Assessing the Societal Burden of Glaucoma Patients With vs. Without Physical or Mental Comorbidities

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Abstract

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Background: Glaucoma is a collection of eye diseases that damage the eye's optic nerve resulting in vision loss and blindness. Treatment for glaucoma is primarily pharmacologic, however, adherence issues with topical medications are problematic. Patients with select comorbid conditions that impact physical or mental function might be most at risk for adherence issues.

Objective: Characterize patients with vs. those without select physical or mental comorbidities and estimate differences in healthcare resource use (HCRU), healthcare expenditures and health related quality of life (HRQoL) between the two groups, using Medical Expenditure Panel Survey (MEPS) data.

Methods: MEPS data collected between 2003-2014 was aggregated and viewed cross-sectionally using the first year of data for each patient during a two year panel survey. The subgrouping by physical or mental comorbid conditions was done using ICD-9 codes collected by MEPS. Between

group comparisons in the outcomes of interest (HCRU, expenditure, HRQoL) were conducted using several different regression analyses.

Results: We identified a total of 2,928 glaucoma patients during the 11 years of collected data, including

1,539 who had a comorbid condition labeled as physical or mental. Those with select physical or mental comorbidities had greater unadjusted HCRU and expenditures (all $P<0.05$), however after adjustment for many possible confounders significant associations did not persist for the majority of individual HCRU or expenditure outcomes. HRQoL as measured by the two component, physical and mental, SF-12 was lower in the with select physical and mental comorbidity subgroup both before and after adjustment for confounding (all $P<0.05$).

Conclusion: Our study displays that glaucoma patients with a physical or mental comorbidity have increased healthcare resource use and expenditure with a lower health-related quality of life compared to those without one, however much, if not all, of this difference is attributable to different baseline characteristics between the two subgroups.

Background

Glaucoma is a collection of eye diseases that damage the eye's optic nerve resulting in vision loss and blindness.[1] Glaucoma is the second leading cause of blindness in the world and is responsible for over 120,000 prevalent cases of blindness in the United States.[2] Moreover, the disease exerts a heavy cost burden, with an estimate of over $2.9 billion in direct medical costs yearly to the United States.[3] Vision loss in glaucoma develops most commonly through increased ocular pressure over time.[1] This subset of the disease is categorized as primary open-angle glaucoma, a chronic, non-curable disease managed with a number of treatment modalities including surgery and medication.[4]

Current treatment for glaucoma is primarily pharmacologic. Alpha agonists and beta blockers came to market in the 1950s and 60s and topical prostaglandins in the late 1990s, allowing for multiple lines of topical medications (drop treatments).[4] Despite being the first-line choice, drop treatments for glaucoma have inherent problems, the most problematic of these drawbacks is potentially poor adherence.[4] Recently, significant improvements have been made in non-drop treatments including laser procedures and minimally invasive glaucoma surgeries (MIGs) involving stents and shunts.[5] These improved alternatives could potentially reduce patients' reliance on drop treatments and partially overcome the problematic adherence and persistence seen with topical eye-drops.[6,7] This, in turn, could lead to recommendations for treatment options that provide better value, or improved health outcomes achieved per dollar spent.[8] This potential increased value would hypothetically be the greatest for patients who have a physical or mental comorbid condition who have associated poor adherence with drop treatments.

The objective of this study is the quantify differences in patient characteristics, health related quality of life, health care utilization and expenditures between glaucoma subpopulations defined as those with a select physical or mental comorbidity (With SPMC) versus those without (Without SPMC).

To date, an analysis subgrouping the glaucoma population in this manner has not been conducted, and the potential results could help guide future research strategies in this therapeutic area.

Methods

Medical Expenditure Panel Survey (MEPS):

All data included in the study are from the Medical Expenditure Panel Survey (MEPS). MEPS is a nationally representative subsample of the National Health Interview Survey, which is a multipurpose and continuously conducted survey of the US non-institutionalized civilian population.[9] MEPS oversamples certain policy-relevant subgroups of the population including low-income households, whereas the National Health Interview Survey oversamples black, Hispanic and Asian individuals.[9] MEPS data are collected in 2.5 year longitudinal panels over five rounds, with overlapping panels in each calendar year (Figure 1).

