

## Projected Ontario budget savings from reduced long-term care utilization due to a disease-modifying Alzheimer's treatment

Hankyung Jun PhD, Sol Price School of Public Policy, University of Southern California (USC)

Zehao Shi, Center for Economic and Social Research, USC

Soeren Mattke MD, DSc, Center for Economic and Social Research, USC

### ABSTRACT

**Background:** A disease-modifying Alzheimer's treatment could provide savings to provincial budgets resulting from a decreased need for admission to long-term care homes. The magnitude of those potential savings is currently unknown. **Method:** We project savings to Ontario's budget from 2023 to 2043 using a Markov model. **Result:** A treatment that reduces disease progression rates by 40%, would avoid 60,830 years of long-term care home use resulting in \$6.1 billion savings assuming current diagnostic technology and capacity. The savings amount to a 22% relative reduction of cost for treatment eligible patients and 4.06% of overall provincial spending on long-term care homes over the 20-year horizon. Cumulative savings could increase to \$8.9 billion with improved triage of patients in primary care settings and to \$9.9 billion with removal of all constraints in the capacity for diagnosis and treatment of patients. **Conclusion:** Access to a disease-modifying Alzheimer's treatment could create savings for the Ontario government by delaying people from progressing into long-term care homes, which might offset a substantial part of the treatment cost. An additional benefit would be lower demand for overburdened long-term care systems and less need to hold patients in hospital while waiting for a long-term care bed. Better diagnostic technology could allow larger savings to be realized sooner.

**ACKNOWLEDGMENTS:** N/A

**CITATION:** Jun, Hankyung; Zehao Shi; Soeren Mattke (2022). Projected Savings to Ontario's Provincial Budget from Reduced Long-Term Care Home Utilization Due to a Disease-Modifying Alzheimer's Treatment. *Canadian Health Policy*, SEP 2022. ISSN 2562-9492, <https://doi.org/10.54194/VCID2992>, [www.canadianhealthpolicy.com](http://www.canadianhealthpolicy.com)

**CORRESPONDENCE:** Dr. Soeren Mattke, Center for Economic and Social Research, University of Southern California, 635 Downey Way, #505N, Los Angeles, CA 90089, USA, [mattke@usc.edu](mailto:mattke@usc.edu)

**DISCLAIMER:** N/A

**DISCLOSURE:** The work was funded by a contract from the Alzheimer's Society of Ontario to the University of Southern California. The sponsor provided comments on a draft of the paper, but the authors had full control of design, analysis, final manuscript, and decision to submit. Soeren Mattke serves on the board of directors of Sencio Systems, Inc., and the scientific advisory board of AiCure Technologies, and Boston Millennia Partners. He has received consulting fees from Biogen, C2N, Eisai, Novartis, and Genentech/Roche. Hankyung Jun and Zehao Shi report no potential conflicts.

**OPEN ACCESS:** Not sponsored.

**REVIEW:** This article was subject to double blind review.

**SUBMITTED:** 19 JUL 2022 | **PUBLISHED:** 14 SEP 2022

## INTRODUCTION

Recent advances in amyloid-directed treatments for Alzheimer's disease<sup>1,2</sup> have given hope to patients and their families that the course of this devastating illness might be altered. However, they have also triggered a debate on the value and affordability of the treatment because of its costs combined with the large treatment-eligible population. Previous research has found that the treatment comes with various cost offsets beyond direct medical cost savings. One recent study found that a disease-modifying Alzheimer's treatment would accrue societal value in the United States of 2.62 trillion USD over 20 years, with the largest contribution stemming from patient quality-adjusted life years (QALY) gains and reductions in long-term care home cost with 63% and 20% of the cumulative value, respectively.<sup>3</sup>

While the value of QALY gains represents a hypothetical benefit to society, a reduction in long-term care home utilization translates into direct budgetary savings to payers. In Ontario, the provincial government pays a significant portion of long-term care costs: Of the \$6.2 billion in spending in 2020-21, \$4.6 billion were funded by the government and \$1.6 billion by patients and their families.<sup>4</sup> With 81% of Ontario long-term care home residents having some form of cognitive impairment,<sup>4</sup> a disease-modifying Alzheimer's treatment may allow more patients to age at home rather than in institutions, which would reduce wait lists for long-term care beds and the need to hold patients in hospital while on the wait list. The combined effect could be lower government spending on institutional care for patients eligible for long-term care.

Cost savings are particularly crucial after the COVID-19 pandemic put a substantial strain on the government's budget. Ontario's government is projected to spend \$173.0 billion in 2021-22, and incur a deficit of \$33.1 billion.<sup>6</sup> If a disease-modifying Alzheimer's treatment decreased the number of patients progressing to severe stages of Alzheimer's disease, leading to fewer long-term care home admissions, it could create budgetary savings that partially offset treatment costs.

Against this background, the objective of this article is to project potential cost savings from reduced long-term care home utilization resulting from a disease-modifying Alzheimer's treatment. We use a simulation model to predict the results of different scenarios from the perspective of Ontario's provincial budget.

## METHODS

### Model Structure

Our simulation model builds on previous work and is based on three components. First, we used a previously published model that projects the annual number of patients formally diagnosed with mild cognitive impairment (MCI) due to Alzheimer's disease, the early disease stage in which the treatment would ideally be used.<sup>7,8</sup> To be treatment-eligible, patients must be diagnosed at this early stage with limited symptoms, requiring a comprehensive evaluation by a dementia specialist to document the impairment, and confirmation of the Alzheimer's pathology using a positron emission tomography (PET) scan or examination of cerebrospinal fluid (CSF). Earlier research has shown that patients experience relatively long wait times for a diagnosis due to limited capacity in Canada, and many Canadians could further progress while waiting to receive a diagnosis and treatment.<sup>9</sup> We apply data from Ontario to this model and project the annual numbers of diagnosed and treated patients, given capacity for dementia specialist evaluation and biomarker testing.

