

RESEARCH ARTICLE

Projection of budgetary savings to US state Medicaid programs from reduced nursing home use due to an Alzheimer's disease treatment

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E-mail: mattke@usc.edu**Abstract**

Introduction: The approval of a disease-modifying Alzheimer's disease (AD) treatment could provide relief to US state budgets that were hit hard by the COVID-19 pandemic, as mostly Medicare would cover treatment cost, whereas Medicaid would see savings from reduced nursing home use.

Methods: We project savings from 2021 to 2040 with a simulation model from the perspective of state Medicaid programs.

Results: Assuming a 40% and 22% relative reduction of disease progression rates with treatment, Medicaid would avoid payments of \$186.2 and \$93.5 billion for around 1.11 and 0.57 million nursing home patient-years, respectively. The savings correspond to a 5.06% and 2.49%, respectively, relative reduction of Medicaid spending on nursing home care. Higher per capita savings were projected for older states, those with higher Medicaid payment rates, those with more nursing home residents covered by Medicaid, and those with a lower federal contribution.

Discussion: States stand to realize substantial savings from a potential AD treatment. A state's health system preparedness to handle the large number of patients will influence the actual magnitude of the savings and how fast they will accrue.

KEYWORDS

Alzheimer's disease, budget impact, disease-modifying treatment, Medicaid, nursing home

1 | INTRODUCTION

The budgetary impact of the COVID-19 pandemic has been enormous on US state coffers. Revenues have dropped due to record unemployment and reduction in consumer spending,¹ while expenditures for managing this public health crisis have increased.² According to Moody's Analytics estimates for fiscal year 2021, states have lost about \$130 to \$172 billion in revenue while spending between \$27 and \$31 billion more on Medicaid.³ Equally worrisome, 33 states

are considered underprepared for the pandemic-induced recession because of limited rainy-day funds, and only Connecticut, Georgia, and Oregon are fully prepared to absorb the fiscal shock. States like Illinois and Pennsylvania have almost no rainy-day funds, and New York's balance of 3.2% of its general fund expenditures is unlikely to suffice given how hard the pandemic has hit the state.⁴ A cumulative budget shortfall of \$555 billion has been projected over fiscal years 2020 to 2022 for all states.⁵ Furthermore, the economic impact will last years; the Congressional Budget Office (CBO) projects that US gross

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domestic product (GDP) may not reach pre-COVID projected levels until 2030.⁶

As states are not permitted to borrow for operational spending, sweeping budget cuts will be inevitable.¹ At the same time, Medicaid enrollment is expected to increase because of the countercyclical nature of the program. Already, Medicaid enrollment and spending have both exceeded pre-pandemic estimates,⁷ as approximately 1.7 million additional Americans have enrolled between March 1 and June 1, 2020, in just 26 states.⁸ As Medicaid outlays are the single biggest item of state spending, even minor changes to program cost have substantial budget implications.

An unexpected source of savings to states may be disease-modifying treatments for Alzheimer's disease (AD), as the Food and Drug Administration (FDA) has accepted an application for aducanumab with June 7, 2021 set as the decision date.⁹ The current consensus is that disease-modifying treatment needs to be started in the mild cognitive impairment (MCI) or mild dementia disease stages with the objective to delay disease progression and allow patients to live independently in their home and community longer. AD being an aging-related disease, the expectation is that longer independence will reduce net nursing home use, as patients may pass away from coexisting conditions while the disease progresses.

If approved, the treatment will result in a windfall to states, because the cost of diagnosing and treating patients will largely fall on the Medicare program, as the primary payer of medical care in the elderly and disabled, and to a lesser degree on commercial carriers for patients below age 65. Medicaid programs, on the other hand, only cover medical care for a small subgroup but are the sole payer of last resort for nursing home care for beneficiaries with low income and/or exhausted assets. Thus, they stand to reap net savings from avoided or delayed nursing home admissions because of reduced dementia progression and thus care dependency.¹⁰

The cost of nursing home care to Medicaid programs is substantial. The average annual Medicaid payment rate amounts to \$79,588 per Medicaid resident in 2020 dollars with a range from \$37,273 in Illinois to \$377,310 in Alaska,¹¹ and long-term care represents \approx 22% of expenditures.¹² Approximately 62% of nursing home residents are primarily supported by Medicaid¹³ and 57% of the national spending on Long-Term Services and Supports are paid by Medicaid and approximately 79% of expenditures are on nursing homes.^{14,15}

Against this background, the objective of this article is to project the potential budgetary savings from a disease-modifying AD treatment due to reduced nursing home use nationally and for each state and the District of Columbia individually. We use a simulation model to estimate the budget impact trajectory from 2021 to 2040.

2 | METHODS

2.1 | Simulation model

Our simulation model has three components. The first projects the annual number of individuals who will be formally diagnosed with MCI

RESEARCH IN CONTEXT

- 1. Systematic review:** We reviewed the peer-reviewed and "gray" (abstracts, reports, etc.) literature on the effect of a disease-modifying Alzheimer's disease (AD) treatment on Medicaid cost. Only one technical report was identified, which is cited in the discussion section.
- 2. Interpretation:** Our predictions suggest substantial net savings potential to state Medicaid programs that scale with the effectiveness of the treatment and depend on a state's age structure, its payment rate for nursing home care, the share of nursing home residents covered by Medicaid, and the federal contribution to its Medicaid program. The degree to which the potential savings will realized will depend on a state's ability to diagnose and treat patients in a timely fashion.
- 3. Future directions:** The article points to two lines of further inquiry. The first is to examine to what degree the projected savings will be realized under real-world conditions, the second to expand the assessment of the overall value of a disease-modifying AD treatment to other components, such as medical cost, caregiver burden, and quality of life.

due to AD, the early disease stage at which treatment is expected to be effective, the second the disease progression with and without treatment and the third the savings from avoided nursing home use for the period from 2021, the year in which the first treatment could become available, to 2040. The model was programmed in Microsoft Excel and the sources and values for all parameters can be found in the supporting information (Exhibit 1).