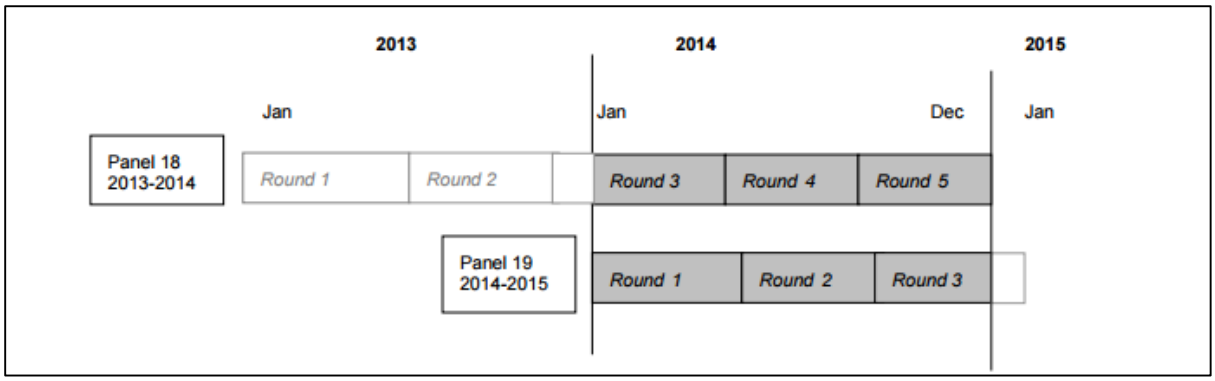

Figure 1 MEPS Panel Data by Rounds

For this study, we used a cross-sectional approach using only yearly calendar files from 2003 to 2014, the last year of finished MEPS files available in June 2017. Moreover, only data collected in the first year of each 2-year MEPS panel was used for each patient to prevent bias arising from including the same patient twice in the analysis in two separate years. Approval by the University of Washington Institutional Review Board was not required for this study, as MEPS is considered a public dataset.

MEPS International Classification of Diseases, Ninth Revision (ICD-9) Clinical Classification Codes were used to identify patients diagnosed with glaucoma, as well as any physical or mental comorbidity used to identify a patient's subgroup. The purpose of splitting the glaucoma patient using this marker was that it was hypothesized that patients who had one of these comorbidities were most likely to have poor adherence to drop treatment because of difficulty remembering to instill drops (mental comorbidities) or have physical difficulty with instilling drops and with their overall self-care (physical comorbidities). Appendix 1 contains all comorbidities included in the grouping of glaucoma patients with SPMC. Identified glaucoma patients were then split into two subgroups as to whether or not they had a qualifying SPMC. Once identified using the MEPS yearly medical conditions file, the patient identification number was used to extract demographic, disability, and outcome data using the full-year consolidated data files. The Charlson comorbidity index (CCI) score was calculated using the D'Hoore method utilizing the MEPS ICD-9 Clinical Classification Codes.[10] Appendix 2 lists the score values and corresponding ICD-9 codes that were used to calculate a CCI score that ranged between 0 and 30. Differences between the with SPMC subgroup and without SPMC subgroup in all demographic and disability variables were tested for significance using chi squared tests for categorical outcomes and simple linear regressions for continuous outcomes.

Health Care Resource Utilization:

To assess differences in health care resource utilization (HCRU) outcomes between glaucoma patients with and without SPMCs, several relevant variables were collected from MEPS. These outcomes include provider visits (both clinic based and outpatient based), emergency room visits, hospital inpatient admissions, home health provider days, and prescription drug fills. Data were collected from the MEPS full year consolidated data file after patient identification was completed using the medical conditions file. Comparisons between the two subgroups in these variables were evaluated using negative binomial regression models; negative binomial models are appropriately used when

count outcomes are of interest, yet they are heavily right skewed. Unadjusted and adjusted incident rate ratios (IRRs) were estimated, the latter adjusting for differences in the two subgroups in demographic and disability variables. Covariates used in regression equations are catalogued in appendix 3.

