Comorbid Depression is Associated With Increased Health Care Use and Expenditures in Individuals With Diabetes

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OBJECTIVE — This study ascertained the odds of diagnosed depression in individuals with diabetes and the relation between depression and health care use and expenditures.

RESEARCH DESIGN AND METHODS — First, we compared data from 825 adults with diabetes with that from 20,688 adults without diabetes using the 1996 Medical Expenditure Panel Survey (MEPS). Second, in patients with diabetes, we compared depressed and nondepressed individuals to identify differences in health care use and expenditures. Third, we adjusted use and expenditure estimates for differences in age, sex, race/ethnicity, health insurance, and comorbidity with analysis of covariance. Finally, we used the Consumer Price Index to adjust expenditures for inflation and used SAS and SUDAAN software for statistical analyses.

RESULTS — Individuals with diabetes were twice as likely as a comparable sample from the general U.S. population to have diagnosed depression (odds ratio 1.9, 95% CI 1.5–2.5). Younger adults (<65 years), women, and unmarried individuals with diabetes were more likely to have depression. Patients with diabetes and depression had higher ambulatory care use (12 vs. 7, $P <$ 0.0001) and filled more prescriptions (43 vs. 21, $P < 0.0001$) than their counterparts without depression. Finally, among individuals with diabetes, total health care expenditures for individuals with depression was 4.5 times higher than that for individuals without depression ($247,000,000 vs. $55,000,000, $P < 0.0001$).

CONCLUSIONS — The odds of depression are higher in individuals with diabetes than in those without diabetes. Depression in individuals with diabetes is associated with increased health care use and expenditures, even after adjusting for differences in age, sex, race/ethnicity, health insurance, and comorbidity.

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Diabetes is a prevalent disease that causes significant morbidity and mortality and is associated with substantial health care costs in the U.S. (1–3). Depression is equally prevalent in the U.S.; it is estimated that ~3% of men and ~5–9% of women have clinical depression (4–7). Primary care physicians see most patients with diabetes (8), and previous work indicates that clinically significant depressive symptoms are highly prevalent in primary care patients (9). However, current studies suggest that comorbid depression is more prevalent in individuals with diabetes than in other primary care patients (10). Therefore, comorbid depression seems to be an important problem in patients with diabetes.

There is evidence that when depression occurs in individuals with diabetes, it is associated with poor metabolic control, poor diet and adherence to the medication regimen, and decreased quality of life (11–13). Among primary care patients, comorbid depression has been shown to increase health care costs and health services use (14–21). It is unclear whether similar increases in health care costs and use are associated with depression among individuals with diabetes. A recent study addressing this question in individuals with diabetes (13) found that in those treated in a primary care setting, there was an association between severe depressive symptoms and poorer diet and adherence to medication, functional impairment, and higher health care costs. A major limitation was the nonrepresentative nature of the study sample. Most patients were white, employed, well-educated adults with health insurance coverage who all lived in the northwestern region of the country. Such a sample is not representative of the universe of individuals with diabetes in the U.S. (3).

We conducted this study with a nationally representative sample of individuals with diabetes to provide estimates that generalize to a larger segment of the population of interest. The objectives of this study were as follows:

- To compare the prevalence of clinically diagnosed comorbid depression in individuals with diabetes with that in a similar sample without diabetes.
- To determine whether comorbid de-

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Abbreviations: AHRQ, Agency for Healthcare Research and Quality; MEPS, Medical Expenditure Panel Survey.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

pression in individuals with diabetes was associated with increased health care use and expenditures.
- To determine whether adjustment for differences in age, sex, race/ethnicity, health insurance status, and other comorbid conditions changed the association between diabetes and depression.

RESEARCH DESIGN AND METHODS

— This study used data from the 1996 Medical Expenditure Panel Survey (MEPS) to determine the prevalence and health care use and expenditures associated with comorbid depression.

