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CADTH Horizon Scan

Technologies to Increase Freedom for People Living With Dementia

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Key Messages

What Is the Issue?

- Dementia refers to symptoms affecting cognition (including memory), behaviour, and mood, which can significantly impact daily activities and independence. Conditions that may contribute to the development of dementia include Alzheimer disease, Parkinson disease, and stroke. As the population ages, the number of people in Canada living with dementia will continue to increase.
- More than 60% of people with dementia live at home rather than in a long-term care facility. Approximately 40% of people aged 80 and older who have dementia reside in long-term care facilities, while others stay in their homes. When living at home in the community, support is needed to maintain safety, independence, and quality of life for both the person living with dementia and their caregiver(s).
- Most of the assistive technologies used to help support people with dementia to live in their homes are paid for by the user and not by provincial or territorial insurance programs, highlighting issues of equity of access related to income.

What Is the Technology?

- A variety of technologies, including medical devices and consumer electronics, are available that can be used with the intention of helping people living with dementia stay in their homes.
- Technologies to support the care of people living with dementia can be broadly grouped into 2 categories: technologies related to diagnosis, assessment, and early risk identification and technologies related to management and rehabilitation.
- This report primarily focuses on technologies that aim to provide management and rehabilitation; these aim to support people with dementia (and their caregivers) – allowing people to live in their homes and communities for longer.
- These are often classified as assistive devices and include GPS trackers, fall monitoring systems, and connected technologies that can increase and simplify access to services such as food or grocery delivery, pharmacies, and telehealth.

What Is the Potential Impact?

- User-friendly, connected, and effective technologies that allow freedom for people living with dementia may also reduce caregiving stress; however, most randomized trials of assistive technologies have not

Key Messages

demonstrated the usefulness of these technologies in real-world settings in a way that support them being formally incorporated into dementia management.

- The use of supportive technologies may help people living with dementia stay safely in their homes for longer, thereby reducing the burden on long-term care facilities and providing potential savings to the health care system.

What Else Do We Need to Know?

- There is a constant conflict between safety and privacy for people living with dementia who may not always be aware of their current state of cognition and may not be able to provide adequately informed consent for the continued use of monitoring technologies.
- The evidence suggests further research into the effectiveness of these technologies in real-world settings is required to understand better their usefulness and place in therapy for people living at home with dementia. There remains a lack of consensus on the effectiveness of these technologies and a lack of guidance for their use.

Purpose

Maintaining self-identity and independence have been identified as important disease management elements for people with dementia.¹ The purpose of this Horizon Scan is to present health care stakeholders in Canada with an overview of information related to new and emerging technologies to support people living with dementia to live in their homes and participate in activities in their community.

Details related to the methods used for this report are available in [Appendix 1](#). CADTH has previously written about related topics such as GPS locator devices for people with dementia,² wireless artificial intelligence systems for monitoring health in the home,³ and funding and access to electronic aids for daily living.⁴

Background

It is projected that there will be 1.4 billion people worldwide aged 60 years or older by 2030.⁵ This number is expected to increase to more than 2 billion by 2050. As the world's population ages, the number of people living with dementia increases. Dementia refers to symptoms affecting cognition (including memory), behaviour, and mood, which can significantly impact daily activities and independence. Dementia is a chronic condition that can be preceded by stages of mild cognitive impairment and worsens progressively over time. Conditions that may contribute to the development of dementia include Alzheimer disease (AD), Parkinson disease, and stroke. Current diagnostic approaches for AD and other causes of dementia involve cognitive and neurologic assessments, medical neuroimaging, and clinical evaluation by trained specialists such as psychiatrists, cognitive neurologists, and geriatricians.⁶ This process may also be supported by laboratory testing of blood and cerebrospinal fluid to detect associated biomarkers and screening for risk-associated genes.^{7,8}

There are currently no curative and few disease-modifying therapies approved for the treatment of dementia in Canada, with current options limited to symptom management and psychosocial interventions. There are several new therapies being evaluated for the treatment of dementia including novel biologic drug therapies, and non-pharmacological approaches including neuromodulation, which was reviewed in a 2021 [CADTH Horizon Scan](#).⁹ Other technologies, such as hearing restorative devices ([reviewed in 2023 CADTH Horizon Scan](#)), are being explored as interventions that may prevent or delay the progression of dementia.

Assistive technologies are those that encourage and help maintain independence and allow people with cognitive or physical limitations to remain safely in their homes.¹⁰ The UK Alzheimer Society defines assistive technology as "any device or system that allows an individual to perform a task that they would otherwise be unable to do, or increases the ease and safety with which the task can be performed."¹¹ These technologies may help people living with dementia stay in their homes longer by monitoring their behaviours and tracking their movements to ensure they stay safe, providing reminders for food and medicine, and monitoring the house for emergencies like fire or flood. The development of assistive technologies is happening quickly and the products available and the evidence to support their use, is evolving quickly as well.

Who Might Benefit?

In 2020, more than 600,000 people in Canada were living with AD and other forms of dementia and 124,000 new cases were diagnosed. From 2019 to 2020, 1,409 out of every 100,000 people living in Canada aged 65 and older were newly diagnosed with dementia.¹² AD is estimated to cost the Canadian health care system \$10.4 billion dollars per year, a number that is expected to double by 2031.¹³ A national dementia strategy for Canada is being developed in response to the passing of the 2017 National Strategy for Alzheimer Disease and Other Dementias Act.¹⁴ The aim is to outline common principles of care and a national objective to guide action relating to dementia care across all levels of government. The 3 national objectives of the plan include prevention of dementia, advancing therapies toward a cure, and improving the quality of life for people living with dementia and their care partners.^{14,15}

In 2016, about 261,000 seniors in Canada with dementia were living outside of publicly funded long-term care or nursing homes.¹²

