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Featured Articles

Medical costs of Alzheimer's disease misdiagnosis among US Medicare beneficiaries

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Abstract

Introduction: Recent developments in diagnostic technology can support earlier, more accurate diagnosis of non-Alzheimer's disease (AD) dementias.

Methods: To evaluate potential economic benefits of early rule-out of AD, annual medical resource use and costs for Medicare beneficiaries potentially misdiagnosed with AD prior to their diagnosis of vascular dementia (VD) or Parkinson's disease (PD) were compared with that of similar patients never diagnosed with AD.

Results: Patients with prior AD diagnosis used substantially more medical services every year until their VD/PD diagnosis, resulting in incremental annual medical costs of approximately $9,500-$14,000. However, following their corrected diagnosis, medical costs converged with those of patients never diagnosed with AD.

Discussion: The observed correlation between timing of correct diagnosis and subsequent reversal in excess costs is strongly suggestive of the role of misdiagnosis of AD - rather than AD comorbidity - in this patient population. Our findings suggest potential benefits from earlier, accurate diagnosis.

Keywords: Misdiagnosis; Vascular dementia; Parkinson's disease; Alzheimer's disease; Economic impact; Medicare

1. Introduction

In 2007, the Aging, Demographics, and Memory Study estimated that the prevalence of dementia in the United States among individuals aged ≥71 years was 13.9% [1]. Alzheimer's disease (AD) is the most common cause of dementia and accounts for 60%–80% of all dementias in the United States, followed by vascular dementias (VD) that account for up to 20% of all dementia patients [2,3]. Other less common causes of dementia include frontotemporal dementias and dementia with Lewy bodies [4]. In addition, approximately one million Americans have Parkinson's disease (PD) [5], which is also associated with dementia [6].

The diagnosis and management of patients with dementing illnesses can be challenging and uncertain as the underlying causes can present clinically in ways that mask their true natures or reflect the impact of confounding comorbid conditions [7]. The diagnostic criteria for patients with cognitive decline rely on a combination of evaluation of cognitive symptoms, neuropathologic abnormalities, and/or neuroimaging techniques that rely on biomarkers to identify factors indicative of dementia (e.g., dopamine transporter scan for PD, computed tomography/magnetic resonance imaging for VD, and amyloid plaques for AD) in the brain [8,9]. The application of neuropathologic and neuroimaging

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techniques has revealed a substantial rate of misdiagnosis for multiple types of dementia in both clinical and research settings, even when using strict diagnostic criteria [10–12]. For example, using longitudinal data from the National Alzheimer's Coordination Center's (NACC) research database, Beach et al. reported that the sensitivity of current clinical diagnostic criteria for AD ranged from 71% to 87% and specificity from 44% to 71%, suggesting substantial rates of AD misdiagnosis among patients with cognitive impairment [11]. This highlights that although clinical evaluation can reliably detect the presence of cognitive impairment, additional testing may be necessary to accurately diagnose the cause of the impairment [9].

Prognosis, treatment, and patient management can vary depending on the underlying cause of dementia. For example, medications used to treat AD (e.g., acetylcholinesterase inhibitors) have been found to have limited to no benefits for patients with frontotemporal dementia [13] and VD [14]. At the same time, previous studies have shown that early diagnosis and treatment for AD can potentially delay institutionalization among these patients and result in substantial cost savings for payers [15,16]. This suggests that arriving at an accurate and timely diagnosis of dementia is an important first step for patients, families, physicians, and policymakers alike.

Although there has been analysis of the economic implications of timely diagnosis and management for AD, information about the implications of potential misdiagnosis of AD among patients with other dementia etiologies is limited. For example, a recent study analyzed data from the NACC Uniform Data Set along with the corresponding NACC neuropathologic data and found that 18%–67% of the patients who were misdiagnosed with AD received medications that were potentially inappropriate [17]. This study, however, was based on a small sample and did not evaluate the effects of AD misdiagnosis on medical resource use and payer costs. Understanding the economic implications of AD misdiagnosis is especially important given the increasing prevalence of dementia [2] and the ongoing evaluation of the costs and benefits of new technologies that inform both diagnosis and rule-out of AD among patients with cognitive decline [18]. The objective of the present study was to assess potentially avoidable medical service utilization and the resulting economic benefits of timely rule-out of AD among US Medicare beneficiaries eventually diagnosed with VD or PD. Specifically, this study estimated the excess medical costs among those previously misdiagnosed with AD as compared with similar patients with no history of AD diagnosis.

2. Methods

2.1. Data

The study was conducted using deidentified administrative claims data from the Standard Analytical Files for a 5% random sample of Medicare beneficiaries. The data span the period 1999–2011 and include information on beneficiaries' Medicare enrollment, medical resources used (e.g., hospitalizations, emergency room [ER] visits), and associated payments made by Medicare to providers. The data do not include Medicare Part D claims—i.e., prescription drug information was not available for analysis.