Data

The MEPS is cosponsored by the Agency for Healthcare Research and Quality (AHRQ) and the National Center for Health Statistics. It provides nationally representative estimates of health care use and expenditures for the civilian noninstitutionalized population of the U.S. A total of ~21,571 individuals provided data for their entire period of eligibility in 1996. The overall response rate was 70.2% after factoring in attrition. The four component surveys in the MEPS are the household, medical provider, insurance, and nursing home components. The household component collects person-level data on demographic characteristics, health conditions, health status, use of medical services, charges and payments, access to care, employment, health insurance coverage, and income.

The medical provider component supplements and validates the household survey in addition to collecting data on all medical and pharmacy events at the person level. Diagnoses are based on ICD-9–Clinical Modification (ICD-9-CM) codes; office-based visits are based on Current Procedural Terminology, 4th Edition (CPT-4) codes; and prescription names, strength, and quantity dispensed are also collected as part of the medical provider component. The insurance component collects data on health insurance plans, and the nursing home component captures data on demographic characteristics, use of services, and health expenditures related to nursing home use (22,23).

Study subjects

In MEPS, the diagnoses of depression, diabetes, and other medical conditions were based on patient self-report. Subsequently, a professional coder assigned fully specified 1996 ICD-9-CM codes to the verbatim text of each patient's self-reported medical condition. In addition, each self-reported medical condition was verified by contacting medical providers and pharmacies that the respondents identified as their source of care. The error rate for any coder did not exceed 2.5% on verification. To protect the confidentiality of respondents, fully specified ICD-9-CM codes were collapsed to three digits. For example, the ICD-9-CM code 250 (diabetes) was used to represent diabetes, diabetes mellitus, high blood glucose, juvenile diabetes, and adult-onset diabetes or diabetic neuropathy. Similarly, the codes for clinical depression were collapsed to 300, 301, 309, and 311.

However, ICD-9-CM codes 300, 301, and 309 included other mental health diagnoses; therefore, we discussed the selection of an appropriate code for depression with AHRQ personnel. Both individuals we contacted are familiar with the use of MEPS depression codes for data analysis (personal communication with Nancy Krauss and Anne Elixhauser, AHRQ, February 2001). Based on their recommendations, we used ICD-9-CM code 311 to identify respondents with clinical depression. In addition, the preliminary analysis we conducted showed that for >70% of the individuals with depression in MEPS, the appropriate ICD-9-CM code was 311.

Person level variables included age, sex, race/ethnicity, marital status, educational level, health insurance status, and income status. The incomes of respondents were reported as percentages of the federal poverty level. We used 125% of the federal poverty level as the cutoff and rated households with combined incomes <125% as poor and those with incomes >125% as not poor. We combined respondents' self-reported physical and mental health into two categories: excellent, very good, and good were considered one category, and fair and poor were considered the second category. Further details on technical and programming information are available (22,23).

Adjustment for chronic illness

The MEPS a priori designated certain conditions as priority conditions due to their prevalence, expense, or relevance to policy. We modified the comorbidity classification in MEPS to focus on major long-term and life-threatening conditions such as cancer, emphysema/chronic obstructive pulmonary disease, high cholesterol, HIV/AIDS, hypertension, ischemic heart disease, and stroke. This modification was based on prior evidence that these conditions were associated with increased prevalence of comorbid depression (5,7). Consequently, we identified an individual as having a comorbid condition if any one of these seven chronic life-threatening conditions was present in addition to diabetes and/or depression. We further categorized comorbid conditions into two groups for analysis based on the presence or absence of any of the seven selected comorbid conditions.

Health care use

We created four categories of health care use: ambulatory visits, emergency department visits, hospital inpatient days, and use of prescription medications. We defined an ambulatory visit as a medical provider visit in an office-based setting or hospital outpatient department or a hospital admission with a zero-night stay, which meant that the admission and discharge occurred on the same day.

