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The costs of dementia subtypes to California Medicare fee-for-service, 2015

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Abstract

INTRODUCTION—Dementia is among the costliest of medical conditions, but it is not known how these costs vary by dementia subtype.

METHODS—The effect of dementia diagnosis subtype on direct healthcare costs and utilization was estimated using 2015 California Medicare fee-for-service data. Potential drivers of increased costs in Lewy body dementia, in comparison to Alzheimer's disease, were tested.

RESULTS—3,001,987 Medicare beneficiaries were identified, of which 8.2% had a dementia diagnosis. Unspecified dementia was the most common diagnostic category (59.6%), followed by Alzheimer's disease (23.2%). Lewy body dementia was the costliest subtype to Medicare, on average, followed by vascular dementia. The higher costs in Lewy body dementia were explained in part by falls, urinary incontinence or infection, depression, anxiety, dehydration, and delirium.

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DISCUSSION—Dementia subtype is an important predictor of healthcare costs. Earlier identification and targeted treatment might mitigate the costs associated with co-occurring conditions in Lewy body dementia.

Keywords

Lewy body dementia; vascular dementia; Alzheimer's disease; healthcare costs; Medicare; falls

1. INTRODUCTION

Dementia is a syndrome defined by a progressive decline in memory or other thinking skills that is severe enough to reduce a person's ability to perform everyday activities [1]. One in every 9 people aged 65 and over, and 1 in every 3 people aged 85 and over, are diagnosed with Alzheimer's disease, the most common etiological cause of dementia [2]. Dementia is among the most expensive diseases in the United States [3]. The 2010 annual cost per person that was attributable to dementia was estimated to be between $41,689 and $56,290, and the total annual U.S. population cost was between $157 billion and $215 billion, with $11 billion of this cost paid by Medicare [3]. The burden of disease will increase as the population aged 65 and over grows, and it is projected to nearly double between 2012 and 2050 [4]. Understanding the healthcare costs and utilization in dementia, as well as the drivers of these costs, is critical to guiding priorities in healthcare programs and policies.

The most common cause of dementia is Alzheimer's disease (AD). However, an estimated 40–50% of dementias are caused by non-AD diseases, most commonly Lewy body dementia (LBD) – which includes both Parkinson's disease with dementia (PDD) and dementia with Lewy bodies (DLB), vascular dementia (VaD), and frontotemporal dementia (FTD) [5–8]. Each of these diseases is characterized by distinct pathological signatures, symptom profiles, disease trajectories, and care needs [9–13]. Consequently, the medical care costs and healthcare utilization patterns would be expected to vary by these dementia subtypes. Indeed, several studies with small samples have found that LBD or VaD are more expensive per patient than AD [14–19]. No economic studies to date, however, have simultaneously compared all four of the most common subtypes, or used large or population-based samples. Understanding the differential cost and utilization patterns by dementia subtype could guide prioritization of care resources and research to support health system reform. Demographic factors and comorbidity burden differ by dementia subtype and may independently impact healthcare costs [20–24] and must be simultaneously examined and considered when attributing costs to dementia subtypes.

Our primary objective was to determine the annual direct Medicare utilization and costs by dementia subtype using 100% Medicare fee-for-service (FFS) claims data from California in 2015. Costs by dementia subtype were estimated twice, once using unadjusted (single-factor) analysis and once in an adjusted analysis controlling for demographic factors, comorbidity burden, and length of coverage. In secondary analyses, we evaluated the impact of potential drivers of increased costs in LBD relative to AD.

2. METHODS

2.1 Sample

We used the Centers for Medicare & Medicaid (CMS) administrative enrollment and claims data for 100% of Medicare beneficiaries enrolled in the fee-for-service (FFS) program in California in 2015. Data are used with permission from and a data use agreement with the ResDAC [25], and our use complied with the requirements of the Privacy Act, the HIPAA Privacy Rule and CMS data release policies. All 3,001,987 Medicare beneficiaries with positive claims were included. Of these, 85% were covered by both Medicare Part A and B plans for the full 2015 year.