Second, we use a disease progression model that simulates disease progression from MCI to mild, moderate, and severe Alzheimer's disease. With disease progression, the risk of mortality and long-term care home admission increases.<sup>10,11</sup>

The model estimates the annual number of patients in Ontario at each disease stage for both community and institution-based residents. We assume the treatment effect as a 40% relative reduction in the progression rates from MCI to mild Alzheimer's disease and from mild to moderate Alzheimer's disease. The effect size is based on clinical results of a composite measure for Activities of Daily Living (ADCS-ADL-MCI) in a high-dose cohort of the EMERGE trial which reflects a better predictive measure of long-term care home admissions compared to measures for cognitive decline.<sup>12</sup> The reduction in disease progression will translate into fewer admissions and lower mortality.

Lastly, our model predicts budgetary impacts resulting from a reduction in long-term care home utilization. Long-term care homes in Ontario are funded primarily by the Ministry of Long-Term Care.<sup>4</sup> A reduction in need for long-term care home admissions will, therefore, lead to budgetary savings for the Ontario government.

Overall, our model projects wait times for diagnosis and treatment, number of patients progressing, reduction in long-term care home utilization with the treatment, and resulting budgetary savings using the 2023 population aged 50 and over in Ontario. The model was programmed using Microsoft Excel.

We use the following assumptions based on expert input on how patients progress through the different stages of their dementia journey:

- When a treatment becomes available, 25% of Ontarians 50 years and older, without an established diagnosis of cognitive impairment, will see their Family Physician for a brief cognitive test each year.
  - Each subsequent year, 5% of those who previously tested negative return for another evaluation.
- The Family Physician will identify those with manifest dementia, i.e., a disease stage in which the treatment would no longer be effective, and those with obvious explanation for cognitive impairment (depression, prior stroke, etc.).
- 80% of those with suspected MCI will get referred to a dementia specialist for confirmatory neurocognitive testing.
- Specialists will identify those who were false positive on the brief cognitive test and order biomarker testing for true positives.
  - 42% of biomarker tests will be based on CSF examination<sup>14</sup> and 58% based on a PET scan.
- 55% will be amyloid-positive based on data from the IDEAS study.<sup>15</sup>
- 80% will have a confirmed treatment indication after full diagnostic evaluation, as specialists might determine a different etiology to be mainly responsible for cognitive impairment or a different life-limiting disease, making a clinical benefit unlikely.

## Model Parameters

We used age and sex-specific population projections of the Ontario population aged 50 and older from 2023 to 2043 from Statistics Canada.<sup>16</sup> Capacity for dementia specialist visits and PET scanners were derived using Ontario data on dementia specialists (geriatricians, neurologists, and dementia psychiatrists)<sup>17</sup> and PET scanners,<sup>18</sup> where the derivation process is described in a previously published study.<sup>10</sup> Capacity to perform lumbar punctures and infusion treatments is assumed to be unconstrained.

Transition probabilities for each stage were applied from Neumann et al.'s study that reported transition rates and mortality rates by age and sex at different stages of dementia.<sup>11</sup> The study also reported transition probabilities into long-term care homes from each dementia stage. General mortality rates by age and sex were obtained from Statistics Canada<sup>19</sup> and mortality rates at the MCI stage were based on age and sex-specific population mortality rates that were adjusted for the increased mortality risk of having MCI.<sup>20,21</sup>

Ontario government's average long-term care home rate was \$184.96 per day per resident in 2020.<sup>22</sup> In addition, the government is covering the cost of Alternative Level of Care (ALC) cases. The term describes patients who are held in hospital after acute care treatment to wait for a long-term care bed to become available because their state of health does not allow discharging them to the community. The daily cost of such ALC bed was \$500 in 2018 or \$524 in 2020,<sup>23</sup> In 2020-21, there were 59,322 long-term care home stays with dementia<sup>24</sup> and 1,331,702 ALC days,<sup>25</sup> half of which were attributed to dementia patients,<sup>13</sup> i.e., 1,824 ALC years for dementia patients. Thus, we calculated provincial spending on dementia patients eligible for long-term care by adding cost of dementia related long-term care and ALC.

All monetary values were inflated to 2022 using the Canadian Health & Personal Care Consumer Price Index (CPI).<sup>26</sup> A 2% growth rate was applied to future values from 2023 based on the Canadian projected CPI values.<sup>27</sup>

## Scenario Analysis

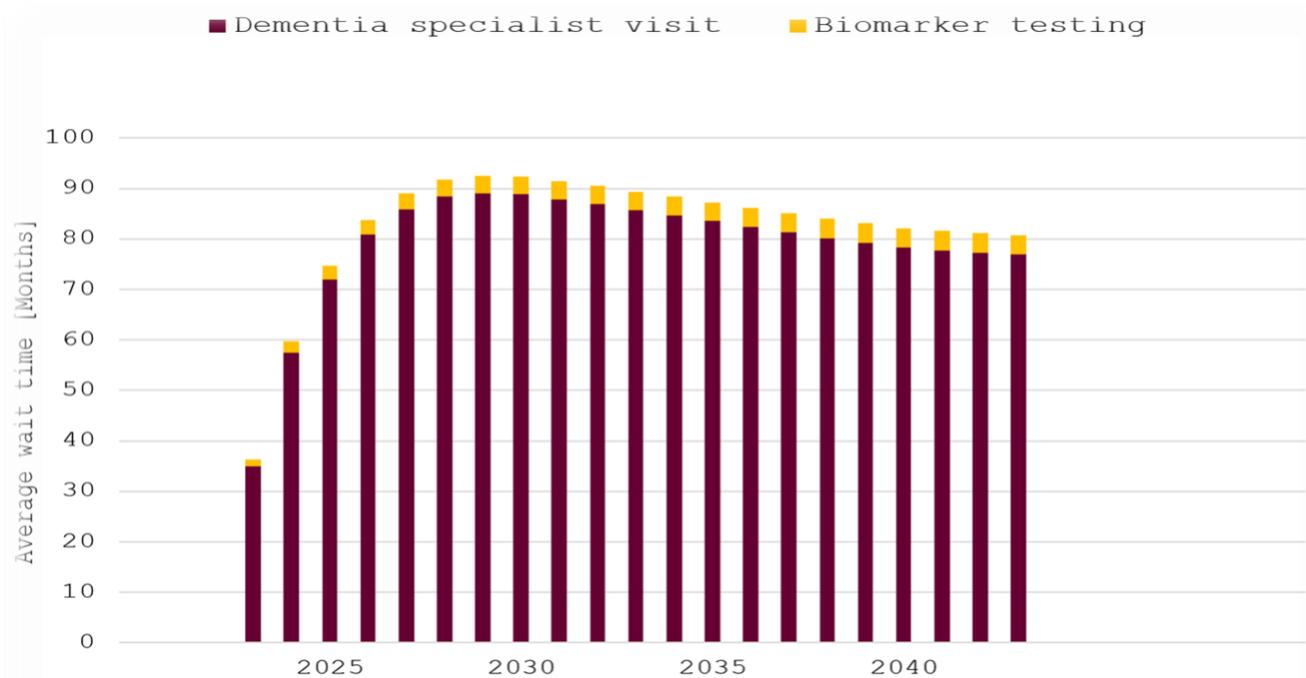
Our base model assumed that referrals to a dementia specialist would be based on test results from a brief cognitive exam, such as the Mini-Mental State Examination, alone. As access to treatment in Ontario is likely to be constrained by the limited capacity of dementia specialists, we investigated two hypothetical scenarios of how patients would be diagnosed faster. First, we assumed a blood-based biomarker test for Alzheimer’s disease pathology would be conducted if the cognitive exam indicated the presence of MCI. Patients would only be referred to a specialist if both the cognitive and the blood test were positive. Our second scenario assumed no capacity constraints, i.e., all patients would be evaluated right away with no wait times for specialist visits and biomarker testing.

