

Evidence Brief

Identifying and Harnessing the Potential of Technology in Long-term Care Settings in Canada

1 & 2 February 2021



HEALTH FORUM

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Evidence Brief:
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McMaster Health Forum

The McMaster Health Forum's goal is to generate action on the pressing health-system issues of our time, based on the best available research evidence and systematically elicited citizen values and stakeholder insights. We aim to strengthen health systems – locally, nationally, and internationally – and get the right programs, services and drugs to the people who need them.

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Merit review

The evidence brief was reviewed by a small number of policymakers, stakeholders and researchers in order to ensure its scientific rigour and system relevance.

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KEY MESSAGES

What's the problem?

- Several factors make it hard to identify and harness the potential of technology in long-term care settings, including:
 - residents of long-term care homes have complex health and social needs;
 - there are many long-standing issues in the long-term care sector across Canada;
 - the full potential of technology isn't being used to address these issues and to improve the quality of life for residents, caregivers and their families; and
 - there are many barriers to designing and using technologies in long-term care homes.

What do we know (from systematic reviews) about three elements of a potentially comprehensive approach to addressing the problem?

- Element 1 – Ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies
 - This element could include efforts to upgrade existing buildings, ensure future buildings are designed and built in a way that is appropriate for enabling the adoption of technologies, and ensure community supports for technology use are available (e.g., availability of affordable broadband internet connections).
 - We found four systematic reviews and one systematic review in progress relevant to upgrading existing buildings, which examined how some long-term care home characteristics and environment design may improve patient outcomes (particularly among residents with dementia), but none focused explicitly on how upgrading existing buildings may help to harness the potential of technology.
- Element 2 – Engage long-term care home operators, staff, residents and their caregivers in developing and adopting technologies
 - This element could include requirements for co-design processes with residents, their caregivers and long-term care operators to develop technologies that meet the needs of residents and caregivers (e.g., for communication with caregivers and with clinicians, and keeping residents safe), support the operation of long-term care homes (e.g., providing training for staff) and integrates with the broader system (e.g., integrated electronic health records, and remote monitoring).
 - We found six systematic reviews and one systematic review in progress that can inform co-design processes. There were variations among the reviews in terms of population focus (e.g., older adults in long-term care, older adults with dementia, community-dwelling older adults, patients in acute-care settings, or the general public), and the focus of co-design processes (e.g., for co-designing research, technologies, or programs and services), but in general, most reviews found beneficial outcomes for co-design approaches, particularly at the idea-generation stage for technologies, and with patients at moderate and severe stages of dementia.
- Element 3 – Enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies
 - This element could include engaging in rapid-learning and improvement cycles that are: 1) centred on residents and caregivers (e.g., by building acceptance for using technology among residents and their caregivers); 2) data and evidence driven (e.g., by creating centralized platforms to share data and evidence about technologies that can be adopted in long-term care, and insights about their use that can be used to drive learning and improvement cycles); 3) supported through aligned system arrangements (e.g., by changing governance, financial and delivery arrangements that currently prevent the adoption, evaluation and continuing modifications of the use of new innovations); and 4) enabled by supportive competencies and culture (e.g., through a long-term care learning collaborative).
 - We were unable to find any systematic reviews that directly address the use of rapid-learning health systems related to long-term care, however, we included two reviews and a series of case studies that related broadly to the characteristics of a rapid-learning health system.

What implementation considerations need to be kept in mind?

- While many barriers to leveraging the potential of technology in long-term care settings may exist at the level of residents and families, providers, provider organizations and systems, perhaps the biggest barrier lies in the long history of not scaling up promising health innovations in Canada.
- Windows of opportunity might include the COVID-19 pandemic that have exposed the long-standing issues in long-term care and have thus created a burning platform for major reforms that could optimize communication and care in long-term care homes.