2.1.1 | Prediction of patient counts

As mentioned above, patients need to be diagnosed at an early disease stage, when they have no or only mild symptoms, which requires a comprehensive neuropsychiatric evaluation by a dementia specialist, such as a geriatrician, geriatric psychiatrist, or neurologist. It is also necessary to confirm the presence of amyloid deposits in the patient's brain, because cognitive decline is caused by AD in only about half (55%) of patients.¹⁶ Currently, the only FDA-cleared modality to make that determination is a positron emission tomography (PET) scan.

Earlier research has shown that the capacity to complete this diagnostic process is limited because of a lack of dementia specialists and PET scanners, that is, patients experience wait times and only a subset of the potentially eligible patients are referred to treatment each year.¹⁷ Consequently, we needed to project the annual numbers of diagnosed and treated patients in each state to size the population-level impact of a treatment. We use a previously published model that

projects how many patients can be diagnosed each year nationally¹⁸ and apply state-specific population numbers by age and sex as well as data for number of specialists and PET scanners to that model.

State population projections are based on US Census estimates.¹⁹ The number of dementia specialists in each state were derived from Redi-Data's address lists of the AMA Masterfile.²⁰ We regarded all physicians specializing in clinical neurophysiology, geriatric medicine, geriatric psychiatry, psychiatric or neurologic palliative care, neurology, and neuropsychiatry as well as 10% of the general psychiatrists as dementia specialists, arriving at a national count of 28,492 specialists, which is similar to a previously published estimate by Liu et al. of 26,927.¹⁷ An estimated number of 2,371 PET scanners and their locations was derived from several sources and details are described in Exhibit 2 in supporting information. This number seems consistent with a 2010 study that estimated approximately 2,000 devices based on expert input.²¹ Indications for PET scanning have expanded since, thus we would expect the number of devices to have increased accordingly.

2.1.2 | Disease progression model

The second component simulates disease progression from MCI through the different stages of dementia and the ensuing transition into nursing home in the subset of patients, who were diagnosed with MCI due to AD (Exhibit 3 in supporting information).²²⁻²⁷

All patients start at the MCI stage and can progress annually through the different dementia stages. While dementia progression rates differ by both sex and age,²³ the progression rate from MCI to dementia is higher in women than in men but does not change with age.²⁸⁻²⁷ Patients with MCI reside at home, but patients at the various stages of dementia may be admitted permanently to a nursing home, with patient risk differing by age, sex, and dementia stage.²³ Patients can die at any stage of disease and nursing home status, with more advanced dementia stages and institutionalization increasing risk.²³ To account for a possible effect of the treatment on life expectancy, we applied Neumann et al.'s estimated age- and sex-specific mortality rates at the different stages of dementia.²³ Mortality rates at the MCI stage were based on age and sex-specific mortality rates of the general US population from the Centers for Disease Control's 2017 mortality tables,²² adjusted for the increased mortality risk associated with MCI.²⁷ As patients age in our model, their rates change accordingly. Disease progression, mortality, and nursing home admission rates, as well as the sex- and age-specific hazard ratios used to adjust these baseline rates to model the general US and specific state populations, are presented in Exhibit 1 in supporting information.

To evaluate the impact of disease-modifying treatments on nursing home use, we first projected the annual number of patients, who would require nursing home care in the scenario that no treatment is available, using the baseline disease progression rates and risk of nursing home admission by disease stage from literature noted above. We then projected the annual number of patients, who would require nursing home care in the scenario that treatment is available. In this treatment

scenario, the diagnosed patients would receive treatment, while undiagnosed patients would not. We modeled treatment effect as a 40% relative reduction of baseline progression rates at the early stages of the disease (i.e., 40% relative reduction in the progression rates from MCI to mild dementia and from mild dementia to moderate dementia) with no effect on progression rates thereafter. Those reductions in disease progression then translated into fewer nursing home admissions. The effect size reflects the effect on a composite measure for Activities of Daily Living (ADCS-ADL-MCI) in the high-dose cohort of the EMERGE trial and expert guidance that changes in this measure is more predictive of nursing home admission than in measures for cognitive decline.³⁰ We estimated an alternative scenario using the effect size of 22% on the Clinical Dementia Rating Sum of Boxes (CDR-SB) from the same trial.

2.1.3 | Savings projection

The third model component predicts the overall and state-specific budget impact as the difference in Medicaid spending on nursing home care between the "no treatment" and "treatment" scenarios. We obtained publicly available data for each state on the share of nursing home residents covered by Medicaid, Medicaid payment rates for nursing homes, the Federal Medical Assistance Percentages (FMAP) to each state's Medicaid program state budgets and federal and state amounts of Medicaid spending. Details of methods and sources are described in Exhibit 4 in supporting information.