2.2. Study sample and time periods

Two mutually exclusive cohorts of patients with either VD or PD diagnoses (*International Classification of Disease, Ninth Revision, Clinical Modification* [*ICD-9-CM*]) were identified in the Medicare database. Given the potential overlap in the presentation of various dementia types, it was important to differentiate between patients with potential misdiagnoses that were later reconciled to be either VD or PD from those with comorbid dementias. Although the claims data do not contain clinical metrics to directly assess such a difference, the sequence of medical claims and diagnoses over time can shed light on clinicians' evaluation of a patient's condition. For example, multiple intertwined claims for medical services over time with diagnoses for different causes of dementia could possibly point to patients with comorbid or mixed dementia. Conversely, a pattern of consecutive diagnoses for a specific cause of dementia, with no intervening or superseding claims with diagnoses of other causes of dementia, is suggestive of a stable, single diagnosis. This stable, correct diagnosis may come well after an earlier episode of care associated with other suspected causes of dementia. Therefore, to be included in the analysis, patients were required to have at least two claims with diagnoses of VD or PD, with no other dementia diagnoses (including AD) between or after them. The first of the two consecutive diagnoses that met these criteria was defined as the "confirmed diagnosis" of VD/PD.

Because the primary aim was to study the differences in medical resource use and costs for patients who were previously misdiagnosed with AD, we separated the patients into two groups within each cohort based on the history of AD diagnosis before the confirmed VD/PD diagnosis. Patients were considered to be misdiagnosed with AD if they had at least two claims with an AD diagnosis code, with their first AD diagnosis within 3 years before their confirmed VD/PD diagnosis. As noted previously, such sequencing of claims (multiple AD diagnoses strictly followed by multiple diagnoses of VD or PD) was chosen to increase the likelihood that patients were indeed misdiagnosed with AD, rather than have comorbid AD and either VD or PD. Patients with single AD diagnosis, or intertwined diagnoses, were excluded. Patients with no AD diagnosis at any point before or after their confirmed VD/PD diagnosis were considered as potential comparators.

The index date was defined as the date of the first AD diagnosis for patients with prior AD diagnosis and as the date of the first confirmed diagnosis of VD or PD for the potential controls. These index dates were assumed to reflect

the first presentation of specific symptoms suspected to be related to either AD or VD/PD. To identify any observable differences between the two cohorts before they presented with dementia-like symptoms, patient characteristics including demographics, comorbidity profile (i.e., the Charlson comorbidity index [CCI] and its components) [19], and medical services used were evaluated in the 6-month period before the index date ("baseline"). Characteristics were compared across the two cohorts using chi-squared tests for categorical variables and Wilcoxon rank-sum tests for continuous variables. Patients were followed for up to 4 years post index, allowing a follow up of at least 12 months after the confirmed VD/PD diagnosis (Fig. 1).

2.3. Outcomes and analytical approach

We examined annual incremental costs (i.e., payments by Medicare to providers) for medical services used by VD/PD patients previously misdiagnosed as having AD relative to similar patients who were correctly diagnosed with VD/PD from the onset. Excess medical costs (i.e., difference in costs between misdiagnosed patients and similar correctly diagnosed patients, in 2012 US dollars) were examined over time, in 1 year increments starting from the index date, both leading up to and following the confirmed VD/PD diagnosis. In addition to overall medical costs, the components of the total medical cost differential in terms of both utilization and costs associated with various types of medical services used (e.g., hospitalizations, ER visits) were evaluated. The analyses were conducted separately for patients with VD and those with PD.

Our analytical approach consisted of two parts: first, patients with a history of misdiagnosis were matched to comparator patients with similar characteristics before the index date using propensity score matching to account for potential confounding factors. Then, medical resource use and costs over time were compared between matched patients with and without prior AD diagnosis. Because matching can result in the exclusion of a subset of patients, potentially affecting the generalizability of the findings, a sensitivity analysis was conducted using multivariate models (see Section 2.4 for details).

Propensity scores were estimated using logistic regression models with group assignment as the dependent variable and all the baseline characteristics as independent variables. The two groups were then matched 1:1 using a propensity score-based "greedy" matching method [20,21]. Specifically, each patient with prior AD was matched to a potential control whose propensity score differed from his own by a distance $\leq$0.25 of the standard deviation of the propensity score across all patients. Potential controls were also required to have identical index years and length of follow-up (relative to index quarter) as their matched counterparts. After matching, patient characteristics were re-evaluated using McNemar's tests for categorical variables and Wilcoxon signed-rank tests for continuous variables to ascertain whether statistical differences remained between the matched pairs.

Next, annual frequency of medical services used (overall and by type—e.g., hospitalizations, outpatient/physician visits) and associated costs during the follow-up period were compared between matched pairs in 1-year intervals, stratified by time from index date to first confirmed VD/PD diagnosis. Statistical comparisons of differences in mean annual costs were conducted using nonparametric bootstrap methods [22].