REPORT

The COVID-19 pandemic has had a disproportionate impact on those in long-term care homes (LTCHs) in Canada. This is driven by LTCH residents being more susceptible to contracting COVID-19 and exacerbated by long-standing issues (e.g., staffing and building upgrades) that have been left unaddressed.(1)

The COVID-19 pandemic is a catalyst for a sharp focus on improving long-term care to address many long-standing and significant concerns in the sector.(2) This has led to the development of several recommendations for strengthening the sector.(1; 3-4) Technology has much potential for helping to address some of the most fundamental problems in long-term care and ultimately optimizing physical health and well-being, and improving communication (e.g., via remote visits with healthcare teams and with caregivers, family and friends), through examples such as:

- interdisciplinary and inter-facility communication (e.g., electronic health record systems);
- safety monitoring (e.g., location tracking or GPS for wandering residents, health monitors, emergency response, and monitoring usage of appliances);
- touchless hardware and voice activated devices (e.g., asking “Google” or “Alexa” to call the nurse and/or front desk staff; and activate features in rooms such as lights, blinds, heating, ventilation and air conditioning; and entertainment); and
- artificial intelligence which can support implementation and enhance functionality and usability.(5-6)

However, considering the use of technology in long-term care needs to be done in a way that enhances person-centred approaches for residents and their caregivers, family and friends, rather than only for enhancing efficiency and reducing costs. Focusing only on the latter is likely to lead to increasingly de-personalized care and potentially exacerbating many of the already existing fundamental issues in long-term care. For example, this can mean ensuring that technology is not used to substitute for human interaction and instead used in a way that can free up staff and care providers for more time for such interactions, thereby supporting enhancements in client experiences and outcomes while also achieving manageable costs and positive provider experiences.

Given this, it is not surprising that the Public Health Agency of Canada (PHAC) has put forth outbreak-

Box 1: Background to the evidence brief

This evidence brief mobilizes both global and local research evidence about a problem, three elements of a potentially comprehensive approach for addressing the problem, and key implementation considerations. Whenever possible, the evidence brief summarizes research evidence drawn from systematic reviews of the research literature and occasionally from single research studies. A systematic review is a summary of studies addressing a clearly formulated question that uses systematic and explicit methods to identify, select and appraise research studies and to synthesize data from the included studies. The evidence brief does not contain recommendations, which would have required the authors of the brief to make judgments based on their personal values and preferences, and which could pre-empt important deliberations about whose values and preferences matter in making such judgments.

The preparation of the evidence brief involved five steps:

- 1) convening a Steering Committee comprised of representatives from the partner organizations (and/or key stakeholder groups) and the McMaster Health Forum;
- 2) developing and refining the terms of reference for an evidence brief, particularly the framing of the problem and three elements of a potentially comprehensive approach for addressing it, in consultation with the Steering Committee and a number of key informants and with the aid of several conceptual frameworks that organize thinking about ways to approach the issue;
- 3) identifying, selecting, appraising and synthesizing relevant research evidence about the problem, elements of a potentially comprehensive approach to address the problem and implementation considerations;
- 4) drafting the evidence brief in such a way as to present concisely and in accessible language the global and local research evidence; and
- 5) finalizing the evidence brief based on the input of several merit reviewers.

The three elements of a potentially comprehensive approach for addressing the problem were not designed to be mutually exclusive. They could be pursued simultaneously or in a sequenced way, and each element could be given greater or lesser attention relative to the others.

The evidence brief was prepared to inform a stakeholder dialogue at which research evidence is one of many considerations. Participants’ views and experiences and the tacit knowledge they bring to the issues at hand are also important inputs to the dialogue. One goal of the stakeholder dialogue is to spark insights – insights that can only come about when all of those who will be involved in or affected by future decisions about the issue can work through it together. A second goal of the stakeholder dialogue is to generate action by those who participate in the dialogue and by those who review the dialogue summary and the video interviews with dialogue participants.

management strategies for long-term care homes, one of which includes the use of technology as an alternative form of communication between residents and their caregivers, family and/or friends.⁽¹⁾ In addition, PHAC has recommended implementing the use of technology to help support residents of long-term care homes, which may include: 1) using technology to assist with residents who travel around the facility (e.g., door sensors); and 2) increased use of communication devices for supporting virtual care needs and promoting social interaction among residents.

Therefore, as part of broader efforts to address the significant concerns that have garnered attention about long-term care across the country, there is a significant opportunity to focus efforts on identifying and harnessing the potential of technology to enhance communication and care provision within long-term care.