People continue to choose to live at home for their own comfort but also because of the high costs and lack of access to sufficient public or private long-term care.¹⁰ The results of a 2021 survey by the Angus Reid Institute showed that 47% of people polled would do everything they could to keep themselves or family members out of long-term care facilities in Canada following the impact the COVID-19 pandemic had on the health care and long-term care systems in Canada.¹⁶

Technologies for People Living at Home With Dementia

A 2019 report from the Canadian Standards Association¹⁷ suggested that the use of active assisted living technologies outside of research and development was in the early stages of being incorporated into health care in Canada at that time. The technologies most used in Canada included smart home devices, telehealth, and assistive technologies.¹⁷ The use of alarms and personal response systems was reported to be relatively low.¹⁷ A poll commissioned by AGE-WELL found that 72% of older adults in Canada feel confident using technology.¹⁸ The increased use of technology to facilitate medical appointments during the acute phase of the COVID-19 pandemic resulted in more than 50% of those polled having used telehealth during that time.¹⁸

There is a large body of existing evidence regarding the use of technology to help people with dementia continue to live safely in their homes. Much of this literature is captured by systematic reviews. [Table 2 \(Appendix 2\)](#) summarizes some of the systematic review literature.

From the information available in the systematic reviews, technologies to support the care of people living with dementia can be broadly grouped into 2 categories: technologies related to diagnosis, assessment, and early risk identification and technologies related to management and rehabilitation.

Technologies Related to Diagnosis, Assessment, and Early Risk Identification

Technologies in the first category have the potential to increase the convenience of remote assessments and reduce the need to travel to clinics or hospitals — assisting clinicians in identifying people at high risk for developing dementia. Early risk identification provides more time to prevent dementia, support plan, and encourage lifestyle supports. These include:

- digital cognitive assessment versus paper-and-pencil assessment (e.g., Cogstate digital cognitive testing system, the computerized national institutes of health toolbox cognition battery, the Cambridge neuropsychological test automated battery)
- technologies in medical imaging
- remote versus onsite cognitive and physical assessment
- biomarkers for risk identification or diagnosis.

Technologies Related to Management and Rehabilitation

This report primarily focuses on technologies that aim to provide management and rehabilitation; these aim to provide support for people with dementia (and their caregivers) — allowing people to live in their homes and communities for longer. These can be categorized into technologies that support:

- autonomy and independence (e.g., empowerment, self-management, social interaction)
- cognitive performances measures (e.g., memory support, execution of tasks)
- physical function improvement (e.g., activities of daily living)
- safety and security (e.g., monitoring or tracking, home security and sensors [e.g., water leaks, fire safety, social alarm, pressure mats, item locators])
- symptoms management and treatment response monitoring (e.g., depressive symptoms, appetite, sleep quality, behaviour changes).

[Table 1](#) provides some examples of specific technologies related to management and rehabilitation that can be used to increase freedom for people living with dementia. Many devices serve similar purposes. The usefulness of each will be dependent on the user. For example, GPS devices are widely available and have various designs. They are meant to provide the exact location of a person or object in real-time. They can be obvious to the user, like a smartwatch, smartphone, or standalone GPS device, or they can be hidden in a piece of clothing or a shoe (e.g., GPS SmartSole) to track the movements of people who may forget to bring their GPS device with them when leaving the house.

Many different types and designs of fall or movement detection devices are available. These range from a fall detection app on a smartwatch or smartphone, a pressure pad that detects when a person has left their bed, and chair to video security systems that can monitor the room to detect when a person has not moved for some time or appears to be in a position or location that is out of the norm (e.g., MetAlert RoomMate).

Table 1: Examples of Technologies to Increase Freedom for People Living With Dementia

Name of technology	Device category	Intended use and features
eSticky ¹⁹	Autonomy and independence	eSticky is a network of visual displays that act as virtual sticky notes around the house, displaying reminders about events, medication, and nutrition. The notes can be programmed by the user or remotely by family members and caregivers.
GPS SmartSole ²⁰	- Autonomy and independence - Safety and security	GPS SmartSole is a shoe insole fitted with a GPS tracking device that allows carers to monitor the location of the wearer. The user's location is updated every 5 minutes and can be accessed by phone or through an app.
Med-E-Lert Automatic Pill Dispenser ²¹	- Autonomy and independence - Safety and security	The Med-E-Lert can be set with up to 6 daily audio and visual medication reminders. The device automatically rotates and dispenses medications 1 compartment at a time. The patient only has access to the dispensed medication once the unit is locked by the caregiver.
MetAlert RoomMate Wall Mounted Alert System ²²	- Safety and security - Symptoms management and response monitoring	The RoomMate provides anonymized fall monitoring. The camera system is mounted on the wall and uses infrared imaging to monitor the behaviours of the person in the room. They system can detect both falls and changes in behaviour that may signal an increased risk of falling.
Toch Smarturns Gas and Electric Stove Safety Device ²³	- Autonomy and independence - Safety and security	Smarturns replace standard stove control knobs and are connected to motion sensor devices. An audible alarm or smartphone notification will trigger if no motion has been detected near the stove for a while, notifying the user or remote caregiver that the stove needs to be turned off.

GPS = global positioning system.