2.2 | Probabilistic sensitivity analysis

We conducted a probabilistic sensitivity analysis to reflect the uncertainty in our disease progression model by varying the clinical parameters, that is, the disease progression and mortality rates, the transition rates to nursing home, and the treatment effect. If our sources had provided distributions for the parameters, we used those, otherwise we assumed a range of $\pm 10\%$ with a uniform distribution (Exhibit 1 in the supporting information). We also used a $\pm 10\%$ uniform distribution to vary the treatment effect in the probabilistic sensitivity analysis for both scenarios. We ran 1,000 iterations of the model drawing for each run a parameter value at random from the distribution.

2.3 | Factors explaining differences in projected savings

To investigate which factors drive state differences in projected savings, we used an ordinary least squares regression model to predict cumulative savings between 2021 and 2040 per capita as a function of a state's proportion of residents aged 65 and older, the share of nursing home residents covered by Medicaid, the Medicaid payment rate for nursing home care in 2020, the 2021 Federal Medical Assistance Percentages, the number of nursing home beds per 100,000 residents,

and the number of dementia specialists per 1,000 population in 2020. The analysis was conducted with Stata/MP version 14. As the study does not involve human subjects data, it was exempt from institutional review board evaluation and registration.

3 | RESULTS

3.1 | National impact

Without disease-modifying treatment, our model predicts that Medicaid-reimbursed nursing home use would rise from 180,564 (probabilistic median interquartile range [IQR]: 179,807 [172,235–189,177]) patient years in 2025 to 2.2 million (probabilistic median [IQR]: 2.4 [2.–2.5]) patient-years in 2040, costing Medicaid ≈\$18.4 billion (probabilistic median [IQR]: \$18.3 [\$17.4–\$19.3]) in 2025 and \$473.2 billion (probabilistic median [IQR]: \$498.2 [\$474.2–\$525.2]) in 2040. Cumulatively from 2021 to 2040, Medicaid programs would pay a total of \$3.7 trillion (probabilistic median [IQR]: \$3.8 [\$3.6–\$4.0]) for 22.6 million (probabilistic median [IQR]: 22.9 [21.9–23.8]) patient-years in nursing homes.

Figure 1 illustrates the annual number of cases of avoided Medicaid-reimbursed nursing home care due to disease-modifying treatment (Panel A), and the annual savings to Medicaid from this reduction in nursing home use (Panel B) from the national perspective assuming a 40% relative reduction in disease progression rates; base estimates, represented by the gray dots, are overlaid with the probabilistic range of possible values, represented by the bar plots. The reduced nursing home use would translate into annual savings for Medicaid programs of \$7.4 billion (probabilistic median [IQR]: \$7.0 [\$6.5–\$7.5]) and \$22.1 billion (probabilistic median [IQR]: \$22.2 [\$20.1–\$24.3]) in 2030 and 2040, respectively). At the peak of the effect in 2038, Medicaid programs would avoid paying for 104,260 patient-years of nursing home care, saving ≈\$20.1 billion. Cumulatively from 2021 to 2040, disease-modifying treatments would help Medicaid programs avoid paying \$186.2 billion (probabilistic median [IQR]: \$181.7 [\$169.0–\$195.7]) for ≈1.11 million (probabilistic median [IQR]: 1.09 [1.02–1.17]) patient-years of nursing home use avoided.

In the alternative scenario of a 22% relative reduction in disease progression rates with disease-modifying treatment, Medicaid would save ≈\$4.0 billion (probabilistic median [IQR]: \$3.8 [\$3.5–\$4.0]) in 2030 and \$10.5 billion (probabilistic median [IQR]: \$10.7 [\$9.8–\$11.7]) in 2040 for 30,688 (probabilistic median [IQR]: 28,954 [27,413–30,613]) and 49,456 (probabilistic median [IQR]: 50,759 [46,343–55,329]) patient-years of avoided nursing home use, respectively (Exhibit 5 in supporting information). Cumulatively from 2021 to 2040, disease-modifying treatments would reduce Medicaid-reimbursed nursing home use by 565,683 (probabilistic median [IQR]: 554,432 [520,382–591,736]) patient-years, saving Medicaid a total of \$93.5 billion (probabilistic median [IQR]: \$91.9 [\$85.2–\$98.7]).

3.2 | Impact on states

Table 1 displays the projected nursing home use and Medicaid spending with and without a disease-modifying treatment for the entire Medicaid program, and for the individual programs of each state and the District of Columbia by 2040 under the assumption of a 40% reduction in disease progression. Of note, the state spending estimates only reflect each state's own general fund expenditures and not the federal contribution to the program.

Cumulatively from 2021 to 2040, disease-modifying treatments are estimated to reduce Medicaid-reimbursed nursing home use by 4.86% in California to 5.78% in Alaska in relative terms.

As expected, the more populous states would have higher absolute reductions; California, for example, as the most populated state, would see a cumulative reduction of 121,402 patient-years in Medicaid-reimbursed nursing care; Wyoming, as the least populated state, only 2,131 patient-years. New York, which is the fourth most populated state and has the fourth highest average Medicare payment rate for nursing homes at \$143,801 (2020 USD) per patient-year, would realize the greatest cumulative savings of \$10.3 billion; South Dakota, as fifth least populated state and with average nursing home rates of \$52,746 (2020 USD), the smallest absolute savings of \$122 million.

Figure 2A is a heat map of the cumulative reduction of Medicaid-covered nursing home use from 2021 to 2040, expressed in patient-years per 100,000 state residents, and Figure 2B a heat map of the corresponding cumulative savings per capita to each state.