Medical provider visits included visits to physicians and nonphysicians, such as physician assistants, nurse practitioners, chiropractors, podiatrists, physical and occupational therapists, and social workers. Other nonphysician visits included visits to nurses, optometrists, psychologists, and technicians/other medical providers. Similarly, hospital outpatient department visits included visits to physician and nonphysician providers.

An emergency department visit was defined as all visits made to the emergency department, including those visits that resulted in an inpatient stay. Hospital inpatient stay was defined as a hospital admission that resulted in at least a one-night stay before discharge for that hospitalization. Prescription use was defined as all prescribed medications purchased or otherwise obtained in 1996, including free samples. Because use data were skewed to the right, we performed base 10 log transformations and used the mean of the log-transformed data for statistical significance testing.

Health care expenditures

In MEPS, expenditures were defined as the sum of direct payments for care pro-

vided during the year. Included in the definition of expenditures were out-of-pocket payments, payments made by Medicare and Medicaid, private insurance, and payments from other sources. Excluded were payments for over-the-counter medications, payments for alternative care services, and indirect payments not related to specific medical events, such as Medicaid disproportionate share and Medicare direct medical education subsidies. Therefore, the definition of expenditures in MEPS reflected the total amount paid for health services out of pocket and by third-party payers in 1996 (all-payers perspective).

Ambulatory expenditures included payments for office-based provider visits, payments for hospital outpatient visits, and payments for zero-night hospital stays. Facility expenses and direct provider expenses were included in payments for hospital outpatient visits and zero-night stays.

Emergency department expenditures included both facility and direct provider expenses for emergency department visits. Expenses associated with emergency department visits that resulted in hospitalization were excluded because they were routinely included in the expense for that hospital stay. Expenditures for hospital stays included facility and direct expenses. Because zero-night hospital stays were classified as ambulatory visits, we excluded the expenses associated with those stays from the total expenses for hospital stays. Expenditures for prescriptions included only expenses for purchased medications and excluded the expenses associated with sample medications to reflect out-of-pocket payments and payments made by third-party payers.

Other categories of use included vision aids and other medical equipment and services, such as ambulance services, orthopedic items, hearing devices, prostheses, bathroom aids, medical equipment, and disposable supplies. Although the MEPS did not provide use data for the use of vision aids and other medical equipment and services, data on expenditures were provided. We included these expenditures in our analysis because the use of these services may be indicative of the severity of diabetes, which may be related to depression in individuals with diabetes. Further details about medical conditions, use, and expenditures definitions and characteristics are available online (23–25).

Analogous to use data, expenditure data were skewed to the right, so we performed base 10 log transformations and used the mean of log-transformed expenditures for statistical significance testing. In addition, we used the Consumer Price Index (26) to adjust mean expenditures to reflect August 2001 dollar values.

Statistical analysis

We used SAS software (SAS Institute, Cary, NC) (27) and SUDAAN software (Research Triangle Institute, Research Triangle Park, NC) (28) for all statistical analyses to account for the complex sampling design of MEPS. We compared unadjusted and adjusted odds of diagnosed depression in individuals with diabetes to that in the general population without diabetes. The odds of having depression in both groups were adjusted for age, sex, race/ethnicity, marital status, poverty status, and comorbidity with multiple logistic regression. We used SUDAAN software to generate weighted estimates representative of the U.S. population.

We used Student's t test and χ^2 test to compare baseline characteristics and health care use and expenditures of depressed and nondepressed individuals with diabetes. In addition, we used Student's t test to compare mean log 10–transformed use and expenditures to determine whether use and expenditures differed between depressed and nondepressed individuals with diabetes.