Health Expenditures:

Analogous MEPS expenditure variables are available corresponding to the six HCRU outcomes of interest. Collection was nearly identical to that used in HCRU, except for home health care and inpatient visit expenditures, for which individual components of expenditures in each category were summed to a total expenditure for each variable, as there was no native MEPS total expenditure for these two outcomes. The Personal Consumption Expenditure Health Price Indices were used to adjust each expenditure to inflation adjusted 2014 US dollars.[11] Comparisons in expenditures between the unsuitable and suitable subgroups were estimated using regression models that employed extended estimating equations (EEE), which improved model fit over the more traditionally used generalized linear model with a gamma family and log link. For each model, the method of recycled predictions was used to estimate differences in expenditures. For one outcome, outpatient based provider visits, no model with the majority of covariates would converge using EEE and a two part model, (first part logit, second part log-link, gamma family generalized linear regression), was used instead. Adjustments for potential confounding were made using several covariates.Eexact regression equations are found in appendix 3.

Health-Related Quality of Life:

The last outcome of interest was health related quality of life (HRQoL), comparing differences between glaucoma patients with and without SPMCs. MEPS collects HRQoL data using the 12-item Short Form Survey (SF-12) which produces a mental component score (MCS) and a physical component

score (PCS). The MCS and PCS have a national mean in the US population of 50 and a standard deviation of 10, meaning those who score above 50 have higher than average health than the typical person in the general US population (age is not held constant) and those below 50 have worse than average health.[12] Each one point difference above or below 50, in either component, corresponds to a one-tenth of a standard deviation. Differences in HRQoL were tested using ordinary least squares regression models, both unadjusted and adjusted for a number of covariates. Regression equations are listed in appendix 3.

Statistical Analysis:

All variables used in the analysis and their tests or regressions conducted on each for significance are found in appendix 4. Analyses were conducted primarily using R version 3.3.0 statistical software, except that STATA 13-IC version 13.1 (StataCorp, College Station, TX) was used in regressions that estimated expenditure outcomes, as programming code for extended estimating equations is only available in STATA. Comparisons between the with and without SPMCs subgroups were performed using a two-tailed alpha level of 0.05.

Results:

Over the eleven year period between 2003 and 2014, 2,928 unique glaucoma patients were identified in the MEPS database. Of the 2,928 who had an ICD-9 MEPS code for glaucoma diagnosis 01,539 (52.6%) also had an ICD-9 diagnosis for a physical or mental comorbidity. Table 1 list the demographic and disability characteristics for the two subgroups, as well as the total glaucoma population. Significant differences between the two subgroups were seen in age (P=0.023), the percent female in each subgroup (P<0.001), insurance coverage (P=0.004), current employment (P<0.001), average wages (P<0.001) and both disability variables: serious cognitive disability and serious difficulty walking (each P<0.001); The with SPMC subgroup was more likely older, female, less likely to be employed and more likely to have limiting cognitive or walking disabilities.

Table 1: Patient Demographics and Disability Status

	Total	Without SPMC	With SPMC	P value
N (%)	2928	1389 (47.4)	1539 (52.6)	
Age (SD)	65.09 (15.84)	64.39 (16.31)	65.73 (15.37)	P=0.023
Female (%)	1708 (58.3)	749 (53.9)	959 (62.3)	P<0.001
Race:				
White (%)	1971 (67.3)	914 (65.8)	1057 (68.7)	P=0.066
Black (%)	735 (25.1)	359 (25.8)	376 (24.4)	
Asian (%)	156 (5.3)	88 (6.3)	68 (4.4)	
Other/ Multiple Races Reported (%)	66 (2.3)	28 (2.0)	38 (2.5)	
Education:				
No Education (%)	21 (0.7)	12 (0.9)	9 (0.6)	P=0.96
High School or less (%)	1243 (42.5)	630 (45.4)	613 (39.8)	
1-3 Years of College (%)	368 (12.6)	183 (13.2)	185 (12.3)	
4 Years of College (%)	250 (8.5)	124 (8.9)	126 (8.2)	
5+ Years of College (%)	216 (7.4)	111 (8.0)	105 (6.8)	
Unreported/not ascertained (%)	830 (28.3)	329 (23.7)	501 (32.6)	
Insurance:				
Private Insurance (%)	1608 (54.9)	777 (56.0)	831 (54.0)	P=0.004
Public Insurance (%)	1171 (40.0)	525 (37.8)	646 (42.0)	
Uninsured (%)	149 (5.1)	87 (6.3)	62 (4.0)	
Employment:				
Employed/job to return to (%)	909 (3.1)	480 (34.6)	429 (27.9)	P<0.001
Unemployed (%)	1952 (66.7)	874 (62.9)	1078 (70.0)	
Unreported/not ascertained (%)	67 (2.3)	35 (2.5)	32 (2.1)	
Mean Wage (SD):	$13,848 (27,664)	$15,159 (28,712)	$12,666 (26,637)	P=0.015
Serious cognitive difficulties (%)	355 (12.1)	91 (6.6)	264 (17.2)	P<0.001
Serious difficulty walking/climbing stairs (%)	966 (33.0)	322 (23.2)	644 (41.8)	P<0.001
Charlson Comorbidity Index (SD) [Out of possible score of 0 to 30]	3.91 (3.92)	2.28 (2.84)	5.38 (4.17)	P<0.001