The states east of the Mississippi River would see a greater reduction in nursing home use with West Virginia having the highest reduction at 518 patient-years per 100,000 residents compared to states west of the Mississippi. For example, Utah had the lowest cumulative reduction in nursing home use at 209 patient-years per 100,000 residents and Texas, the second most populous state in the nation, had the fourth lowest at 289 patient-years per 100,000 residents.

In terms of savings, Alaska, with its high Medicaid rate of \$377,310 (2020 USD) per patient-year, which is around 10 times the rate of Illinois—the state with the lowest rate—and ≈82% of its nursing home residents covered by Medicaid, is an outlier with estimated cumulative savings of \$1,686 per capita. It is followed by Hawaii (\$578) and New York (\$532), which have high payment rates and a low FMAP, that is, states are contributing more of the funding and conversely retain more of the savings (Exhibit 2). Conversely, Maine and West Virginia would have relatively large reductions in use but small reductions in spending because of a high FMAP and low payment rate. The contiguous US states with higher projected savings tend to be found in the Northeast (Connecticut, Maine, Vermont, New York, New Hampshire, and Pennsylvania). With a relatively young population, high FMAP, and low proportion of Medicaid-covered nursing home residents, Utah is predicted to have the lowest savings of \$117 per capita.

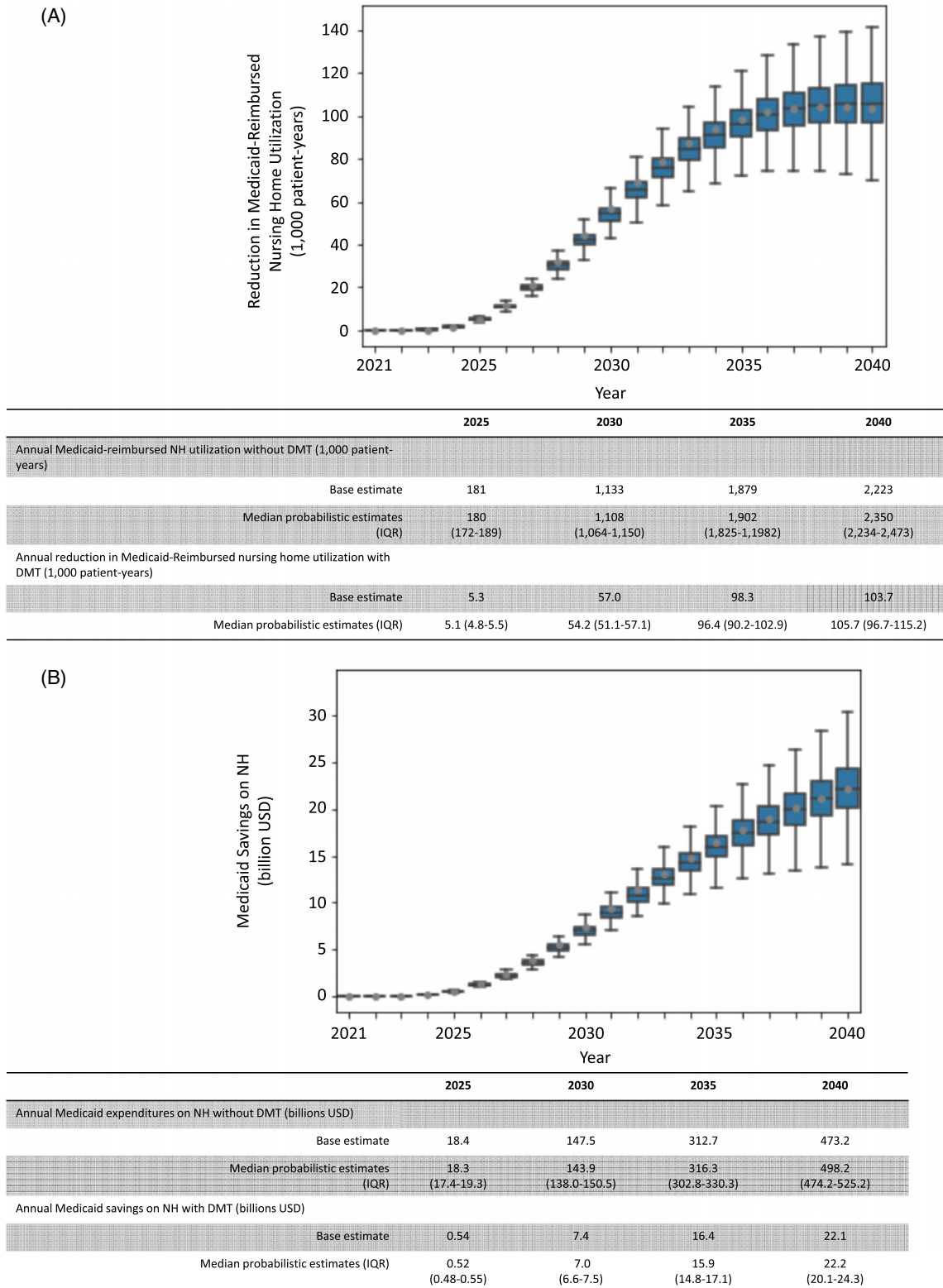


FIGURE 1 National reduction in Medicaid-reimbursed nursing home use (A) and resulting savings (B) from disease-modifying Alzheimer’s disease (AD) treatment, 2021 to 2040 (assuming a 40% treatment effect). Source: authors’ estimates. A, Annual number of Medicaid-reimbursed nursing home patient-years avoided (in thousands). B, Annual savings to Medicaid from the reduction in nursing home use (in billions USD), assuming a 40% relative reduction in disease progression rate with disease-modifying treatment. The top two rows of data (not plotted) in both the tables of (A) and (B) represent Medicaid-reimbursed nursing home use and costs for AD patients in the scenario without disease-modifying treatments. Subsequent rows of data in the tables represent the reduction in nursing home use and cost savings with disease-modifying treatments. Base estimates are represented by the gray dots and the probabilistic estimates are represented by blue box plot. IQR, interquartile range