Aim of the evidence brief

This evidence brief will inform deliberations that aim to identify and harness the potential of technology in long-term care settings in Canada. In doing so, it mobilizes the best available evidence to identify: 1) the challenges in identifying and harnessing technology in long-term care settings; 2) three elements of a potentially comprehensive approach to address the problem; and 3) key implementation considerations for these elements. As explained in Box 1, the evidence brief does not contain recommendations. Moving from evidence to recommendations would have required the authors to introduce their own values and preferences. Instead, the intent is for this evidence brief to inform deliberations where participants in a stakeholder dialogue will themselves decide what actions are needed based on the available evidence, their own experiential knowledge, and insights arising through the deliberations.

To draw attention to equity considerations in the framing of the problem and identification of potential solutions, the evidence brief also focuses on two perspectives that were identified by the Steering Committee and key informants. Specifically, when considering the challenges in identifying and harnessing technology in long-term care settings, the evidence brief explores equity considerations from the perspective of: 1) operators of older long-term care homes, which face more challenges to adopting technologies than those with newer design features; and 2) long-term care residents who may not have the ability to use technology (see Box 2). Many other groups warrant serious consideration as well, and a similar approach could be adopted for any of them.

Key definitions

This evidence brief uses several key terms that need to be defined, and in some cases described. The terms and their definitions and descriptions are outlined in Table 1.

Box 2: Equity considerations

A problem may disproportionately affect some groups in society. The benefits, harms and costs of three elements of a potentially comprehensive approach to address the problem may vary across groups. Implementation considerations may also vary across groups.

One way to identify groups warranting particular attention is to use “PROGRESS,” which is an acronym formed by the first letters of the following eight ways that can be used to describe groups[†]:

- place of residence (e.g., rural and remote populations);
- race/ethnicity/culture (e.g., First Nations and Inuit populations, immigrant populations and linguistic minority populations);
- occupation or labour-market experiences more generally (e.g., those in “precarious work” arrangements);
- gender;
- religion;
- educational level (e.g., health literacy);
- socio-economic status (e.g., economically disadvantaged populations); and
- social capital/social exclusion.

The evidence brief strives to address all Canadians, but (where possible) it explores equity considerations from two angles:

- operators of older long-term care homes; and
- residents with limited capacity to use technology.

Many other groups warrant serious consideration as well, and a similar approach could be adopted for any of them.

[†] The PROGRESS framework was developed by Tim Evans and Hilary Brown (Evans T, Brown H. Road traffic crashes: operationalizing equity in the context of health sector reform. *Injury Control and Safety Promotion* 2003;10(1-2): 11–12). It is being tested by the Cochrane Collaboration Health Equity Field as a means of evaluating the impact of interventions on health equity.

Table 1. Key definitions

Term	Definition and description
Long-term care home	<ul style="list-style-type: none"> • Long-term care homes (sometimes referred to as nursing homes, continuing-care facilities, or residential-care homes) provide 24/7 access to nursing and personal care to residents – generally more than can be safely met through supportive housing or a retirement home, but not so much care that they require admission to a hospital unit
Rapid-learning health and social systems	<ul style="list-style-type: none"> • The combination of health/ social and research systems that at all levels (self-management, clinical/client encounter, program, organization, regional, and government levels) is: 1) anchored on the needs, perspectives and aspirations of patients/clients; 2) driven by timely data and evidence; 3) supported by appropriate decision supports and aligned governance, financial and delivery arrangements; and 4) enabled with a culture of and competencies for rapid learning and improvement (7) • The focus of such a system would be on making small yet rapid changes that are centred on residents, caregivers and families to support the development, evaluation and implementation of new technologies using the type of cycle depicted in Figure 1 and the model detailed in element 3 later in the brief
Scaling up	<ul style="list-style-type: none"> • Scaling up refers to deliberate efforts to tackle “the infrastructural problems (across an organization, locality, or health system) that arise during full scale implementation”(8) • Scaling-up strategies aim to “increase the impact of successfully tested health innovations so as to benefit more people and to foster policy and program development on a lasting basis”(9) • We use the term here to mean ensuring that the potential of technology is harnessed in LTCHs, and thus support all of those who can benefit from it
Spreading	<ul style="list-style-type: none"> • Spread refers to “replicating an initiative somewhere else”(9)
Technology	<ul style="list-style-type: none"> • Technologies developed for long-term care homes can be grouped into 14 categories, which are depicted in Figure 2 (10) • In this evidence brief, we focus on technologies that can optimize: <ul style="list-style-type: none"> ○ Communication (as technologies that support 'resident'-family-formal-healthcare team communication - goes beyond LTC and bridges critical issues of staffing, operational models and privacy legislation), which could include communication between formal staff, staff and family/residents. and family and residents (supported by formal staff) ○ Provision of care and supports, including for activities of daily living, mealtimes, help with safely moving around (falls, wayfinding, monitoring) and medical care (diagnostics, monitoring and medication administration)

