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## **Final Report**

### **Medicare Research and Demonstration (MRAD) Contract**

#### **Task Order Number 1**

#### **Activity 2**

### **Monitoring Chronic Disease Care and Outcomes among Elderly Medicare Beneficiaries with Multiple Chronic Diseases**

#### **Submitted by**

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## Abstract

We report the 2-year mortality rates in 2003 and 2004, as well as the costs to Medicare in 2003, among elderly Medicare beneficiaries with one, two or three of these diseases: diabetes, diabetes + chronic obstructive pulmonary disease (COPD), diabetes + major depression, or diabetes + COPD + major depression. Elderly beneficiaries having diabetes, COPD or major depression as of 12/31/02 were identified using the CMS Chronic Condition Warehouse (CCW) files and categorized into cohorts having diabetes only (n=184,941), diabetes + COPD (n=23,793), diabetes + major depression (n=19,111) and diabetes + COPD + major depression (n=5,670). Bivariate and multivariate regression analyses were performed to compare mortality rates and costs between these groups. In addition, the mean cost per beneficiary in 2003 was tabulated for various types of Medicare reimbursed services. We found that the age-adjusted mortality rate was the lowest among persons with diabetes only (13.8 per 100). It was 1.7 times greater for those with diabetes + depression (24.0 per 100); 2.2 times greater for those with diabetes + COPD (30.3 per 100); and 3.0 times greater for those with all three diseases (40.8 per 100),  $p < 0.05$  for all comparisons. The mean per beneficiary cost to Medicare in 2003 varied almost 3-fold between the cohort with diabetes only (\$9,052) and the cohort with all three diseases (\$26,707). Intermediate in cost burden was the cohort with diabetes + depression (\$14,647) and the cohort with diabetes + COPD (\$18,756). The regression analysis using covariates that had the potential to influence the outcomes confirmed the mortality and cost findings. The most salient finding was the progressively decreasing odds of dying and of lower costs as the number of diabetes care services received increased. Those who received an HbA1c test, lipid test and eye examination had approximately one-half the odds of dying compared with those who received none of these services. Depending on the cohort, the cost to Medicare of those who received all three tests was \$3,300 to \$9,540 less than among those who received none of these services. Among Medicare elderly beneficiaries with diabetes there was a strong association of having COPD, depression, or COPD + depression with an increased probability of dying and increased cost to Medicare. The strong association we found between the use of diabetes care services and lower mortality rates and costs should be emphasized.

## Executive Summary

**Introduction:** We report the 2-year mortality rates in 2003 and 2004, as well as the costs to Medicare in 2003, among elderly Medicare beneficiaries with one, two or three of the following diseases: diabetes, depression, and chronic obstructive pulmonary disease (COPD).

**Methods:** Elderly beneficiaries having diabetes, COPD or major depression as of 12/31/02 were identified using the CMS Chronic Condition Warehouse (CCW) files and categorized into cohorts having diabetes only (n=184,941), diabetes + COPD (n=23,793), diabetes + major depression (n=19,111), diabetes + COPD + major depression (n=5,670), COPD only (n=59,158) and major depression only (n=70,031). Covariates that had the potential to influence outcomes were obtained from the CCW data and the 2000 U.S. Census SF3 file. Bivariate and multivariate regression analyses were performed to compare mortality rates and costs. In addition, the mean cost per beneficiary in 2003 was tabulated for various types of Medicare reimbursed services.

**Results:** The age-adjusted mortality rate was the lowest among persons with diabetes only (13.8 per 100). It was 1.7 times greater for those with diabetes + depression (24.0 per 100); 2.2 times greater for those with diabetes + COPD (30.3 per 100); and 3.0 times greater for those with all three diseases (40.8 per 100). All of these differences were statistically significant ( $p < 0.05$ ). Significant differences in the age-adjusted mortality rates between the cohorts were also found for almost all of the covariates. In almost all cases, the rate was lowest in those with diabetes only. Those with diabetes + depression had lower rates than those with diabetes + COPD, and the rate in those with all three diseases was the highest. In these bivariate age-adjusted analyses comparing the subgroups of the covariates, mortality rates were higher in those who were older, were in a Medicaid administered program, had higher Charlson scores, had a prior hospitalization, or had visited a psychiatrist or a pulmonologist in 2002. Mortality rates decreased as the number of physician office visits increased, except that the rate went up again for those with 15 or more visits. Mortality decreased dramatically as the number of diabetes care services received in 2002 increased. These relationships held among the four cohort groups. The results of the regression models were consistent with the findings described above. Perhaps, the most salient finding was the progressively decreasing odds of dying as the number of diabetes care services increased. Those who received an HbA1c test, lipid test and eye examination had one-half the odds of dying compared with those who received none of these services.

The mean per beneficiary cost to Medicare in 2003 varied almost 3-fold between the cohort with diabetes only (\$9,052) and the cohort with all three diseases (\$26,707). Intermediate in cost burden was the cohort with diabetes + depression (\$14,647) and the cohort with diabetes + COPD (\$18,756). For all but two of the covariates the same pattern was seen in the rank order (low to high) of the costs: beneficiaries with diabetes only cost less than beneficiaries with diabetes + depression, who cost less than beneficiaries with diabetes + COPD who cost less than beneficiaries with all three diseases. The variations in mean cost per beneficiary by subgroup of the covariates showed an increasing cost with age (although not for those with all three diseases). Those with higher Charlson scores, those who had a history of hospitalization in 2002 and those who visited endocrinologists, psychiatrists or pulmonologists had the highest costs. For each of the four disease cohorts, mean cost per beneficiary decreased as the number of diabetes care services increased from 0 to 3. The multivariate regression run on each of the four cohorts with

diabetes confirmed all of the above findings. Similar to the mortality findings, the receipt of diabetes care services in 2003 was strongly and linearly related to a lower cost to Medicare for all four cohorts of beneficiaries. After adjusting for other covariates, differences in the annual cost of care between those who received no diabetes care services and those who received all three ranged from \$3,300 for those with diabetes only to \$9,540 for those with all three diseases. Payments to hospitals for inpatient care accounted for up to half of the expenditures (45% to 50%). Carrier file expenditures were the second largest contributors to cost, 18% to 27%.

**Discussion:** The mortality results for the total elderly population with diabetes are consistent with the most recently reported mortality among Medicare beneficiaries with diabetes in 2001, 8.8/100 per year (McBean, et al., 2004). Finding that mortality rates increased among beneficiaries with diabetes who also had either depression or COPD, or both, is not surprising. The 2-year age-adjusted mortality rates for persons with these other two diseases are higher than for diabetes: diabetes only = 13.8%; COPD only = 23.8%; and depression only = 16.6% (Table A.M1). Similarly, the greater impact of COPD than depression among those with diabetes is not surprising because the mortality rate among those with COPD only was almost 50% greater than among those with depression only.

The strength of the health status measures in predicting death is expected, and increasing Charlson score was second only to age in predicting mortality. While initially counterintuitive, we found that visiting any of the three type of specialists, endocrinologist, psychiatrist or pulmonologist was associated with an increased probability of death. Thus, it is likely that these visits are reflective of more severe diabetes, depression or pulmonary disease in these patients. On the positive side, the receipt of diabetes care services in 2002 was strongly and linearly related to a lower relative odds of dying. This strong relationship was found for all of the individual disease cohorts.

The findings reported here confirm the increasing cost burden of additional specific chronic diseases, and show that the additional burden of COPD is greater than that of depression. The mean cost to Medicare of the beneficiaries with diabetes in 2003 that we found, \$10,817, was similar to that recently reported for 2007 by the American Diabetes Association for the care of diabetics 65+ years of age, \$9,713 using a very different methodology (ADA, 2008). Similar to the mortality findings, the receipt of diabetes care services in 2003 was strongly and linearly related to a lower cost to Medicare for all four cohorts of beneficiaries. After adjusting for other covariates, differences in the annual cost of care between those who received no diabetes care services and those who received all three ranged from \$3,300 for those with diabetes only to \$9,540 for those with all three diseases. Finding this strong relationship of the reduced odds of dying for all of the individual disease cohorts, as well as the four cohorts combined, reinforces the importance of providing these services to all persons with diabetes regardless of comorbidity.

**Summary:** Among Medicare elderly beneficiaries with diabetes there was a strong association of having COPD, depression, or COPD + depression with an increased probability of dying and increased cost to Medicare. The strong association we found between the use of diabetes care services and lower mortality rates and reduced costs should be emphasized.

## Introduction

### Background

Wolff, et al. have pointed out that in 1999, 82% of elderly Americans had at least one chronic disease, 65% had 2 or more, 43% had 3 or more, and 24% had 4 or more. However, only a few researchers such as Bertoni, et al. (2004) and Foley, et al. (2005) have examined the impact of having specific chronic diseases, such as diabetes and incident congestive heart failure (Bertoni) or diabetes and chronic kidney disease (Foley), on subsequent mortality, and none has looked at the costs to Medicare. This study complements the work already reported in the Activity 1 Report of MRAD Task Order #1 “Monitoring Chronic Disease Care and Outcomes among Elderly Medicare Beneficiaries with Multiple Chronic Diseases”. In that report, we documented the negative impact of having COPD, depression or both diseases among people with diabetes on the receipt of three diabetes care services (serum hemoglobin A1c determination, serum lipid determination and eye examination), as well as three preventive services (influenza immunization, screening mammography, and prostate specific antigen testing). The most consistent result was the association of lower age-adjusted rates of health service use in those with all three diseases compared with the rates among those with diabetes only. For the most important indicator of good diabetes care, annual HbA1c testing, there was an important difference between those with diabetes only and those with all three diseases. For example, in 2003, the rate of HbA1c testing for the cohort with all 3 diseases was 17.7% lower than for the cohort with diabetes only.

The second most consistent finding of the Activity 1 Report was that for the three diabetes care measures, the age-adjusted rates of HbA1c and lipid testing and eye examination were highest for those with diabetes only, intermediate for those with two diseases, and lowest for those with all three diseases. In the age-adjusted rates for the diabetes services, there was also a consistent pattern of a greater negative association with COPD compared with depression. The fully adjusted regression analysis confirmed that those with diabetes + COPD had lower rates for all three services. The full model also showed that those with diabetes + depression had a lower rate of lipid testing than those with diabetes alone. However, those with diabetes + depression had higher rates of HbA1c testing and similar rates of eye examination compared with those with diabetes only.

Diabetes is the primary chronic disease on which we focused in this Task Order. We recently have reported that diabetes affected 20% of the elderly (those 65+ years of age) Medicare population in 2001, an increase of 40% over 1994 (McBean, et al., 2004). Boyle, et al. (2001) estimate that the greatest increase in diabetes between 2000 and 2050 will be among the elderly; increasing from 252% to 537% depending on the age-sex stratum. In addition, the annual mortality rate among elderly persons with diabetes was 8.7/100, slightly over 60% higher than among the elderly without diabetes (McBean, et al.). Finally, although precise numbers are lacking in the literature, it has been estimated that persons with diabetes account for approximately one-third of Medicare expenditures among the elderly. Thus, diabetes is an important disease of elderly Medicare beneficiaries, and the impact other diseases may have in its presence is worth studying.

In addition to the obvious burden caused by diabetes, there were other reasons for including diabetes in the Task Order: (1) the algorithm used to identify persons with diabetes using administrative data has been validated (Hebert, et al., 1999; Wang, et al., 2005), and it is widely accepted; and (2) there are well established national guidelines for the treatment of diabetes, and several of these can be monitored using CCW data. Depression and COPD were selected as the other two chronic conditions to study because of their high prevalence in the elderly population, the presumed accuracy of claims data in identifying persons with these diseases and because they are not pathophysiologically related to diabetes. The latter reason means that there is no *a priori* reason for either more or less care to be provided to beneficiaries with these additional chronic diseases.

## **Purpose**

The purpose of Activity 2 is to analyze and report the mortality rates and costs to Medicare (hereafter called “costs”) among elderly Medicare beneficiaries with one, two or three specific chronic diseases: diabetes, diabetes + depression, diabetes + chronic obstructive pulmonary disease (COPD), or diabetes + depression + COPD. The mortality rates are for 2003-2004 and the costs are for 2003.

## Methods

### Data Sources

The primary data sources for this study were Medicare claims and enrollment data obtained from the CMS Chronic Condition Warehouse at the Iowa Foundation for Medical Care (IFMC). Specifically, we used the enhanced 5% Inpatient, Outpatient, Carrier, Home Health Agency (HHA), Skilled Nursing Facility (SNF), Durable Medical Equipment, Hospice, Beneficiary Eligibility Summary (BES), and Chronic Condition Summary files for years 2001 to 2004.