TABLE 1 National and state-level cumulative Medicaid-reimbursed nursing home use and the corresponding Medicaid spending with and without disease-modifying Alzheimer's disease/treatment from 2021 to 2040

	Cumulative projected number of patient-years of nursing home use covered by Medicaid, 2021–2040			Cumulative projected Medicaid spending on nursing home care, 2021–2040 [million USD]			Share of population aged 65 and over	FMAP 2021	Share of nursing home residents covered by Medicaid	Medicaid payment per resident [USD]			
	No treatment	Treatment	Difference	Relative change	No treatment	Treatment					Difference	Relative change	
United States													
Total	22,540,637	21,397,764	1,142,872	5.07%	\$3,806,417	\$3,613,329	\$193,087	5.07%	17.0%	62%	\$79,588		
Federal					\$2,234,776	\$2,121,194	\$113,582	5.08%					
States					\$1,571,641	\$1,492,135	\$79,506	5.06%					
States													
Alaska	AK	52,639	49,605	3034	5.76%	\$20,759	\$19,558	\$1201	5.78%	12.9%	50.0%	82%	\$377,310
Alabama	AL	382,771	362,895	19,877	5.19%	\$16,090	\$15,254	\$836	5.20%	17.4%	72.6%	67%	\$73,427
Arkansas	AR	228,564	216,786	11,778	5.15%	\$9650	\$9153	\$497	5.15%	17.4%	71.2%	66%	\$70,309
Arizona	AZ	491,237	466,361	24,875	5.06%	\$23,660	\$22,461	\$1199	5.07%	18.0%	70.0%	60%	\$76,970
California	CA	2,510,339	2,388,937	121,402	4.84%	\$132,384	\$125,956	\$6428	4.86%	14.8%	50.0%	62%	\$50,498
Colorado	CO	346,915	328,328	18,587	5.36%	\$31,147	\$29,475	\$1672	5.37%	14.7%	50.0%	61%	\$85,969
Connecticut	CT	309,591	293,733	15,858	5.12%	\$28,607	\$27,140	\$1466	5.13%	17.7%	50.0%	70%	\$88,497
Washington, DC	DC	48,566	46,050	2516	5.18%	\$4746	\$4500	\$246	5.18%	12.4%	70.0%	79%	\$155,978
Delaware	DE	76,455	72,468	3987	5.22%	\$7819	\$7411	\$408	5.22%	19.5%	57.7%	63%	\$115,939
Florida	FL	1,649,588	1,570,931	78,657	4.77%	\$130,849	\$124,606	\$6243	4.77%	21.0%	62.0%	58%	\$99,961
Georgia	GA	758,052	717,767	40,285	5.31%	\$50,729	\$48,028	\$2702	5.33%	14.4%	67.0%	72%	\$97,132
Hawaii	HI	107,009	101,629	5381	5.03%	\$15,762	\$14,969	\$792	5.03%	19.6%	53.0%	62%	\$150,285
Iowa	IA	170,932	162,235	8697	5.09%	\$9809	\$9310	\$499	5.09%	17.5%	61.8%	46%	\$71,894
Idaho	ID	118,132	111,881	6250	5.29%	\$8207	\$7772	\$435	5.30%	16.3%	70.4%	64%	\$112,492
Illinois	IL	823,422	781,595	41,827	5.08%	\$31,429	\$29,830	\$1599	5.09%	16.2%	51.0%	58%	\$37,273
Indiana	IN	459,822	435,913	23,909	5.20%	\$36,441	\$34,544	\$1897	5.21%	16.1%	65.8%	62%	\$111,076
Kansas	KS	170,462	161,678	8784	5.15%	\$8256	\$7830	\$426	5.16%	16.4%	59.7%	53%	\$57,551

(Continues)

TABLE 1 (Continued)