## RESULTS

### Impact on wait times for Alzheimer’s disease diagnosis and testing

As shown in FIGURE 1, average annual wait times would increase to more than seven years during the peak in 2029 and remains high afterwards. The main constraint is the lack of dementia specialists that delays patients from proceeding to confirmatory biomarker testing.

**FIGURE 1. Projected wait times for Alzheimer’s disease diagnosis and testing**



### Impact on long-term care home years and related cost savings

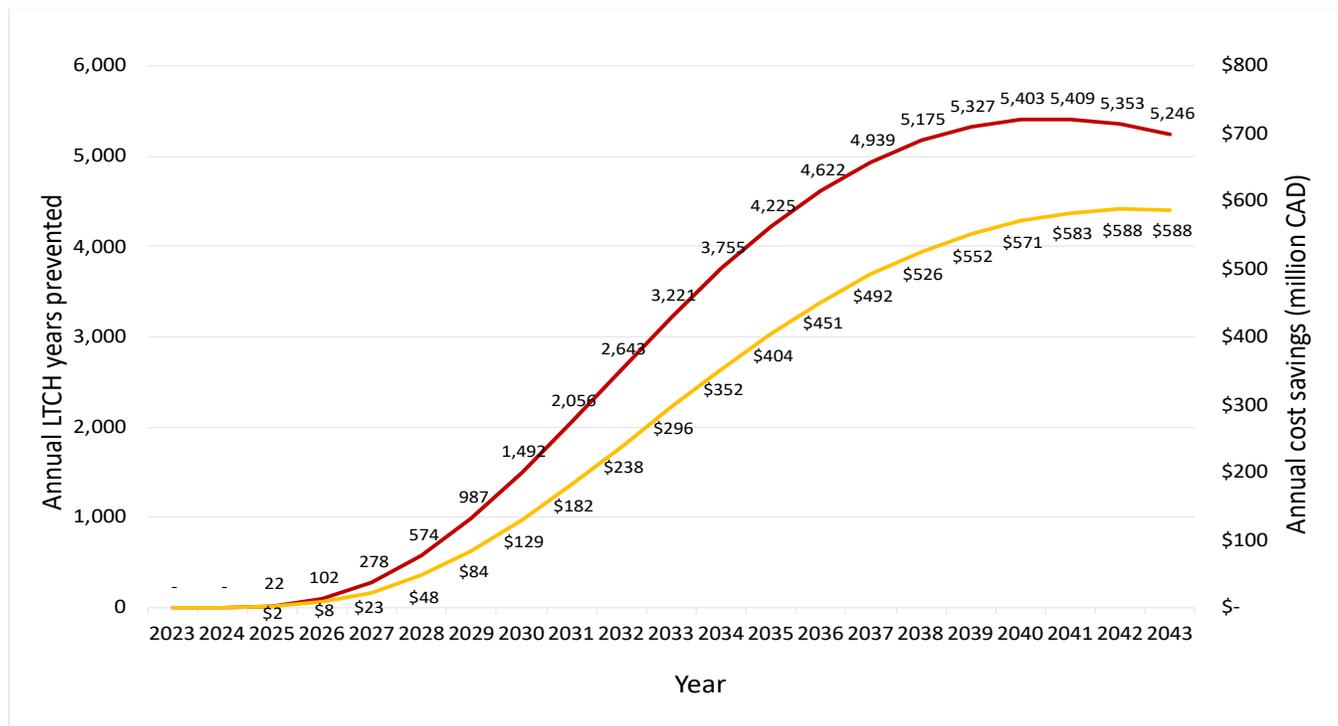
Without a disease-modifying treatment, our model projects that long-term care home years or years in ALC would rise up to 32,775 patient years in 2043, resulting in a cumulative cost of \$27.8 billion from 2023 to 2043. Utilizing such a treatment is estimated to reduce long-term care home years annually, leading to a lower cumulative spending of \$21.7 billion, a 22% relative reduction among treatment eligible patients. FIGURE 2 illustrates the annual number of years prevented and the related cost savings. At the peak of the effect in 2042, the Ontario government is projected to avoid spending on long-

term care homes and ALC of \$588 million. Cumulatively from 2023 to 2043, a treatment is projected to avoid 60,830 years of long-term care home use resulting in \$6.1 billion savings.