2.2 Dementia and dementia subtype identifications

Because the tenth revision of the International Classification of Diseases took place in October 2015, dementia diagnoses were determined by both ICD-9-CM and ICD-10-CM dementia-related diagnosis codes [26]. People who had at least one diagnosis of dementia across all 2015 Medicare files were considered as dementia patients; all other beneficiaries were controls (Supplementary Table 1).

We created mutually exclusive dementia subtype categories so that we would be able to assess their independent effects on costs using multivariate regression models. We applied a three-level prioritization rule favoring the most specific diagnosis (Table 1 and Supplementary Table 1). *Prioritization level 1* were diagnoses that specified dementia etiology and included AD, VaD, LBD, FTD, Creutzfeldt-Jakob disease, drug-induced persisting dementia, and Huntington's disease. Beneficiaries with multiple level 1 diagnoses were categorized as "mixed." *Prioritization level 2* was the diagnosis "dementia in other diseases classified elsewhere." As this diagnosis is frequently given in conjunction with level 1 diagnoses, we assigned it a lower priority than the level 1 diagnoses. *Prioritization level 3* included all dementia-related diagnoses that did not specify etiology and included senile and presenile dementia and dementia not otherwise specified. People with multiple diagnoses across prioritization levels were assigned the diagnosis from the higher level. For example, patients who were diagnosed with both AD and VaD were categorized into "mixed;" patients with AD and dementia in conditions classified elsewhere were "AD;" and patients with dementia in conditions classified elsewhere and senile dementia were considered "classified elsewhere." In secondary analyses, we separated the LBD group into PDD and DLB. PD and DLB differ in the timeline of first symptoms. Once PD has progressed to include dementia, PDD and DLB are very similar clinically and pathologically [9]. For this reason, and because the DLB diagnosis code is likely given to many patients with PDD (Supplementary Table 1), we focus on the larger LBD group for all primary analyses.

2.3 Analysis

2.3.1 Prevalence estimates—We counted the frequency of subjects with any dementia diagnosis and by the mutually exclusive dementia subgroups in the full California Medicare claims sample.

2.3.2 Covariates—Demographic characteristics (age, gender, race, and geographic locale based on Rural-Urban Commuting Area "RUCA" codes) and comorbidity burden were summarized using descriptive statistics by dementia status (i.e, non-dementia versus dementia), and by dementia subtypes (Supplementary Methods). Medicare Part A and B plan coverage for the full 2015 year (85% of beneficiaries) versus partial year coverage was also covaried.

Dementia subtypes could vary in costs due in part to differences in the frequency of certain symptoms or co-occurring conditions. We quantified the following potential drivers of increased costs: falls, delirium, depression, anxiety, delusions, hallucinations, dehydration, urinary incontinence or infection, orthostasis, and sleep disorder (insomnia or REM sleep behavior disorder). These conditions were selected as potential cost drivers by a multidisciplinary team of clinician – researchers who care for these patients (K.L.P., J.M., S.J.B., B.L.M., K.L., W.C.), and were identified by both ICD-9 and ICD-10 diagnosis codes in the claims data. Presence of falls was determined by all fall-related injuries, which were captured by identifying not only diagnosis but also procedure codes indicative of falls, including fractures, head injuries, joint dislocation, and accidental falls, according to previously published methods [27]. Details on how the conditions were identified in the claims data are provided in the supplement. Associations of covariates with dementia status and subtypes were evaluated using chi-square test for categorical variables and ANOVA for continuous variables.

2.3.3 Health care utilization, costs, and cost drivers—The unadjusted costs and utilization were calculated by summing across all types of direct care services based on the structure of the Medicare claims payment categories: inpatient, outpatient, carrier, home health agency (HHA), hospice, and skilled nursing facilities (SNF). Then, healthcare cost and utilization were calculated according to more specific services provided, including hospitalization, physician visits, emergency room (ER) visits, and ambulance service (including visits with and without transport to a health care facility). The Carrier RIF file independently provided information on physician's visits; the Inpatient RIF file and the Outpatient RIF file combined provided information on ER visits; and the Outpatient RIF file and the Carrier RIF file combined provided information on ambulance services. Next, we calculated the adjusted cost using multivariable Gamma regression (log link) with weighted least square estimation. Dementia subtype was the main exposure of interest, and patient's demographic characteristics (age, gender, race), RUCA category (urban v. rural v. missing), comorbidity scores, and length of Medicare Part A&B coverage (12 months v. less than 12 months) were simultaneously controlled as confounding factors.