2.4. Sensitivity analysis

Regression-adjusted annual medical costs were compared between those with and without prior AD diagnosis among VD/PD patients using generalized linear regression models with a log link and a gamma distribution of the error term. The dependent variable was annual costs,

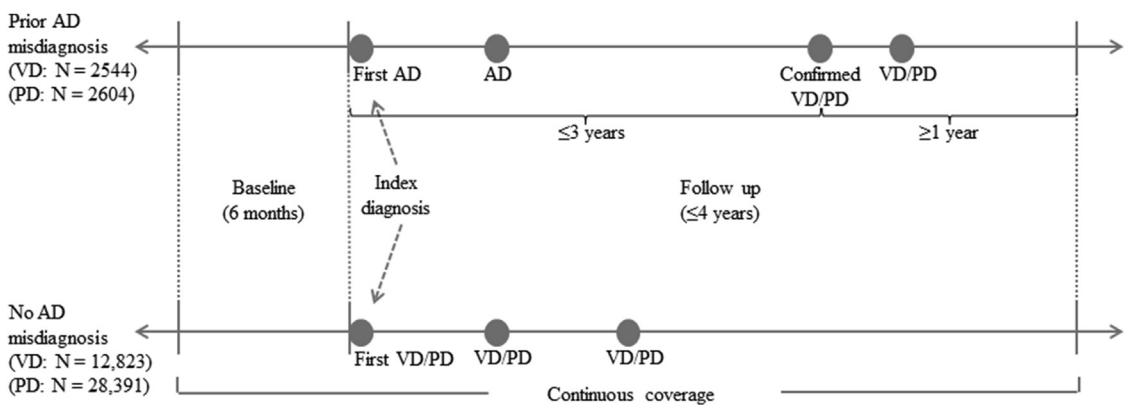

Fig. 1. Patient selection, study timeline, and comparison cohorts. A total of 259,261 patients had $\geq$1 VD/PD diagnosis in 1999–2011. Of these, 138,335 were excluded because they had $\geq$1 diagnosis for dementia types other than VD/PD (e.g., frontotemporal dementia, AD) between or after the two most recent VD/PD diagnoses. Additional 13,858 patients with $\geq$1 AD diagnoses were excluded because their first 2 AD diagnoses were not within 3 years before their confirmed VD/PD diagnosis. Of the remaining patients, 60,706 did not have continuous insurance coverage (eligibility) throughout the observation period and were therefore excluded. Abbreviations: VD, vascular dementia; PD, Parkinson's disease; AD, Alzheimer's disease.

and the key explanatory variable was prior AD diagnosis. The models accounted for the same set of baseline patient characteristics that were included in the propensity score matching analysis.

3. Results

3.1. Sample characteristics

Approximately one in six (17%) of the 15,367 VD patients in our study was classified as misdiagnosed with AD before their confirmed VD diagnosis. Similarly, about one in 12 (8%) of the 30,995 PD patients analyzed had a history of AD misdiagnosis. Among the misdiagnosed patients included in the study, median time to confirmed VD/PD diagnosis was approximately four quarters (Fig. 2).

Before matching, VD/PD patients previously misdiagnosed with AD were significantly older and more likely to be female relative to those with no prior misdiagnosis. In addition, patients eventually diagnosed with PD had a higher CCI and were more likely to use medical services (i.e., have ER visits, outpatient/physician office visits, inpatient stays and so forth) at baseline, compared with those not previously misdiagnosed (Table 1).

Baseline differences were largely eliminated following propensity score matching (Table 1). The matched samples consisted of 2088 and 2058 matched pairs of VD and PD patients, respectively, reflecting approximately 80% of the misdiagnosed patients in each group.

3.2. Differences in total health care costs

Despite having similar characteristics before their index dates, patients with prior AD diagnosis incurred significantly higher medical costs in the periods leading up to and including their confirmed diagnosis, compared with patients without prior AD diagnosis (Figs. 3 and 4).

Specifically, examining separately patients correctly diagnosed within 1, 2, or 3 years after AD misdiagnosis shows that correct diagnosis was consistently associated with a reversal in the excess costs trend. Although costs among the misdiagnosed patients were higher and usually increasing leading up to and including the year of correct diagnosis, the differences largely dissipated in subsequent years, with misdiagnosed patients' costs converging to those with no prior misdiagnosis (Figs. 3 and 4). Over time, excess medical costs for patients with prior AD diagnosis peaked at approximately \$9500 to >\$14,000 per patient per year, depending on the time to confirmed VD/PD diagnosis. Further analysis found that approximately two-thirds of the excess costs in the year of confirmed VD/PD diagnosis were incurred in the quarter of confirmed diagnosis alone (see Supplementary Table 1 for details).