Figure 1: Rapid learning and improvement cycle

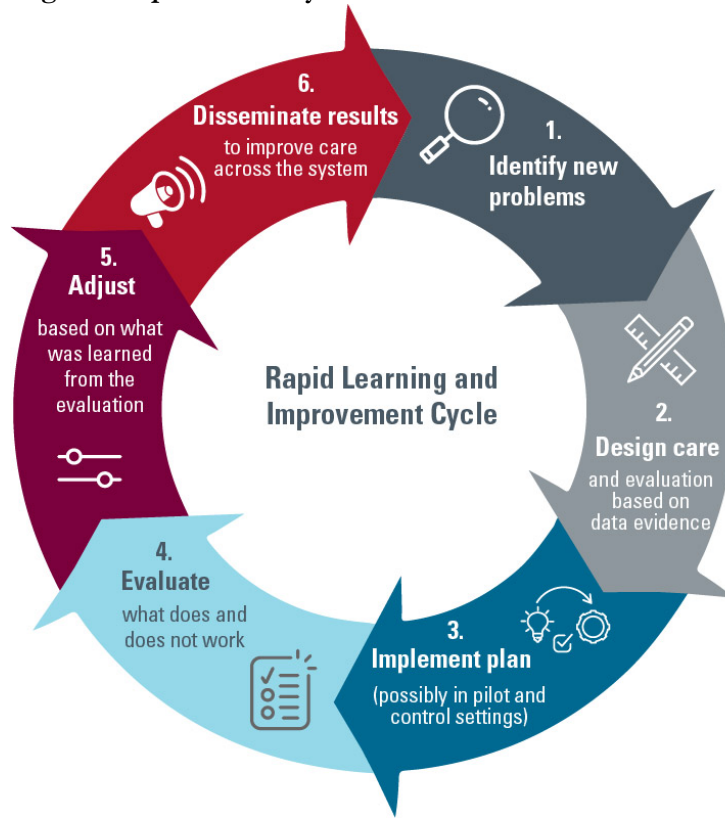
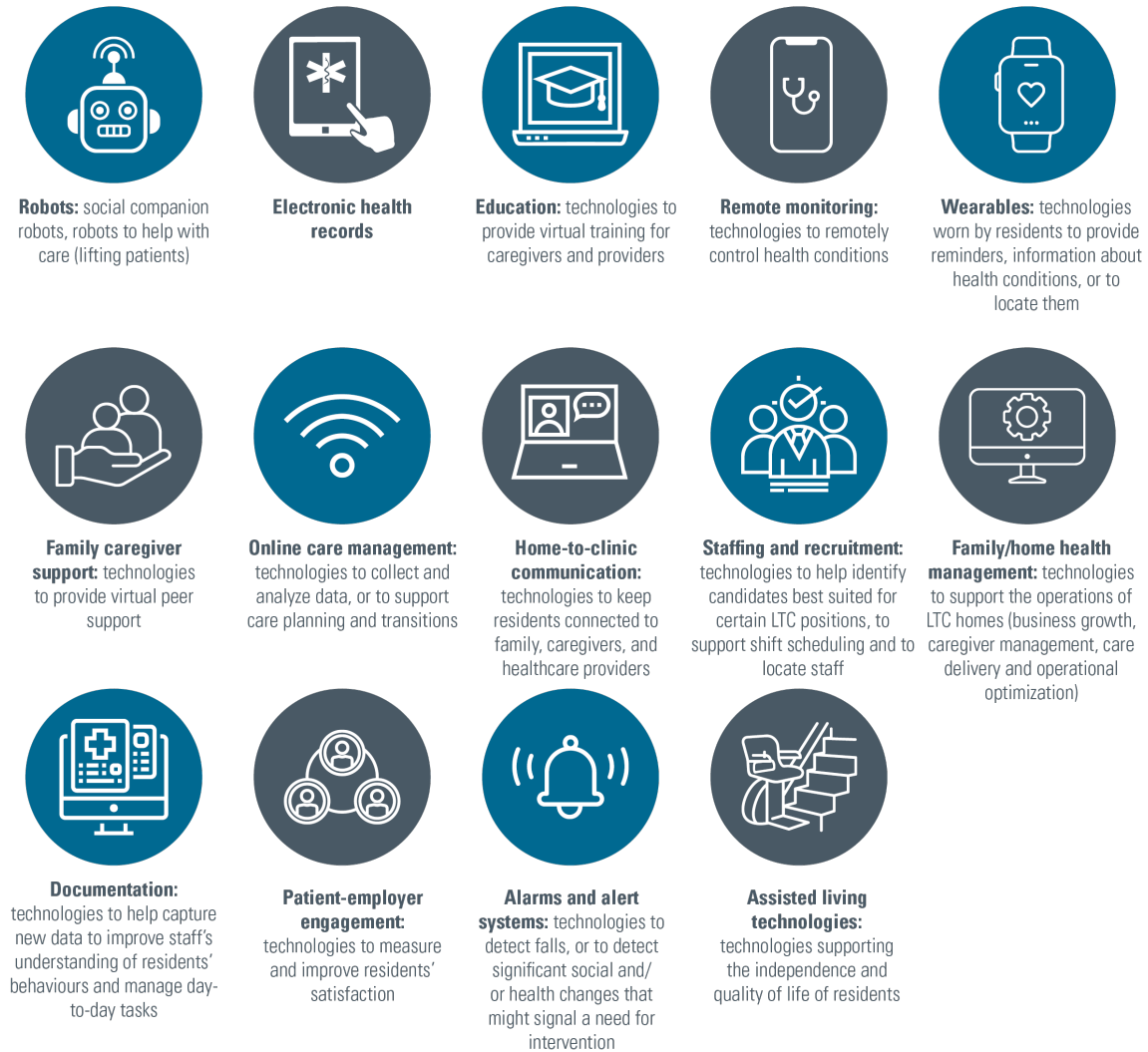