While there are some regulated medical device technologies available related to management and rehabilitation for people with dementia, many people use consumer electronics as an alternative. Reid and colleagues (2023)²⁴ analyzed buyer reviews for 5 top-selling smart home devices available through Amazon UK to discover how they were used by family and carers of people living with dementia. The authors identified 135 product reviews for analysis by searching for keywords related to care provision. This included reviews for a smart tablet display with an integrated camera for video calls, smart lightbulbs, a smart thermostat, a smart plug, and a video doorbell.²⁴ The sale prices for these devices ranged from £24.99 to £180.27. Analysis of the reviews showed that the devices were widely used to support informal caregiving from afar. People purchased devices for their own use and/or by people supporting the care of another.²⁴ The smart display with camera and the video doorbell were most often purchased by family members or other informal caregivers who are trying to care from afar and the video capabilities of these devices allowed them to check in with people living with dementia or monitor the activities within the household from a distance.²⁴

The authors of some of the systematic reviews (SRs) summarized in [Appendix 2](#) included evaluations of other consumer electronics products in their reviews. The table provides a summary of the characteristics of systematic reviews that evaluated assistive technologies for people living with dementia. The commonly recognized consumer devices mentioned in the reviews included wearable movement tracking or GPS

devices (e.g., wearable sensors or smartwatches),²⁵⁻²⁷ smartphones,^{10,26,28} and exercise using the Xbox 360 Kinect.²⁹

- Tracking and GPS devices are often cited as useful devices to help track the movements of people living with dementia and allow them to move around on their own; however, the authors of a review of monitoring and tracking devices were not able to identify an existing device that they considered to be ideal for standardized use in research of their effectiveness.²⁵
- The goal of using smartphones and other technologies was to improve care, provide therapy, or assist in symptom management.²⁸
- Much of the evidence identified in the included reviews came from case studies or case series and cannot be used to establish the effectiveness of the devices and further study is required.^{10,28}
- The use of the Xbox to facilitate exercise resulted in improvements in cognitive assessments.²⁹

Current Practice

The most recent Canadian Consensus Conference on the Diagnosis and Treatment of Dementia was held in 2019.³⁰

There is only 1 recommendation that specifically mentions the use of technology to include cognitive training and stimulation via computer-based and group cognitive training for people at risk or with a diagnosis of mild cognitive impairment or mild dementia.³⁰ The recommendations do not provide a specific program to follow.

There is a fragmented approach to allowing people to live at risk in the community. People are left to purchase supportive technologies on their own and there is inconsistency between regions in how to access and fund these devices. Some supports are available from care professionals and through the Alzheimer Society of Canada and its provincial and territorial counterparts.³¹

Considerations for the Use of Assistive Devices

There are several factors to consider when deciding to add assistive technologies to aid in the care and support of people living 'at risk' in the community with dementia. These factors include how the device will be used, how the user will be supported, how the device will be maintained, and how it will be paid for. These and other considerations for use are described here.

Considerations for Implementation

A poll commissioned by AGE-WELL identified 5 themes central to a home where technology can support all adults choosing to age in place.¹⁸ Technologies should be user-friendly, intelligent, connected, effective, and ethical. These themes echo those found throughout the literature. Recommendations from AGE-WELL and the published literature are summarized here.

User-Friendly

First and foremost, any technology placed in the home that is intended to help support daily living should be simple and easy to use.^{18,32} A person's ability to use technology in the way it is intended can have a large impact on whether they will adopt that technology in a meaningful way.³² Training and support for both the use of the specific technology and in general digital literacy should be available to both people living with dementia and their carers.¹⁸ Support from carers can help overcome some of the technological barriers to use; however, there is limit to how much help the user needs before they become discouraged from using the technology at all.³²

Assistive devices have often been designed as a 1 size fits all solution rather than being tailored to the user's needs or level of impairment.³³ Personalized training and co-designed solutions are considered facilitators of technology use.³⁴ Content that is personalized to the preferences and interests of the user can also increase the user's willingness to use a technology.³² People tend to react more favourably toward apps or technologies that focus on the good things that remain in their lives rather than focusing on the losses or negative health effects of dementia.³² Devices that are discreet or easy to hide from visitors may increase adoption by providing some aid or peace of mind without making it obvious to everyone who enters the space that the person who lives there is using assistive devices.³⁵ Special consideration should be given to how easy it is to use the technology in high-stress or crisis situations, as this is when people struggle with much-needed technology the most.¹⁸ Technologies should come with good customer service and customer support to enable simple troubleshooting and instruction that is geared toward the technical proficiency of the specific user.¹⁸ The authors of a qualitative study found that people using assistive technologies valued the information that the technologies provided but they did not always understand what it meant (e.g., what heart rate or sleep quality had to do with their day to day).³⁶ Users were also afraid of the potential for the devices to identify early cognitive decline and the consequences of what that might mean for their future and ability to live independently.³⁶

Fear of failure and lack of confidence are barriers to adoption of new technologies for both people living with dementia and their caregivers.³²

Supportive technologies should not be seen as a replacement for in-person care, or create a barrier to accessing care, but should supplement and support in-person caregiving.¹⁸ The user's physical and contextual factors influence their ability to use an app or device.³² Physical dexterity, visual impairments, deterioration in cognition, and variability in mood impact the ability of people to engage. Technologies need to be introduced at the right time within the progression of a person's disease for them to be adopted by the user in the most significant way.³²

Intelligent

An intelligent technology is 1 that can be customized to the needs of the user, providing more or less support or content depending on the user's physical or mental health status.¹⁸ Technologies targeted to people living with dementia should be customizable and adapt to individual needs along the care continuum. People

require different types of support at different times through the progression of their disease.¹⁸ Technologies like smart screens with associated apps that provide proactive reminders for users to eat, drink, or take medication may be useful.¹⁸ There is a general preference for assistive technologies that enhance the user's sense of control and confidence by providing meaningful, well-timed prompts instead of frequent alerts, reminders, and instructions that can become overwhelming.³⁵

Connected

A connected technology enables the user to connect easily with friends, family, and community.^{18,37} Connection may be in real-time, like a video or phone call, or asynchronous, like sending a text message that the recipient can respond to at their convenience. Technologies to support people living at home with dementia should also be connected to their circle of care.¹⁸ This includes connection with caregivers, both formal and informal, and health care providers. With consent, these connected technologies can be used to keep people within the circle of care informed of what is going on in the home such as alerting them to any emergencies or notifying any noteworthy changes in behaviour, depending on the functions of the device.¹⁸ Ideally, these technologies are connected in a way that they complement each other and any other medical devices the person living with dementia uses. The use of connected technologies can increase and simplify access to services (e.g., food or grocery delivery, pharmacies, telehealth, and so forth).¹⁸