Health Care Resource Use:

The unadjusted IRR between glaucoma patients with and without SPMCs was significant for each of the six HCRU outcomes, as seen in table 2. However, after adjusting for covariates, only differences in office based provider visits, IRR 1.114 (95% Confidence Interval (CI), 1.032 to 1.202), and home health provider days, IRR 1.906 (95% CI, 1.253 to 2.900), remained significant. A 90% increase,

after adjustment, in home health provider days in glaucoma patients with an SPMC compared to those without suggests a much higher comparative resource use particularly in this outcome, whereas in all other outcomes comparative differences after adjustment were between 0.8% (prescription fills) to 17.3% (outpatient based provider visits) more usage in the with SPMC subgroup.

Table 2: Health Care Resource Use

Outcome	Without SPMC (Mean)	With SPMC (Mean)	Unadjusted Difference	Unadjusted IRR (95% CI)	Adjusted IRR (95% CI)
Office Based Provider Visits (OBTOTV)	9.536	13.69	4.154	1.436 (1.332 , 1.547)**	1.114 (1.032 , 1.202)**
Outpatient Based Provider Visits (OPTOTV)	0.9777	1.506	0.5283	1.540 (1.283 , 1.848)**	1.173 (0.970 , 1.418)
Emergency Room Visits (ERTOT)	0.2462	0.3814	0.1352	1.550 (1.285 , 1.869)**	1.039 (0.852 , 1.268)
Inpatient Hospital Stays (IPDIS)	0.1555	0.2632	0.1077	1.692 (1.364 , 2.103)**	1.062 (0.844 , 1.336)
Home Health Provider Days (HHTOTD)	3.866	12.35	8.484	3.195 (2.138 , 4.775)**	1.906 (1.253 , 2.900)**
Prescription Fills (RXTOT)	27.07	38.51	11.44	1.422 (1.316 , 1.537)**	1.008 (0.936 , 1.085)

*P<0.05 **P<0.01

Adjusting for age, gender, race, insurance, employment status, wage, physical limitation, cognitive limitation, and CCI.

Expenditures:

All unadjusted expenditures were higher in the with SPMC glaucoma subgroup although no significant differences persisted after adjustment for confounding using regression models with extended estimating equations, or the two part model. In total, the expenditures of these six outcomes combined was, on average, $12,324 in the SPMC subgroup and $8,590 for the without SPMC subgroup over one year of MEPS expenditure data.

Table 3: Expenditures

Outcome	Without SPMC (Mean)	With SPMC (Mean)	Unadjusted Difference	Adjusted difference (95% CI)	P value
Office Based Provider Expenditures (OBVEXP)	$2047	$2688	$641	$77 (-271.27, 425.50)	0.664
Outpatient Based Provider Expenditures (OPVEXP)	$439	$497	$58	-$3 (-$14, $8)*	>0.05*
Emergency Room Expenditures (ERTEXP)	$278	$311	$33	-$42 (-176.54, 92.55)	0.522
Inpatient Hospital Expenditures (IPTEXP)	$3337	$4314	$977	-$883 (-2230.72, 463.38)	0.174
Home Health Expenditures (HHTEXP)	$406	$1014	$608	$116 (-170.23, 403.64)	0.443
Prescription Drug Expenditures (RXEXP)	$2333	$3500	$1167	-$3 (-326.53, 319.99)	0.984

Adjusting for age, gender, race, insurance, employment status, wage, physical limitation, cognitive limitation, and CCI (each outcome used a different set of covariates as needed because of limitations in attaining model convergence) See Appendix 3. *Using Bootstrapping in two part logit/log-link gamma model.