The CCW database was developed out of requirements of Section 723 of the Medicare Prescription Drug, Improvement, and Modernization Act of 2003. This specified that CMS make Medicare data available to researchers who are studying chronic diseases in the Medicare population. Algorithms for 21 chronic conditions were developed and cohorts of beneficiaries with these diseases were identified. The chronic diseases include acute myocardial infarction, Alzheimer's disease, chronic obstructive pulmonary disease (COPD), diabetes, hip fracture, stroke, breast, colorectal, lung, endometrial and prostate cancer, and major depression, among others. For 1999 to 2004, the CCW database population is based on the 5% national Medicare sample. The sample is "enhanced" because, unlike the CMS 5% national sample, any beneficiary who becomes part of the 5% sample because of the digits in their Medicare identification number (HIC), remains in the sample from that point forward regardless of subsequent HIC changes, if any. This is beneficial in following patients over time in this longitudinal study. More information about the CCW database can be found by following the link on the Research Data Assistance Center (ResDAC) website, [http://www.resdac.umn.edu/CCW/data\\_available.asp](http://www.resdac.umn.edu/CCW/data_available.asp).

### Definition of Study Cohort

Cohorts of beneficiaries having diabetes, chronic obstructive pulmonary disease (COPD) and major depression were requested from the CCW database. The algorithms to identify diabetes, COPD and major depression are described below. They are also listed in the CCW Manual at <http://www.ccwdata.org/downloads/CCW%20User%20Manual.pdf> (link active as of 4/13/09).

#### *Diabetes*

A diagnosis of diabetes (any diagnosis on the claim) on at least one inpatient, SNF or HHA claim, or two Outpatient or Carrier<sup>1</sup> claims during a 2-year "look-back" period is required. The diagnoses on Outpatient or Carrier claims must be at least one day apart. The ICD-9 diagnoses used for diabetes are 250.00 to 250.93, 357.2, 362.01, 362.02, and 366.41. This algorithm has been validated to have a sensitivity of 90%, a specificity of 95% and a positive

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<sup>1</sup> Carrier claims are claims for Medicare Part B services that are primarily submitted by physicians, but include other Medicare Part B providers. The intent of the CCW algorithms is to exclude claims where the services do not require a licensed health care professional. Thus, for all three algorithms used to select beneficiaries for this study, claims for which a line item Berenson-Eggers Type of Service variable equaled D1A, D1B, D1C, D1D, D1E, D1F, D1G, or O1A were excluded. The categories with D1 in the first two positions are Durable Medical Equipment categories. The O1A category includes ambulance services.



predictive value of 82% for identifying elderly Medicare beneficiaries with diabetes (Wang, et al., 2005).

### *COPD*

A diagnosis of COPD (any diagnosis on the claim) on at least one inpatient, SNF, HHA, or two Outpatient or Carrier claims during a 1-year “look-back” period is required. The diagnoses on Outpatient or Carrier claims must be at least one day apart. The ICD-9 diagnoses used for COPD are 491.0 to 491.9, 492.0, 492.8, 494.0, 494.1, and 496.

### *Major Depression*

A diagnosis of major depression (any diagnosis on the claim) on at least one inpatient, SNF, HHA, Outpatient, or Carrier claim during a 1-year “look-back” period is required. The ICD-9 diagnoses used for major depression are 296.20 to 296.36, 298.0, 300.4, 309.1, and 311.

For this study, we requested that years 2001 and 2002 be used as the “look-back” period for diabetes, and 2002 be used as the look-back period for COPD and depression.

In addition, the CCW chronic condition algorithms exclude beneficiaries (and their associated claims) who were in managed care or who did not have continuous Part A and Part B coverage during the look-back period because of the possibility of the beneficiary receiving services used in the algorithms during a period when there was no Medicare coverage. We also requested that beneficiaries with ESRD, who were less than 67 years of age (diabetes) or less than 66 years of age (COPD and depression), or who were not alive as of 12/31/2002 be eliminated from the study cohort. This was done because those with ESRD are often high and atypical users of care, those less than 67 years of age would not have 2 years of Medicare coverage for use in the diabetes algorithm, those less than 66 years of age would not have 1 full year of coverage for use in the COPD and depression algorithm, and those who were not alive would have no outcomes to contribute.

After receiving the data from IFMC, we excluded beneficiaries (n=7,863) who were not residents of the 50 United States or the District of Columbia in 2002, as well as beneficiaries in the COPD and depression cohorts who were < 67 years of age to make that cohort consistent with the diabetes cohort. We also excluded beneficiaries who were in managed care or who did not have continuous Part A and Part B coverage during 2003 and 2004, the study outcome period in order to make sure that all outcomes were captured. This resulted in 233,515, 112,452 and 96,897 eligible persons with diabetes, COPD and major depression, respectively, who were alive as of 12/31/02.

We categorized beneficiaries into study cohorts defined as persons having

- diabetes only (n=184,941),
- diabetes plus COPD (n=23,793),
- diabetes plus major depression (n=19,111), and
- diabetes plus COPD plus major depression (n=5,670).

In addition, there were 59,158 beneficiaries with COPD only and 70,031 beneficiaries with major depression only.

## Definitions of Covariates

Socio-demographic, health status, and health services information obtainable directly in the Medicare data or that can be derived from the Medicare data that had the potential to influence outcomes were used to help understand mortality and cost. Thus, to describe and compare the study cohorts and to adjust for differences between cohorts in the regression analyses, we used the following covariates.

### *Age*

Age was calculated as of 1/1/03.

### *Gender*

The gender recorded in the 2002 BES file was used.

### *Race/ethnicity*

The CMS categories recorded in the 2002 BES file were used: 1 = White, 2 = Black, 4 = Asian, 5 = Hispanic. "Other" combines categories: 0 = Unknown, 3 = Other, 6 = North American Native.

### *In Medicaid administered program (yes or no)*

The value of this variable was defined as "yes" if any of the 12 monthly state buy-in indicators in the 2002 BES file are "A", "B", or "C". Buy-in values of "A", "B", or "C" indicate that the state paid the premiums for a beneficiary's Part B coverage.

### *Median household income of zip code*

The beneficiary's zip code in the 2002 BES was matched against the 2000 U.S. Census Bureau's SF3 file. The SF3 file contains the median household income for each zip code. When zip code level income was not available, the aggregated income at the county level was used.

Income was divided into three roughly equal categories, in terms of number of beneficiaries, of "<\$34,000", "\$34,000-\$45,000" and ">\$45,000".

### *Charlson score*

To identify coexisting disease burden in addition to the three diseases being studied, we calculated the Charlson score (Deyo, et al., 1992) for each beneficiary using the diagnoses found in the 2001 and 2002 Inpatient, Outpatient and Carrier files. The Charlson score includes certain comorbidities that have been shown to have an effect in predicting mortality in hospitalized patients. Different diseases are given different weights depending on their predictive power. Deyo (1992) adopted this for use with ICD-9 codes for the diseases originally identified by Charlson as having predictive value. Because all persons with diabetes or COPD would have a Charlson score  $\geq 1$ , and because the effect of these diseases was already included as the disease cohort variable, diabetes and COPD were excluded when calculating the Charlson scores. There is no contribution to the Charlson score for depression. Charlson scores were categorized as "0", "1-2", and "3+".

### *Hospitalization history in 2001 or 2002 (yes or no)*

Hospitalization history equals “yes” if the beneficiary had a claim record in the 2001 or 2002 Inpatient file.

### *Months alive in 2003*

The death dates in the 2003 BES files were used to determine the months alive for each beneficiary in 2003. This covariate was included in the analysis of cost to adjust for the differential mortality among the cohorts.

### *U.S. region of residence*

The beneficiary’s state in the 2002 BES file was used to determine the U.S. region of residence as defined by the U.S. Census Bureau. The regions are:

- Northeast – CT, ME, MA, NH, RI, VT, NJ, NY, PA
- Midwest – IN, IL, MI, OH, WI, IA, KS, MN, MO, NE, ND, SD
- South - DE, DC, FL, GA, MD, NC, SC, VA, WV, AL, KY, MS, TN, AR, LA, OK, TX
- West – AZ, CO, ID, NM, MT, UT, NV, WY, AK, CA, HI, OR, WA

### *Rural/urban residence*

To determine whether the beneficiary resided in a rural or an urban area, we matched the beneficiary’s zip code found in the 2002 Beneficiary Summary file with the “rural – urban commuting area” (RUCA) codes developed by the WWAMI Rural Health Research Center at the University of Washington in collaboration with Health Resources and Service Administration's (HRSA) Office of Rural Health Policy (ORHP) and the Department of Agriculture's Economic Research Service (ERS). The RUCA codes are described at <http://www.depts.washington.edu/uwruca/index.html> (active as of 5/27/08). Of the many definitions of “rural” (Hart, et al., 2005), we chose Categorization D described at [http://depts.washington.edu/uwruca/ruca1/use\\_healthcare.html](http://depts.washington.edu/uwruca/ruca1/use_healthcare.html) in which urban is defined as “all places that have 30% or more of their workers going to a Census Bureau defined Urbanized area”. For the relatively few cases where the RUCA zip code and the beneficiary zip code did not match, we matched the RUCA zip code with a numerically adjacent zip code.

119 out of approximately 376,000 beneficiaries could not be matched for income and/or rural/urban residence and were not included in the regression analyses.

### *Number of physician office visits*

This count includes office visits to all physicians including visits to psychiatrists and ophthalmologists in 2002 (used in the analysis of mortality) and 2003 (used in the analysis of cost). To count visits, we checked the Carrier line item file for line item services with BETOS codes of M1A (office visits – new) and M1B (office visits – established), and HCPCS of 90801 to 90815 for psychiatrists, and 92002 to 92004 and 92012 to 92014 for ophthalmologists.

The number of visits were categorized as “<5”, “5-9”, “10-14” and “15+”.

### *Visited a specialist*

To determine whether or not a beneficiary visited one of the specialists below, the Carrier line item file for the year of the outcome measure was searched for BETOS codes equal to M1A,

M1B, M2A, M2B, M2C, M3, M4A, M4B, M5A, M5B, M5C, M5D, or M6. These BETOS codes are for office, hospital, emergency room, home, nursing home, specialist and consultation visits. Specialist visits in 2002 were used in the mortality analysis; specialist visits in 2003 were used in the cost analysis.

*Visited an Endocrinologist (yes or no)*

The beneficiary was counted as having visited at least one endocrinologist if there was a line item service in the list of BETOS codes above and the HCFA specialty equaled “46”.

*Visited an OB/GYN visits (yes or no)*

The beneficiary was counted as having visited at least one OB/GYN if there was a line item service in the list of BETOS codes above and the HCFA specialty equaled “16”. Only visits by women were counted.

*Visited a psychiatrist (yes or no)*

The beneficiary was counted as having visited at least one psychiatrist if there was a line item service in the list of BETOS codes above and the HCFA specialty equaled “26”.

*Visited a pulmonologist (yes or no)*

The beneficiary was counted as having visited at least one endocrinologist if there was a line item service in the list of BETOS codes above and the HCFA specialty equaled “29”.

*Number of diabetes care services received in 2002 or 2003*

HbA1c tests, lipid tests and eye examination were the diabetes care services included in this covariate. Thus, the total score ranged from “0” to “3” with “0” meaning that the beneficiary received none of the three services during the year; “1” meaning that they received 1 of the services; “2” meaning that they received 2 of the services, and “3” meaning that they received all 3 of the services. The mean number of services was calculated for each person in 2002 (used in the analysis of mortality) and 2003 (used in the analysis of cost).

## **Definition of Outcome Measures**

*Mortality rates*

Mortality was measured over two years, 2003 and 2004, as the number of beneficiaries who died in either 2003 or 2004 divided by the number of beneficiaries alive as of the start of the 2 year period, 12/31/02.

Both crude and age-adjusted mortality rates were calculated. Rates were age-adjusted using the cohort of beneficiaries with only diabetes in 2002 as the standard population. This population is described in Tables 1.1 and 1.2.

Mortality rates for each level of each covariate were calculated for each of the study cohorts.

*Cost*

For this study, cost is defined as the cost to Medicare. This is the “claim payment amount” for Carrier, DME, Outpatient, HHA, Hospice, and SNF claims and the “claim payment amount” plus

the “per-diem” times the “utilization days” for Inpatient claims. Allowed 2003 Medicare claims of all service types were included in the cost calculations.

Both total and mean costs were derived for each level of each covariate for all study cohorts. Total cost is the sum of the costs over all beneficiaries for all types of service. Mean cost is calculated by dividing total cost by total person-years. In addition, total cost for each individual beneficiary was calculated for use in the regression analysis. Also, the 2003 mean cost per beneficiary for the following types of service was tabulated for each of the disease cohorts: hospital inpatient, hospital outpatient, carrier (mostly physician claims), skilled nursing facility care, home health agency care, hospice care, and durable medical equipment.

Payment outliers were checked using SAS Proc Univariate. 2003 Outpatient claims with payment amounts over \$100,000 were excluded. Negative claim payment amounts were not excluded.

### **Statistical Methods**

To compare the baseline composition of the study cohorts, we used chi square tests for the categorical variables and t-tests for the continuous variables. We tested each covariate for distributional differences among the four study cohorts.