### Scenario Analysis

We assumed two scenarios that eliminated some of the barriers to diagnosis and testing of patients. FIGURE 3 shows the difference in annual cost savings resulting from avoided long-term care home years in these scenarios. With a blood test, savings at the peak in 2038 would increase to \$752 million leading to a rise in cumulative savings to \$8.9 billion during 2023 to 2043, a 45% increase compared to the base case scenario. Eliminating all constraints is projected to increase cumulative savings by 62% than the base case, to \$9.9 billion.

**FIGURE 2. Long-term care home years prevented and related savings by year**

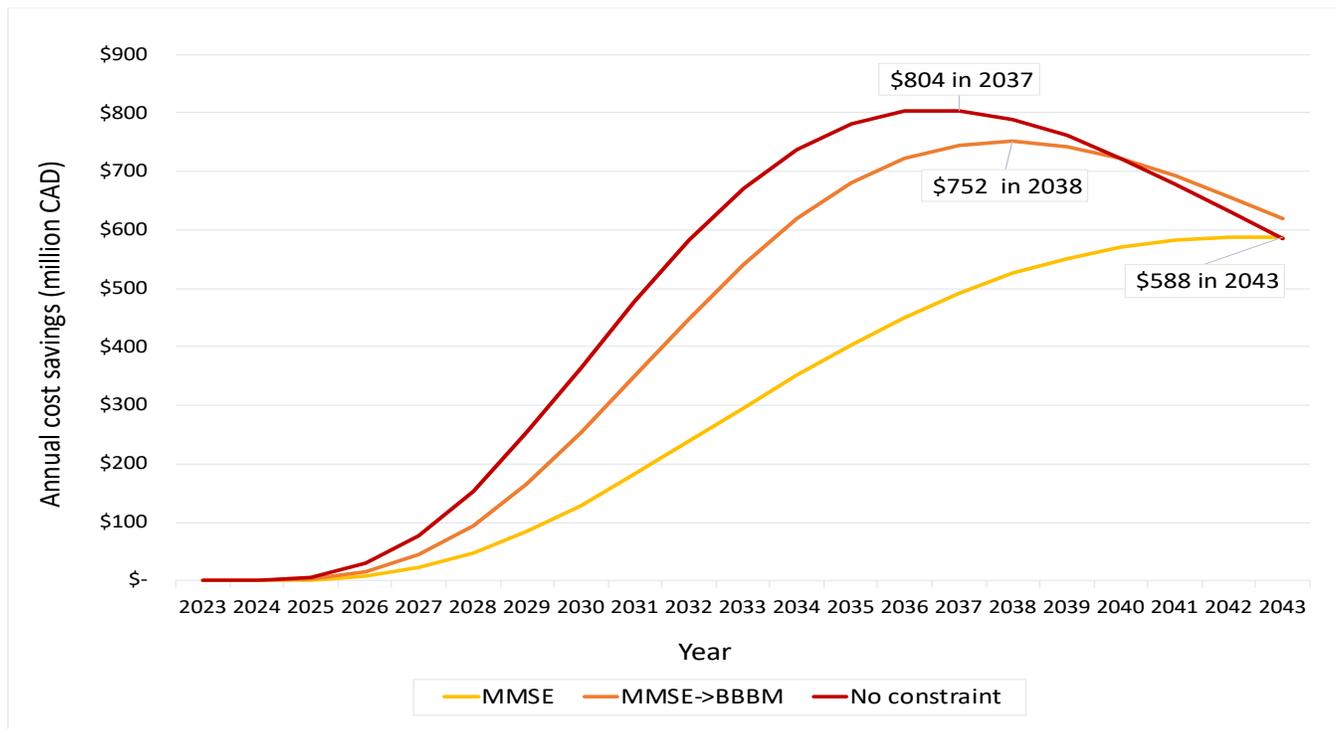


LTCH = Long-term care home

### INTERPRETATION

We project the potential cost savings from reduced long-term care utilization, both in care homes and in ALC beds, to Ontario’s provincial government from providing a disease-modifying Alzheimer’s treatment to eligible patients. Our estimated gross savings are \$6.1 billion from 60,830 lower long-term care home eligible years between 2023 and 2043, a relative reduction of 22% among treatment eligible patients. If we compare gross savings among the total projected long-term care home spending, based on Ontario’s FY2022 spending of \$6.9 billion and using a compound annual growth rate of 9% for the following 20 years,<sup>28</sup> the savings correspond to a 4.06% relative reduction. The results are similar to a previous study in the United States, which projected a disease-modifying Alzheimer’s treatment to create cumulative savings of 186 billion USD over 19 years, corresponding to a 5.06% relative reduction of Medicaid’s spending on nursing

**FIGURE 3. Annual cost savings from reduced long-term care home years across scenarios**



MMSE = Mini-Mental State Examination; BBBM = Blood-based biomarker

home care.<sup>5</sup> The lower rate of savings in Ontario are likely a consequence of the longer projected wait times that prevent patients from getting treated in a timely manner. Those wait times are indeed considerably longer than estimated in a previous study<sup>29</sup> as those prior results relied on a number of simplifying assumptions that underestimated the scale of the problem.<sup>30</sup> The study assumed “perfect” tests along the patient journey, i.e., no false-positive and false-negative results, that only patients with actual cognitive impairment would seek out evaluation and that individuals would never return for a repeat evaluation after testing negative.