Health Related Quality of Life:

HRQoL differences can be seen in table 4. As a whole, glaucoma patients with SPMCs had worse unadjusted HRQoL in both the MCS and PCS of the SF-12 (beach P<0.001). On average, those with glaucoma in the SPMC subgroup had an MCS score -1.278 points (95% CI: -2.099, -0.458, P<0.01) worse and a PCS -0.849 points (95% CI: -1.640, -0.058, P<0.05) worse than those without an SPMC after adjustment. As a whole, glaucoma patients in the combined cohort had an average MCS similar to the

average population at 50.15 (SD: 10.56), where mean SF-12 MCS is 50 and SD is 10 for the entire US population; and an average PCS was of 41.79 (SD: 12.55) well below the population mean.

Table 4: Health Related Quality of Life using SF-12 Mental and Physical Component Scores

SF-12 Component	Total Mean (SD)	Without SPMC Mean (SD)	With SPMC Mean (SD)	Difference (unadjusted) (95% CI)	Difference (adjusted) (95% CI)
Mental Component Score	50.17 (10.56)	51.79 (9.512)	48.74 (11.22)	-3.049 (-3.833, 2.266)**	-1.278 (-2.099, -0.458)**
Physical Component Score	41.79 (12.55)	44.67 (11.66)	39.22 (12.76)	-5.458 (-6.381, -4.534)**	-0.849 (-1.640, -0.058)*

*P<0.05 **P<0.01

Adjusting for age, gender, race, insurance, employment status, wage, physical limitation, cognitive limitation, and CCI.

Discussion:

Using the MEPS database, a representative sample of the US civilian population, this cross-sectional study evaluated 11 years of the most recently collected MEPS data to compare two distinct glaucoma subgroups, those with a physical or mental comorbidity compared to those without one. Demographic and disability characteristics were statistically different between the two subgroups suggesting that this sectioning can be used to group those who are more likely older, female, less likely to be employed and more likely to have limiting disabilities. As projected, glaucoma patients with an SPMC were more likely to have increased use of all HCRU outcomes and higher expenditures, along with decreased HRQoL as measured by the SF-12. Because of the clear differences in baseline characteristics between the two subgroups, adjustments were made for confounding. After adjustment, few statistically significant differences persisted in HCRU outcomes, and none for expenditure outcomes. Specifically, home health provider days and office based provider visits remained significant after

adjustment, however, the corresponding expenditures for both HCRU outcomes became non-significant after adjustment, which calls into question the value of the HCRU difference. HRQoL measured by SF-12, displayed major differences between these two subgroups in PCS and MCS even after adjustment.

Although our results cannot support any concrete policy changes they do support conducting more research in whether appropriate sectioning of the entire glaucoma population into subgroups to find populations with potential higher value for new non-drop treatments, such as laser or minimally invasive surgical procedures or implants. These alternative treatment pathways have higher upfront costs but could provide increased effectiveness for populations where drop treatments might be less effective due to decreased adherence.

We found no current published literature that utilizes the subgrouping of the total glaucoma population into a similar fashion to compare expenditures as we did. However, a growing amount of published cost-effectiveness and other economic studies on new treatment alternatives compared to existing drop treatments are becoming available as these new alternatives receive approval.[13-20] Attempting to find appropriate populations to target for new therapies, because of decreased drop treatment adherence, will be valuable in future detailing treatment pathways for both new and prevalent cases of glaucoma, to limit costs to society while providing ideal clinical care.

The strength of this study was that we used the nationally representative MEPS data. The study also has a few limitations. First, the aggregation of ICD-9 codes in MEPS doesn't allow one to only look at primary open-angle glaucoma, resulting in an aggregation of other glaucoma diagnoses, including acute conditions not of interest in this analysis. Second, the makeup of the with SPMC subgroup, which uses a large number of heterogeneous physical and mental comorbidities precludes a more granular understanding of the effect of each individual comorbidity. However, further subgrouping by each individual comorbid conditions led to populations too small for meaningful statistical inference.

Moreover, the lack of a uniform set of covariates that fit all regression models was problematic and also suggests that the sample size wasn't sufficiently large to conduct this analysis using all relevant covariates. Third, this is a prevalent cohort, and collected data from newly diagnosed patients as well as more refractory patients, therefore cost comparisons and treatments are not perfectly comparable between individuals, nor can any statement be made on the first treatment choice or treatment pathway after diagnosis.