3.3. Differences in frequency and costs of medical services used

To better understand the main drivers of excess medical costs in the year of confirmed diagnosis among patients misdiagnosed with AD, the utilization and costs of different

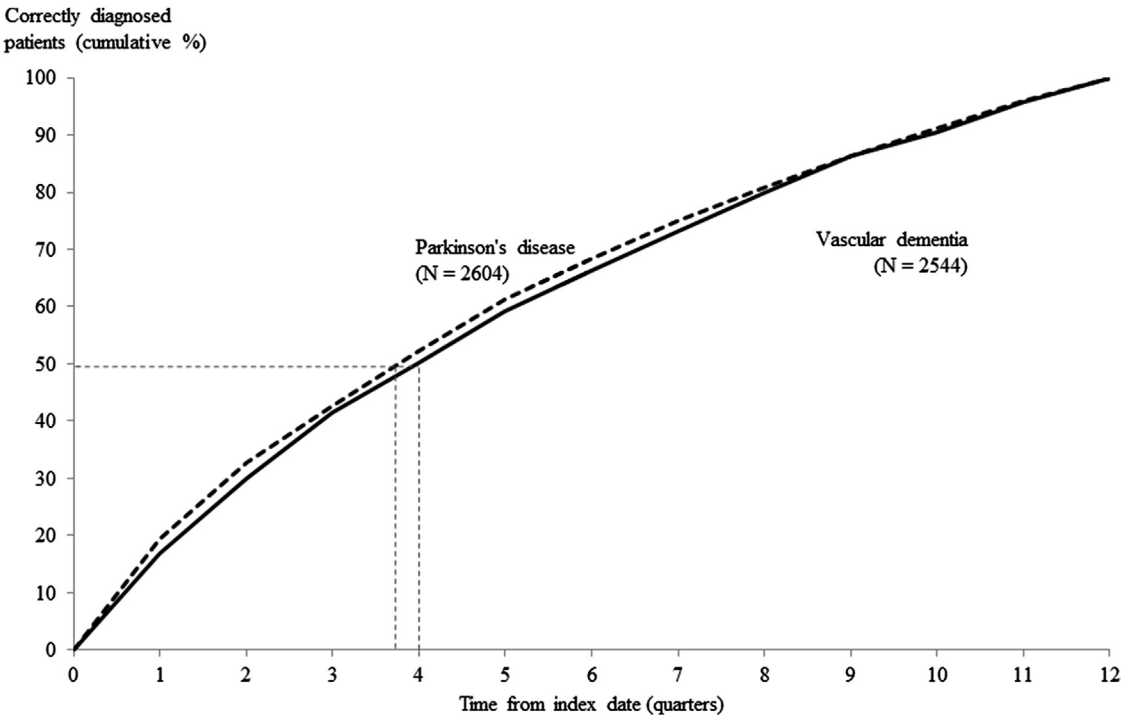

Fig. 2. Time from index date to first confirmed diagnosis among patients previously misdiagnosed with Alzheimer's disease (AD). The index date was defined as the date of the first AD diagnosis.

Table 1
Characteristics of vascular dementia (VD) and Parkinson's disease (PD) patients—during 6 months before the index date*

Characteristics	Prematch			Postmatch		
	Prior AD†	No prior AD	P‡	Prior AD†	No prior AD	P§
Vascular dementia (VD), n	2544	12,823	N/A	2088	2088	N/A
Demographics						
Age¶, mean (SD)	80.5 (8.1)	78.4 (10.5)	<.001	80.6 (8.0)	80.0 (9.7)	.107
Male, %	33	38	<.001	34	32	.247
CCI, mean (SD)	2.2 (2.0)	2.3 (2.1)	.034	1.9 (1.9)	1.9 (1.9)	.722
Select medical resource use, % with ≥1 visit						
Emergency room	43	43	.632	41	41	.974
Inpatient	29	32	.001	27	26	.525
Outpatient/physician	95	95	.443	94	94	.832
Laboratory	84	86	.026	83	83	1.000
Other#	68	69	.135	65	65	.945
Parkinson's disease (PD), n	2604	28,391	N/A	2058	2058	N/A
Demographics						
Age¶, mean (SD)	78.6 (7.7)	74.6 (10.1)	<.001	78.6 (7.8)	78.9 (8.2)	.035
Male, %	45	51	<.001	45	46	.778
CCI, mean (SD)	1.7 (1.8)	1.5 (1.8)	<.001	1.7 (1.8)	1.6 (1.7)	.134
Select medical resource use, % with ≥1 visit						
Emergency room	40	29	<.001	38	37	.269
Inpatient	27	19	<.001	25	25	.561
Outpatient/physician	98	95	<.001	97	97	.838
Laboratory	86	83	<.001	86	86	.613
Other#	71	63	<.001	70	68	.140

Abbreviations: AD, Alzheimer's disease; N/A, not applicable; SD, standard deviation; CCI, Charlson comorbidity index.

*The index date was defined as the date of the first AD diagnosis for those with prior AD misdiagnosis and as the earliest date with a VD/PD diagnosis after which no diagnoses for a non-VD/PD dementia occurred for those with no prior AD misdiagnosis.

†Prior AD misdiagnosis was defined as ≥2 diagnoses for AD within the three years preceding the first confirmed VD/PD diagnosis.

‡Chi-squared tests were used to compare categorical variables and Wilcoxon rank-sum tests were used for age and CCI.

§McNemar's tests were used to compare categorical variables and Wilcoxon signed-rank tests were used for age and CCI.