To compare mortality and cost, both bivariate and multivariate regression analyses were performed. Chi square tests were used to compare mortality and cost between cohorts at every level for each covariate.

For the analysis of mortality, multivariate logistic regressions were run for each of the study cohorts individually. A multivariate logistic regression was also run with all study cohorts combined with the disease cohort as the independent variable of primary interest.

For the analysis of cost, generalized linear models were fit using SAS Proc Genmod. Similarly to the analysis of mortality, the analysis was run for each of the study cohorts separately and with the cohorts combined.

Thus, we could examine the effect of adding additional disease burden on mortality and cost. The multivariate regression also allowed us to examine the impact of the covariates on mortality and cost while simultaneously adjusting for the others.

Differences between groups were judged statistically significant if the 95% confidence interval (CI) did not include 1.00. All statistical analyses were performed using SAS 9.1 for Windows, SAS Institute Inc., Cary, NC, 2006.

## Results

The results for the mortality and cost to Medicare analyses for the 4 study cohorts are presented immediately below. The Appendix contains tables showing the information for the cohorts of beneficiaries with COPD only and with depression only.

### Distribution of covariates

Table 1.1 contains the distributions of the baseline socio-demographic and health status characteristics as of 12/31/2002 for the four study cohorts: beneficiaries with diabetes only, diabetes + COPD, diabetes + depression, and all three diseases. Tables 1.2 and 1.3 contain the distributions of the health services used by the study cohorts in 2002 and 2003, respectively. Significant differences existed in the distribution of the baseline characteristics between the cohort with diabetes only and those with diabetes + COPD, diabetes + depression, or all three diseases for almost all of the patient characteristics and health service use measurements we studied. Those with additional diseases were older, were more likely to be white, be in a state Medicaid administered program, have a higher Charlson co-morbidity score, have more physician office visits and have been previously hospitalized. Persons with all three diseases were more likely to visit a psychiatrist in 2002 than those with diabetes + depression (35% versus 30%), and slightly more persons with all three diseases visited a pulmonologist in 2002 compared with those with diabetes + COPD (36% versus 34%). The mean number of diabetes care services received in 2002 was greatest among those with diabetes only, and least among those with all three diseases. All of the above differences were statistically significant,  $p < 0.05$ ; See Table footnotes.

The distributions of the covariates for cohorts with COPD only and depression only are also presented in the Appendix (Tables A.1.1 and A.1.2).

### Mortality

#### *Crude, age-specific and age-adjusted mortality rates*

The crude, age-specific and age-adjusted mortality rates for the two years 2003-2004 for the four cohort groups are presented in Table M1. The age-adjusted mortality rate was the lowest among persons with diabetes only (13.8 per 100). It was 1.7 times greater for those with diabetes + depression (24.0 per 100); 2.2 times greater for those with diabetes + COPD (30.3 per 100); and 3.0 times greater for those with all three diseases (40.8 per 100).

As indicated above, people with diabetes + depression had a 70% higher mortality than those with diabetes only. However, the impact of having COPD was even greater. Those with diabetes + COPD had a 120% higher mortality than those with diabetes only.

All of the differences in the age-adjusted rates between the total populations of each cohort were statistically significant ( $p < 0.05$ ). Significant differences between the

cohorts were also found for almost all of the subgroups of the patient characteristics, health status and health service use. In almost all instances, the rate was lowest among those with diabetes only. Those with diabetes + depression had lower rates than those with diabetes + COPD, and the rate in those with all three diseases was the highest. Of the 234 possible pair-wise comparisons between the sub-groups of the four cohorts in Table M1, only eight were found not to be significantly different and six of these were comparisons between race/ethnicity subgroups with small numbers of persons in the cohorts of persons with diabetes + COPD, diabetes + depression, and all three diseases.

Examining differences within disease cohorts, mortality rates were higher in those who were older, were in a Medicaid administered program, had higher Charlson scores, a prior hospitalization, or visited a psychiatrist or a pulmonologist in 2002. Mortality rates decreased as the number of physician office visits increased, except that the rate went up again for those with 15+ visits. They decreased dramatically as the number of diabetes care services received in 2002 increased.

#### *Regression results using individual covariates*

Multivariate logistic regressions were conducted on each of the four cohorts (Table M2) as well as on the entire study population with diabetes (Table M3). This allowed us to analyze the impact of each of the covariates on mortality while controlling for all other covariates (Table M2), as well as the impact of the additional diseases (Table M3).

In general, the results of the regression models were consistent with the findings of the bivariate analysis described above. As seen in Table M3, compared with people with diabetes only, the relative odds of dying within two years among those with diabetes + COPD was 1.75 (95% C.I. = 1.68-1.81). For those with diabetes + depression it was 1.30 (95% C.I. = 1.25-1.35), and for those with all three diseases it was 2.06 (95% C.I. = 1.93-2.19). The model that included all people with diabetes confirmed the association of the increase in mortality with increasing age, being in a Medicaid administered program, increasing Charlson score, prior hospitalization, and a visit to either a psychiatrist or a pulmonologist. Members of all minority race/ethnicity groups had lower relative odds of dying compared with whites. Visiting an endocrinologist was associated with a slight increase in mortality (odds ratio = 1.06 (95%CI = 1.01-1.11). However, visiting an obstetrician-gynecologist was associated with a markedly lower relative odds of dying, odd ratio of 0.66 (95% C.I. = 0.62-0.70). Perhaps, the most salient finding was the progressively decreasing odds of dying as the number of diabetes care services increased. Those who received an HbA1c test, lipid test and eye examination had one-half the odds of dying compared with those who received none of these services. These relationships held among the four cohort groups.

The multivariate analyses of each of the cohorts (Table M2) generally showed the same associations of the covariates with mortality as the analyses for all persons with diabetes.

## Costs

The mean per beneficiary cost to Medicare in 2003 varied almost 3-fold between the cohort with diabetes only (\$9,052) and the cohort with all three diseases (\$26,707) (Table C1). Intermediate in the total cost burden was the cohort with diabetes + depression (\$14,647) and the cohort with diabetes + COPD (\$18,756). For all but two of the covariates the same pattern was seen in the rank order (low to high) of the costs: beneficiaries with diabetes only cost less than beneficiaries with diabetes + depression, who cost less than beneficiaries with diabetes + COPD who cost less than beneficiaries with all three diseases. The only two exceptions were found in the diabetes + COPD cohort and the diabetes + depression cohort. In the former group, those who saw a psychiatrist had the highest cost among the four cohorts, and for the latter, those who visited a pulmonologist had higher costs than those with diabetes + COPD. These two exceptions may have been caused by misidentification/misclassification of a small number of beneficiaries by the COPD and depression algorithms. Those with diabetes + COPD who saw a psychiatrist may have had depression and would thus be more correctly coded as having all three diseases. The same may have been true for those with diabetes + depression who saw a pulmonologist. They may have had COPD.

The variations in mean cost per beneficiary by subgroup of the covariates showed an increasing cost with age (although not for those with all three diseases). Those with higher Charlson scores, those who had a history of hospitalization in 2002 and those who visited endocrinologists, psychiatrists or pulmonologists had the highest costs. For each of the four disease cohorts, mean cost per beneficiary decreased as the number of diabetes care services increased from 0 to 3.

The multivariate regression run on each of the four cohorts with diabetes confirmed all of the above findings (Table C2). In addition, the cost of treating blacks was consistently greater than that of treating whites. Increasing income was associated with decreasing costs. Also, among those with all three diseases, the costs decreased with age, a marked distinction from those with diabetes only.

The initial model that we ran that included all four cohort groups also included all available covariates (See Table C3, Part A. All covariates). In this model, those with diabetes + depression had lower costs than those with diabetes only (-\$607), and the mean cost among those with diabetes + COPD was only \$274 greater than the cost among those with diabetes only. We re-ran the model excluding the two variables “Visited a psychiatrist in 2003” and “Visited a pulmonologist in 2003”. We did this because of possible colinearity between having depression and visiting a psychiatrist, and of having COPD and visiting a pulmonologist. Thus, we felt that the models that used all available covariates were overadjusting and masking the effect of having depression or of having COPD. The results of this new model (See Table C3, Part B) were more consistent with the bivariate results (Table C1).

The mean cost per beneficiary by different type or location of service indicates that payments to hospitals for inpatient care accounted for almost half of the expenditures (45% to 49%) (Table C4 and Figures CF1 and CF2). The associated physician charges for these hospital stays would likely take this amount to over 50% for all four cohorts. Carrier file expenditures were the second largest contributors to cost: 18% for those with all three diseases to 27% for those with



diabetes only. The payment types with the biggest relative variations between cohorts were skilled nursing facility (SNF) care and durable medical equipment (DME). For those with diabetes + depression, 12% of expenditures were for SNF care compared with 8% for those with diabetes only or diabetes + COPD. For those with diabetes only or with diabetes + depression, 4% of expenditures were for DME compared with 7% for those with diabetes + COPD. Whether depression is causing persons with diabetes to be placed in SNF care, or it is only an association cannot be determined. The reader is reminded that SNF care is skilled care with a 100 day limit per episode of disease, not extended custodial care.

## Discussion

The purpose of Activity 2 was to compare the mortality rates and costs to Medicare between elderly fee-for-service Medicare beneficiaries with diabetes only, and those with diabetes plus one or both of two other chronic diseases: COPD and major depression. Not surprisingly, death rates and costs increased as the number of diseases increased. Of particular interest, as the number of diabetes care services increased, both the likelihood of death and the cost to Medicare decreased.

### Mortality

The mortality results are consistent with the most recently reported mortality among Medicare beneficiaries with diabetes (McBean, et al., 2004). In the most recent year they reported, 2001, the annual mortality rates of all beneficiaries 67+ years of age was 8.7/100. The 2-year mortality experience in 2003-2004 for the total cohort with diabetes in this report was 17.6%, roughly 8.8/100 per year. This earlier publication only adjusted the rates for gender by age and race/ethnicity, and the rates for race/ethnicity by age and gender. In the current study, we included other demographic characteristics, as well as health status and health service utilization information. As a result, we found in the regression model results that mortality was not different between men and women (adjusted odds ratio = 1.01 (95%CI = 0.98-1.04)). Also, we found that the mortality rate was significantly higher among whites than among any of the other race/ethnicity groups: range of odds ratios from 0.54 compared with Asians to 0.87 compared with blacks or race group other.

Finding that mortality rates increased among beneficiaries with diabetes who also had either depression or COPD, or both, is not surprising. The 2-year age-adjusted mortality rates for persons with these other two diseases are higher than for diabetes: diabetes only = 13.8%; COPD only = 23.8%; and depression only = 16.6% (Table A.M1). Similarly, the greater impact of COPD than depression is not surprising because the mortality rate among those with COPD only was almost 50% greater than among those with depression only.

The strength of the health status measures in predicting death is expected, and increasing Charlson score was second only to age in predicting mortality.

While initially counterintuitive, we found that visiting each of the three type of specialists, endocrinologist, psychiatrist or pulmonologist was associated with an increased probability of death. Thus, it is likely that these visits are reflective of more severe diabetes, depression or pulmonary disease in these patients.

On the positive side, the receipt of diabetes care services in 2002 was strongly and linearly related to a lower relative odds of dying. The relative odds of dying if a person received one diabetes service was 0.84 (95%CI = 0.81-0.88) compared with a person who received no such service, and it decreased to 0.50 (95%CI = 0.48-0.52) if the person received three services. This strong relationship was found for all of the individual disease cohorts indicating the importance of providing these services to all persons with diabetes. Seeing this relationship in the

multivariate analyses in which we controlled for patient characteristics, health status and other health service use strengthens the conclusion that the benefits of diabetes care services are real.

The association of visiting an obstetrician-gynecologist with a significantly lower odds of dying likely reflects women in good health who may engage in other healthy behaviors that we could not measure, rather than care provided by that type of physician.

## **Cost**

The mean cost to Medicare of the beneficiaries with diabetes in 2003 that we found, \$10,817 (Table C4) was similar to that recently reported for 2007 by the American Diabetes Association for the care of diabetics 65+ years of age, \$9,713, using a very different methodology (ADA, 2008). They reported inpatient hospitalizations, including physician and other related costs, comprised 54% of the estimated costs, similar to our findings.

We know of no information in the literature comparing the cost to Medicare or the total cost of care among people with diabetes with or without COPD and/or depression. The findings reported here confirm the additional cost burden of additional specific chronic diseases, and show that the burden of COPD is greater than that of depression.

Similar to the mortality findings, the receipt of diabetes care services in 2003 was strongly and linearly related to a lower cost to Medicare for all four cohorts of beneficiaries. After adjusting for other covariates, differences in the annual cost of care between those who received no diabetes care services and those who received all three ranged from \$3,300 for those with diabetes only to \$9,540 for those with all three diseases. Finding this strong relationship for all of the individual disease cohorts, as well as the four cohorts combined, reinforces the importance of providing these services to all persons with diabetes. As we stated in the discussion of mortality, seeing this relationship in the multivariate analyses in which we controlled for patient characteristics, health status and other health service use strengthens the conclusion that the benefits of the diabetes care services are real.