Future work on the collected MEPS dataset was going to include trends in yearly data, but because of the small total sample size use of only the pooled data across time was feasible. Other possible further analyses include comparative use of the second year of MEPS data for each individual patient in the cohort, as well as potentially looking at the second year of glaucoma data for patients with no diagnosed glaucoma during their first year in the analysis, for the purpose of looking at expenditure data in the incident year of glaucoma diagnosis.

Conclusion:

In this nationally representative sample using MEPS data we estimated that HCRU and expenditures including use of office based and outpatient based provider visits, emergency room visits, inpatient hospital stays, home health provider days, and prescription drug fills, as well as their associated expenditures, were greater, and HRQoL lower, for patients with glaucoma who also have a physical or mental comorbidity compared to those without one. This highlighted subgroup could potentially be targeted for new non-drop treatments of glaucoma to provide better, and potentially cost-effective, clinical care.

Appendix 1: ICD-9 and MEPS Codes for Defined Unsuitable Comorbidities

Subgroup	ICD-9/CPT Codes	MEPS Codes
Comorbidities resulting in limited mobility		
Gout	274.**	274
Tics	307.2*	307 is Special symptom NEC
Movement Disorders	307.3*	N/A
Hereditary & Degenerative Disease of the CNS (PD, ALS, other movement disorders)	332.**, 333, 334, 335.**	331 cereberal degeneration, 332 Parkinsons, 333 EPS,
MS, paralysis, epilepsy, cerebral palsy	340.**to 342.**; 344.0, 344.2, 344.4; 345	340 MS, 343 infantile Cerebral Palsy, 345 Epilepsy, 344 Other Paralytic Syndromes
Late effects of cerebrovascular disease	438.2, 438.3, 438.5	436 CVA, 437 Other cerebrovascular disease
Mononeuritis of upper limb	354.**(except 354.2 and 354.3)	354 Mononeuritis upper limp, 355 Mononeuritis leg
Hereditary & idiopathic peripheral neuropathy	356.**	357 Neuropathy,
Inflammatory and toxic neuropathy	357	N/A
Myoneuronal disorders, muscular dystrophy	358.**to 359.**	359 Muscular Dystrophies
SLE	710.0	710 Connective Tissue Disorders
Polymyositis	710.4	710 Connective Tissue Disorders
Crystal arthropathies	712.*1 to 712.*4	N/A
RA	714.**	714 Other inflammatory polyarthropathy
OA	715.*1 to 715.*4	715 OA
Joint derangement	718.*1 to 718.*4	717 internal joint derangement, 718 other joint derangement
Joint disorder	719.*1 to 719.*4	719 Joint disorder
Reduction deformities of upper limb	755.2*	754 congenital musculoskeletal deformities, 755 other congenital limb

		anomalies, 756 other musculoskeletal anomalies
Down's, Patau's, and Edward's syndrome	758.0 to 758.2	758 chromosomal anomalies, 759 congenital anomalies (nec/nos)
More than 1 Physical Type	2 or more physical (but no mental/CNS)	
Mental/CNS comorbidities		
Dementia and Psychoses	290.**to 299.**	294, other organic psych condition, 295 schizophrenic disorder, 296 affective psychoses, 298 other nonorganic psychoses, 299 pervasive development disorders
Other cerebral degenerations (include AD)	331.0-2	331 cerebral degeneration
Dissociative amnesia	300.12	300 neurotic disorders ? 301 personality disorders ?
Alcohol dependence	303.**	303 alcohol dependence syndrome
Drug dependence	304.**	304 drug dependence
Physiological malfunction arising from mental factors (Musculoskeletal)	306.0	N/A
Nonpsychotic mental disorder due to brain damage	310.**	N/A
Intellectual Disability	317.** to 319.**	315 specific developmental delays
Anoxic brain damage	348.1	348 other brain conditions
Encephalopathy	348.3*, 291.2, 572.2, 437.2, 349.82	437 other cerebrovascular disease, 349 CNS disorder nec/nos
Other CNS disorders	348.2, 348.4, 348.5, 348.8, 348.9	348 other brain conditions