The mediating effects of falls, delirium, depression, anxiety, delusions, hallucinations, dehydration, urinary incontinence or infection, orthostasis, and sleep disorder were separately evaluated in the context of the counterfactual framework using multivariable Gamma regression (log link) models [28, 29], calculating the natural indirect effect over the total effect. We determined the percentage of the higher LBD costs, relative to AD costs, that could be explained by each covariate. This mediation effect is estimated from two quantities that can be computed through the Gamma model: the natural direct effect (NDE) and natural indirect effect (NIE). The NDE is the estimated impact on the total annual healthcare cost

associated with having a diagnosis of LBD but experiencing the symptoms of a person diagnosed with AD, compared with those diagnosed with AD. The NIE is the estimated impact on the total annual healthcare cost of the symptom for people diagnosed with LBD, compared with the hypothetical situation where a person diagnosed with LBD is as likely to experience the symptom as a person diagnosed with AD. The NDE thus captures part of the effect of dementia subtype which is not mediated by a potential mediator (eg., falls), whereas the NIE captures the dementia subtype effect that is mediated by a the potential mediator. The proportion mediated was calculated by NIE divided by the total effect (sum of NDE and NID). The corresponding p value was calculated by Wald $\chi 2$ tests for multivariate hypotheses, which account for the uncertainty inherent to the working model. A significant result (p value < 0.05) suggests that the natural direct and indirect effect odds differ significantly between the dementia subtypes; i.e., the symptom mediates the causal pathway between dementia subtype and total annual healthcare cost. The mediating effects of these symptoms were also examined separately for DLB and PDD, each in comparison to AD.

Data manipulation was performed using SAS software (version 9.4, SAS, Cary, NC), and statistical analysis was conducted using R Statistical Software (Foundation for Statistical Computing, Vienna, Austria). Additional details on how the variables were defined, including ICD codes used, are provided in the Supplementary Methods.

3. RESULTS

Of the 3,001,987 Medicare beneficiaries from 2015 in California, 247,007 (8.2%) had a diagnosis of dementia. According to the prioritization rules (Table 1 and Supplementary Table 1), all dementia cases were categorized into mutually exclusive subtypes. The most common specific dementia subtype was AD (23.2%), followed by LBD (4.4%), VaD (4.0%), FTD (0.3%), and other (0.2%) (Table 1). More than one of these diagnoses was given in 3.6% of cases. Of these “mixed” cases, 93.7% had a diagnosis of AD, 64.5% LBD, 41.3% VaD, and 3.7% FTD. In 4.7% of dementia cases, the diagnosis was dementia in conditions classified elsewhere. In 59.6% of cases, dementia subtype was unspecified.

Demographic and clinical characteristics by dementia status and subtype are presented in Table 2. Patients with dementia were significantly older (mean 83.0 years), and a higher proportion were female (63%) than those without dementia (72.6 years and 56%, respectively). AD diagnoses were more often given to women (69%), and LBD to men (54%). Ten percent of beneficiaries with a VaD diagnosis identified as Black, versus only 6% of beneficiaries with AD, 4% LBD, and 4% FTD. A high percentage of beneficiaries diagnosed with FTD identified as White (77%), and the percentages of beneficiaries diagnosed with FTD who identified as Black, Asian or Hispanic were lower than for any other dementia subtype.

Annualized overall healthcare costs and utilization by service type and place of service, and by dementia status and subtype, are summarized in Table 3 and detailed in Supplementary Table 2. The cost to 2015 California Medicare Part A and Part B programs of all beneficiaries with dementia was $4.2 billion and per beneficiary was $16,867, which was nearly three times more than for the average beneficiary without a dementia diagnosis

($6,070). Among dementia patients with subtype diagnoses, AD was the dementia subtype with the largest overall burden on California Medicare FFS programs ($798 million), followed by LBD ($245 million), VaD ($208 million) and FTD ($11 million).