	Cumulative projected number of patient-years of nursing home use covered by Medicaid, 2021–2040				Cumulative projected Medicaid spending on nursing home care, 2021–2040 [million USD]				Share of population aged 65 and over	FMAP 2021	Share of nursing home residents covered by Medicaid	Medicaid payment per resident [USD]
	No treatment	Treatment	Difference	Relative change	No treatment	Treatment	Difference	Relative change				
Kentucky	335,673	318,052	17,620	5.25%	\$14,466	\$13,706	\$760	5.26%	72.1%	66%	\$73,840	
Louisiana	374,683	354,985	19,698	5.26%	\$15,207	\$14,407	\$800	5.26%	67.4%	74%	\$59,653	
Mas-sachusetts	511,862	486,053	25,809	5.04%	\$43,491	\$41,294	\$2197	5.05%	50.0%	63%	\$81,372	
Maryland	418,961	397,245	21,716	5.18%	\$41,096	\$38,962	\$2134	5.19%	50.0%	62%	\$93,906	
Maine	122,697	116,322	6375	5.20%	\$8345	\$7911	\$434	5.20%	63.7%	66%	\$89,749	
Michigan	716,694	679,903	36,791	5.13%	\$46,787	\$44,382	\$2406	5.14%	64.1%	60%	\$87,052	
Minnesota	333,071	315,826	17,245	5.18%	\$27,727	\$26,289	\$1437	5.18%	50.0%	53%	\$79,745	
Missouri	466,351	442,472	23,880	5.12%	\$17,871	\$16,955	\$916	5.13%	65.0%	65%	\$52,390	
Mississippi	251,731	238,547	13,184	5.24%	\$8442	\$8000	\$442	5.24%	77.8%	76%	\$72,218	
Montana	76,766	72,739	4027	5.25%	\$4178	\$3959	\$219	5.25%	65.6%	59%	\$75,841	
North Carolina	749,438	710,769	38,669	5.16%	\$35,545	\$33,708	\$1837	5.17%	67.4%	64%	\$69,668	
North Dakota	42,317	40,153	2164	5.11%	\$4,082	\$3873	\$209	5.12%	52.4%	52%	\$97,122	
Nebraska	111,492	105,746	5746	5.15%	\$6570	\$6232	\$339	5.16%	56.5%	53%	\$64,867	
New Hampshire	109,071	103,277	5794	5.31%	\$10,981	\$10,397	\$584	5.32%	50.0%	63%	\$96,417	
New Jersey	594,691	564,401	30,290	5.09%	\$48,518	\$46,043	\$2475	5.10%	50.0%	57%	\$78,124	
New Mexico	160,379	152,044	8335	5.20%	\$7486	\$7096	\$389	5.20%	73.5%	66%	\$84,270	
Nevada	179,173	169,582	9591	5.35%	\$12,777	\$12,092	\$685	5.36%	63.3%	56%	\$93,056	
New York	1,440,384	1,371,794	68,590	4.76%	\$216,252	\$205,921	\$10,331	4.78%	50.0%	63%	\$143,801	
Ohio	835,446	793,104	42,343	5.07%	\$46,382	\$44,028	\$2354	5.08%	63.6%	60%	\$73,121	
Oklahoma	281,489	266,881	14,608	5.19%	\$9970	\$9452	\$518	5.19%	68.0%	66%	\$53,007	
Oregon	277,212	262,827	14,385	5.19%	\$26,023	\$24,672	\$1352	5.19%	60.8%	57%	\$114,870	

(Continues)

TABLE 1 (Continued)

	Cumulative projected number of patient-years of nursing home use covered by Medicaid, 2021–2040			Cumulative projected Medicaid spending on nursing home care, 2021–2040 [million USD]			Share of population aged 65 and over	FMAP 2021	Share of nursing home residents covered by Medicaid	Medicaid payment per resident [USD]			
	No treatment	Treatment	Difference	Relative change	No treatment	Treatment					Difference	Relative change	
Pennsylvania	PA	1,054,159	1,002,010	52,149	4.95%	\$98,779	\$93,887	\$4892	4.95%	18.7%	52.2%	65%	\$93,922
Rhode Island	RI	79,378	75,299	4079	5.14%	\$6763	\$6415	\$348	5.14%	17.7%	54.1%	61%	\$88,879
South Carolina	SC	373,583	354,071	19,513	5.22%	\$15,590	\$14,775	\$815	5.23%	18.3%	70.6%	62%	\$68,057
South Dakota	SD	51,117	48,466	2650	5.18%	\$2347	\$2225	\$122	5.19%	17.2%	58.3%	51%	\$52,746
Tennessee	TN	452,694	429,104	23,590	5.21%	\$21,175	\$20,070	\$1105	5.22%	16.8%	66.1%	59%	\$66,080
Texas	TX	1,619,104	1,535,755	83,349	5.15%	\$80,180	\$76,039	\$4141	5.16%	12.9%	61.8%	62%	\$62,061
Utah	UT	125,161	118,469	6692	5.35%	\$6987	\$6613	\$374	5.36%	11.4%	67.5%	51%	\$82,297
Virginia	VA	558,677	529,569	29,109	5.21%	\$39,352	\$37,299	\$2054	5.22%	16.1%	50.0%	60%	\$67,448
Vermont	VT	52,484	49,727	2758	5.25%	\$4884	\$4627	\$257	5.26%	20.1%	54.6%	64%	\$98,144
Washington	WA	481,325	456,018	25,307	5.26%	\$37,460	\$35,487	\$1973	5.27%	16.0%	50.0%	60%	\$74,544
Wisconsin	WI	379,050	359,349	19,700	5.20%	\$25,870	\$24,524	\$1346	5.20%	17.5%	59.4%	55%	\$80,462
West Virginia	WV	179,920	170,638	9283	5.16%	\$9988	\$9472	\$515	5.16%	20.5%	75.0%	76%	\$106,381
Wyoming	WY	39,908	37,777	2131	5.34%	\$3725	\$3526	\$199	5.35%	17.2%	50.0%	62%	\$89,445

Source: Authors' estimates. The estimates provided here are under the assumption of a 40% relative reduction in disease progression rate with disease-modifying treatment.