¶Age was calculated on the index date.

#Other types of resource use include home health care, care received in skilled nursing facilities, use of durable equipment and imaging services, and places of services not clearly classified in select medical resource use categories (e.g., specialist visits, rehabilitation centers).

medical services among the misdiagnosed patients were compared with those of matched patients correctly diagnosed from the onset. As seen in Table 2, depending on the year of confirmed diagnosis, VD patients who were previously misdiagnosed had, on average, 40%–143% more inpatient days, 45%–79% more ER visits, 19%–48% more outpatient/physician visits, 61%–221% more skilled nursing facility visits, 13%–56% more home health care days, and up to 44% more claims for durable medical equipment per year, compared with matched controls.

Fig. 5 reports the share of excess costs associated with the main categories of resource use during the same periods. Among VD patients, the key driver of the excess cost differential in the year of confirmed diagnosis was greater cost of hospitalizations, which accounted for 36%–44% of the incremental costs. Of note, for both groups (i.e., VD patients with and without prior misdiagnosis), a substantial share of inpatient stays in the year of confirmed diagnosis (64%–74%) resulted from ER visits. Other cost drivers included higher costs of care in skilled nursing facilities (33%–42%) and in outpatient facilities or physician offices (8%–12%).

Similar resource use and cost results were observed for previously misdiagnosed PD patients (Table 2 and Fig. 5).

3.4. Sensitivity analysis

Using regression-adjusted means based on the multivariate analysis resulted in similar findings for the costs stratified by time to correct diagnosis (see Supplementary Figs. 1 and 2, available online, for results).

4. Discussion

The results of this study suggest substantial levels of AD misdiagnosis among Medicare beneficiaries who eventually receive a corrected diagnosis of either VD or PD (17% and 8%, respectively). These findings are consistent with previous studies as well as expert testimony presented at a Medicare Evidence Development and Coverage Advisory Committee meeting, noting AD misdiagnosis rates ranging from 12% to 23% in pathologically confirmed studies [23]. Our research provides further insight into this problem: for half of the misdiagnosed patients, a correct diagnosis may not be confirmed for over 1 year, leaving patients subject to extended periods of potentially inappropriate treatment. These periods coincide with substantially higher levels of medical

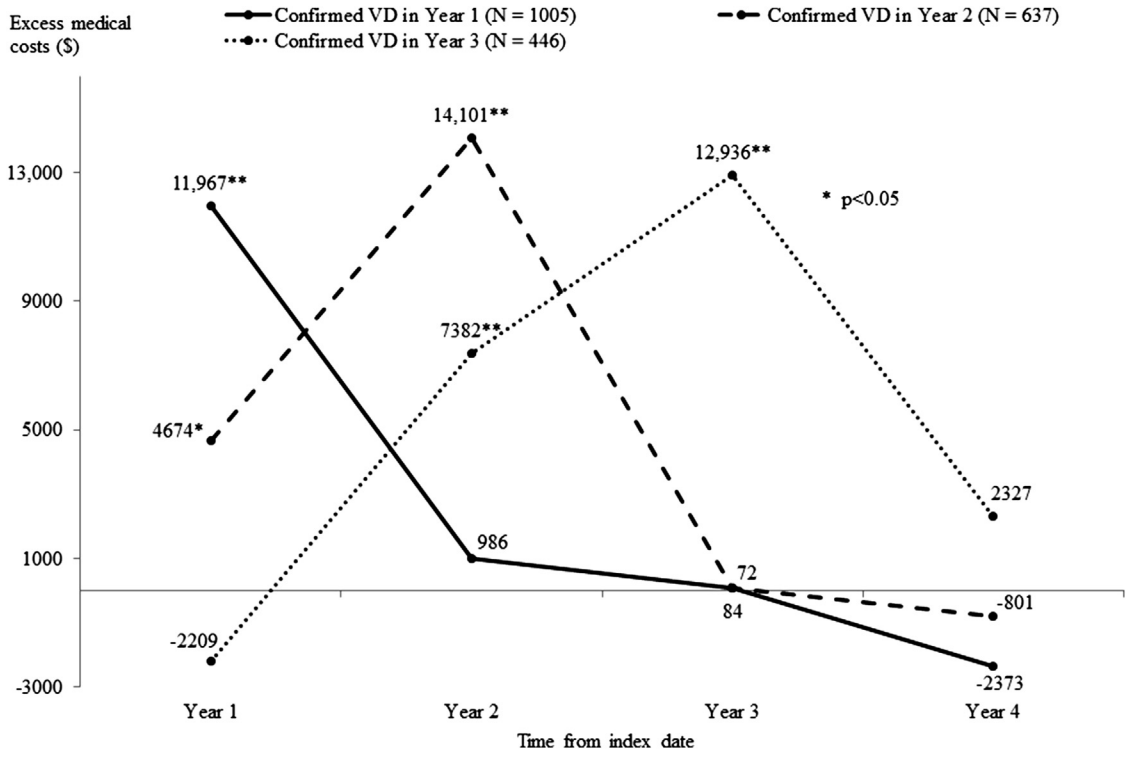

Fig. 3. Excess annual medical costs among vascular dementia (VD) patients previously misdiagnosed with Alzheimer's disease (AD)—by time from index date to first confirmed VD diagnosis. Excess medical costs (paid to providers by Medicare) were calculated as the difference in costs between patients with prior AD and those with no prior AD. Statistical significance evaluated using paired *t* tests with bias-corrected bootstrapping.