In Canada, the geographical isolation and low population density of many communities increase the challenges of incorporating technologies into the home and contribute to inequity in access to supportive technologies.¹⁷

There may be a lack of access to reliable or affordable internet, rendering connected devices unhelpful. Some users experienced what the authors referred to as “digital exclusion,” which resulted from a lack of access to strong and reliable WiFi, a lack of availability of smartphones compatible with the devices they were using, and poor digital literacy overall.³⁶

Effective

The ability of supportive technologies to provide a meaningful benefit to people living at home with dementia has not been well established in a real-world setting. Effectiveness may be difficult to define for these technologies. It is often evident that these technologies do what they are designed to do. For example, video cameras enable video calls, GPS devices can track people's movements, and automated medication dispensers can provide access to medication at predetermined times. It is more difficult to establish the secondary effectiveness of these devices and their impact on a person's cognitive abilities or personal safety in their homes. Evidence of validated and reproducible results that these technologies are effective for indications specific to people living with dementia should be established before wide dissemination for this purpose.¹⁸ Technologies should be reliable and resilient and should function adequately in a range of less-than-ideal scenarios, like poor connectivity or power outages.¹⁸

The authors of an umbrella review (review of reviews)³⁵ examined why supportive technologies for older adults living at home and aging in place have been so extensively studied without providing an established agreement of their effectiveness. Effectiveness appears to be strongest to support activities of daily living, including sensors to detect falls, sensors to detect nighttime wandering, sensors to detect fire or flooding, home automation, and medication reminders. However, the quality of the evidence base overall is low for both primary studies and literature reviews.³⁵ The authors concluded that additional research evidence is required to push these technologies beyond the proof of concept or pilot project stages and the evaluation of effectiveness in real life scenarios is required to support the widespread adoption of these technologies.³⁵ The evidence of effectiveness for these technologies remains unclear despite the volume of existing research literature.³⁵

There appears to be a consensus in the literature that assistive technologies are generally beneficial to the people who use them; however, few controlled studies demonstrate this benefit in a real-world setting. In the ATILLA pragmatic randomized controlled trial, Gathercole and colleagues³⁸ sought to determine whether assistive technologies and telecare assessments extended the time people living with suspected or diagnosed dementia could live independently at home. They also investigated the cost-effectiveness of these technologies.

- The study included 495 people living with dementia and their unpaid caregivers in England with follow up over 2 years or until they died or moved out of their home.
- The participants were randomized to receive a full assistive technology package and telecare or a limited control (pendant alarm, nonmonitored smoke and carbon monoxide detectors, and a key safe where indicated).
- There were no statistically significant differences measured in time spent in their homes between the 2 groups after 2 years of follow up.
- There was no difference in safety incidents between groups.
- There were no statistically significant differences in health care, social care resource costs, or societal costs between the 2 groups after 2 years.
- Caregiver scores on depression or anxiety scales did not change significantly over the course of the study. Participants found the technologies were sometimes disruptive to their day-to-day activities.
- The authors concluded that the presumed usefulness of assistive technologies to increase the amount of time people living with dementia may be able to stay safely in their homes may not be as beneficial in real-world conditions as previous studies have suggested.³⁸

There is a general lack of implementation studies to guide the use of these technologies in a real-world setting.³⁵ These types of studies would be beneficial to better understand the specific ways to overcome barriers and to facilitate adoption of assistive technologies in the home. Tannou and colleagues also concluded there was low to moderate effectiveness demonstrated for these devices to adequately support aging in place.³⁵ Studies should include the perspectives not only of those living with dementia, but their caregivers as well. The responsibility of caregiving is significant and technologies and interventions that

reduce caregiver stress are important. It is also important to consider quality of life and quality of life at home, not just the amount of time people are able to stay safely in their homes.

Ethical

The need to maintain the physical safety of a person living with dementia sometimes results in caregivers choosing safety over consent and other ethical considerations when implementing monitoring and other technologies as part of their care.³⁴ There is a constant conflict between safety and privacy for people living with dementia who may not always be aware of their current state of cognition and may not be able to provide adequately informed consent for the continued use of monitoring technologies.³⁴

Data ownership and privacy should be prioritized by using an opt-in approach to data sharing rather than opt-out.¹⁸ People want to feel safe with regard to their personal information when using an app or technology.³² Ensuring the information collected does not contain any overly personal details may help facilitate uptake.³⁵ Research on technologies for people living with dementia often does not include discussion of the privacy standards used and descriptions of data management or encryption standards of the manufacturer are often unavailable.^{35,39}

Technologies meant to support people living at home with dementia should be accessible to users throughout their disease progression and be usable despite any different physical or psychological barriers the user might face.¹⁸

Part of creating a user-friendly experience is adequate consideration of the users' backgrounds and circumstance. Differences in language and cultural context must be considered to provide the most seamless user experience.³² A survey by Petersen and colleagues (2023)³³ found that people with dementia who identified as part of a racial or ethnic minority group considered the need for assistance with basic activities of daily living to be more important than did people with mild dementia who were identified as non-Hispanic white.³³

A component of ethical access is affordability. If the cost determined by the manufacturer is not affordable to the average user, subsidy, financing, or leasing options should be made available to those who qualify to potentially increase equitable access for those who would benefit most from using the technology.¹⁸ The cost of maintenance should also be considered.³⁵ Older adults may be on a fixed income and may not be able to, or be willing to, spend on new technology.³⁷ Older adults tended to be more accepting of the use of supportive technologies when their children or the government paid for them.³⁷