Thus, savings could increase substantially if patients were diagnosed and treated at a faster pace: Canada was projected to have the longest wait times among G7 countries primarily due to a shortage of dementia specialists. If all constraints were removed, cumulative savings could increase to \$9.9 billion (62%). The introduction of a blood-based biomarker test alone would allow primary care physicians to triage patients with a likely treatment indication for referral more efficiently and reduce wait times.<sup>8</sup> As shown in our scenario analyses, combining a blood-based test with the Mini-Mental State Examination would increase cumulative savings by 45%, from \$6.1 to \$8.9 billion, compared to relying solely on a Mini-Mental State Examination. Other scalable and non-invasive methods to detect the Alzheimer’s pathology are being developed as well. For example, Retispec, an Ontario-based company, has developed a technology using retinal scans to detect early-stage Alzheimer’s disease.<sup>31</sup>

In addition, a disease-modifying Alzheimer’s treatment could provide partial relief to Ontario’s already stretched medical and social care infrastructure. Today’s waitlist to be placed in a long-term care home in Ontario is long, with average wait times in 2017-18 being 146 days throughout the province and 223 days in the Greater Toronto Area.<sup>32</sup>

With an aging population, demand for long-term care homes will naturally increase. The Financial Accountability Office of Ontario projected an increase in long-term care beds of 38% by 2028-29 and will not keep pace with the expected 52% growth of the population aged 75 and older.<sup>28</sup>

The insufficient number of long-term care beds has an upstream effect on acute care settings: even today nearly 20% of Ontarians waiting for long-term care waited in ALC beds,<sup>32</sup> and already 18.3% of hospital days in Ontario were from ALC cases.<sup>25</sup> According to a report from the Ontario Hospital Association, Ontario has a lower number of hospital beds (1.2 per 1,000 population) when compared nationally (2.0 per 1,000 population) and hospitals routinely operate at 100% capacity.<sup>23</sup> Thus, the need to hold patients in ALC beds, who could otherwise be cared for at home with proper support, could limit access for other patients in need of acute care services.

Our study comes with several limitations. First, a simulation simplifies clinical pathways and care patterns and may be affected by unaccounted factors. However, our model is intended to provide information on potential cost savings and to identify capacity challenges with the use of an Alzheimer's disease modifying therapy. Second, our transition probabilities to long-term care by disease stage were based on a U.S. study because no such data were available for Canada. However, a Canadian study<sup>35</sup> reported an average annual admission risk 11.76%, slightly higher than the corresponding U.S. estimate of 9.25%, which implies that we have underestimated the savings. Third, our cost savings only account for savings from reduced long-term care home use and do not incorporate other contributors to overall societal value.<sup>37</sup>

To summarize, improving access to a disease-modifying Alzheimer's treatment could create savings for the Ontario government by delaying disease progression and subsequent admission into long-term care homes, which might offset a substantial part of the treatment cost. Another benefit would be lower demand for scarce long-term care beds, and reduction in ALC days allocated to individuals living with dementia awaiting transfer to long-term care. Better diagnostic technology could allow larger savings to be realized sooner.

## REFERENCES

1. Mintun MA, Lo AC, Duggan Evans C, et al. Donanemab in Early Alzheimer's Disease. *New England Journal of Medicine*. 2021;384(18):1691-1704. doi:10.1056/nejmoa2100708
2. Swanson CJ, Zhang Y, Dhadda S, et al. A randomized, double-blind, phase 2b proof-of-concept clinical trial in early Alzheimer's disease with lecanemab, an anti-A $\beta$  protofibril antibody. *Alzheimer's Research & Therapy*. 2021;13(1)doi:10.1186/s13195-021-00813-8
3. Prados MJ, Liu Y, Jun H, Lam J, Mattke S. Projecting the long-term societal value of a disease-modifying treatment for Alzheimer's disease in the United States. *Alzheimer's & Dementia*. 2022;18(1):142-151. doi:10.1002/alz.12578
4. Long-Term Care Overview: Funding and Staffing, Sep 24 2020. Ministry of Long-Term Care. Accessed Apr 15, 2022, [https://wayback.archive-it.org/17275/20210810151226/http://www.ltccommission-commissionsld.ca/presentations/pdf/Long-Term\\_Care\\_Staffing\\_and\\_Funding\\_Overview.pdf](https://wayback.archive-it.org/17275/20210810151226/http://www.ltccommission-commissionsld.ca/presentations/pdf/Long-Term_Care_Staffing_and_Funding_Overview.pdf)
5. 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. *Alzheimers Dement (Amst)*. 2021;13(1):e12159. doi:10.1002/dad2.12159
6. 2021 Ontario Budget - Ontario's Action Plan: Protecting People's Health and Our Economy. Ministry of Finance. Accessed May 14, 2022, <https://budget.ontario.ca/2021/contents.html>
7. Liu JL, Hlavka JP, Hillestad R, Mattke S. *Assessing the Preparedness of the U.S. Health Care System Infrastructure for an Alzheimer's Treatment*. RAND Corporation; 2017.
8. Mattke S, Cho SK, Bittner T, Hlávka J, Hanson M. Blood-based biomarkers for Alzheimer's pathology and the diagnostic process for a disease-modifying treatment: Projecting the impact on the cost and wait times. *Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring*. 2020;12(1)doi:10.1002/dad2.12081