Then, we used analysis of covariance to determine differences in health care use and expenditures, adjusting for age, sex, race/ethnicity, health insurance, and comorbidity. Statistical significance testing for differences in use and expenditures were performed on log 10–transformed values. Similarly, the mean use and expenditures presented in Tables 2 and 3 are the values of anti-log 10 of the mean log 10–transformed values of use and expenditures. All results were weighted to represent the civilian noninstitutionalized population of the U.S. with diabetes. The institutional review board of our institution approved this study.

RESULTS

Prevalence of depression

In 1996, individuals with diabetes were 2.5 times more likely to have comorbid clinical depression than individuals without diabetes in the general population (odds ratio 2.5, 95% CI 1.9–3.4). After adjusting for baseline differences in age, sex, race/ethnicity, marital status, poverty status, and comorbidity, individuals with diabetes remained twice as likely as individuals without diabetes to have a clinical diagnosis of depression (1.9, 1.5–2.5).

Demographic and clinical characteristics of the study subjects

Of the 883 patients with diabetes in the MEPS, 825 had complete data for all relevant variables and were included in our analysis. A total of 85 of the 825 individuals with diabetes had diagnosed depression, whereas the remaining 740 did not have a diagnosis of depression. The baseline characteristics of the 825 individuals with diabetes in this study are shown in Table 1.

Mean age did not differ between the depressed and nondepressed groups (58.6 ± 1.7 vs. 60.6 ± 0.7 years, $P = 0.2856$), but individuals with depression were more likely to be <65 years of age than those without depression (71 vs. 55%, $P = 0.011$). There were higher proportions of women in the depressed group than in the nondepressed group (79 vs. 53%, $P = 0.0001$). Of the individuals with diabetes, those with depression were more likely to be unmarried than those without depression (56 vs. 39%, $P = 0.009$). Similarly, depressed patients with diabetes were more likely to report being in poor physical health (68 vs. 45%, $P = 0.002$) and poor mental health (31 vs. 13%, $P = 0.002$) than nondepressed patients with diabetes. There were no significant differences in race/ethnicity, level of education, number of comorbid conditions, health insurance status, and poverty level between the groups.

Health care use

A comparison of mean health care use among depressed and nondepressed individuals with diabetes is presented in Table 2. After adjusting for age, sex, race/ethnicity, health insurance, and comorbid conditions, depressed patients with diabetes had more ambulatory care visits than their nondepressed counterparts (12 vs. 7, $P < 0.0001$). Similarly, depressed patients with diabetes filled more prescriptions than those without depression (43 vs. 21, $P < 0.0001$). There were no statistically

Table 1—*Baseline characteristics of depressed and nondepressed individuals with diabetes (U.S. 1996)*

	Depressed	Nondepressed	*P*
n	85	740	
Age (years)			0.011
<65	71	55	
65+	29	45	
Sex			0.0001
Male	21	47	
Female	79	53	
Ethnicity			0.2678
White	83	78	
Nonwhite	17	22	
Education			0.632
Less than high school	36	39	
More than high school	64	60	
Marital status			0.009
Married	44	61	
Not married	56	39	
Comorbid conditions			0.0779
Yes	77	68	
No	23	32	
Insured status			0.785
Yes	20	19	
No	80	81	
Percentage of poverty level			0.099
<125	69	78	
125+	31	22	
Perceived physical health			0.002
Good/excellent	32	55	
Fair/poor	68	45	
Perceived mental health			0.002
Good/excellent	69	87	
Fair/poor	31	13	

Data are %.

significant differences in the mean number of emergency department visits and hospital inpatient days.

Health care expenditures

A comparison of mean health care expenditures among depressed and nondepressed individuals with diabetes is shown in Table 3. Expenditures were adjusted for inflation with the Consumer Price Index to reflect August 2001 dollars, and *P* values were based on log 10–transformed comparisons of expenditure categories adjusted for covariates. Expenditures for prescription medications were higher in depressed individuals than in nondepressed individuals with diabetes ($1,392 vs. $666, $P < 0.0001$). Similarly, depressed patients with diabetes had significantly higher total health care expenditures than their nondepressed counterparts with diabetes ($247,000,000 vs. $55,000,000, $P < 0.0001$). There were no statistically significant differences in other expenditure categories. This finding suggests that comorbid depression is associated with an almost fivefold increase in total health care expenditures for diabetes. In addition, the data suggest that comorbid depression in individuals with diabetes may be associated with increased total health care expenditures, to an amount of ~$192,000,000.