## **Summary**

We found that among Medicare elderly beneficiaries with diabetes there was a strong association of having COPD, depression, or COPD + depression with an increased probability of dying and an increased cost to Medicare. The strong association we found between the use of diabetes care services with lower mortality rates and lower costs to the Medicare program should be emphasized.

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## MRAD Activity 2 Tables and Figures

I. Tables and figures to accompany text: four study cohorts (diabetes only, diabetes + COPD, diabetes + depression, and diabetes + COPD + depression)

Baseline characteristics - personal characteristics, health status and health service use

Table 1.1	Baseline characteristics
Table 1.2	Baseline characteristics of health service use in 2002
Table 1.3	Baseline characteristics of health service use in 2003

Mortality: Crude and age-adjusted mortality rates in 2003 and 2004

Table M1	Mortality rates by cohort
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Mortality: Full model logistic regression results presenting covariates

Table M2	For each cohort
Table M3	For all cohorts

Cost: Total and mean cost in 2003

Table C1	Total and mean cost by cohort
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Cost: Full model logistic regression results presenting covariates

Table C2	For each cohort
Table C3	For all cohorts

Cost: By cohort and service type

Table C4	Mean cost by service type and cohort
Figure CF1	Histograms
Figure CF2	Pie charts

II. Appendix: Diabetes only, COPD only, and depression only

Table A.1.1	Baseline characteristics
Table A.1.2	Baseline characteristics of health service use in 2002
Table A.1.3	Baseline characteristics of health service use in 2003
Table A.M1	Mortality rates by cohort
Table A.C1	Total and mean cost by cohort

**Table 1.1. Patient baseline characteristics as of 01/01/03 among cohorts with diabetes only (DM), diabetes+chronic obstructive pulmonary disease (DM+COPD), diabetes+depression (DM+D), and all three diseases (DM+COPD+D)**

	DM		DM+COPD		DM+D		DM+COPD+D	
	Number	%	Number	%	Number	%	Number	%
All	184,941		23,793		19,111		5,670	
<b>Age-group (years)</b>								
67-69	29,025	15.7	3,117	13.1	2,476	13.0	716	12.6
70-74	51,276	27.7	5,970	25.1	4,315	22.6	1,332	23.5
75-79	47,374	25.6	6,473	27.2	4,639	24.3	1,474	26.0
80-84	33,017	17.9	4,732	19.9	3,967	20.8	1,193	21.0
85+	24,249	13.1	3,501	14.7	3,714	19.4	955	16.8
<b>Age (mean)</b>		<b>76.5</b>		<b>77.2</b>		<b>78.0</b>		<b>77.7</b>
<b>Gender</b>								
Male	78,141	42.3	11,624	48.9	5,107	26.7	1,900	33.5
Female	106,800	57.8	12,169	51.2	14,004	73.3	3,770	66.5
<b>Race/ethnicity</b>								
White	153,236	82.9	20,629	86.7	16,513	86.4	4,990	88.0
Black	21,732	11.8	2,120	8.9	1,666	8.7	394	7.0
Hispanic	4,110	2.2	488	2.1	549	2.9	169	3.0
Asian	2,815	1.5	284	1.2	157	0.8	51	0.9
Others	3,048	1.7	272	1.1	226	1.2	66	1.2
<b>In Medicaid-administered program</b>								
Yes	31,473	17.0	5,870	24.7	5,615	29.4	2,151	37.9
No	153,468	83.0	17,923	75.3	13,496	70.6	3,519	62.1
<b>Median household income of zip code<sup>b,c</sup></b>								
< \$34,000	63,024	34.1	8,867	37.3	6,429	33.7	2,059	36.3
\$34,000-\$45,000	61,966	33.5	8,041	33.8	6,401	33.5	1,926	34.0
> \$45,000	59,925	32.4	6,878	28.9	6,278	32.9	1,685	29.7
<b>Income (mean)</b>		<b>\$41,936</b>		<b>\$40,657</b>		<b>\$42,008</b>		<b>\$40,793</b>
<b>Charlson score</b>								
0	59,665	32.3	2,545	10.7	2,883	15.1	278	4.9
1-2	72,112	39.0	8,309	34.9	6,635	34.7	1,417	25.0
3+	53,164	28.8	12,939	54.4	9,593	50.2	3,975	70.1
<b>Charlson score (mean)</b>		<b>1.9</b>		<b>3.2</b>		<b>3.0</b>		<b>4.1</b>
<b>History of hospitalization in 2001 or 2002</b>								
Yes	69,279	37.5	17,678	74.3	12,179	63.7	4,969	87.6
No	115,662	62.5	6,115	25.7	6,932	36.3	701	12.4
<b>U.S. region of residence<sup>c</sup></b>								
Midwest	48,646	26.3	6,033	25.4	5,462	28.6	1,441	25.4
Northeast	38,379	20.8	5,098	21.4	4,097	21.4	1,258	22.2
South	73,861	39.9	9,813	41.2	7,226	37.8	2,312	40.8
West	24,045	13.0	2,849	12.0	2,325	12.2	659	11.6
<b>Rural residence<sup>c,f</sup></b>								
Yes	51,635	27.9	7,099	29.9	5,209	27.3	1,572	27.7
No	133,262	72.1	16,686	70.2	13,901	72.7	4,097	72.3

All differences in pair-wise comparisons between cohorts are significant,  $p < 0.05$ , except as footnoted. Each alphabetic letter indicates a non-significant difference in the rates of the two groups as listed below.  
a) DM and DM+COPD; b) DM and DM+D; c) DM and DM+COPD+D  
d) DM+COPD and DM+D; e) DM+COPD and DM+COPD+D; f) DM+D and DM+COPD+D

**Table 1.2. Health services that patients received among cohorts with diabetes only (DM), diabetes + chronic obstructive pulmonary disease (DM+COPD), diabetes+depression (DM+D) and all three diseases (DM+COPD+D)**

	DM		DM+COPD		DM+D		DM+COPD+D	
	Number	%	Number	%	Number	%	Number	%
<b>Health services that patients received in 2003</b>								
Number of physician office visits in 2003								
< 5	54,076	29.2	6,515	27.4	7,321	38.3	2,350	41.5
5-10	61,239	33.1	5,833	24.5	4,406	23.1	1,076	19.0
10-15	36,460	19.7	4,808	20.2	3,141	16.4	848	15.0
15 +	33,166	17.9	6,637	27.9	4,243	22.2	1,396	24.6
<b>No. of visits (mean)</b>		<b>9.1</b>		<b>11.1</b>		<b>9.4</b>		<b>9.7</b>
Visited an endocrinologist in 2003								
Yes	12,963	7.0	1,596	6.7	1,248	6.5	270	4.8
No	171,978	93.0	22,197	93.3	17,863	93.5	5,400	95.2
Visited an obstetrician-gynecologist in 2003 (women only)								
Yes	9,247	8.7	806	6.6	1,000	7.1	207	5.5
No	97,553	91.3	11,363	93.4	13,004	92.9	3,563	94.5
Visited a psychiatrist in 2003								
Yes	5,861	3.2	1,239	5.2	4,523	23.7	1,017	17.9
No	179,080	96.8	22,554	94.8	14,588	76.3	4,653	82.1
Visited a pulmonologist in 2003								
Yes	12,738	6.9	7,269	30.6	1,730	9.1	1,138	20.1
No	172,203	93.1	16,524	69.5	17,381	91.0	4,532	79.9
Visited a urologist in 2003 (men only) <sup>f</sup>								
Yes	21,759	27.9	3,201	27.5	1,443	28.3	465	24.5
No	56,382	72.2	8,423	72.5	3,664	71.7	1,435	75.5
<b>Health services that patients received in 2004*</b>								
Number of physician office visits in 2004								
< 5	49,669	28.9	5,368	27.5	6,106	37.6	1,676	40.3
5-10	55,416	32.3	4,754	24.4	3,737	23.0	825	19.8
10-15	34,171	19.9	3,926	20.1	2,716	16.7	610	14.7
15 +	32,507	18.9	5,456	28.0	3,668	22.6	1,048	25.2
<b>No. of visits (mean)</b>		<b>9.3</b>		<b>11.0</b>		<b>9.5</b>		<b>9.9</b>
Visited an endocrinologist in 2004 <sup>a,d</sup>								
Yes	12,663	7.4	1,361	7.0	1,147	7.1	270	6.5
No	159,100	92.6	18,143	93.0	15,080	92.9	3,889	93.5
Visited an obstetrician-gynecologist in 2004 (women only)								
Yes	8,247	8.4	631	6.4	930	7.8	158	5.6
No	90,459	91.6	9,299	93.7	10,968	92.2	2,644	94.4
Visited a psychiatrist in 2004								
Yes	6,136	3.6	1,107	5.7	3,463	21.3	1,017	24.5
No	165,627	96.4	18,397	94.3	12,764	78.7	3,142	75.6
Visited a pulmonologist in 2004								
Yes	12,920	7.5	5,731	29.4	1,481	9.1	1,138	27.4
No	158,843	92.5	13,773	70.6	14,746	90.9	3,021	72.6
Visited a urologist in 2004 (men only)								
Yes	20,608	28.2	2,646	27.6	1,228	28.4	361	26.6
No	52,449	71.8	6,928	72.4	3,101	71.6	996	73.4

\* Persons who died in 2003 are excluded

All differences in pair-wise comparisons between cohorts are significant, p<0.05, except as footnoted. Each alphabetic letter indicates a non-significant difference in the rates of the two groups as listed below.

- a) DM and DM+COPD; b) DM and DM+D; c) DM and DM+COPD+D  
d) DM+COPD and DM+D; e) DM+COPD and DM+COPD+D; f) DM+D and DM+COPD+D

**Table 1.3. Health services that patients received and months alive in 2003 among cohorts with diabetes only (DM only), diabetes + chronic obstructive pulmonary disease (DM+COPD), diabetes+depression (DM+D), and all three diseases (DM+COPD+D)**

	DM only		DM+COPD		DM+D		DM+COPD+D	
	Number	%	Number	%	Number	%	Number	%
<b>Health services that patients received in 2003</b>								
Number of physician office visits in 2003								
< 5	54,076	29.2	6,515	27.4	7,321	38.3	2,350	41.5
5-9	61,239	33.1	5,833	24.5	4,406	23.1	1,076	19.0
10-14	36,460	19.7	4,808	20.2	3,141	16.4	848	15.0
15 +	33,166	17.9	6,637	27.9	4,243	22.2	1,396	24.6
<i>No. of visits (mean)</i>		<b>9.1</b>		<b>11.1</b>		<b>9.4</b>		<b>9.7</b>
Visited an endocrinologist in 2003								
Yes	12,963	7.0	1,596	6.7	1,248	6.5	270	4.8
No	171,978	93.0	22,197	93.3	17,863	93.5	5,400	95.2
Visited an obstetrician-gynecologist in 2003 (women only)								
Yes	9,247	8.7	806	6.6	1,000	7.1	207	5.5
No	97,553	91.3	11,363	93.4	13,004	92.9	3,563	94.5
Visited a psychiatrist in 2003								
Yes	5,861	3.2	1,239	5.2	4,523	23.7	1,017	17.9
No	179,080	96.8	22,554	94.8	14,588	76.3	4,653	82.1
Visited a pulmonologist in 2003								
Yes	12,738	6.9	7,269	30.6	1,730	9.1	1,138	20.1
No	172,203	93.1	16,524	69.5	17,381	91.0	4,532	79.9
Number of diabetic care services received in 2003								
0	24,191	13.1	4,971	20.9	3,639	19.0	1,620	28.6
1	37,351	20.2	5,849	24.6	4,903	25.7	1,606	28.3
2	67,607	36.6	7,852	33.0	6,264	32.8	1,566	27.6
3	55,792	30.2	5,121	21.5	4,305	22.5	878	15.5
<i>Number of diabetic care services (mean)<sup>d</sup></i>		<b>2.1</b>		<b>2.0</b>		<b>2.0</b>		<b>1.8</b>
<i>Months alive (mean)</i>		<b>11.6</b>		<b>10.9</b>		<b>11.1</b>		<b>10.3</b>

All differences in pair-wise comparisons between cohorts are significant,  $p < 0.05$ , except as footnoted. Each alphabetic letter indicates a non-significant difference in the rates of the two groups as listed below.  
a) DM and DM+COPD; b) DM and DM+D; c) DM and DM+COPD+D  
d) DM+COPD and DM+D; e) DM+COPD and DM+COPD+D; f) DM+D and DM+COPD+D