9. Liu JL, Hlavka JP, Coulter DT, Baxi SM, Mattke S, Gidengil CA. *Assessing the Preparedness of the Canadian Health Care System Infrastructure for an Alzheimer's Treatment*. 2019.
10. 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 & Dementia: Diagnosis, Assessment & Disease Monitoring*. 2021;13(1)doi:10.1002/dad2.12159
11. Neumann PJ, Araki SS, Arcelus A, et al. Measuring Alzheimer's disease progression with transition probabilities. *Estimates from CERAD*. 2001;57(6):957-964. doi:10.1212/wnl.57.6.957
12. Budd Haeberlein S, Aisen PS, Barkhof F, et al. Two Randomized Phase 3 Studies of Aducanumab in Early Alzheimer's Disease. *The Journal of Prevention of Alzheimer's Disease*. 2022;doi:10.14283/jpad.2022.30
13. Canadian Institute for Health Information. Dementia in hospitals. Accessed May 15, 2022, <https://www.cihi.ca/en/dementia-in-canada/dementia-care-across-the-health-system/dementia-in-hospitals>
14. UK. AsR. *Dementia Attitudes Monitor Wave 2*. 2021. <https://www.dementiastatistics.org/attitudes/>
15. Rabinovici GD, Gatsonis C, Apgar C, et al. Association of Amyloid Positron Emission Tomography With Subsequent Change in Clinical Management Among Medicare Beneficiaries With Mild Cognitive Impairment or Dementia. *JAMA*. Apr 2 2019;321(13):1286-1294. doi:10.1001/jama.2019.2000
16. Projected population, by projection scenario, age and sex. Statistics Canada. Accessed April 15, 2022, <https://doi.org/10.25318/1710005701-eng>
17. Number of physicians by province/territory and speciality, Canada. Canadian Medical Association. Accessed April 15, 2022, <https://www.cma.ca/sites/default/files/2019-11/2019-01-spec-prov.pdf>
18. *The Canadian Medical Imaging Inventory 2019-2020*. 2021. *CADTH health technology review*.
19. Mortality rates by age group. Statistics Canada. Accessed March 15, 2022, <https://doi.org/10.25318/1310071001-eng>
20. Bennett DA, Wilson RS, Schneider JA, et al. Natural history of mild cognitive impairment in older persons. *Neurology*. 2002;59(2):198-205. doi:10.1212/wnl.59.2.198
21. Kochanek K, Murphy S, Xu J, Arias E. Deaths: final data for 2017. *Natl Vital Stat Rep*. 2019;68(9)
22. Long-Term Care Overview: Funding and Staffing. Presentation to the LTC Commission (Sep. 2020). Ontario Ministry of Long-term Health. Accessed April 15, 2022, [https://wayback.archive-it.org/17275/20210810151226/http://www.ltccommission-commissionsld.ca/presentations/pdf/Long-Term\\_Care\\_Staffing\\_and\\_Funding\\_Overview.pdf](https://wayback.archive-it.org/17275/20210810151226/http://www.ltccommission-commissionsld.ca/presentations/pdf/Long-Term_Care_Staffing_and_Funding_Overview.pdf)
23. A balanced approach: the path to ending hallway medicine for Ontario patients and families. Pre-budget submission, 2019 Ontario budget. Ontario Hospital Association. Accessed May 15, 2022, <https://www.oha.com/Bulletins/A%20Balanced%20Approach%20-%202019%20Pre-Budget%20Submission.pdf>
24. Canadian Institute for Health Information. Profile of Residents in Residential and Hospital-Based Continuing Care, 2020–2021. Ottawa, ON: CIHI; 2021. May 15, 2022.
25. Inpatient Hospitalization, Surgery and Newborn Statistics, 2020–2021. Canadian Institute for Health Information. Accessed May 15, 2022, <https://www.cihi.ca/en/hospital-stays-in-canada>
26. Consumer Price Index, annual average, not seasonally adjusted. Statistics Canada. Accessed May 15, 2022, <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1810000501&pickMembers%5B0%5D=1.2&cubeTimeFrame.startYear=2002&cubeTimeFrame.endYear=2021&referencePeriods=20020101%2C20210101>
27. Projected Consumer Price Indices (CPIs) for Baseline Countries/Regions (in percent) 2011-2031. USDA Economic Research Service. . Accessed April 15, 2022, <https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.ers.usda.gov%2Fwebdocs%2FDataFiles%2F51832%2FProjectedCPIsValues.xls%3Fv%3D0&wdOrigin=BROWSELINK>
28. Gurnham M, Kim J, Devakos T, Stephenson M, Ngo L, Novak J. Ministry of long-term care - spending plan review. *Financial Accountability Office of Ontario*. 2021;

29. Mattke S, Wang M. Why would Canada have the longest wait times for an Alzheimer's treatment among the G7 countries? *Canadian Health Policy*. 2022;2022(JAN)doi:<https://doi.org/10.54194/AKQT5456>,
30. Mattke S, Hanson M. Expected wait times for access to a disease-modifying Alzheimer's treatment in the United States. *Alzheimer's & Dementia*. 2021;doi:10.1002/alz.12470
31. More SS, Beach JM, McClelland C, Mokhtarzadeh A, Vince R. In Vivo Assessment of Retinal Biomarkers by Hyperspectral Imaging: Early Detection of Alzheimer's Disease. *ACS Chemical Neuroscience*. 2019;10(11):4492-4501. doi:10.1021/acscemneuro.9b00331
32. Um S-g, Iveniuk J. Waiting for long-term care in the GTA: trends and persistent disparities. *Wellesly Institute*. 2020;
33. Cheng C, Hirdes JP, Heckman G, Poss J. Predictors of Home Care Costs Among Persons With Dementia, Amyotrophic Lateral Sclerosis, and Multiple Sclerosis in Ontario. *Health Services Insights*. 2020;13:117863292090373. doi:10.1177/1178632920903731
34. Manis DR, Rahim A, Poss JW, et al. Association Between Dementia Care Programs in Assisted Living Facilities and Transitions to Nursing Homes in Ontario, Canada: A Population-Based Cohort Study. *J Am Med Dir Assoc*. Oct 2021;22(10):2115-2120 e6. doi:10.1016/j.jamda.2021.07.002
35. Cloutier DS, Penning MJ, Nuernberger K, Taylor D, Macdonald S. Long-Term Care Service Trajectories and Their Predictors for Persons Living With Dementia: Results From a Canadian Study. *Journal of Aging and Health*. 2019;31(1):139-164. doi:10.1177/0898264317725618
36. Knapp M, Chua KC, Broadbent M, et al. Predictors of care home and hospital admissions and their costs for older people with Alzheimer's disease: findings from a large London case register. *BMJ Open*. Nov 18 2016;6(11):e013591. doi:10.1136/bmjopen-2016-013591
37. Prados MJ, Liu Y, Jun H, Lam J, Mattke S. Projecting the long-term societal value of a disease-modifying treatment for Alzheimer's disease in the United States. *Alzheimer's & Dementia*. 2022;18(1):142-151. doi:10.1002/alz.12578
38. Long-Term Care in Ontario Sector Overview. Ministry of Health and Long-Term Care. Sep 2015. Accessed May 15, 2022, <http://longtermcareinquiry.ca/wp-content/uploads/Exhibit-169-Long-Term-Care-in-Ontario-Sector-overview.pdf>