Figure 2: Taxonomy of technologies in long-term care homes (10)



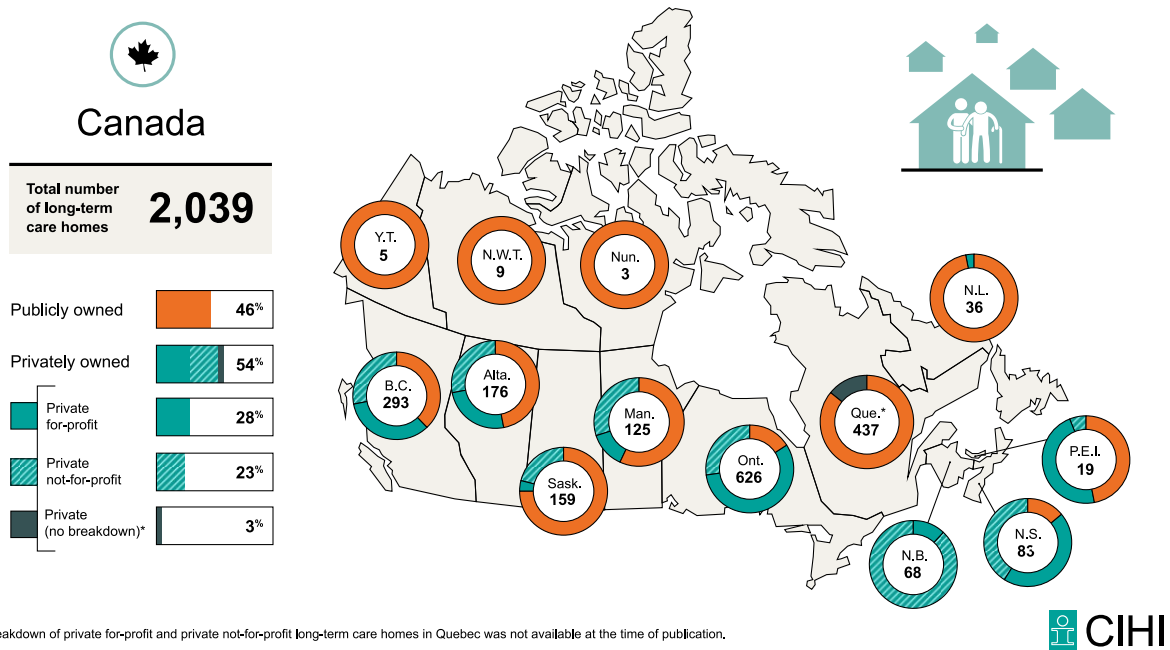
Long-term care in Canada

As of 2020, there are 2,039 long-term care homes (LTCHs) nationwide, 46% of which are publicly owned and 54% of which are privately owned. All privately owned LTCHs can be further subdivided into private not-for-profit and for-profit homes. Of the 54% of LTCHs nationwide that are privately-owned, 28% are not-for-profit homes and 23% are for-profit homes.