CONCLUSIONS — This study had two major findings. First, individuals with diabetes were twice as likely to have clinical depression as a comparable sample from the general U.S. population. Second, individuals with diabetes and comorbid depression had higher health care use and expenditures than nondepressed individuals with diabetes, even after adjusting for age, sex, race/ethnicity, health insurance, and comorbid conditions.

The results of our study are similar to that of a recent meta-analysis, which found that the odds of depression in individuals with diabetes were twice that in individuals without diabetes in controlled studies (10). In addition, our findings support the observation of Anderson et al. (10) that odds ratios provide results that are more consistent across populations than prevalence estimates. Our unadjusted prevalence estimate initially suggested that individuals with diabetes were 2.5 times more likely to have clinical depression than individuals without diabetes. However, after adjusting for several covariates with multiple logistic regression, the odds ratio of clinical depression in individuals with diabetes decreased to 1.9. Future studies should consider these observations when designing or reporting depression estimates in individuals with diabetes.

The characteristics of depressed individuals in this study were similar to those found in a study of 75,858 patients in which the prevalence of depression in primary care settings was estimated (9). Sim-

Table 2—*Comparison of mean health care use among depressed and nondepressed individuals with diabetes (U.S. 1996)*

	Depressed		Nondepressed		
Utilization category	*n*	Mean utilization	*n*	Mean utilization	*P**
Ambulatory visits	85	12	708	7	0.0001
Emergency department visits	29	1	144	1	0.1624
Hospital inpatient days	23	1	147	1	0.8983
Number of prescription medications	85	43	717	21	<0.0001

**P* value for mean log 10–transformed use adjusted for age, sex, race/ethnicity, health insurance, and comorbidity.

Table 3—*Comparison of mean health care expenditures among depressed and nondepressed individuals with diabetes (U.S. 1996)*

	Depressed		Nondepressed		
Expenditure categories	*n*	Mean expenditures ($)*	*n*	Mean expenditures ($)*	*P*†
Ambulatory expenditures	85	920	708	666	0.1235
Emergency department expenditures	26	350	130	383	0.8524
Hospital inpatient expenditures	23	10,082	147	7,648	0.1802
Prescription medication expenditures	85	1,392	717	666	<0.0001
Other medical expenditures	35	188	239	211	0.7883
Total expenditures	85	247,492,008	732	55,406,559	<0.0001

*Expenditures are adjusted for inflation with the Consumer Price Index to reflect August 2001 dollars; †*P* value for mean log 10–transformed expenditures adjusted for age, sex, race/ethnicity, health insurance, and comorbidity.

ilar to the results of that study, we found that depressed individuals with diabetes were more likely to be <65 years of age, to be women, to be unmarried, and to report poor physical and mental health.

Previous studies have reported increased health care use and expenditures in association with comorbid depression in the general population (14–21) and among individuals with diabetes (13). The major difference between this study and earlier studies is our emphasis on categories of use and expenditures. Although cost of health care typically reflects the pattern of use, this is not always the case. Exploring the effect of different types of use on total expenditures helps identify cost drivers and provides some explanation for any observed increases in total expenditures. For example, even after adjusting for potential covariates, we found that ambulatory visits and use of prescription drugs were the major areas of difference in use between depressed and nondepressed individuals with diabetes. This may be an important starting point for generating hypotheses for future studies.