## TECHNICAL APPENDIX

**TABLE 1: Parameters and Sources**

	Value	Reference
<b>Initial prevalence</b>		
Cognitively normal	85%	(1) (2)
MCI	9%	(1, 2)
Dementia	6%	(3)
Proportion of MCI patients with Alzheimer’s disease	55%	(4)
Population projections by age group and sex for general Ontario population, 2020-40		(5)
<b>Annual mortality rate by age group and sex for general Ontario population (%)</b>		
Male:		(6)
50-54	0.4	
55-59	0.6	
60-64	0.9	
65-69	1.4	
70-74	2.1	
75-79	3.5	
80-84	6.1	
85+	11.1	
Female:		
50-54	0.2	
55-59	0.4	
60-64	0.6	
65-69	0.9	
70-74	1.4	
75-79	2.4	
80-84	4.3	
85+	8.1	
<b>Hazard ratio for excess mortality</b>		
MCI (95% CI)	1.43; 1.7 (1.2-2.5)	(7) (8) (9)
Dementia	3.26	(10) (11)
Alzheimer’s dementia, by stage of dementia: male (reference: female)		(11)
Mild dementia (SE)	1.78 (0.68)	
Moderate dementia (SE)	1.85 (0.41)	
Severe dementia (SE)	1.58 (0.19)	
Alzheimer’s dementia, by stage of dementia: age 65-74 (reference: 50-64)		
Mild dementia (SE)	1.79 (1.40)	
Moderate dementia (SE)	1.48 (0.61)	
Severe dementia (SE)	1.12 (0.19)	
Alzheimer’s dementia, by stage of dementia: age 75+ (reference: 50-64)		
Mild dementia (SE)	4.08 (3.07)	
Moderate dementia (SE)	3.33 (1.28)	
Severe dementia (SE)	1.69 (0.28)	
3-year rate of conversion from MCI to Alzheimer’s dementia*	0.43	(12)
<b>Annual transition probability for Alzheimer’s disease progression</b>		
Cognitively normal to MCI	0.03	(13)

MCI to mild dementia*	0.065	(14)
Mild dementia to mild dementia	0.614	(11)
Mild dementia to moderate dementia	0.322	
Mild dementia to severe dementia	0.042	
Moderate dementia to moderate dementia	0.565	
Moderate dementia to severe dementia	0.399	
Severe dementia to severe dementia	0.847	
Mild dementia, community to nursing home	0.038	
Moderate dementia, community to nursing home	0.11	
Severe dementia, community to nursing home	0.259	
Hazard ratio associated with age groups and sex for Alzheimer’s disease progression		
MCI to dementia: female (reference: male) (95% CI)	1.7 (1.2-2.3)	(12)
Between dementia stages: male (reference: female)		(11)
Mild to moderate (SE)	1.16 (0.12)	
Mild to severe (SE)	1.46 (0.40)	
Moderate to severe (SE)	1.07 (0.10)	
Between dementia stages: age 65-74 (reference: 50-64)		
Mild to moderate (SE)	0.83 (0.11)	
Mild to severe (SE)	0.68 (0.24)	
Moderate to severe (SE)	1.02 (0.12)	
Between dementia stages: age 75+ (reference: 50-64)		
Mild to moderate (SE)	0.82 (0.11)	
Mild to severe (SE)	0.75 (0.27)	
Moderate to severe (SE)	0.84 (0.10)	
Community to nursing home: male (reference: female)		
Mild dementia (SE)	0.65 (0.22)	
Moderate dementia (SE)	0.97 (0.18)	
Severe dementia (SE)	1.21 (0.20)	
Community to nursing home: age 65-74 (reference: 50-64)		
Mild dementia (SE)	0.84 (0.41)	
Moderate dementia (SE)	1.09 (0.27)	
Severe dementia (SE)	1.02 (0.22)	
Community to nursing home: age 75+ (reference: 50-64)		
Mild dementia (SE)	1.80 (0.83)	
Moderate dementia (SE)	0.98 (0.25)	
Severe dementia (SE)	0.92 (0.20)	
Initial and confirmatory tests		
MMSE – Sensitivity	0.82	(15)
MMSE – Specificity	0.73	
Blood-based biomarker test (Abeta42/40) – Sensitivity	0.89	(16)
Blood-based biomarker test (Abeta42/40) – Specificity	0.69	
Confirmatory cognitive testing – Sensitivity	0.95	Assumption
Confirmatory cognitive testing – Specificity	0.95	Assumption
Confirmatory testing with CSF (pTau/Abeta42) – Sensitivity	0.91	(17)
Confirmatory testing with CSF (pTau/Abeta42) – Specificity	0.89	
Confirmatory testing with PET – Sensitivity	0.92	(18)
Confirmatory testing with PET – Specificity	0.95	
Proportion of patients receiving amyloid PET scan	90%	Assumption
Proportion of patients receiving CSF testing	10%	Assumption

Annual probability for screening		
Screening naïve	50%	Estimated based on participation rates in cancer screening
Screening experienced	10%	Assumption
Capacity		
Specialist (geriatricians, neurologists, dementia psychiatrists)	754 in 2019	(19)
PET scanners	23 in 2019	(20)
Long-term care home cost		
Consumer Price Index (CPI) -Health & Personal Care	2020-22	(21)
CPI projection	2% annually for 2023-2040	(22)
LTCH Gov’t daily per diem rate	\$184.96	(23)
LTCH residents with dementia, 2020-21	59,322	(24)
ALC length of stay (days), 2020-21	1,331,702	(25)
ALC cost per day per patient, 2018	\$500	(26)

\*To estimate the number of patients who would be diagnosed with mild cognitive impairment before progression to Alzheimer’s dementia, we used the transition probability of 0.065. For the disease progression model where we are evaluating treatment effect on a clinical population of patients with a confirmed diagnosis of mild cognitive impairment, we use the 0.43 3-year conversion rate (which annualizes to 0.17).

MCI: mild cognitive impairment; MMSE: mini-mental state exam; CSF: cerebral spinal fluid; LTCH: long-term care home; ALC: alternative level of care.