Average annual costs were substantially higher among beneficiaries with than without dementia diagnosis for hospitalization ($8,522 vs. $2,131), physician visits ($2,341 vs. $925), emergency room (ER) visits ($3,836 vs. $926), ambulance services ($624 vs. $97), and long-term care services (HHA: $2,166 vs $427; hospice: $119 vs $18; SNF: $580 vs $88), all ps < .0001 (Supplementary Table 2). Patients diagnosed with dementia were more frequently hospitalized and had longer length of stays compared to non-dementia patients. They also had triple the number of ER visits and almost seven times more frequent ambulance services (ps < 0.0001). In addition, they had more HHA visits, hospice service requests, and SNF admissions (all ps < 0.0001). The average length of stay in SNF is about ten times longer for dementia than for non-dementia beneficiaries ($p < 0.0001$). About half of the total cost of care for dementia patients was spent on inpatient services (51%), and 19% on long term care facilities (HHA, hospice, SNF).

As shown in Table 3, LBD was the costliest type of dementia to Medicare in the crude analysis, with an annual cost of $22,514 per beneficiary, and VaD followed closely at $21,002. AD had the lowest costs per person ($13,935) with FTD costing more ($14,853). Cost differences by subtype were driven primarily by differences in hospitalization costs. Annual hospital rate, length of stay, and costs for LBD and VaD were each almost double that of AD (Supplementary Table 2). LBD had the highest average number of physician visits (42.7) in 2015. LBD and VaD patients each had more ER visits annually (6.4 for LBD, 5.8 for VaD) than AD patients (4.2). Those with VaD had twice the ambulance use (6.5) than AD patients (3.8), and LBD ambulance use was also high (5.7). The highest utilizers of HHA visits were those with LBD (14.3 visits) compared with 11.1 for VaD and 11.5 for AD.

After controlling for each patient's demographic, comorbidity burden, and length of 2015 Medicare coverage (Table 4), LBD remained the costliest dementia subtype. Compared to AD patients, the adjusted total annual healthcare cost was 31% more for LBD patients and 10% more for VaD patients. When this analysis was repeated excluding beneficiaries without a full 12 months of coverage, the results were nearly identical (not shown). Of the dementia subtypes, LBD had the highest proportion with history of falls (72.4%), depression (15.5%), anxiety (9.5%), hallucinations (1.0%), dehydration (15.6%), urinary incontinence or infection (27.7%), and orthostasis (3.1%) and the second highest proportion with delirium (17.4%), delusion (.6%), and sleep disorders (3.6%) (Table 2). Based on the mediating effect analyses, we found that presence of falls explained 21.3% of higher costs for LBD relative to AD, followed by urinary incontinence or infection (15.2%), depression (4.9%), dehydration (4.2%), anxiety (3.4%), delirium (3.3%), orthostasis (2.7%), sleep disorder (1.9%), hallucination (1.2%), and delusion (<1%).

In secondary analyses, we analyzed the costs and symptoms separately in PDD and DLB. The total per beneficiary costs were similar ($23,527 for DLB and 21,639 for PDD), with the higher costs in DLB explained primarily by higher inpatient costs (Supplementary Table 3). The symptom frequencies and their mediating effects on costs, relative to AD, revealed

similar patterns across these LBD subtypes but with slightly higher frequencies of and percentage of costs explained by delirium, depression, hallucinations, dehydration, urinary incontinence and infection, and orthostasis in DLB; and a higher percentage of costs explained by falls in PDD (Supplementary Table 4).

4. DISCUSSION

Although dementia is among the costliest of medical conditions [3], dementia subtype costs have not previously been evaluated in a population-based sample. In this study, we categorized all beneficiaries from a 100% 2015 California Medicare Fee-for-Service dataset into mutually exclusive dementia diagnosis subtypes. The majority of dementia patients did not have a specified subtype. LBD was the most expensive subtype per beneficiary, followed by VaD. This pattern was observed in both an unadjusted analysis and after adjusting for demographic factors, comorbidity burden, and length of coverage. The higher cost attributable to LBD diagnosis was partially explained by symptoms or conditions that often co-occur with the disease including falls, urinary incontinence or infection, depression, and anxiety.