**Table M1. Crude, age-specific and age-adjusted mortality rates in 2003 and 2004 among study cohorts diabetes only (DM only), diabetes+chronic obstructive pulmonary disease (DM+COPD), diabetes+depression (DM+D), and all three diseases (DM+COPD+D)**

	DM only		DM+COPD		DM+D		DM+COPD+D	
	Number Dead	Rate /100	Number Dead	Rate /100	Number Dead	Rate /100	Number Dead	Rate /100
<b>Crude Rates</b>								
Total	26,108	14.1	7,423	31.2	5,103	26.7	2,413	42.6
<b>Age group (years)</b>								
67-69	1594	5.5	635	20.4	272	11.0	203	28.4
70-74	3937	7.7	1375	23.0	657	15.2	449	33.7
75-79	5598	11.8	1899	29.3	1074	23.2	576	39.1
80-84	6252	18.9	1701	35.9	1265	31.9	603	50.5
85+	8727	36.0	1813	51.8	1835	49.4	582	60.9
<b>Age-adjusted Rates</b>								
Total	26,108	13.8	7,423	30.3	5,103	24.0	2,413	40.8
<b>Sex</b>								
Male	10052	14.2	3522	30.4	1366	26.3	842	43.0
Female	16056	14.0	3901	30.2	3737	23.1	1571	39.7
<b>Race/ethnicity</b>								
White	21806	14.1	6501	30.5	4503	24.2	2163	41.4
Black	3205	13.4	657	30.9	410	24.2	162	40.8
Asian	244	9.3	64	21.0 <sup>bc</sup>	27	17.6 <sup>d</sup>	18	31.2 <sup>e</sup>
Hispanic	453	11.9	137	26.4 <sup>e</sup>	101	18.3	48	27.1 <sup>f</sup>
Others	400	14.1	64	24.3 <sup>bc</sup>	62	24.9 <sup>cd</sup>	22	32.3 <sup>ef</sup>
<b>In Medicaid-administered program</b>								
Yes	6377	19.0	2021	33.5	1814	28.9	946	43.2
No	19731	13.1	5402	29.3	3289	22.1	1467	39.4
<b>Median household income of zip code</b>								
< \$34,000	9085	14.6	2664	29.7	1659	23.9	856	40.5
\$34,000-\$45,000	8801	14.2	2554	30.8	1713	24.2	871	43.5
> \$45,000	8217	13.5	2200	30.4	1729	24.0	686	38.5
<b>Charlson scores</b>								
0	3236	6.7	318	14.3	216	9.5	54	23.2
1-2	9053	12.4	1952	23.2	1304	17.8	454	31.6
3+	13819	23.5	5153	38.2	3583	33.2	1905	45.6
<b>History of hospitalization in 2001 or 2002</b>								
Yes	11313	19.7	6260	34.1	3887	28.7	2238	43.2
No	14795	10.5	1163	19.4	1216	16.3	175	24.5
<b>U.S. region of residence</b>								
Midwest	6893	14.1	1885	30.5	1526	24.9 <sup>cd</sup>	624	41.5
Northeast	5570	13.7	1570	28.5	1120	23.5	559	42.2
South	10409	14.6	3054	30.9	1868	24.2	969	40.3
West	3234	13.5	914	30.7	589	22.7	261	38.9
<b>Rural Residence</b>								
Yes	7381	14.5	2173	30.2	1396	24.5	677	41.6
No	18708	14.0	5244	30.3	3702	23.9	1735	40.5
<b>Number of physician office visits in 2002</b>								
< 5	8968	17.8	1802	39.7 <sup>d</sup>	2210	34.6 <sup>d</sup>	797	51.1
5-9	7055	11.4	1608	27.4	1093	21.7	515	43.5
10-14	4568	12.0	1465	26.3	700	18.0	421	38.0
15 +	5517	15.9	2548	29.9	1100	19.9	680	33.9
<b>Visited an endocrinologist in 2002</b>								
Yes	1557	14.0	541	31.8	290	21.9	171	37.1
No	24551	14.1	6882	30.2	4813	24.2	2242	41.2
<b>Visited an obstetrician-gynecologist in 2002 (women only)</b>								
Yes	881	9.3	214	20.5	205	16.2	95	30.5
No	15175	14.4	3687	31.1	3532	23.8	1476	40.6
<b>Visited a psychiatrist in 2002</b>								
Yes	1336	30.1	426	43.8 <sup>e</sup>	1708	26.5	920	43.9 <sup>e</sup>
No	24772	13.7	6997	29.8	3395	23.0	1493	39.2
<b>Visited a pulmonologist in 2002</b>								
Yes	1802	22.4	2821	34.5 <sup>d</sup>	494	33.8 <sup>d</sup>	941	45.4
No	24306	13.7	4602	28.1	4609	23.3	1472	37.9
<b>Number of diabetic care services received in 2002</b>								
0	4476	22.1	1391	41.9	959	35.4	515	50.3
1	7512	17.7	2378	36.4	1759	29.2	845	45.5
2	8848	12.9	2407	27.2	1610	21.9	748	38.4
3	5272	9.9	1247	22.0	775	16.6	305	29.3

All differences in pair-wise comparisons between cohorts are significant, p<0.05, except as footnoted. Each alphabetic letter indicates a non-significant difference in the rates of the two groups as listed below.

- a) DM and DM+COPD; b) DM and DM+D; c) DM and DM+COPD+D  
d) DM+COPD and DM+D; e) DM+COPD and DM+COPD+D; f) DM+D and DM+COPD+D

**Table M2. Mortality in 2003 and 2004: results of logistic regression for each cohort group, diabetes only (DM only), diabetes+COPD (DM+COPD), diabetes+depression (DM+D), and diabetes+COPD+depression (DM+COPD+D)**

	DM only Odds Ratio (95% CI)	DM+COPD Odds Ratio (95% CI)	DM+D Odds Ratio (95% CI)	DM+COPD+D Odds Ratio (95% CI)
<b>Age-group (years)</b>				
67-69 - reference				
70-74	1.38 (1.30-1.47)	1.19 (1.06-1.32)	1.32 (1.13-1.54)	1.29 (1.05-1.58)
75-79	2.02 (1.90-2.14)	1.53 (1.38-1.71)	2.01 (1.73-2.34)	1.53 (1.25-1.87)
80-84	3.15 (2.97-3.35)	1.97 (1.77-2.20)	2.70 (2.33-3.14)	2.27 (1.84-2.80)
85+	6.28 (5.91-6.66)	3.30 (2.94-3.71)	4.76 (4.09-5.53)	3.20 (2.57-4.00)
<b>Sex</b>				
Male - reference				
Female	1.02 (0.99-1.05)	1.05 (0.98-1.11)	0.88 (0.81-0.95)	0.88 (0.78-0.99)
<b>Race/ethnicity</b>				
White - reference				
Black	0.88 (0.84-0.92)	0.88 (0.79-0.98)	0.78 (0.68-0.89)	0.81 (0.65-1.02)
Asian	0.54 (0.47-0.62)	0.55 (0.40-0.75)	0.51 (0.32-0.80)	0.73 (0.39-1.37)
Hispanic	0.64 (0.57-0.71)	0.74 (0.60-0.92)	0.62 (0.49-0.79)	0.52 (0.36-0.75)
Others	0.90 (0.80-1.01)	0.70 (0.52-0.95)	0.91 (0.66-1.26)	0.64 (0.37-1.11)
<b>In Medicaid-administered program</b>				
No - reference				
Yes	1.32 (1.27-1.37)	1.05 (0.97-1.13)	1.15 (1.06-1.25)	1.06 (0.93-1.20)
<b>Median household income of zip code</b>				
< \$34,000 - reference				
\$34,000-\$45,000	1.07 (1.03-1.11)	1.12 (1.04-1.21)	1.03 (0.94-1.13)	1.17 (1.02-1.35)
> \$45,000	1.01 (0.97-1.06)	1.12 (1.03-1.22)	1.02 (0.93-1.13)	0.86 (0.73-1.02)
<b>Charlson score</b>				
0 - reference				
1-2	2.01 (1.92-2.10)	1.69 (1.48-1.93)	2.11 (1.80-2.48)	1.41 (1.01-1.97)
3+	4.03 (3.85-4.22)	3.30 (2.89-3.77)	4.25 (3.63-4.98)	2.50 (1.80-3.45)
<b>History of hospitalization in 2001 or 2002</b>				
No - reference				
Yes	1.35 (1.31-1.40)	1.46 (1.35-1.58)	1.38 (1.26-1.50)	1.85 (1.52-2.26)
<b>U.S. region of residence</b>				
Northeast - reference				
Midwest	0.97 (0.93-1.01)	0.95 (0.87-1.03)	0.92 (0.84-1.02)	1.01 (0.86-1.20)
South	1.03 (0.99-1.07)	1.06 (0.98-1.14)	0.97 (0.89-1.07)	1.00 (0.86-1.15)
West	0.98 (0.93-1.03)	1.14 (1.02-1.26)	0.97 (0.85-1.10)	1.02 (0.83-1.26)
<b>Rural residence</b>				
No - reference				
Yes	1.02 (0.98-1.05)	1.02 (0.95-1.10)	1.00 (0.92-1.10)	0.98 (0.85-1.13)
<b>Number of physician office visits in 2002</b>				
< 5 - reference				
5-9	0.65 (0.63-0.68)	0.64 (0.59-0.71)	0.60 (0.54-0.67)	0.79 (0.67-0.94)
10-14	0.60 (0.58-0.63)	0.56 (0.51-0.62)	0.46 (0.41-0.51)	0.63 (0.53-0.76)
15 +	0.72 (0.69-0.75)	0.61 (0.55-0.67)	0.47 (0.42-0.52)	0.52 (0.44-0.61)
<b>Visited an endocrinologist in 2002</b>				
No - reference				
Yes	1.07 (1.01-1.14)	1.08 (0.96-1.21)	1.03 (0.89-1.20)	0.88 (0.71-1.09)
<b>Visited an obstetrician-gynecologist in 2002</b>				
No - reference				
Yes	0.65 (0.61-0.71)	0.60 (0.51-0.71)	0.73 (0.62-0.86)	0.73 (0.56-0.95)
<b>Visited a psychiatrist in 2002</b>				
No - reference				
Yes	1.66 (1.53-1.79)	1.37 (1.18-1.59)	1.00 (0.92-1.08)	1.05 (0.93-1.19)
<b>Visited a pulmonologist in 2002</b>				
No - reference				
Yes	1.47 (1.38-1.56)	1.33 (1.25-1.42)	1.53 (1.35-1.74)	1.38 (1.22-1.56)
<b>Number of diabetic care services in 2002</b>				
0 - reference				
1	0.81 (0.78-0.85)	0.89 (0.81-0.98)	0.90 (0.80-1.00)	0.94 (0.79-1.11)
2	0.61 (0.58-0.64)	0.62 (0.57-0.68)	0.71 (0.64-0.80)	0.76 (0.64-0.90)
3	0.47 (0.46-0.51)	0.49 (0.44-0.54)	0.57 (0.50-0.65)	0.54 (0.44-0.67)
-2 Log likelihood	127213.01	26530.609	18799.928	7012.804
C-statistic	0.775	0.712	0.764	0.700

**Table M3. Mortality in 2003 and 2004: results of logistic regression for all cohorts**

Mortality in 2003 and 2004	
	Odds ratio (95% CI)
Chronic conditions	
Diabetes - reference	
DM+ COPD	1.75 (1.68-1.81)
DM + D	1.30 (1.25-1.35)
DM+ COPD + D	2.06 (1.93-2.19)
Age-group (years)	
67-69 - reference	
70-74	1.33 (1.26-1.39)
75-79	1.90 (1.81-1.99)
80-84	2.83 (2.70-2.97)
85+	5.41 (5.15-5.67)
Sex	
Male - reference	
Female	1.01 (0.99-1.04)
Race/ethnicity	
White - reference	
Black	0.87 (0.84-0.91)
Asian	0.54 (0.48-0.61)
Hispanic	0.63 (0.58-0.69)
Others	0.87 (0.78-0.96)
In Medicaid-administered program	
No - reference	
Yes	1.25 (1.21-1.29)
Median household income of zip code	
< \$34,000 - reference	
\$34,000-\$45,000	1.08 (1.04-1.11)
> \$45,000	1.02 (0.99-1.06)
Charlson score	
0 - reference	
1-2	2.02 (1.94-2.10)
3+	4.04 (3.87-4.21)
History of hospitalization in 2001 or 2002	
No - reference	
Yes	1.39 (1.36-1.43)
U.S. region of residence	
Northeast - reference	
Midwest	0.96 (0.93-1.00)
South	1.02 (0.99-1.05)
West	1.00 (0.96-1.04)
Rural residence	
No - reference	
Yes	1.01 (0.99-1.05)
Number of physician office visits in 2002	
< 5 - reference	
5-9	0.65 (0.63-0.67)
10-14	0.58 (0.56-0.60)
15 +	0.65 (0.63-0.68)
Visited an endocrinologist in 2002	
No - reference	
Yes	1.06 (1.01-1.11)
Visited an obstetrician-gynecologist in 2002	
No - reference	
Yes	0.66 (0.62-0.70)
Visited a psychiatrist in 2002	
No - reference	
Yes	1.24 (1.18-1.30)
Visited a pulmonologist in 2002	
No - reference	
Yes	1.43 (1.38-1.49)
Number of diabetic care services in 2002	
0 - reference	
1	0.84 (0.81-0.88)
2	0.63 (0.60-0.65)
3	0.50 (0.48-0.52)
-2 Log likelihood	180092.94
C-statistic	0.790