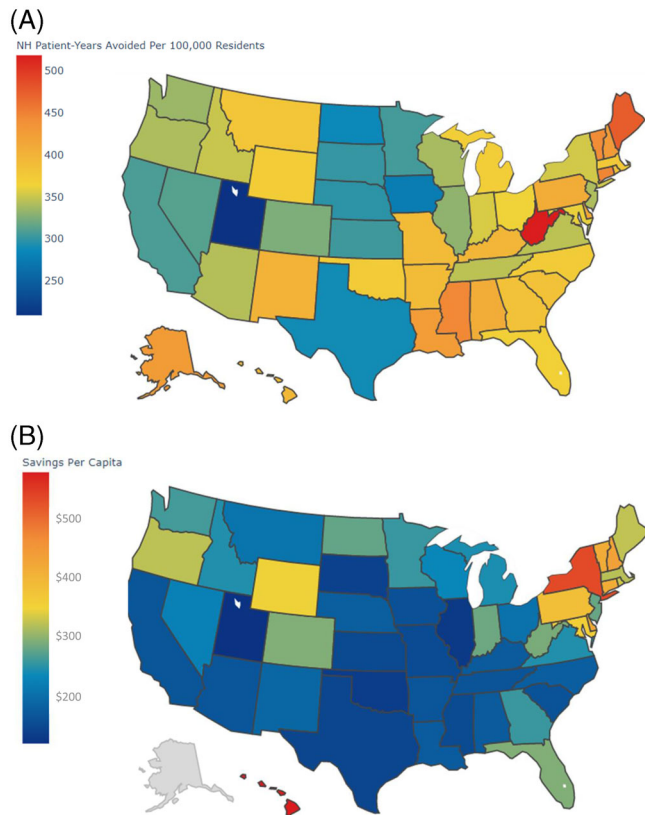


FIGURE 2 Heat maps of cumulative number of avoided Medicaid-reimbursed nursing home patient-years (A) and Savings (B) from 2021 to 2040. Source: Authors' estimates. The estimates provided here are under the assumption of a 40% relative reduction in disease progression rate with disease-modifying treatment. Results are expressed in number of avoided nursing home patient-years and savings as per capita. Alaska as an outlier in savings in (B) has projected cumulative savings of \$1,686 per capita

3.3 | Factors influencing projected savings

Table 2 illustrates the effect of different factors on cumulative savings per state resident between 2021 and 2040 using a linear regression model, with and without Alaska. The model has a strong goodness-of-fit (R-squared 0.9698) indicating that the cumulative savings can mostly be explained by the included factors.

Higher per capita savings were projected for states with higher Medicaid payment rates, those with a larger share of nursing home residents covered by Medicaid, those with an older population, and those with a lower FMAP, whereas the size of a state's Medicaid budget and its number of dementia specialists and nursing home beds per capita were not significantly associated with projected savings. A \$1,000 difference in the payment rate was estimated to change per capita savings by \$3 (95% confidence interval [CI], \$2.7–\$3.5), and a one percentage point increase in the share of residents 65 and older, the FMAP and the share of residents covered by Medicaid by \$1,400 (\$896–\$1,905), –\$726 (–\$827–\$625), and \$419 (\$308–\$530), respectively.

A comparison of states that mainly differ on one of those parameters makes the impact apparent. For instance, Missouri and Indiana have a

TABLE 2 Factors predicting cumulative savings per capita to Medicaid programs

	Without Alaska	With Alaska
Share of population age 65 and over	1400.38** (251.23)	972.96** (303.97)
FMAP 2021	-726.21** (50.22)	-834.90** (84.35)
Share of residents paid by Medicaid	418.98** (55.05)	528.02** (79.82)
Medicaid payment per resident (1,000 USD)	3.09** (0.19)	4.20** (0.21)
Medicaid budget per capita (1,000,000 USD)	-9457.29 (8805.32)	-12139.37 (8941.89)
Specialists per 1,000 residents	25.97 (144.40)	-438.44 (246.98)
Nursing home beds per 1,000 residents	2.41 (1.37)	6.08* (2.58)
Constant	-62.27 (56.31)	-59.58 (68.52)
N	50	51
R ²	0.9698	0.9813

Abbreviation: FMAP, Federal Medical Assistance Percentages.

Notes: Robust standard errors in parentheses.

* $P < .05$.

** $P < .01$.

similar share of residents 65 and older (17% vs. 16%), FMAP (65% vs. 66%), and share of nursing home residents paid by Medicaid (65% vs. 62%); however, they differ greatly in the annual Medicaid payment rate per resident (\$50,000 vs. \$110,000), which leads to a substantial difference in the cumulative net savings per capita of \$150 for Missouri and \$282 for Indiana.

Similarly, Massachusetts and South Carolina have a comparable age structure (17% vs. 18%), share of residents covered by Medicaid (63% vs. 62%), and payment rates (\$80,000 vs. \$70,000), while there is a marked difference in the FMAP by 50% versus 71%, respectively. The projected per capita savings for Massachusetts are \$319 while those for South Carolina are \$160.

Differences in the share of nursing home residents paid by Medicaid can also contribute to differences in savings. Cumulative savings per capita are \$412 for Connecticut and \$255 for Minnesota with the resident share being 70% and 53%, respectively. Both states have a similar percentage of population age 65 and older (18% vs. 16%), FMAP (50%), and payment rate (\$90,000 vs. \$80,000).

4 | DISCUSSION

We project the budget impact of the introduction of a disease-modifying AD treatment on states and estimate national net savings of \$186.2 billion (probabilistic median [IQR]: \$181.7 [\$169.0–\$195.7]) between 2021 and 2040 and \$21.1 billion (probabilistic median [IQR]: \$19.8 [\$18.6–\$21.2]) in the first decade because of reduced nursing

home use covered by Medicaid. Our numbers, which reflect reduction rather than elimination of disease progression, are lower than those from an earlier simulation, which estimated that a treatment that delays dementia onset by 5 years would lead to \approx \$54B in Medicaid savings over 10 years.³¹

The fact that states stand to make a net financial gain is another example of the distorted incentive structure of the US healthcare system, in which commonly the entity that invests in better outcomes for patients is not the one to realize the cost offsets from better health.³² The situation would be different, for example, in Germany, which has mandatory long-term care insurance that is administered by the respective public or private payer carrying one's health insurance.