Appendix 2: D'Hoore method Charlson Comorbidity Scoring

Weights	Conditions	ICD-9 Codes
1	Myocardial infarct	410,411
	Congestive Heart Failure	398,402,428
	Peripheral Vascular Disease	440-447
	Dementia	290,291,294
	Cerebrovascular Disease	430-433,435
	Chronic Pulmonary Disease	491-493
	Connective Tissue Disease	710,714,725
	Ulcer Disease	531-534
	Mild Liver Disease	571,573
2	Hemiplegia	342,434,436,437
	Moderate or Severe Renal Disease	403,404,580-586
	Diabetes	250
	Any Tumor	140-195
	Leukemia	204-208
	Lymphoma	200,202,203
3	Moderate or Severe Liver Disease	070,570,572
6	Metastatic Solid Tumor	196-199

Appendix 3: Regression Equations

Variable	Regression Covariates
Office Based Provider Visits (OBTOTV)	Age sex race insurance employment wage dfwalk dfcog cci
Outpatient Based Provider Visits (OPTOTV)	Age sex race insurance employment wage dfwalk dfcog cci
Emergency Room Visits (ERTOT)	Age sex race insurance employment wage dfwalk dfcog cci
Inpatient Hospital Stays (IPDIS)	Age sex race insurance employment wage dfwalk dfcog cci
Home Health Provider Days (HHTOTD)	Age sex race insurance employment wage dfwalk dfcog cci
Prescription Fills (RXTOT)	Age sex race insurance employment wage dfwalk dfcog cci
Office Based Provider Expenditures (OBVEXP)	agec $agec^2$ sex race insurance employment lnwage dfwalk dfcog cci
Outpatient Based Provider Expenditures (OPVEXP)	Age sex race insurance employment wage dfwalk dfcog cci
Emergency Room Expenditures (ERTEXP)	agec $agec^2$ sex race insurance employment lnwage dfwalk dfcog cci
Inpatient Hospital Expenditures (IPTEXP)	agec agec2 sex race employment lnwage dfwalk dfcog cci
Home Health Expenditures (HHTEXP)	agec sex race employment lnwage dfwalk dfcog cci
Prescription Drug Expenditures (RXEXP)	agec $agec^2$ sex race insurance employment lnwage dfwalk dfcog cci

Mental Component Score (MCS)	Age sex race insurance employment wage dfwalk dfcog cci
Physical Component Score (PCS)	Age sex race insurance employment wage dfwalk dfcog cci

Race: White, Black, Asian, Other/unreported
Insurance: Public, Private, Uninsured
dfwalk – serious walking difficulty
dfcog – serious cognitive difficulty
cci – charlson comorbidity index score
agec – age centered at 65
$agec^2$ – age centered squared
lnwage – ln of wage variable

Appendix 4: Variables used in the analysis

MEPS Variable Name	Description	Test or Regression type Used for Significance
Descriptive Variables		
AGE	Age	T-test
SEX	gender	Chi Squared
RACEX	Race/ethnicity	Chi Squared
EDUCYR	Years of education	Chi Squared
INSCOV	Insurance (Public/Private/Uninsured)	Chi Squared
WAGEP	Wage and salary income	T-test
EMPST	Employment status	Chi Squared
Disability Variables		
DFCOG	Serious cognitive difficulty	T-test
DFWLKC	Difficulty walking or climbing stairs	T-test
Health Related Quality of Life (HRQoL) Variables		
PCS	PCS-12 (Physical) Score of SF-12	Linear
MCS	MCS-12 (Mental) Score of SF-12	Linear
Health Care Resource Use (HCRU) Variables		
OBTOTV	Office Based Provider Visits	Negative Binomial
OPTOTV	Outpatient Based Provider Visits	Negative Binomial
ERTOT	Emergency Room Visits	Negative Binomial
IPDIS	Inpatient Hospital Days	Negative Binomial
HHTOTD	Home Health Provider Days	Poisson (lack of convergence with Negative Binomial)
RXTOT	Prescription fills	Negative Binomial
Expenditure Variables		
OBVEXP	Office Based Provider Expenditures	Extended Estimating Equations with Recycled Predictions
OPVEXP	Outpatient Based Provider Expenditures	Two part model 1. Logit 2. Log-link Gamma Generalized Linear Model
ERTEXP	Emergency Room Expenditures	Extended Estimating Equations with Recycled Predictions
IPTEXP	Inpatient Expenditures	Extended Estimating Equations with Recycled Predictions
HHTEXP	Home Health Expenditures	Extended Estimating Equations with Recycled Predictions
RXEXP	Prescription Drug Expenditures	Extended Estimating Equations with Recycled Predictions

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