**Table C1. Total and mean (person-years) cost to Medicare in 2003 among study cohorts, diabetes only (DM only), diabetes+chronic obstructive pulmonary disease (DM+COPD), diabetes+depression (DM+D), and all three diseases (DM+COPD+D)**

	DM only		DM+COPD		DM+D		DM+COPD+D	
	Cost in dollars		Cost in dollars		Cost in dollars		Cost in dollars	
	Total	Mean	Total	Mean	Total	Mean	Total	Mean
<b>Total</b>	1,615,195,559	9,052	403,251,893	18,756	257,820,324	14,647	128,929,704	26,707
<b>Age-group (years)</b>								
67-69	196,140,822	6,848	50,484,955	17,175	29,687,246	12,396	18,515,376	28,768
70-74	387,950,894	7,703	97,211,256	17,467	56,290,754	13,661	32,313,168	27,299
75-79	426,003,259	9,246	113,517,945	19,273	66,047,315	15,269	33,813,295	26,287
80-84	334,626,709	10,630	83,203,426	19,707	55,951,790	15,502	25,221,126	35,721
85+	270,473,875	12,363	58,834,311	20,411	49,843,219	15,817	19,066,739	25,998
<b>Sex</b>								
Male	669,186,009	8,850	193,334,504	18,386	73,186,569	15,602	43,298,453	27,102
Female	946,009,550	9,201	209,917,390	19,111	184,633,754	14,301	85,631,251	26,512
<b>Race/ethnicity</b>								
White	1,314,678,246	8,893	338,006,622	18,143	216,715,424	14,281	107,563,592	25,365
Black	211,730,891	10,130	43,686,427	22,938	27,562,156	17,771	13,019,823	39,167
Asian	23,118,065	8,386	5,527,729	20,979 <sup>ab</sup>	2,353,683	15,531 <sup>a</sup>	1,335,895	31,882 <sup>c</sup>
Hispanic	40,580,493	10,145	11,415,810	25,621	8,472,491	16,348	5,468,128	35,911
Others	25,087,865	8,524	4,615,306	18,015 <sup>c</sup>	2,716,569	13,163	1,542,266	25,563 <sup>c</sup>
<b>In Medicaid-administered program</b>								
Yes	336,755,010	11,316	117,254,097	22,414	82,504,417	16,226	52,399,706	28,907
No	1,278,440,549	8,599	285,997,796	17,580	175,315,907	14,006	76,529,998	25,384
<b>Median household income of zip code</b>								
< \$34,000	552,527,675	9,084	150,313,409	18,715	86,118,074	14,459	48,089,163	27,106
\$34,000-\$45,000	519,649,983	8,697	131,172,481	18,076	82,611,366	14,052	42,874,179	26,323
> \$45,000	542,731,407	9,385	121,391,262	19,564	89,022,537	15,443	37,966,362	26,649
<b>Charlson score</b>								
0	277,976,957	4,705	20,800,920	8,420	17,380,447	6,118	2,857,388	10,736
1-2	591,401,129	8,427	112,218,470	14,362	71,310,974	11,297	25,946,000	20,156
3+	745,817,472	15,168	270,232,504	24,095	169,128,903	20,018	100,126,316	30,581
<b>History of hospitalization in 2001 or 2002</b>								
Yes	869,930,501	13,351	336,394,223	21,483	201,923,367	18,416	119,862,563	28,733
No	745,265,058	6,579	66,857,670	11,446	55,896,957	8,421	9,067,141	13,822
<b>U.S. region of residence</b>								
Midwest	391,889,271	8,354	94,860,086	17,435	67,367,468	13,435	29,932,641	24,411
Northeast	379,546,335	10,265	93,164,971	20,189	62,016,488	16,542	31,420,971	29,461
South	634,976,808	8,905	163,940,315	18,462	97,783,261	14,624	52,653,988	26,732
West	208,652,799	8,981	51,286,521	20,002	30,651,707	14,250	14,922,104	26,403
<b>Rural residence</b>								
Yes	395,675,233	7,937	103,565,541	16,091	60,610,371	12,605	28,380,537	21,244
No	1,218,959,831	9,483	299,512,596	19,894	197,175,757	15,413	100,537,486	28,802
<b>Number of physician office visits in 2003</b>								
< 5	387,340,161	7,901	107,928,617	22,641	94,788,834	15,756	50,026,933	30,415
5-9	384,478,342	6,373	81,168,414	14,731	50,064,166	11,694	23,024,856	23,383
10-14	331,072,616	9,159	70,695,196	15,094	39,641,131	12,784	18,236,875	22,178
15 +	512,304,439	15,559	143,459,666	21,940	73,326,193	17,444	37,641,041	27,360
<b>Visited an endocrinologist in 2003</b>								
Yes	184,928,184	14,615	43,820,789	29,384	26,144,750	22,031	13,022,047	40,410
No	1,430,267,375	8,628	359,431,104	17,964	231,675,574	14,114	115,907,657	25,727
<b>Visited an obstetrician-gynecologist in 2003 (women only)</b>								
Yes	77,935,843	8,510	13,760,901	17,484	13,293,751	13,483	5,425,961	27,015
No	868,073,707	9,269	196,156,488	19,237	171,340,004	14,368	80,205,290	26,478
<b>Visited a psychiatrist in 2003</b>								
Yes	159,061,062	29,442	46,062,423	41,951	83,840,260	19,807	45,238,557	35,021
No	1,456,134,497	8,416	357,189,470	17,508	173,980,064	13,014	83,691,147	23,670
<b>Visited a pulmonologist in 2003</b>								
Yes	367,698,209	32,188	199,351,608	30,791	60,696,542	41,440 <sup>f</sup>	60,632,266	45,131 <sup>f</sup>
No	1,247,497,349	7,470	203,900,285	13,571	197,123,781	12,215	68,297,439	19,603
<b>Number of diabetic care services received in 2003</b>								
0	277,741,571	13,764	102,740,147	30,574	59,117,637	22,323	40,440,924	39,979
1	377,478,724	10,519	107,364,482	19,773	71,347,369	15,658	37,471,367	26,083
2	546,379,095	8,180	121,901,078	15,945	78,452,884	12,819	33,787,716	22,357
3	413,596,168	7,443	71,246,186	14,068	48,902,434	11,434	17,229,698	19,848

All differences in pair-wise comparisons between cohorts are significant, p<0.05, except as footnoted. Each alphabetic letter indicates a non-significant difference in the rates of the two groups as listed below.  
a) DM and DM+COPD; b) DM and DM+D; c) DM and DM+COPD+D  
d) DM+COPD and DM+D; e) DM+COPD and DM+COPD+D; f) DM+D and DM+COPD+D

**Table C2. Regression results for cost to Medicare in 2003 for each cohort group: diabetes only (DM Only), diabetes+COPD (DM+COPD), diabetes+depression (DM+D) and diabetes+COPD+depression (DM+COPD+D)**

	DM only		DM+COPD		DM+D		DM+COPD+D	
	Estimate (\$)	Pr > ChiSq	Estimate (\$)	Pr > ChiSq	Estimate (\$)	Pr > ChiSq	Estimate (\$)	Pr > ChiSq
Age-group (years)								
67-69 - reference								
70-74	218	0.05	-260	0.59	361	0.45	-825	0.50
75-79	710	<.0001	591	0.22	896	0.06	-2,189	0.07
80-84	1,059	<.0001	378	0.46	802	0.10	-3,090	0.02
85+	1,126	<.0001	-808	0.14	-50	0.92	-3,527	0.01
Sex								
Male - reference								
Female	77	0.30	83	0.78	-302	0.34	-78	0.92
Race/ethnicity								
White - reference								
Black	838	<.0001	2,644	<.0001	2,893	<.0001	8,531	<.0001
Asian	-853	0.00	849	0.53	1,144	0.46	7,298	0.05
Hispanic	365	0.14	2,685	0.01	690	0.41	7,219	0.00
Others	127	0.65	1,088	0.42	-529	0.68	1,797	0.58
In Medicaid-administered program								
No - reference								
Yes	1,085	<.0001	2,786	<.0001	783	0.02	1,023	0.20
Median household income of zip code								
< \$34,000 - reference								
\$34,000-\$45,000	-290	0.00	-601	0.09	-610	0.08	-1,314	0.14
> \$45,000	-391	<.0001	-883	0.03	-110	0.78	-3,044	0.00
Charlson score								
0 - reference								
1-2	995	<.0001	2,659	<.0001	2,206	<.0001	4,079	0.02
3+	3,712	<.0001	7,173	<.0001	6,432	<.0001	9,213	<.0001
History of hospitalization in 2001 or 2002								
No - reference								
Yes	2,393	<.0001	4,034	<.0001	4,681	<.0001	6,935	<.0001
U.S. region of residence								
Northeast - reference								
Midwest	418	<.0001	1,089	0.01	976	0.01	1,266	0.22
South	-369	<.0001	-442	0.23	91	0.80	-981	0.28
West	-148	0.23	1,384	0.01	473	0.32	318	0.80
Rural residence								
No - reference								
Yes	-19	0.83	-328	0.35	-174	0.61	-2,934	0.00
Number of physician office visits in 2003								
< 5 - reference								
5-9	1,552	<.0001	1,053	0.01	2,377	<.0001	719	0.49
10-14	3,473	<.0001	1,566	0.00	2,942	<.0001	1,662	0.16
15 +	7,872	<.0001	5,795	<.0001	5,136	<.0001	3,749	0.00
Visited an endocrinologist in 2003								
No - reference								
Yes	3,441	<.0001	7,174	<.0001	5,152	<.0001	7,746	<.0001
Visited an obstetrician-gynecologist in 2003								
No - reference								
Yes	-1,476	<.0001	-1,083	0.18	-719	0.25	2,107	0.27
Visited a psychiatrist in 2003								
No - reference								
Yes	14,869	<.0001	18,139	<.0001	5,053	<.0001	8,548	<.0001
Visited a pulmonologist in 2003								
No - reference								
Yes	17,608	<.0001	13,158	<.0001	20,743	<.0001	18,199	<.0001
Number of months alive in 2003								
per month	-887	<.0001	-359	<.0001	-261	<.0001	574	<.0001
Number of diabetic care services received in 2003								
0 - reference								
1	-658	<.0001	-1,676	0.00	-1,191	0.01	-2,903	0.00
2	-2,033	<.0001	-4,179	<.0001	-2,809	<.0001	-6,231	<.0001
3	-3,300	<.0001	-6,504	<.0001	-4,524	<.0001	-9,540	<.0001

**Table C3. Regression results for cost to Medicare in 2003 for all cohort groups: (A) using all available covariates and (B) excluding the covariates "Visited a psychiatrist in 2003" and "Visited a pulmonologist in 2003"**

Chronic conditions	A. All covariates		B. Excluding a psychiatrist and a pulmonologist visit	
	Estimate (\$)	Pr > ChiSq	Estimate (\$)	Pr > ChiSq
DM only - reference				
DM+COPD	274	0.02	3,796	<.0001
DM+D	-607	<.0001	1,685	<.0001
DM+COPD+D	2,608	<.0001	7,905	<.0001
Age-group (years)				
67-69 - reference				
70-74	181	0.10	201	0.09
75-79	703	<.0001	758	<.0001
80-84	955	<.0001	931	<.0001
85+	797	<.0001	662	<.0001
Sex				
Male - reference				
Female	79	0.28	114	0.14
Race/ethnicity				
White - reference				
Black	1,216	<.0001	1,191	<.0001
Asian	-592	0.05	-1,100	0.00
Hispanic	720	0.00	674	0.01
Others	99	0.73	-232	0.44
In Medicaid-administered program				
No - reference				
Yes	1,406	<.0001	1,795	<.0001
Median household income of zip code				
< \$34,000 - reference				
\$34,000-\$45,000	-385	<.0001	-374	<.0001
> \$45,000	-499	<.0001	-342	0.00
Charlson score				
0 - reference				
1-2	1,142	<.0001	1,440	<.0001
3+	4,445	<.0001	5,089	<.0001
History of hospitalization in 2001 or 2002				
No - reference				
Yes	2,835	<.0001	3,198	<.0001
U.S. region of residence				
Northeast - reference				
Midwest	563	<.0001	1,102	<.0001
South	-377	<.0001	-223	0.02
West	74	0.54	-131	0.31
Rural residence				
No -reference				
Yes	1,513	<.0001	-895	<.0001
Number of physician office visits in 2003				
< 5 - reference				
5-9	3,115	<.0001	1,632	<.0001
10-14	7,138	<.0001	3,680	<.0001
15 +	-134	0.12	8,901	<.0001
Visited an endocrinologist in 2003				
No - reference				
Yes	4,112	<.0001	5,494	<.0001
Visited an obstetrician-gynecologist in 2003				
No - reference				
Yes	-1,302	<.0001	-1,394	<.0001
Visited a psychiatrist in 2003				
No - reference				
Yes	11,857	<.0001		
Visited a pulmonologist in 2003				
No - reference				
Yes	16,866	<.0001		
Number of months alive in 2003				
Per month	-661	<.0001	-910	<.0001
Number of diabetic care services received in 2003				
0 - reference				
1	-958	<.0001	-804	<.0001
2	-2,543	<.0001	-2,793	<.0001
3	-3,956	<.0001	-4,609	<.0001