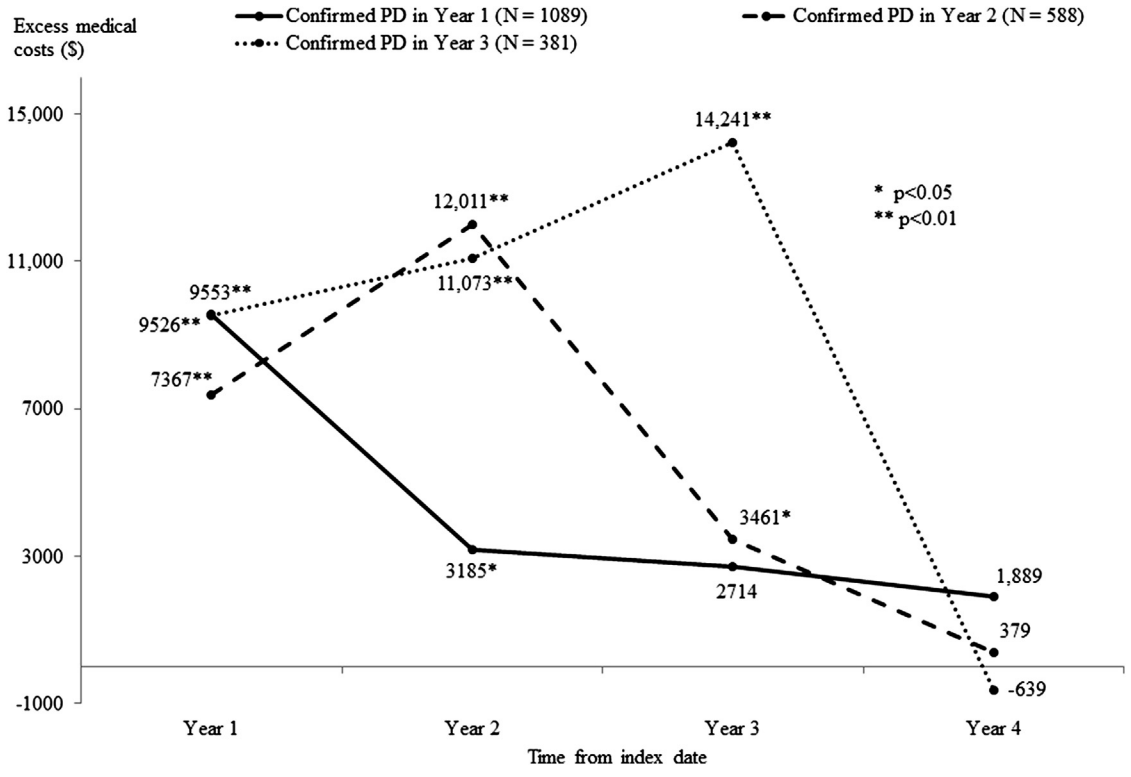

Fig. 4. Excess annual medical costs among Parkinson's disease (PD) patients previously misdiagnosed with Alzheimer's disease (AD)—by time from index date to first confirmed PD diagnosis. Excess medical costs (paid to providers by Medicare) were calculated as the difference in costs between patients with prior AD and those with no prior AD. Statistical significance evaluated using paired *t* tests with bias-corrected bootstrapping.

Table 2
Medical resource use among patients previously misdiagnosed with Alzheimer's disease (AD) and their matched counterparts—in the year of confirmed diagnosis