In addition, the higher total health care expenditures found in this study are consistent with the results of two recent studies (13,21). The first study found that individuals with depressive symptoms, major depression, or substance abuse disorder within the previous 12 months had higher mean total health care costs than individuals without similar disorders (21). The second study, which was conducted in individuals with diabetes, found that depression increased total health care costs over a 6-month period (13).

Therefore, our findings not only support these earlier studies but also add to the body of knowledge about the relationship between diabetes and depression. Specifically, we have shown that the increase in total health care expenditures for diabetes that is associated with comorbid depression is on the order of $192,000,000 per year. In addition, this study indicates that subgroups of individuals with diabetes, such as women, unmarried persons, younger adults (<65 years), and individuals who report poor physical or mental health, seem more likely to have depression. Whether identifying and treating depression in individuals with diabetes can eliminate these added expenditures is unknown and will need to be addressed in future studies.

There are limitations to the interpretation of the results of this study. First, as in all observational studies, we cannot show causality, meaning that we cannot conclude that the increased health care use and expenditures observed in this study among depressed individuals with diabetes was due solely to depression. The increased health care use and expenditures observed in this study could potentially be due solely to diabetes, depression, or a combination of both diseases. Data on type of diabetes, complications of diabetes, duration of disease, course of clinical depression, and duration of treatment for depression are needed to prove or disprove these alternate hypotheses. In addition, prospective studies that allow for the study of the direction of the relationship between diabetes and depression will also be helpful to establish causality.

Second, because our criteria for depression did not include all possible cases, our prevalence estimates may be lower than the true estimate. However, our use and cost calculations are likely to be reliable because there are no reasons to expect that the depression criteria used in our study had a nonrandom relationship with use or cost. Third, because our study sample was weighted to reflect the noninstitutionalized civilian U.S. population, our finding cannot be generalized beyond that population. Finally, our estimates for total health care expenditures for diabetes may differ from those found in previous economic studies (2) because of differences in perspectives and assumptions behind the different calculations.

There are two major implications of our study. First, there may be benefit to screening a select population of adults with diabetes. Based on the results of this study, women, unmarried persons, persons <65 years of age, and individuals who report poor physical or mental health may benefit from screening because they seem to be at high risk for depression.

Although a recent cost-utility study of depression screening in primary care did not recommend routine screening for depression and actually found such screening cost-ineffective, the authors acknowledged that one-time screening was cost-effective (29). A limitation of this cost-benefit study was that it focused on routine screening of primary care patients for depression without examining the benefit of screening high-risk patients. Therefore, until a cost-effectiveness analysis is performed to determine the benefit of screening for depression in high-risk patients with diabetes, it will be difficult not to recommend screening for these patients. It is now clear that screening alone is not adequate (30). Instead, there is a need to emphasize depression screening in high-risk patients as part of a comprehensive plan of care that should include aggressive treatment and appropriate

follow-up. This is particularly important because of the prevalence, adverse consequences, and increased health care costs associated with depression.

Second, the implications of the increased total health care expenditures associated with comorbid depression in individuals with diabetes remain unclear. There are at least two possible explanations. The increased expenditures associated with depression may be due solely to medical care for depression, meaning that increased detection of depression in this population may actually increase health care costs for diabetes. Alternatively, the increased expenditures may be due to possible adverse effects of depression on diabetes outcomes that result in increased costs of medical care. This alternative means that early detection and treatment of depression could potentially decrease total cost of diabetes care.

Recent studies have even challenged the direction of the relationship between diabetes and depression (31,32). The questions raised by these authors are very important and should stimulate research on the true nature of the relationship between diabetes and depression. However, moving beyond our current level of understanding requires research that provides an acceptable causal explanation for the relationship between diabetes and depression. Therefore, there is need for epidemiologists, health services researchers, and basic scientists to collaborate to define the causal relationship between diabetes and depression.

In conclusion, we have used nationally representative data to show that clinical depression is prevalent in individuals with diabetes and that depression in individuals with diabetes is associated with higher health care use and expenditures.

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