Goodman and colleagues reported prevalence estimates of the most common dementia subtypes based on 100% of Medicare FFS beneficiaries nationwide. They found that across three years of claims data, 14% of beneficiaries over the age of 68 received a service or treatment that was associated with a dementia diagnosis. Unspecified dementia was the most common diagnosis (93%), followed by AD (44%), VaD (15%), and LBD (5%). In that study, multiple dementia diagnoses per beneficiary were included in the frequency counts. To evaluate the costs by subtypes, we classified all dementia patients into mutually exclusive dementia subtypes, so that each beneficiary would only be counted once; this method resulted in lower frequencies. We found that unspecified dementia was the most common dementia diagnosis subtype (59.6%), consistent with Goodman et al. This gap in care, which been attributed to the limited capacity of dementia specialists [30], creates missed opportunities for appropriate treatment and management [8]. If an effective disease-modifying therapy becomes available, closing this gap will be dire. Among the 40.4% of dementia cases where subtype was specified, AD was most common (23.2% of dementia cases), followed by LBD (4.4%), VaD (4.0%), and FTD (0.3%).

Individuals diagnosed with dementia used more health services, and they cost nearly three times more Medicare dollars on average, compared to those without dementia. Consistent with previous studies, we found that dementia patients had a higher comorbidity burden than their cognitively healthy counterparts [31]. The nature of comorbid medical conditions or their treatment may exacerbate the progression of dementia [32–34], and cognitive decline may undermine patients' abilities to self-manage chronic conditions and manage their health appropriately [35]. This interaction between comorbidity burden and dementia may lead to multiple hospitalizations and extended hospital stays. In order to improve adherence to management plans for dementia and coexisting conditions, as well as to address safety concerns and behavioral dysfunction, patients with dementia are more likely to be admitted to long-term care facilities [36].

While AD diagnosis was the specified subtype with the largest population-based burden on California Medicare FFS ($787 million), this was driven by AD's high prevalence, despite it having the lowest individual-cost burden ($13,935). LBD diagnosis had the largest individual burden, followed by VaD, both before and after adjusting for the effects of demographic factors, comorbidity burden, and length of coverage. When the LBD group was split into DLB and PDD subtypes, DLB costs were higher, and both were found to have higher costs than all other dementia subtypes. This is the first population-based study to estimate costs by dementia subtypes, and our findings converge with the findings from studies with much smaller samples. Prior to this study, the largest economic study of DLB was conducted by Mueller and colleagues [17]. They found that persons diagnosed with DLB (N=194) had an average of 4 hospital days more per person year than those with AD (N=776), and this increased utilization was explained in part by neuropsychiatric symptoms and poor physical health. In other studies, DLB or parkinsonism in the setting of AD [14, 15, 19] and VaD [16, 18] have each been associated with greater costs than AD alone. We examined several conditions that frequently occur in LBD and that could help explain the higher costs, relative to AD. Of the conditions we examined, falls explained the most (21.3%) of the increased costs, followed by urinary incontinence or infection (15.2%), psychiatric conditions (depression 4.9%, anxiety 3.4%), dehydration (4.2%), delirium (3.3%), orthostasis (2.7%), sleep disorders (1.9%), hallucination (1.2%), and delusion (<1%). Healthcare focused on preventing or managing these symptoms in the home or outpatient settings has the potential to reduce the high costs of LBD to Medicare.

