6912 ($11,776)	$2596 ($5915)	$3486 ($6191)	$1286 ($3254)	<.0001
Inpatient cost, mean (SD)	$25,764 ($27,100)	$7,970 ($14,294)	$18,744 ($20,758)	$4164 ($9314)	<.0001
Total cost (SD)	$32,676 ($31,813)	$10,566 ($16,845)	$22,230 ($22,745)	$5,450 ($10,500)	<.0001
Inpatient pharmacy cost, mean (SD)	$6060 ($8880)	$1550 ($4152)	$4393 ($7829)	$782 ($2601)	<.0001
Medical/surgical cost, mean (SD)	$4438 ($6793)	$1203 ($2835)	$3448 ($6006)	$735 ($2390)	<.0001
Physical therapy cost, mean (SD)	$1541 ($2589)	$569 ($1532)	$1209 ($2167)	$292 ($1000)	<.0001
Laboratory cost, mean (SD)	$9012 ($11,191)	$2200 ($4608)	$5849 ($7833)	$1117 ($3169)	<.0001

DM, diabetes mellitus; HF, heart failure; SD, standard deviation.

The annual data are aggregated across a 2-year follow-up period.

Table 3

Regression Models Predicting Health Care Resource Utilization and Costs of the 4 Study Groups with the No-HF and No-DM Group as the Reference or Control Group (95% Confidence Interval in Brackets) (n = 7996)

	HF + DM	DM Only	HF Only	No-DM + No-HF
	n = 498	**n = 971**	**n = 1089**	**n = 5438**
Health Care Resource Utilization				
Relative number of emergency room visits	3.99 (3.68–4.33)	1.54 (1.41–1.70)	2.91 (2.71–3.13)	1.00
Relative length of inpatient stay in days	2.49 (2.18–2.86)	1.55 (1.35–1.78)	1.98 (1.78–2.21)	1.00
Relative number of surgical procedures	4.85 (4.46–5.28)	1.51 (1.35–1.68)	3.22 (2.98–3.48)	1.00
Relative number of outpatient visits	1.67 (1.61–1.73)	1.32 (1.28–1.36)	1.51 (1.47–1.56)	1.00
Relative number of inpatient visits	2.07 (1.93–2.22)	1.19 (1.11–1.29)	1.59 (1.49–1.69)	1.00
Costs				
Relative outpatient cost	3.69 (2.16–4.59)	1.74 (1.53–1.97)	2.08 (1.86–2.35)	1.00
Relative inpatient cost	4.79 (3.76–6.11)	1.59 (1.30–1.96)	3.54 (2.96–4.23)	1.00
Relative total cost	4.51 (3.82–5.31)	1.63 (1.43–1.87)	3.17 (2.81–3.58)	1.00
Relative inpatient pharmacy cost	6.26 (4.95–7.90)	1.59 (1.31–1.93)	4.58 (3.85–5.44)	1.00
Relative medical/surgical cost	4.90 (3.87–6.21)	1.37 (1.12–1.67)	3.57 (2.99–4.26)	1.00
Relative physical therapy cost	5.21 (4.06–6.69)	2.19 (1.79–2.69)	3.85 (3.19–4.64)	1.00
Relative laboratory cost	6.16 (4.86–7.78)	1.69 (1.39–2.05)	4.23 (3.56–5.03)	1.00

DM, diabetes mellitus; HF, heart failure.

*Adjusted for Charlson comorbidity score categories (2 dummy variables with Charlson comorbidity score of 0 as the reference category), age, gender, ethnicity, and exposure months of observation.