## TECHNICAL REFERENCES

1. Petersen RC, Roberts RO, Knopman DS, Geda YE, Cha RH, Pankratz VS, et al. Prevalence of mild cognitive impairment is higher in men. *The Mayo Clinic Study of Aging. Neurology.* 2010 Sep 7;75(10):889-97.
2. Petersen RC, Lopez O, Armstrong MJ, Getchius TSD, Ganguli M, Gloss D, et al. Practice guideline update summary: Mild cognitive impairment: Report of the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology. *Neurology.* 2018 Jan 16;90(3):126-35.
3. Hebert LE, Weuve J, Scherr PA, Evans DA. Alzheimer disease in the United States (2010-2050) estimated using the 2010 census. *Neurology.* 2013 May 7;80(19):1778-83.
4. Rabinovici GD, Gatsonis C, Apgar C, Chaudhary K, Gareen I, Hanna L, et al. Association of Amyloid Positron Emission Tomography With Subsequent Change in Clinical Management Among Medicare Beneficiaries With Mild Cognitive Impairment or Dementia. *JAMA.* 2019 Apr 2;321(13):1286-94.
5. Projected population, by projection scenario, age and sex. Statistics Canada. <https://doi.org/10.25318/1710005701-eng>. Accessed April 15, 2022.
6. Mortality rates by age group. Statistics Canada. <https://doi.org/10.25318/1310071001-eng>. Accessed March 15, 2022.
7. Yesavage JA, O’Hara R, Kraemer H, Noda A, Taylor JL, Ferris S, et al. Modeling the prevalence and incidence of Alzheimer’s disease and mild cognitive impairment. *Journal of Psychiatric Research.* 2002;36(5):281-6.
8. 2017 Alzheimer's disease facts and figures. *Alzheimer's & Dementia.* 2017;Volume 13, Issue 4:Pages 325-73.
9. Bennett DA, Wilson RS, Schneider JA, Evans DA, Beckett LA, Aggarwal NT, et al. Natural history of mild cognitive impairment in older persons. *Neurology.* 2002 Jul 23;59(2):198-205.
10. Aneshensel CS, Pearlin LI, Levy-Storms L, Schuler RH. The transition from home to nursing home mortality among people with dementia. *J Gerontol B Psychol Sci Soc Sci.* 2000 May;55(3):S152-62.

11. Neumann PJ, Araki SS, Arcelus A, Longo A, Papadopoulos G, Kosik KS, et al. Measuring Alzheimer's disease progression with transition probabilities: estimates from CERAD. *Neurology*. 2001 Sep 25;57(6):957-64.
12. Lee SJ, Ritchie CS, Yaffe K, Stijacic Cenzer I, Barnes DE. A clinical index to predict progression from mild cognitive impairment to dementia due to Alzheimer's disease. *PLoS One*. 2014;9(12):e113535-e.
13. Lin KA, Choudhury KR, Rathakrishnan BG, Marks DM, Petrella JR, Doraiswamy PM, et al. Marked gender differences in progression of mild cognitive impairment over 8 years. *Alzheimers Dement (N Y)*. 2015 Sep 1;1(2):103-10.
14. Mitchell AJ, Shiri-Feshki M. Rate of progression of mild cognitive impairment to dementia - meta-analysis of 41 robust inception cohort studies. *Acta Psychiatrica Scandinavica*. 2009;119(4):252-65.
15. Roalf DR, Moberg PJ, Xie SX, Wolk DA, Moelter ST, Arnold SE. Comparative accuracies of two common screening instruments for classification of Alzheimer's disease, mild cognitive impairment, and healthy aging. *Alzheimers Dement*. 2013 Sep;9(5):529-37.
16. Palmqvist S, Janelidze S, Stomrud E, Zetterberg H, Karl J, Zink K, et al. Performance of Fully Automated Plasma Assays as Screening Tests for Alzheimer Disease-Related beta-Amyloid Status. *JAMA Neurol*. 2019 Jun 24.
17. Hansson O, Seibyl J, Stomrud E, Zetterberg H, Trojanowski JQ, Bittner T, et al. CSF biomarkers of Alzheimer's disease concord with amyloid-beta PET and predict clinical progression: A study of fully automated immunoassays in BioFINDER and ADNI cohorts. *Alzheimers Dement*. 2018 Nov;14(11):1470-81.
18. Clark CM, Pontecorvo MJ, Beach TG, Bedell BJ, Coleman RE, Doraiswamy PM, et al. Cerebral PET with florbetapir compared with neuropathology at autopsy for detection of neuritic amyloid-beta plaques: a prospective cohort study. *Lancet Neurol*. 2012 Aug;11(8):669-78.
19. Number of physicians by province/territory and speciality, Canada. Canadian Medical Association. <https://www.cma.ca/sites/default/files/2019-11/2019-01-spec-prov.pdf>. Accessed April 15, 2022.
20. The Canadian Medical Imaging Inventory 2019-2020. Ottawa: CADTH;2021.
21. Consumer Price Index, annual average, not seasonally adjusted. Statistics Canada. Accessed May 15, 2022.
22. Projected Consumer Price Indices (CPIs) for Baseline Countries/Regions (in percent) 2011-2031. USDA Economic Research Service. . <https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.ers.usda.gov%2Fwebdocs%2FDataFiles%2F51832%2FProjectedCPIsValues.xls%3Fv%3D0&wdOrigin=BROWSELINK>. Accessed April 15, 2022.
23. Policy: LTCH Level-of-Care Per Diem Funding Summary (August 2019). Ontario Ministry of Health & Ministry of Long-term Health. [https://www.health.gov.on.ca/en/public/programs/ltc/ltaa\\_policies.aspx](https://www.health.gov.on.ca/en/public/programs/ltc/ltaa_policies.aspx). Accessed April 15, 2022.
24. Canadian Institute for Health Information. Profile of Residents in Residential and Hospital-Based Continuing Care, 2020–2021. Ottawa, ON: CIHI; 2021.
25. Inpatient Hospitalization, Surgery and Newborn Statistics, 2020–2021. Canadian Institute for Health Information. <https://www.cihi.ca/en/hospital-stays-in-canada>. Accessed May 15, 2022.
26. A balanced approach: the path to ending hallway medicine for Ontario patients and families. Pre-budget submission, 2019 Ontario budget. Ontario Hospital Association.