Cost and Administration

Assistive technologies can be expensive, particularly when used at home. CADTH conducted an Environmental Scan in 2021 to assess funding and access to assistive technologies and electronic aids to daily living for adults with physical disabilities that limit mobility and functioning (e.g., spinal cord injury,

neuromuscular disorder) living in their homes.⁴ While not explicitly focused on people living with dementia, there is some overlap in the types of devices used, and the issues with funding and access are similar. Assistive technologies are paid for in a variety of ways in Canada and around the world. These devices may be paid for through public funding, third-party insurance, charity, out-of-pocket payment, or a combination.⁴ Assistive devices can be cost-prohibitive, particularly in cases where the cost is paid directly by the patient or their family or caregivers. Some funding programs rely on a person receiving a specific diagnosis rather than assessing each person's individual need for support.⁴

Final Remarks

Despite the large volume of research literature regarding assistive technologies to aid people living with dementia to stay safely in their homes, there remains a lack of consistent results on the usefulness of these technologies, how to define usefulness and a lack of guidance for their use. Smart home technology will continue to develop over time, and more assistive technology options will likely become available. Further research into the effectiveness of these technologies in real-world settings would be helpful to understand better their usefulness and place in therapy for people living at home with dementia. Considerations of the impact of the use of these technologies on the household and caregivers could also be made. Additionally, the inconsistency in how these technologies are funded and their overall affordability for users continues to contribute to issues of equity of access due to affordability. Payers could consider funding these technologies based on assessed need instead of based on a specific diagnosis.

References

1. Dementia Concerns and Considerations: A CADTH Panel of People With Lived Experience. Ottawa (ON): CADTH 2022. <https://www.cadth.ca/dementia-concerns-and-considerations-cadth-panel-people-lived-experience> Accessed 2022 Nov 22.
2. GPS locator devices for people with dementia. Ottawa (ON): CADTH; 2016: <https://www.ncbi.nlm.nih.gov/books/NBK391026/>. Accessed 2022 Nov 22.
3. A Wireless, Artificial Intelligence System for Monitoring Health in the Home. Ottawa (ON): CADTH; 2019: <https://www.cadth.ca/health-technology-update-issue-24>. Accessed 2022 Nov 22.
4. Funding and Access to Assistive Technologies: Electronic Aids to Daily Living. Ottawa (ON): CADTH; 2021: <https://www.cadth.ca/sites/default/files/es/ES0346%20Funding%20and%20Access%20to%20EADLs%20Final.pdf>. Accessed 2023 Jul 5.
5. Global action plan on the public health response to dementia 2017 - 2025. Geneva (Switzerland): World Health Organization; 2017: <https://www.who.int/publications/i/item/global-action-plan-on-the-public-health-response-to-dementia-2017--2025>. Accessed 2023 Jul 5.
6. Tam-Tham H. Provision of dementia-related services in Canada: a comparative study. *BMC Health Serv Res*. 2016;16:184. [PubMed](#)
7. Serrano A. APOE and Alzheimer's disease: advances in genetics, pathophysiology, and therapeutic approaches. *Lancet Neurol*. 2021;20(1). [PubMed](#)
8. An Overview of New and Emerging Technologies for Early Diagnosis of Alzheimer Disease. Ottawa (ON): CADTH; 2022: <https://www.cadth.ca/sites/default/files/hs-eh/EH0103%20Alzheimer%20Diagnosis%20v.7.0-meta.pdf>. Accessed 2023 Jul 24.
9. Neuromodulation Technologies for the Treatment of Alzheimer Disease. Ottawa (ON): CADTH; 2021: <https://www.cadth.ca/sites/default/files/hs-eh/EH0095%20Neuromodulation%20Alzheimer%20Final.pdf>. Accessed 2023 Jul 5.
10. Behera CK, Condell J, Dora S, Gibson DS, Leavey G. State-of-the-Art Sensors for Remote Care of People with Dementia during a Pandemic: A Systematic Review. *Sensors*. 2021;21(14):08.
11. Alzheimer's Society. Alzheimer's Society's view on assistive technology. 2020; <https://web.archive.org/web/20220121053235/https://www.alzheimers.org.uk/about-us/policy-and-influencing/what-we-think/assistive-technology>. Accessed 2022 Nov 22.
12. Canadian Institute for Health Information. Dementia in Canada. 2018; <https://www.cihi.ca/en/dementia-in-canada>. Accessed 2023 Jul 4.
13. Alzheimer Society. Dementia numbers in Canada. 2023; <https://alzheimer.ca/en/about-dementia/what-dementia/dementia-numbers-canada>. Accessed 2023 Jul 5.
14. A Dementia Strategy for Canada. Ottawa (ON): Public Health Agency of Canada; 2019: https://www.canada.ca/content/dam/phac-aspc/images/services/publications/diseases-conditions/dementia-strategy/National%20Dementia%20Strategy_ENG.pdf. Accessed 2023 Jul 5.
15. A Dementia Strategy for Canada: Together We Achieve - 2020 Annual Report. Ottawa (ON): Public Health Agency of Canada; 2020: <https://www.canada.ca/en/public-health/services/publications/diseases-conditions/dementia-strategy-annual-report-parliament-june-2020.html>. Accessed 2023 Jul 5.
16. Angus Reid Institute. Long-Term Care in Canada: Three-quarters say significant change is needed; only one-in-five believe it will happen. 2021; <https://angusreid.org/canada-long-term-care-policy/>. Accessed 2023 Jul 24.
17. The Active Assisted Living Landscape in Canada. Toronto (ON): CSA Group; 2019: <https://www.csagroup.org/wp-content/uploads/CSA-Group-Research-AAL.pdf>. Accessed 2023 Jul 5.
18. Technology and aging at home: the future of aging in place. Toronto (ON): AGE-WELL Industry Advisory Group; 2021: https://agewell-nce.ca/wp-content/uploads/2021/08/AGE-WELLWhitePaper_TechnologyandAgingatHome_Pages.pdf. Accessed 2022 Nov 22.
19. Mettouris C, Yeratziotis A, Fixl L, et al. eSticky: An Advanced Remote Reminder System for People with Early Dementia. *Sn Computer Science*. 2023;4(4):334. [PubMed](#)