Table C4 Mean cost and percent of total cost to Medicare per beneficiary by type of service and cohort in 2003\*

Cohort group as of 12/31/02	Number	Outpatient		Inpatient		SNF**		HHA		Carrier		DME**		Hospice		Total	
		Mean (\$)	%	Mean (\$)	%	Mean (\$)	%	Mean (\$)	%	Mean (\$)	%	Mean (\$)	%	Mean (\$)	%	Mean (\$)	%
DM***	184,941	734	8.1	4,202	46.4	686	7.6	497	5.5	2,419	26.7	334	3.7	180	2.0	9,052	100
DM+COPD	23,793	1,106	5.9	9,468	50.5	1,417	7.6	1,064	5.7	3,877	20.7	1,331	7.1	493	2.6	18,756	100
DM+D	19,111	1,164	7.9	6,560	44.8	1,810	12.4	964	6.6	3,141	21.4	515	3.5	494	3.4	14,647	100
DM+COPD+D	5,670	1,578	5.9	13,102	49.1	2,912	10.9	1,836	6.9	4,798	18.0	1,665	6.2	815	3.1	26,707	100
Total	233,515	822	7.6	5,091	47.1	894	8.3	618	5.7	2,669	24.7	474	4.4	249	2.3	10,817	100

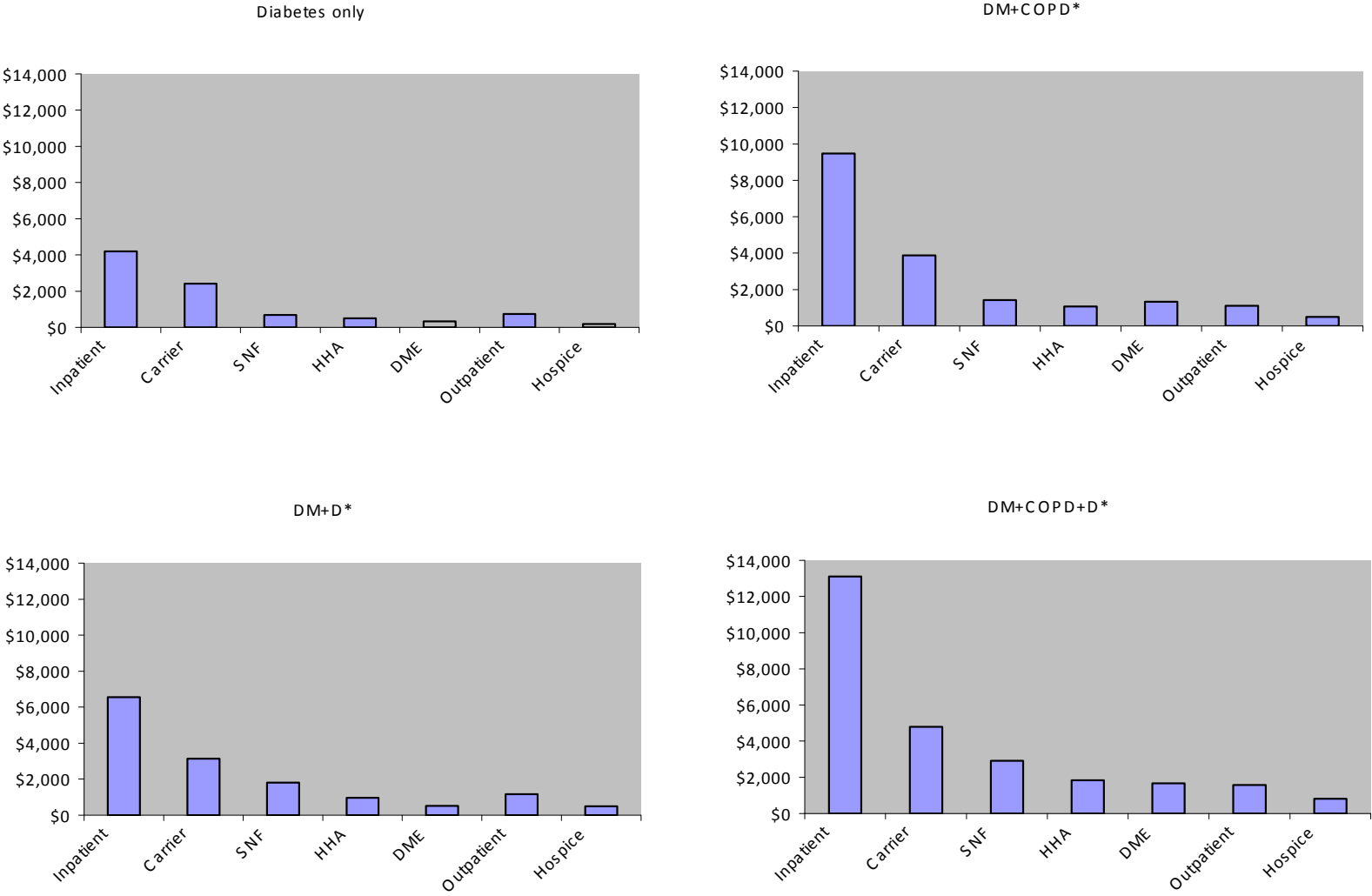
\*Mean cost calculated based on person-years

\*\*SNF=skilled nursing facility; HHA=home health agency; DME=durable medical equipment

\*\*\*DM=Diabetes; DM+COPD=Diabetes + chronic obstructive pulmonary disease; DM+D=Diabetes + depression;

DM+COPD+D= Diabetes + chronic obstructive pulmonary disease + depression

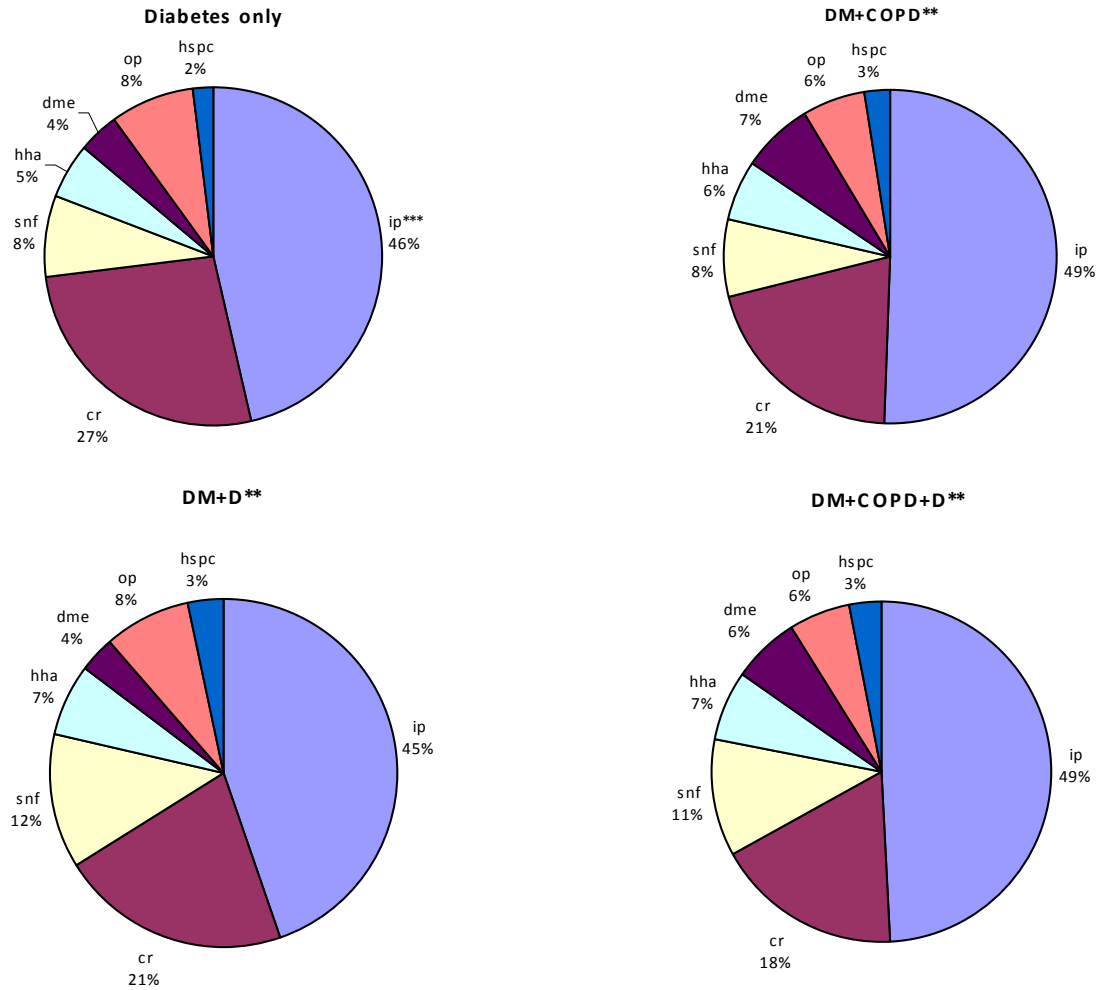
**Figure CF1. Mean cost to Medicare per beneficiary by type of service and cohort in 2003**



\*DM+COPD=diabetes+chronic obstructive pulmonary disease; DM+D=diabetes+depression; DM+COPD+D=diabetes+chronic obstructive pulmonary disease+depression



Figure CF2. Percent distribution of mean cost to Medicare per beneficiary in 2003\*



\* mean cost calculated based on person-years.

\*\*DM+COPD=diabetes+chronic obstructive pulmonary disease; DM+D=diabetes+depression; DM+COPD+D=diabetes+chronic obstructive pulmonary disease+depression

\*\*\*ip=inpatient; cr=carrier; snf=skilled nursing facility; hha=home health agency; dme=durable medical equipment; op=outpatient; hspc=hospice

# Appendix

**Table A.1.1. Patient baseline characteristics as of 01/01/03 among cohorts with diabetes only (DM only), chronic obstructive pulmonary disease (COPD) only, and depression only (D)**

	DM		COPD		D	
	Number	%	Number	%	Number	%
All	184,941		70,031		59,158	
<b>Age-group (years)</b>						
67-69	29,025	15.7	8,320	11.9	7,302	12.3
70-74	51,276	27.7	16,749	23.9	12,220	20.7
75-79	47,374	25.6	18,045	25.8	13,007	22.0
80-84	33,017	17.9	14,354	20.5	12,172	20.6
85+	24,249	13.1	12,563	17.9	14,457	24.4
<b>Age (mean)</b>		<b>76.5</b>		<b>77.8</b>		<b>78.9</b>
<b>Gender</b>						
Male	78,141	42.3	32,422	46.3	13,218	22.3
Female	106,800	57.8	37,609	53.7	45,940	77.7
<b>Race/ethnicity</b>						
White	153,236	82.9	64,421	92.0	55,012	93.0
Black	21,732	11.8	3,605	5.2	2,578	4.4
Hispanic	4,110	2.2	769	1.1	793	1.3
Asian	2,815	1.5	633	0.9	314	0.5
Others	3,048	1.7	603	0.9	461	0.8
<b>In Medicaid-administered program</b>						
Yes	31,473	17.0	12,006	17.1	10,938	18.5
No	153,468	83.0	58,025	82.9	48,220	81.5
<b>Median household income of zip code</b>						
< \$34,000	63,024	34.1	24,349	34.8	17,122	29.0
\$34,000-\$45,000	61,966	33.5	23,783	34.0	20,265	34.3
> \$45,000	59,925	32.4	21,893	31.3	21,764	36.8
<b>Income (mean)</b>		<b>\$42,193</b>		<b>\$41,648</b>		<b>\$43,909</b>
<b>Charlson score</b>						
0	59,665	32.3	15,629	22.3	15,603	26.4
1-2	72,112	39.0	28,381	40.5	23,693	40.1
3+	53,164	28.8	26,021	37.2	19,862	33.6
<b>Charlson score (mean)</b>		<b>1.9</b>		<b>2.4</b>		<b>2.1</b>
<b>History of hospitalization in 2001 or 2002</b>						
Yes	69,279	37.5	28,989	41.4	28,783	48.7
No	115,662	62.5	41,042	58.6	30,375	51.4
<b>U.S. region of residence</b>						
Midwest	48,646	26.3	17,956	25.6	16,861	28.5
Northeast	38,379	20.8	13,610	19.4	12,073	20.4
South	73,861	39.9	28,553	40.8	21,888	37.0
West	24,045	13.0	9,908	14.2	8,334	14.1
<b>Rural residence</b>						
Yes	51,635	27.9	21,565	30.8	16,171	27.3
No	133,262	72.1	48,454	69.2	42,973	72.7