With approximately 21% of Medicaid spending going to long-term care,³³ the relative magnitude of the effect is substantial, as it would lower each state's Medicaid spending on that line item by an average 5.2% in this timeframe with a peak of 5.6% in 2033. This translates into an average cumulative savings of \$282 per capita with a range from \$1,686 for Alaska to \$117 for Utah. The reduction of nursing home use can be an additional benefit for states that already lack nursing home capacity because of a combination of low payment rates, workforce shortages, and limited construction.³⁴

The cumulative savings represent between 2.64% (Alaska) and 0.22% (Washington, DC) of a state's 2018 GDP with no clear regressive or progressive properties. New York and Alaska projected to have the 3rd and 5th highest GDP and high proportional savings with 0.82% and 2.64% as have 44th- and 49th-ranked Maine (0.83%) and West Virginia (0.79%). The redistributive effect of the FMAP means that the southern states would have a relatively large reduction in nursing home use covered by Medicaid but relatively low savings per capita.

It should be kept in mind that our projections assume that only a subset of eligible patients will receive treatment because of capacity constraints in diagnosing patients.¹⁸ If all cases could be identified and treated immediately, the cumulative savings would more than quadruple from approximately \$186 billion to \$989 billion (432%) with \$580 and \$409 billion accruing to the federal and state component, respectively, of Medicaid. While assuming that all patients would be treated right away is certainly unrealistic, there are several technologies in development that would relieve capacity constraints by improving triage of patients at the primary care level.³⁵

The most likely diagnostic technology are blood tests for the AD pathology, which have evolved to tests that can be conducted on fully automated platforms.³⁶ Combined with a brief cognitive exam, they would allow primary care physicians to identify patients with suspected cognitive decline due to AD and prioritize those for evaluation over those with no evidence of cognitive decline or of the AD pathology. A recent study predicted that this approach could substantially decrease wait lists and speed up access to care.¹⁸ Using those assumptions, we predict that cumulative savings to Medicaid programs from 2021 to 2040 would increase from approximately \$186 billion to around \$301 billion (62%).

5 | LIMITATIONS

Our study is not without limitations. A simulation does not constitute direct evidence and is fraught with uncertainty over our relatively long horizon. While the probabilistic sensitivity analysis suggests reasonably bounded estimates, unaccounted factors may have a substantial effect on the predictions in either direction. Future changes to the Medicaid program and/or spread of Medicaid waiver programs may increase or decrease the number of nursing home residents covered by Medicaid. Our assumed treatment effect is based on the results from a clinical trial program for a single drug, and it is uncertain how the effect size will generalize to other treatments, to real-world conditions, and to patients with higher comorbidity burden than those in clinical trials, as well as how durable is the effect. However, if history is any indication, future treatments are going to perform better, as we have witnessed for many diseases, such as cancer and HIV/AIDS. We also note that we could not include patients with mild dementia due to AD in the starting cohort, because prevalence data were lacking, although this will have a minor effect, as we do account for patients who progress to mild dementia over the course of the simulation. The actual share of patients seeking evaluation and treatment will depend on various factors, like disease awareness, access to care, the label of a treatment, cost sharing requirements, and receptivity of clinicians. We assume homogeneity of patients, whereas disparities in access to diagnostic services and Medicaid eligibility for nursing home care may change our predictions. Last, we need to emphasize that we only account for savings from reduced nursing home use, while ignoring effects on family caregiver productivity, which are estimated to be the same to twice as high as nursing home cost³⁷, and medical cost.

6 | IMPLICATIONS

To summarize, while we have to acknowledge that our estimates may provide an upper bound, states stand to realize substantial net savings from a potential disease-modifying AD treatment. How fast the savings will accrue and how large they will be is going to depend on how well a state's health system is prepared to handle the large backlog of patients.

ACKNOWLEDGMENTS

The study was funded through a research contract from Biogen, Inc. to the University of California. The sponsor provided editorial suggestions on an earlier draft of the manuscript and had no other involvement in the study design, analysis, and decision to submit. We owe our gratitude to Mo Wang and Anissa Dallmann for their help in retrieving, compiling, and deduplicating PET scanner sites. We also want to thank Redi-Data, IMV, and the Intersocietal Accreditation Commission for providing data and reports for this study.

CONFLICTS OF INTEREST

The work was funded by a contract from Biogen to the University of Southern California. The sponsor had no role in the design of the study, interpretation of the findings, and decision to submit for publication. Soeren Mattke serves on the board of directors of Senscio Systems, Inc., and the scientific advisory board of AiCure Technologies and Boston Millennia Partners. He has received consulting fees from AARP, Biotronik, Bristol-Myers Squibb, and Defined Health. The other authors report no potential conflicts.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

How to cite this article: Lam J, Jun H, Cho SK, Hanson M, Mattke S. Projection of budgetary savings to US state Medicaid programs from reduced nursing home use due to an Alzheimer's disease treatment. *Alzheimer's Dement*. 2021;13:e12159. <https://doi.org/10.1002/dad2.12159>