20. SmartSole. GPS SmartSole. 2023; <https://www.gpssmartsole.com/>. Accessed 2023 Jul 24.
21. Med-E-Lert. Med-E-Lert. 2023; <https://www.medelert.com/>. Accessed 2023 Sep 21.
22. MetAlert. RoomMate Wall Mounted Alert System. 2023; <https://metalert.com/roommate/>. Accessed 2023 Jul 24.
23. Tochtech Technologies. Toch Smartturns: Gas & Electric Stove Safety Device. 2023; <https://www.tochtech.com/smartturns-cooking-safety/>. Accessed 2023 Jul 24.
24. Reid L, Sisel G. Digital care at home: Exploring the role of smart consumer devices. *Health & Place*. 2023;80:102961. [PubMed](#)
25. Cullen A, Mazhar MKA, Smith MD, Lithander FE, M OB, Henderson EJ. Wearable and Portable GPS Solutions for Monitoring Mobility in Dementia: A Systematic Review. *Sensors*. 2022;22(9):27. [PubMed](#)
26. Gillani N, Arslan T. Intelligent Sensing Technologies for the Diagnosis, Monitoring and Therapy of Alzheimer's Disease: A Systematic Review. *Sensors*. 2021;21(12):21. [PubMed](#)
27. Ray PP, Dash D, De D. A Systematic Review and Implementation of IoT-Based Pervasive Sensor-Enabled Tracking System for Dementia Patients. *J Med Syst*. 2019;43(9):287. [PubMed](#)
28. Palmdorf S, Stark AL, Nadolny S, et al. Technology-Assisted Home Care for People With Dementia and Their Relatives: Scoping Review. *JMIR Aging*. 2021;4(1):e25307. [PubMed](#)
29. Gettel CJ, Chen K, Goldberg EM. Dementia Care, Fall Detection, and Ambient-Assisted Living Technologies Help Older Adults Age in Place: A Scoping Review. *J Appl Gerontol*. 2021;40(12):1893-1902. [PubMed](#)
30. Ismail Z. Recommendations of the 5th Canadian Consensus Conference on the diagnosis and treatment of dementia. *Alzheimer's & Dementia*. 2020;16:1182-2295. [PubMed](#)
31. Alzheimer Society. Alzheimer Society. 2023; <https://alzheimer.ca/en>. Accessed 2023 Jul 24.
32. Conway A, Ryan A, Harkin D, Mc Cauley C, Goode D. A review of the factors influencing adoption of digital health applications for people living with dementia. *Digital Health*. 2023;9:20552076231162985. [PubMed](#)
33. Petersen CM, DeLucia PR, Oswald FL, et al. Toward user-centered assistive technologies for aging in place with cognitive impairment: a survey. *Disabil Rehabil*. 2023;Assistive technology.:1-7.
34. Boyle LD, Husebo BS, Vislapuu M. Promotors and barriers to the implementation and adoption of assistive technology and telecare for people with dementia and their caregivers: a systematic review of the literature. *BMC Health Serv Res*. 2022;22(1):1573. [PubMed](#)
35. Tannou T, Lihoreau T, Couture M, et al. Is research on 'smart living environments' based on unobtrusive technologies for older adults going in circles? Evidence from an umbrella review. *Ageing Res Rev*. 2023;84 (no pagination). [PubMed](#)
36. Wilson S, Ardlie RM, Tolley C, Slight S. Usability and acceptability of wearable technology in the early detection of dementia. *Alzheimer's & Dementia*. 2022;18 Suppl 2:e059820. [PubMed](#)
37. Pirzada P. Ethics and acceptance of smart homes for older adults. *Inform Health Soc Care*. 2021. [PubMed](#)
38. Gathercole R, Bradley R, Harper E, et al. Assistive technology and telecare to maintain independent living at home for people with dementia: the ATTILA RCT. *Health Technology Assessment (Winchester, England)*. 2021;25(19):1-156. [PubMed](#)
39. Wigg JM. Recent Developments in Technological Support for Wanderers. *Curr Geriatr Rep*. 2020;9(2):101-106.
40. Lobe C, AboJabel H. Empowering people with dementia via using intelligent assistive technology: A scoping review. *Arch Gerontol Geriatr*. 2022;101 (no pagination). [PubMed](#)
41. Howes J, Gastmans C. Electronic tracking devices in dementia care: A systematic review of argument-based ethics literature. *Arch Gerontol Geriatr*. 2021;95:104419. [PubMed](#)
42. Lee AR, Gerritzen EV, McDermott O, Orrell M. Exploring the role of web-based interventions in the self-management of dementia: Systematic review and narrative synthesis. *J Med Internet Res*. 2021;23(7) (no pagination).
43. Ohman F, Hassenstab J, Berron D, Scholl M, Papp KV. Current advances in digital cognitive assessment for preclinical Alzheimer's disease. *Alzheimers Dement (Amst)*. 2021;13(1):e12217. [PubMed](#)