There are limitations to this research. Although dementia is among the most expensive conditions for Medicare, Medicare pays only a fraction of the total costs, because Medicare does not cover long-term care or out-of-pocket costs [3]. It is unknown how these additional and substantial costs vary by dementia subtype. For example, in FTD, high rates of behavioral disturbances might result in higher out-of-pocket costs for in-home caregiving or earlier placement in long-term care facilities. Future research is needed to estimate how costs borne by other payers and by patients and families vary by dementia subtype. Second, while claims data are an essential source of information for understanding the financial burden of disease offering large and representative samples, some studies have demonstrated that identifying dementia in claims has only modest sensitivity to detect dementia. For example, Taylor and colleagues found an 86% agreement between dementia diagnoses derived from Medicare claims and based on a comprehensive and standard assessment in the ADAMS sample (N=758) [37]. In most cases, claims-based identification likely underestimates the true prevalence and total expenditures in dementia, and overestimates the per beneficiary expenditures, due in part to later diagnosis documentation in claims than in clinical samples [38,39]. Third, dementia subtype diagnoses reflect clinical phenomenology as applied variably by providers and should not be assumed to correspond reliably to biological disease. Fourth, we were not able to make any meaningful inferences about how the number of codes given across the levels is associated with costs because PDD is typically coded using a PD code (Prioritization Level 1) combined with a Level 2 or Level 3 code. Last, these findings provide costs during a one-year period. Research is needed on the cost trajectory in dementia subtypes from preclinical to end of life [40].

Despite these limitations, our findings demonstrate that the subtype of dementia with which patients have been diagnosed predicts clinical symptoms, healthcare utilization, and healthcare costs. Dementia subtype is an important factor to consider when determining dementia research priorities, healthcare policy, and clinical management. Earlier identification of dementia and its subtypes, followed by proactive care aimed at the prevention and management of expensive co-occurring conditions, have the potential to mitigate the high costs of dementia. Dementia care management, care navigation and caregiver support programs have demonstrated cost savings and improved care quality [41–47]. For patients diagnosed with Lewy body dementia, these programs should include care focused on fall prevention, early identification and treatment of urinary tract infections and dehydration, attention to acute changes in health status that may indicate delirium, psychiatric conditions, and sleep problems.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1.

Prevalence estimates of dementia subtype diagnoses and prioritization levels

	Frequency	Percent	Prioritization levels
Dementia (total)	247,007	100.0%	-
Alzheimer's disease Lewy body dementia Vascular dementia Frontotemporal dementia Other Mixed	57,225 10,869 9,911 728 513 8,816	23.2% 4.4% 4.0% 0.3% 0.2% 3.6%	1
Classified elsewhere	11,618	4.7%	2
Not otherwise specified	147,327	59.6%	3

Table 2.

Demographic and clinical characteristics of the study population by dementia status and subtype

Variables	Total	Non-Dementia	Dementia	LBD	FTD	VaD	AD	Other/Classified elsewhere/NOS/Mixed
N	3,001,987	2,754,980	247,007	10,869	728	9,911	57,225	168,274
Age	73.4 (10.2)	72.6 (9.7)	83.0 (9.5)	81.4 (8.4)	76.7 (10.2)	83.9 (9.6)	85.4 (8.2)	82.3 (9.8)
Male	43.80%	44%	37%	54%	45%	39%	31%	38%
Race								
White	63%	63%	65%	69%	77%	64%	67%	64%
Black	5%	5%	6%	4%	4%	10%	6%	6%
Asian	17%	17%	15%	14%	9%	14%	16%	15%
Hispanic	12%	12%	11%	11%	7%	10%	9%	12%
North American Native	0%	0%	0%	0%	0%	0%	0%	0%
Other/Unknown	3%	3%	2%	2%	2%	2%	2%	2%
RUCA categories								
Metropolitan	95%	94%	96%	96%	95%	96%	97%	96%
Rural area	5%	6%	4%	4%	5%	4%	3%	4%
Missing	0%	0%	0%	1%	0%	1%	1%	1%
Co-morbidity score								
0	79%	81%	55%	44%	56%	45%	57%	55%
1	7%	7%	8%	7%	9%	5%	5%	9%
2+	14%	12%	37%	49%	35%	50%	38%	36%
History of Falls	40.90%	38.90%	63.50%	72.40%	54.10%	61.10%	56.40%	65.50%
Delirium	3.40%	2.40%	14.50%	17.40%	12.10%	30.20%	12.50%	14.10%
Depression	3.30%	2.70%	10.30%	15.50%	10.40%	13.00%	9.40%	10.10%
Anxiety	2.60%	2.30%	6.80%	9.50%	5.90%	6.90%	5.90%	6.90%
Hallucinations	0.00%	0.00%	0.30%	1.00%	0.30%	0.30%	0.20%	0.30%
Delusions	0.00%	0.00%	0.30%	0.60%	0.90%	0.50%	0.30%	0.30%
Dehydration	2.10%	1.40%	10.50%	15.60%	8.50%	15.20%	11.90%	9.60%
Urinary incontinence or infection	4.00%	2.70%	19.40%	27.7%	15.90%	27.6%	21.40%	17.9%
Orthostasis	0.30%	0.20%	1.10%	3.10%	2.00%	1.30%	0.90%	1.00%
Sleep disorders	0.80%	0.70%	2.10%	3.60%	3.60%	2.70%	1.90%	2.10%