	Time of confirmed diagnosis relative to index date								
	Year 1			Year 2			Year 3		
Characteristics	Prior AD*	No prior AD	$P^{\dagger}$	Prior AD*	No prior AD	$P^{\dagger}$	Prior AD*	No prior AD	$P^{\dagger}$
Vascular dementia (VD), n	1005			637			446		
Average (mean) number of									
Inpatient days	14.43	10.27	<.001	6.77	2.93	<.001	6.48	2.67	<.001
Emergency room visits	6.63	4.57	<.001	4.22	2.56	<.001	4.07	2.27	<.001
Outpatient/physician office visits	42.45	35.79	<.001	35.12	23.70	<.001	32.32	22.85	<.001
Home health care days	1.21	1.07	.135	0.77	0.50	.001	0.74	0.51	.004
Skilled nursing facility days	35.73	22.14	<.001	18.81	5.86	<.001	18.47	6.03	<.001
Laboratory visits	16.14	15.42	.029	15.66	13.11	<.001	13.95	11.90	.001
DME claims	4.33	4.03	.462	3.04	3.08	.665	3.85	2.68	.014
Other visits‡	7.31	5.66	<.001	5.24	3.16	<.001	4.72	3.16	<.001
Parkinson's disease (PD), n	1089			588			381		
Average (mean) number of									
Inpatient days	10.34	7.03	<.001	6.65	3.11	<.001	6.73	3.08	<.001
Emergency room visits	5.30	4.45	<.001	4.21	2.39	<.001	4.60	2.20	<.001
Outpatient/physician office visits	40.56	33.75	<.001	33.64	24.72	<.001	34.61	25.47	<.001
Home health care days	1.46	1.11	<.001	1.23	0.87	.001	1.10	0.76	.003
Skilled nursing facility days	22.40	16.00	<.001	13.93	6.45	<.001	16.35	4.81	<.001
Laboratory visits	14.63	13.17	<.001	13.68	11.54	.001	14.27	10.73	<.001
DME claims	5.49	4.79	.001	4.89	4.37	.202	4.86	3.13	.020
Other visits‡	6.74	5.17	<.001	5.19	3.66	<.001	5.55	3.39	<.001

Abbreviation: DME, durable medical equipment.
*Prior AD misdiagnosis was defined as ≥2 diagnoses for AD within the 3 years preceding the first confirmed VD/PD diagnosis.
†Absolute differences in annual resource use were compared using Wilcoxon signed-rank tests.
‡Other types of resource use include places of services not clearly classified in select medical resource use categories (e.g., specialist visits, rehabilitation centers).

resource utilization and costs until the point at which patients are ultimately correctly diagnosed.

The demonstration that substantial and potentially avoidable medical services and related costs immediately dissipate after a correct non-AD diagnosis is a key finding for understanding the role that early and accurate diagnosis can play in effective management of Medicare beneficiaries with dementia. These results are consistent with those of previous studies that have found that arriving at a correct diagnosis can reduce the use of unnecessary resources [24,25]. For example, in a clinical trial, Grundman et al. found that after confirming the dementia etiology using amyloid imaging results, physicians often did not order additional brain imaging or neuropsychological testing but altered the treatment regimens depending on whether the patient had AD [25]. Our finding takes on added importance given that the trends in resource use and costs remain similar regardless of whether patients received a correct diagnosis in the first, second, or third year after their AD misdiagnosis, thereby suggesting that greater patient benefit and cost saving could be achieved via early and accurate diagnosis.

Fig. 5 enumerates the costs associated with excess use of specific medical services among patients previously misdiagnosed with AD. It is noteworthy that many of the service types driving the excess costs, increased days spent in the hospital and skilled nursing facilities, additional visits to the ER, and so forth, are typically indicative of worse patient outcomes. The elevated rates of these negative patient outcome surrogates suggest that the impact of a misdiagnosis may extend beyond simply requiring additional tests to provide more information or spending more time with a primary care physician as additional health factors are considered. The fact that this type of excess medical service use disappears once a correct diagnosis is achieved provides further evidence of the relationship between accurate diagnosis and improved patient outcomes.

Given the overlap in presentations of potentially unclear dementia causes, it is tempting to try to explain these findings as an unavoidable aspect of the difficulty in differential diagnosis—excess costs attributed not to misdiagnosis but rather to the treatment of comorbid conditions, including multiple dementia types. Although both clinical and coding realities make this possible, the methods used in this analysis suggest an alternative explanation for the findings. The extra care taken in the selection of the study sample to remove patients with patterns clearly suggestive of comorbid dementia, and the strong correlation found between the timing of correct diagnosis and subsequent reversals in peak excess costs, are strongly suggestive of the role of misdiagnosis of AD in this patient population. Furthermore, by examining potentially avoidable medical services and their costs compared with a matched sample of similar Medicare patients, we have minimized most observed differences between the