44. Shu S, Woo BK. Use of technology and social media in dementia care: Current and future directions. *World j.* 2021;11(4):109-123.
45. Brandt A, Jensen MP, Soberg MS, Andersen SD, Sund T. Information and communication technology-based assistive technology to compensate for impaired cognition in everyday life: a systematic review. *Disabil.* 2020;15(7):810-824. [PubMed](#)
46. Husebo BS, Heintz HL, Berge LI, Owoyemi P, Rahman AT, Vahia IV. Sensing technology to facilitate behavioral and psychological symptoms and to monitor treatment response in people with dementia: A systematic review. *Front Pharmacol.* 2020;10 (no pagination).
47. Kruse CS, Fohn J, Ummakwe G, Patel K, Patel S. Evaluating the Facilitators, Barriers, and Medical Outcomes Commensurate with the Use of Assistive Technology to Support People with Dementia: A Systematic Review Literature. *Healthcare.* 2020;8(3):18. [PubMed](#)
48. Daly Lynn J, Rondon-Sulbaran J, Quinn E, Ryan A, McCormack B, Martin S. A systematic review of electronic assistive technology within supporting living environments for people with dementia. *Dementia.* 2019;18(7-8):2371-2435. [PubMed](#)
49. King AC, Dwan C. Electronic memory aids for people with dementia experiencing prospective memory loss: A review of empirical studies. *Dementia.* 2019;18(6):1994-2007. [PubMed](#)
50. Koumakis L, Chatzaki C, Kazantzaki E, Maniadi E, Tsiknakis M. Dementia Care Frameworks and Assistive Technologies for Their Implementation: A Review. *IEEE Rev Biomed Eng.* 2019;12:4-18. [PubMed](#)
51. Lorenz K, Freddolino PP, Comas-Herrera A, Knapp M, Damant J. Technology-based tools and services for people with dementia and carers: Mapping technology onto the dementia care pathway. *Dementia.* 2019;18(2):725-741. [PubMed](#)

Appendix 1: Methods

Note that this appendix has not been copy-edited.

Literature Search Strategy

A limited literature search was conducted by an information specialist on key resources including MEDLINE, Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL), the Cochrane Database of Systematic Reviews. Grey literature was identified by searching relevant sections of the *Grey Matters* checklist (<https://www.cadth.ca/grey-matters>). The search strategy comprised both controlled vocabulary, such as the National Library of Medicine's MeSH (Medical Subject Headings), and keywords. The main search concepts were dementia, assistive technologies, and home. No filters were applied to limit the retrieval by study type. The search was completed on October 26, 2022 and limited to English-language documents published since January 1, 2017.

Regular alerts updated the search until project completion; only citations retrieved before June 2023 were incorporated into the analysis.

Study Selection

One author screened the literature search results and reviewed the full text of all potentially relevant publications. Publications were considered for inclusion if the intervention was a technology intended for use by people living with dementia, AD, mild cognitive impairment living at home. Technologies intended for use by formal and informal caregivers supporting people living with dementia, AD, and mild cognitive impairment to live at home and in the community were also included. Conference abstracts and grey literature were included when they provided additional information to that available in the published studies. Inclusion of published literature in this report was limited due to the volume of relevant literature identified and the authors included articles relevant to overall themes without the aim of conducting an exhaustive analysis of the literature.

This report is not a systematic review and does not involve critical appraisal or include a detailed summary of study findings. It is not intended to provide recommendations for or against the use of the technology.

Appendix 2: Summary of Evidence

Note that this appendix has not been copy-edited.

Table 2: Brief Summary of Overviews and Systematic Reviews^a

Author (year), general quality statement	Topic area	Review type	Technologies included	Main information
Cullen et al. (2022) ²⁵ Okay	Monitoring or tracking	Systematic review	Wearable or portable GPS, include smartwatch, wrist watch, home monitoring system, location pocket, SenTra kit, smartphone, QStarz	- Patients with both dementia and MCI were included - Huge heterogeneity - No ideal GPS tracking device for clinical research.
Löbe et al. (2022) ⁴⁰	Autonomy, independence, and empowerment	Scoping review	IAT	- Heterogeneity in the conceptualization and measurement of the concept of empowerment - The role of IAT remains somewhat unclear - For people with mild/moderate dementia, IAT might be used to enhance patients' capacity to live more independently with privacy.
Behera et al. (2021) ¹⁰ Okay	Telecare or remote care	Systematic review	- Assistive technologies - Cognitive assistive technologies - Smart home, avoiding hospitalization, virtual visiting, reminder systems, video monitoring system, GPS-based devices, safe walking, smart phones, exercising in virtual environment, health monitors, safety keys, autowater controller, autogas supply controller, safe home, social alarm system, pressure mats, telephone-blocker, item locator	- Qualitative synthesis - User testing of devices is needed - Telecare: reduce hospitalization, virtual visiting, reminder systems, video monitoring - Location: health monitors - Safety and security: home security, social alarm system, pressure mats, telephone blockers, item locator.
Gettel et al. (2021) ²⁹	Effectiveness of technologies and user's experience	Scoping review	- Usability and knowledge gaps - Persons with dementia - Technologies: virtual	Feasible and useful improvement in cognitive performances, ADL function, depressive symptomatology, appetite,

Author (year), general quality statement	Topic area	Review type	Technologies included	Main information
			reality, care robots, home monitoring systems, wearable cameras, apps, computer-based interventions, augmented reality, Xbox 360 Kinect, wearable activity monitor, active music therapy, electric calendar, intelligent cognitive assistant	sleep quality, cognitive measures. • Patients with dementia had higher intention to use them than health controls • Barriers: lack of experience, lack of desire for assistance by technology, difficulties learning, privacy concerns, social isolation.
Gillani et al. (2021) ²⁶ Good	Diagnosis, effectiveness, and rehabilitation	Systematic review	• Intelligent Sensing Technologies • Smart cupboard • Mobile application • Wearable system: smartphone/smartwatch • Robot dog • Music player	• Diagnosis • Monitoring and therapy of AD • Rehabilitation
Howes et al. (2021) ⁴¹ Okay	Ethical considerations	Systematic review	• Electronic tracking devices	• Ethical approaches, conceptual frames, and principles • These devices may have a dual effect: potentially blistering or eroding the ethical principles. • Privacy and informed consent.
Lee et al. (2021) ⁴² Okay	Autonomy and independence, self-management	Systematic review	• Web-Based or app-based technologies: touch screen computers, smartphone apps, and multicomponent	• Substantial inconsistencies in the self-management domain were found: activities, engagement, adoption and usability • A small number of studies report positive outcomes regarding using these technologies. • High-quality research in this field is needed.
Ohman et al. (2021) ⁴³ Good	Diagnosis or assessment	Scoping review	• Digital cognitive assessment vs. paper-and pencil version • In clinic: Cogstate digital cognitive testing system, the computerized national institutes of health toolbox cognition	• The evidence remains nascent • Several promising newly developed assessment instruments were mentioned • Provide future directions: further research is needed,