Variables	Total	Non-Dementia	Dementia	LBD	FTD	VaD	AD	Other/Classified elsewhere/NOS/Mixed
Full year coverage	85%	86%	74%	70%	73%	64%	65%	78%

Table 3.

Mean annual direct healthcare costs by service category and dementia subtype

	Non-Dementia (N=2,754,980)	Dementia (N=247,007)	LBD (N=10,869)	FTD (N=728)	VaD (N=9,911)	AD (N=57,225)	Other/Classified elsewhere/NOS/Mixed (N=168,274)
Total cost *,†	6,070 (16,163)	16,867 (28,712)	22,514 (32,414)	14,853 (26,540)	21,002 (34,622)	13,935 (23,969)	17,265 (29,448)
Inpatient cost *,†	2,131 (10,911)	8,522 (21,670)	11,736 (25,088)	8,160 (20,721)	11,956 (26,484)	6,866 (17, 621)	8,678 (22,309)
Outpatient cost *,†	443 (1,828)	488 (1,764)	599 (2,152)	584 (2,602)	444 (1,671)	353 (1,354)	529 (1,856)
Carrier cost *,†	2,778 (7,497)	4,726 (7,262)	5,699 (7,408)	3,663 (5,006)	4,937 (8,275)	3,511 (5,910)	5,069 (7,561)
Home health agency (HHA) cost *,†	612 (2,757)	2,431 (4,693)	3,569 (5,503)	1,782 (4,658)	2,670 (4,796)	2,534 (4,726)	2,312 (4,607)
Hospice cost *,†	18 (249)	119 (638)	137 (689)	144 (841)	224 (932)	206 (827)	85 (525)
Skilled nursing facility (SNF) cost *,†	88 (1,115)	580 (2,734)	774 (3,071)	521 (3,019)	771 (3,106)	466 (2,402)	595 (2,790)

All values mean (s.d.) in U.S. dollars, and based on all beneficiaries.

*We found a significant difference between non-dementia and dementia at alpha level of 0.0001.

†We found a significant difference across all dementia subtypes at alpha level of 0.0001.

Table 4.

Effect of dementia subtypes on annual healthcare costs based on 2015 100% California Medicare fee-for-service data

Variables	Parameter estimates	95% Confidence Interval
Intercept	$12,185	$11,562 – $12,841
Dementia subtypes		
AD	Ref	
LBD	1.31	1.27 – 1.35
VaD	1.10	1.09 – 1.11
FTD	0.92	0.83 – 1.01
NOS/Other/Mixed/Classified elsewhere	1.10	1.06 – 1.14
Age	0.99	0.99 – 0.99
Gender		
Male	1.09	1.05 – 1.14
Female	Ref	
Race		
White	Ref	
Black	1.08	1.06 – 1.11
Asian	0.99	0.97 – 1.01
Hispanic	0.95	0.93 – 0.96
North American Native	0.88	0.80 – 0.96
Other/Unknown	1.09	1.05 – 1.14
RUCA categories		
Metropolitan	Ref	
Rural areas	0.75	0.72 – 0.76
Missing	0.71	0.57 – 0.91
Comorbidity score		
0	Ref	
1	2.65	2.60 – 2.70
2+	5.64	5.58 – 5.70
Length of Medicare Part A&B coverage		
Less than 12 months	Ref	
12 months	1.07	1.06 – 1.08