**Table A.1.2. Health services that patients received in 2002 among cohorts with diabetes only (DM only), chronic obstructive pulmonary disease (COPD) only, and depression only (D)**

	DM		COPD		D	
	Number	%	Number	%	Number	%
<b>Health services that patients received in 2002</b>						
Number of physician office visits in 2002						
< 5	47,220	25.5	15,466	22.1	16,948	28.6
5-9	64,142	34.7	21,860	31.2	16,683	28.2
10-14	38,871	21.0	15,666	22.4	11,313	19.1
15 +	34,708	18.8	17,039	24.3	14,214	24.0
<i>No. of visits (mean)</i>		<b>9.6</b>		<b>10.8</b>		<b>10.6</b>
Visited an endocrinologist in 2002						
Yes	12,359	6.7	1,018	1.5	1,064	1.8
No	172,582	93.3	69,013	98.5	58,094	98.2
Visited an obstetrician-gynecologist in 2002 (women only)						
Yes	11,215	10.5	4,077	10.8	6,028	13.1
No	95,585	89.5	33,532	89.2	39,912	86.9
Visited a psychiatrist in 2002						
Yes	3,762	2.0	2,042	2.9	16,551	28.0
No	181,179	98.0	67,989	97.1	42,607	72.0
Visited a pulmonologist in 2002						
Yes	7,918	4.3	22,070	31.5	3,062	5.2
No	177,023	95.7	47,961	68.5	56,096	94.8
Number of diabetic care services (mean) in 2002						
0	18,050	9.8	23,278	33.2	19,883	33.6
1	37,575	20.3	30,826	44.0	25,064	42.4
2	71,375	38.6	15,107	21.6	13,445	22.7
3	57,941	31.3	820	1.2	766	1.3
<i>No. of diabetic care services (mean)</i>		<b>2.11</b>		<b>1.38</b>		<b>1.39</b>

**Table A.1.3. Health services that patients received and months alive in 2003 among cohorts with diabetes only (DM only), chronic obstructive pulmonary disease (COPD) only, depression only (D)**

	DM only		COPD		D	
	Number	%	Number	%	Number	%
<b>Health services that patients received in 2003</b>						
Number of physician office visits in 2003						
< 5	54,076	29.2	21,869	31.2	22,657	38.3
5-9	61,239	33.1	20,394	29.1	15,494	26.2
10-14	36,460	19.7	13,533	19.3	9,751	16.5
15 +	33,166	17.9	14,235	20.3	11,256	19.0
<i>No. of visits (mean)</i>		<b>9.1</b>		<b>9.4</b>		<b>9.0</b>
Visited an endocrinologist in 2003						
Yes	12,963	7.0	1,120	1.6	1,021	1.7
No	171,978	93.0	68,911	98.4	58,137	98.3
Visited an obstetrician-gynecologist in 2003 (women only)						
Yes	9,247	8.7	3,181	8.5	4,718	10.3
No	97,553	91.3	34,428	91.5	41,222	89.7
Visited a psychiatrist in 2003						
Yes	5,861	3.2	2,877	4.1	13,315	22.5
No	179,080	96.8	67,154	95.9	45,843	77.5
Visited a pulmonologist in 2003						
Yes	12,738	6.9	20,570	29.4	4,082	6.9
No	172,203	93.1	49,461	70.6	55,076	93.1
Number of diabetic care services received in 2003						
0	24,191	13.1	26,924	38.4	22,369	37.8
1	37,351	20.2	27,901	39.8	23,460	39.7
2	67,607	36.6	13,998	20.0	12,299	20.8
3	55,792	30.2	1,208	1.7	1,030	1.7
<i>Number of diabetic care services (mean)</i>		<b>2.1</b>		<b>1.4</b>		<b>1.4</b>
<i>Months alive (mean)</i>		<b>11.6</b>		<b>11.2</b>		<b>11.4</b>

**Table A.M1 Crude, age-specific and age-adjusted mortality rates in 2003 and 2004 among study cohorts: diabetes only (DM only), chronic obstructive pulmonary disease only (COPD) and depression only (D)**

	DM only		COPD		D	
	Number Dead	Rate/ 100	Number Dead	Rate/ 100	Number Dead	Rate/ 100
<b>Crude Rates</b>						
Total	26,108	14.1	17,987	25.7	12,374	20.9
<b>Age-group (years)</b>						
67-69	1594	5.5	1148	13.8	411	5.6
70-74	3937	7.7	2824	16.9	1059	8.7
75-79	5598	11.8	4039	22.4	1751	13.5
80-84	6252	18.9	4252	29.6	2842	23.3
85+	8727	36.0	5724	45.6	6311	43.7
<b>Age-adjusted Rates</b>						
Total	26,108	13.8	17,987	23.8	12,374	16.6
<b>Sex</b>						
Male	10052	14.2	8152	24.4	2893	19.5
Female	16056	14.0	9835	23.3	9481	15.7
<b>Race/ethnicity</b>						
White	21806	14.1	16607	23.9	11624	16.7
Black	3205	15.4	966	25.8	504	16.9
Asian	244	9.3	103	15.1	53	15.4
Hispanic	453	11.9	151	17.7	89	10.7
Others	400	14.1	160	23.4	104	16.8
<b>In Medicaid-administered program</b>						
Yes	6377	19.0	3820	29.2	3278	22.8
No	19731	13.1	14167	22.7	9096	15.3
<b>Median household income of zip code</b>						
< \$34,000	9085	14.6	6304	24.4	3507	16.8
\$34,000-\$45,000	8801	14.2	6033	23.6	4169	16.6
> \$45,000	8217	13.5	5648	23.3	4696	16.5
<b>Charlson score</b>						
0	3236	6.7	1926	13.3	967	7.1
1-2	9053	12.4	6299	20.7	4443	14.6
3+	13819	23.5	9762	34.0	6964	27.0
<b>History of hospitalization in 2001 or 2002</b>						
Yes	11313	19.7	12947	28.8	7923	21.1
No	14795	10.5	5040	17.1	4451	12.6
<b>U.S. region of residence</b>						
Midwest	6893	14.1	4697	24.3	3781	17.0
Northeast	5570	13.7	3490	22.7	2642	16.5
South	10409	14.6	7225	24.0	4283	16.4
West	3234	13.5	2574	24.0	1667	16.5
<b>Rural Residence</b>						
Yes	7381	14.5	5506	24.1	3331	16.6
No	18708	14.0	12466	23.7	9037	16.7
<b>Number of physician office visits in 2002</b>						
< 5	8968	17.8	5085	28.5	5917	23.9
5-9	7055	11.4	4886	21.3	2769	13.8
10-14	4568	12.0	3500	21.1	1625	12.5
15 +	5517	15.9	4516	25.4	2063	13.7
<b>Visited an endocrinologist in 2002</b>						
Yes	1557	14.0	252	23.3	186	16.3
No	24551	14.1	17735	23.8	12188	16.6
<b>Visited an obstetrician-gynecologist in 2002</b>						
Yes	881	9.3	616	15.5	514	9.6
No	15175	14.4	9219	24.2	8967	16.6
<b>Visited a psychiatrist in 2002</b>						
Yes	1336	30.1	879	36.7	4001	19.6
No	24772	13.7	17108	23.5	8373	15.5
<b>Visited a pulmonologist in 2002</b>						
Yes	1802	22.4	6295	27.8	848	23.8
No	24306	13.7	11692	21.9	11526	16.2
<b>Number of diabetic care services received in 2002</b>						
0	4476	22.1	8033	31.4	6248	23.3
1	7512	17.7	7227	21.9	4660	15.2
2	8848	12.9	2595	16.5	1394	9.9
3	5272	9.9	132	15.5	72	8.7

**Table A.C1. Total and mean (person-years) cost to Medicare in 2003 among study cohorts diabetes only (DM only), chronic obstructive pulmonary disease only (COPD), and depression only (D)**

	DM		COPD		D	
	Cost in dollars		Cost in dollars		Cost in dollars	
	Total	Mean	Total	Mean	Total	Mean
Total	1,615,195,559	9,052	821,593,681	12,672	539,839,985	9,693
Age-group (years)						
67-69	196,140,822	6,848	82,840,052	10,356	48,544,735	6,751
70-74	387,950,894	7,703	177,097,708	11,066	94,316,264	7,897
75-79	426,003,259	9,246	211,981,869	12,526	120,511,892	9,590
80-84	334,626,709	10,630	180,787,291	13,760	126,258,234	11,078
85+	270,473,875	12,363	168,886,760	15,683	150,208,860	11,923
Sex						
Male	669,186,009	8,850	380,924,662	12,683	131,282,848	10,599
Female	946,009,550	9,201	440,669,019	12,663	408,557,137	9,433
Race/ethnicity						
White	1,314,678,246	8,893	745,811,504	12,501	497,102,101	9,606
Black	211,730,891	10,130	50,897,056	15,456	27,260,444	11,177
Asian	23,118,065	8,386	6,555,291	10,908	3,187,173	10,539
Hispanic	40,580,493	10,145	11,835,179	16,439	8,083,877	10,461
Others	25,087,865	8,524	6,494,651	11,597	4,206,390	9,703
In Medicaid-administered program						
Yes	336,755,010	11,316	160,449,283	14,780	111,248,412	11,147
No	1,278,440,549	8,599	661,144,398	12,248	428,591,573	9,375
Median household income of zip code						
< \$34,000	552,527,675	9,084	285,761,594	12,680	155,772,725	9,632
\$34,000-\$45,000	519,649,983	8,697	267,348,293	12,134	172,241,021	9,012
> \$45,000	542,731,407	9,385	268,453,189	13,250	211,727,122	10,377
Charlson score						
0	277,976,957	4,705	105,519,286	6,941	77,950,173	5,060
1-2	591,401,129	8,427	295,278,272	11,021	197,650,081	8,746
3+	745,817,472	15,168	420,796,124	18,425	264,239,732	14,936
History of hospitalization in 2001 or 2002						
Yes	869,930,501	13,351	589,114,263	15,912	346,633,065	13,128
No	745,265,058	6,579	232,479,418	8,359	193,206,920	6,596
U.S. region of residence						
Midwest	391,889,271	8,354	195,016,457	11,753	138,308,486	8,753
Northeast	379,546,335	10,265	173,210,382	13,747	123,493,865	10,904
South	634,976,808	8,905	336,340,261	12,700	201,243,964	9,718
West	208,652,799	8,981	116,992,566	12,782	76,734,107	9,765
Rural residence						
Yes	395,675,233	7,937	228,527,908	11,426	127,165,031	8,327
No	1,218,959,831	9,483	592,920,426	13,228	412,567,193	10,210
Number of physician office visits in 2003						
< 5	387,340,161	7,901	232,729,436	13,060	188,115,192	9,567
5-9	384,478,342	6,373	185,583,933	9,427	112,301,066	7,390
10-14	331,072,616	9,159	157,011,576	11,820	90,187,475	9,340
15 +	512,304,439	15,559	246,268,736	17,535	149,236,253	13,348
Visited an endocrinologist in 2003						
Yes	184,928,184	14,615	23,966,191	22,756	15,349,989	15,446
No	1,430,267,375	8,628	797,627,490	12,506	524,489,996	9,588
Visited an obstetrician-gynecologist in 2003 (women only)						
Yes	77,935,843	8,510	33,225,393	10,594	38,535,149	8,257
No	868,073,707	9,269	407,443,626	12,868	370,021,988	9,576
Visited a psychiatrist in 2003						
Yes	159,061,062	29,442	84,119,140	32,900	170,343,849	13,424
No	1,456,134,497	8,416	737,474,541	11,842	369,496,136	8,592
Visited a pulmonologist in 2003						
Yes	367,698,209	32,188	392,074,918	20,838	106,181,065	29,548
No	1,247,497,349	7,470	429,518,764	9,334	433,658,920	8,323
Number of diabetic care services received in 2003						
0	277,741,571	13,764	365,341,894	16,192	230,462,223	11,860
1	377,478,724	10,519	306,260,669	11,267	204,416,219	8,887
2	546,379,095	8,180	136,509,068	9,831	95,932,657	7,840
3	413,596,168	7,443	13,482,051	11,226	9,028,886	8,792