Author (year), general quality statement	Topic area	Review type	Technologies included	Main information
			battery, the Cambridge neuropsychological test automated battery - Remotely administered: feasibility, using mobile and serial assessment, cognitive function targeting, big data - Data collection systems: spoken language analysis, eye-tracking, virtual reality and spatial navigation, digital pen	such as to establish observed associations and feasibility studies to identify potential barriers AD biomarkers.
Palmdorf et al. (2021)²⁸ Good	Technology-assisted home care	Scoping review	- Computers, telephones, smartphones, televisions, gaming consoles, monitoring devices, ambient assisted living, and robots. - People with dementia or their informal carers in the home care setting. - Mild cognitive impairment was excluded	- The goal of using these technologies: to improve care, provide therapy or symptoms management - Most evidence from case studies or case series - About 25% RCT with small sample size - Outcomes: effectiveness, feasibility, or usability.
Shu et al. (2021)⁴⁴ Good	Diagnosis, effectiveness; and need ethical issues	Traditional review	- Advanced medical imaging technologies and fluid biomarkers - Continuous driving monitoring - Internet use	- Technology as an aid in diagnosis - Smart homes: voice-activated smart speakers - Sensors and safety: locator devices, falls, wandering, nighttime ambulation, security, water leaks, fire safety - Medication aids - Wearable technology - Social media - Artificial intelligence: therapeutic robots, assistive service robots, driverless vehicles
Brandt et al. (2020)⁴⁵ Good	Autonomy and independence, self-management, support of daily life	Systematic review	Information and communication technology-based assistive technology	- These technologies can be used to support activity and participation in everyday life for people with memory problems - Smartphones, mobile phones, personal digital

Author (year), general quality statement	Topic area	Review type	Technologies included	Main information
				assistants or similar mainstream products with reminder software • Personal digital assistants and similar product can improve memory and execution of tasks for people with cognitive impairment • These technologies should be individually tailored.
Husebo et al. (2020) ⁴⁶ Good	Effectiveness, treatment responses, and ethical considerations	Systematic review	• Sensing technology • Wearable sensors • Nonwearable motion sensor • Assistive technologies/ smart home technologies • Other: noninvasive body sensor network, monitoring system, assistive technology, communication technologies, tablet devices or software	• These technologies can be used in precision care for dementia for patients and caregivers • A framework for sustainable ethical innovation was proposed. • Interdisciplinary cooperation.
Kruse et al. (2020) ⁴⁷ Good	Effectiveness, facilitators, barriers	Systematic review	• Assistive technologies: cognitive stimulators and social robots	• Facilitators: caregivers want technologies, increased independence • Barriers: cost, patients reject technologies • Medical outcomes were improved: cognitive abilities, ADLs, autonomy, and zero negative outcomes were reported.
Daly Lynn et al. (2019) ⁴⁸ Good	Technologies in long-term care settings: barriers	Systematic review	• Electronic assistive technologies	• Focus on long-term care settings • Provides data in the following sections: telecare, light therapy, robotic companions, well-being and leisure, simulated presence, orientation and activities of daily living • There are a wide range of devices and systems commercially available to support people living with dementia yet very little

Author (year), general quality statement	Topic area	Review type	Technologies included	Main information
				validated information to help caregivers select the most suitable technologies.
King et al. (2019)⁴⁹ Okay	Effectiveness of memory aids	Review with a limited literature search (Google Scholar and Web of Science with Boolean search terms)	Electronic memory aids: TV, tablet, phone, digital planning boards, iPad, Memojog, COGKNOW Day Navigator, chatbot, calendars, recorder	- Most studies with small sample size include an early stage in the development of devices, focusing on the effectiveness rather than user outcomes (function, QOL or social connectedness) - Very few devices have been trialled in the home environment - Summarized potential usefulness and technical difficulties of devices, as well as the controlled environment (not in users' homes) of studies and heterogeneous needs of participants (poor fit for users' individual needs).
Koumakis et al. (2019)⁵⁰ Okay	Cost-effectiveness of technologies in integrated dementia care	Methodological review	Assistive technologies (mobile, wearable, and home-based systems)	- Summarized assistive technologies for integrated care models in dementia: mHealth applications, in home-based settings - Cost-effectiveness of dementia-focused interventions supported by information and communication technologies.
Lorenz et al. (2019)⁵¹ Okay	Effectiveness of technologies	Scoping review	- Mild cognitive impairment - Early stages of dementia - Moderate to severe dementia - Unpaid carers - Health-social care professionals - Setting: at home in the community and in institutional care settings	- Memory support (global positioning system devices and voice prompts) - Safety and security (passive monitors) for early stages of dementia; - Treatment and care delivery (technology-aided reminiscence or therapeutic aspects of care) - Training - Social interaction and other - Limited evidence of

Author (year), general quality statement	Topic area	Review type	Technologies included	Main information
				widespread practical application.
Ray et al. (2019)²⁷ Good	Monitoring or tracking	Systematic review	• Tracking devices and techniques • Wearables • GPS sensors • IoT	• Summarized the related works to tracking devices • Feature description of tracking devices: technology gap • A case study of an IoT-based Force Sensor Resistance enabled System were proposed • Technology gap.

AD = Alzheimer disease; ADL = activities of daily living; GPS = global positioning system; IAT = intelligent assistive technology; IoT = internet of things; MCI = mild cognitive impairment; QoL = quality of life; RCT = randomized controlled trial.

^aThis table is not comprehensive and does not include all systematic reviews on the topic as there is a large volume of published research literature in this space.

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