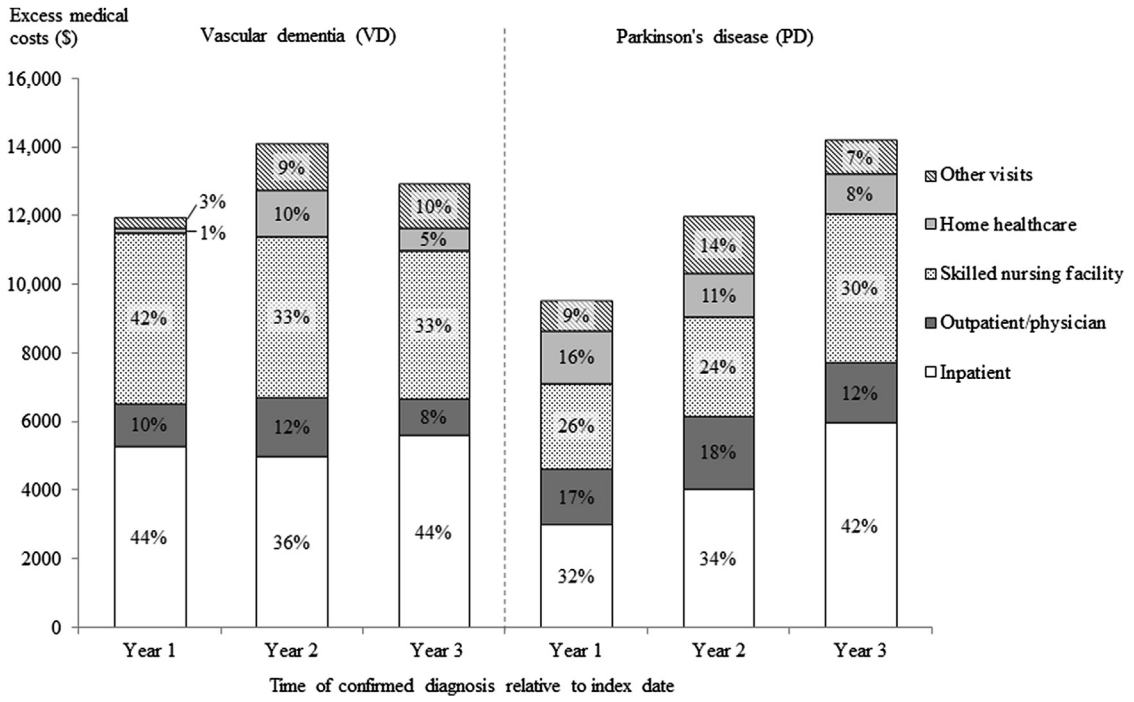

Fig. 5. Components of excess medical costs in the year of confirmed diagnosis—by time of confirmed diagnosis relative to index date. Excess medical costs were calculated as the difference in costs of patients with prior AD and those without prior AD. Annual medical costs were compared using paired *t* tests with bias-corrected bootstrapping. Inpatient costs include ER visits resulting in an inpatient admission; outpatient/physician costs include doctor visits, ER visits not resulting in an inpatient admission, and laboratory and imaging services used in an outpatient setting or doctor's office; other visits include durable medical equipment use and places not classified as inpatient, outpatient/physician, skilled nursing facility, or home health care. Abbreviations: AD, Alzheimer's disease; ER, emergency room.

compared patient populations, leaving the potential misdiagnosis as the most notable difference between the groups. As a result, the attribution of our findings is less likely to align with the challenges of real-world medical practice and more likely to be attributable to the accuracy and timeliness of a patient's dementia diagnosis.

4.1. Study limitations

First, the analyses relied on information captured within the Medicare administrative claims data set, and the effects of any inaccuracies in the data elements on the study findings are unknown. Furthermore, the ICD-9 CM codes used to identify the study population are retrieved from billing claims records and do not contain any information by which to confirm clinical diagnoses, severity of illness, or physician interpretation. Additionally, previous research has demonstrated substantial rates of potentially inappropriate medication use among patients misdiagnosed as having AD. However, these claims records do not include prescription drug use and over-the-counter medications. As such, the implications of AD misdiagnosis on the treatment of patients in our sample are unknown. Effects on medical services covered wholly or in part by other payers, out of pocket expenses, and informal care are also not captured within this framework.

Second, the propensity score matching approach effectively controls for observed differences within the data set but cannot address any unobserved patient characteristics.

Third, although the study findings demonstrate that misdiagnosis of AD is associated with excess health care resource use and costs relative to those correctly diagnosed from the onset, specific mechanisms resulting in these differential estimates need to be further explored in the future.

Finally, the study findings are limited to beneficiaries enrolled in the traditional fee-for-service Medicare program, and additional research is required to understand whether similar patterns are observed among those enrolled in Medicare Advantage (managed care) plans.

5. Conclusions

The significant and potentially avoidable medical resource use and related costs associated with misdiagnosis of AD—and their dissipation after the correction of that diagnosis—suggest substantial value not only of ruling out AD but of doing so as early as possible. The ability to limit inpatient hospital stays, minimize ER visits, and potentially avoid additional medical procedures and interactions adds clarity and understanding to the role that timely and accurate dementia diagnoses can play in patients' lives while potentially providing substantial savings within the Medicare system.

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Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jalz.2015.06.1889.

RESEARCH IN CONTEXT

1. Systematic review: A review of recent literature suggests considerable challenges in differential diagnosis of underlying causes of dementia among patients with cognitive impairment, potentially affecting their clinical management. Although prior research has considered the implications of earlier diagnosis and treatment of Alzheimer's disease (AD), the effects of misdiagnosis of AD among patients with other dementia etiologies have remained largely unexplored.
2. Interpretation: We find substantial excess medical resource use and costs associated with misdiagnosis of AD among Medicare beneficiaries. The ability to limit medical resource use and potentially avoid additional medical procedures and interactions help clarify the role that timely and accurate dementia diagnoses can play in patients' lives, while potentially providing substantial savings within the Medicare system.
3. Future directions: Future research is necessary to explore the specific mechanisms through which misdiagnosis of AD increases medical resource use and costs and to assess the degree to which they are avoidable.

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