As shown in Figure 3, the number of LTCHs and their ownership type varies by jurisdiction. Provinces such as Ontario (n = 626) and Quebec (n = 437) have the highest number of LTCHs, whereas Nunavut (n = 3), Yukon (n = 5), and Northwest Territories (n = 9) have the fewest number of homes. With respect to ownership type, LTCHs in Nunavut (n = 3), Yukon (n = 5), and Northwest Territories (n = 9) are entirely publicly owned, whereas homes in New Brunswick (n = 68) are entirely privately owned. All remaining provinces have an unequal distribution of both publicly owned and privately-owned homes. Provinces with a higher proportion of publicly owned homes compared to privately owned homes include Saskatchewan, Newfoundland and Labrador, Manitoba, and Quebec. In contrast, provinces with a higher proportion of

privately-owned homes compared to publicly owned homes include British Columbia, Ontario, Nova Scotia, Alberta, and Prince Edward Island (P.E.I.). Provinces with a higher proportion of private for-profit homes compared to private not-for-profit homes include P.E.I. and Ontario. All 3% of privately-owned homes in Newfoundland and Labrador are private for-profit organizations. Provinces with a higher proportion of private not-for-profit homes compared to private for-profit homes include New Brunswick, Saskatchewan, and Manitoba. All remaining provinces with privately owned LTCHs (British Columbia, Alberta, and Nova Scotia) have a relatively even distribution of private for-profit and private not-for-profit homes.

Figure 3: Profile of long-term care homes in Canada (11) (reproduced with permission of authors)



On average, long-term care is inhabited by an estimated 1.2% of the older adult population in Canada.(12) Within the last decade, the demographic profile of long-term care residents has dramatically shifted, with increases in the number of residents living with cognitive impairments, complex medical needs, and co-existing health conditions.

The Canadian Institute for Health Information (CIHI) published a report detailing the profile of residents accessing long-term care services in 2019-2020 in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Newfoundland and Labrador and Yukon.(11) A wide distribution of demographic, clinical and functional characteristics of residents admitted to LTCH facilities across Canada was observed. Although the average age of LTCH residents is 83 years, approximately 6.7% (n = 12,621) of residents are under 65 years. Of all those admitted, 65.2% (n = 123,621) are female residents. With respect to the medical condition of residents, neurological diseases (e.g., dementia and cerebrovascular accident), heart and circulation diseases (e.g., hypertension, cardiovascular disease, and congestive heart failure), musculoskeletal diseases (e.g., arthritis and osteoporosis) were found to be the most commonly diagnosed diseases in residents. Moreover, 48.5% of residents are reported to be suffering with a mild/moderate form of cognitive impairment, and 32.7% of residents are suffering with a severe form. CIHI further reports that 52.8% of residents may have possible depressive symptoms or depressive disorders. An additional 43.9% of assessed residents are reported to have reduced physical function. Of all residents residing in LTCHs, 82.8% are reportedly dependent or require extensive assistance (i.e., reported a score of three or higher on the ADL Performance Hierarchy Scale) when performing daily living activities, including tasks relating to personal hygiene, toileting, locomotion, and eating.

THE PROBLEM

Several factors make it hard to identify and harness the potential of technology in long-term care settings, including:

- 1) residents of long-term care homes have complex health and social needs;
- 2) there are many long-standing issues in the long-term care sector across Canada;
- 3) the full potential of technology isn't being used to address these issues and to improve the quality of life for residents, caregivers and their families; and
- 4) there are many barriers to designing and using technologies in long-term care homes.

We describe each of these challenges in turn below based on data and evidence we identified from our searches, as well as from insights we identified through the key-informant interviews that we conducted during the preparation of this evidence brief.

Residents of long-term care homes have complex health and social needs

It is estimated that 1.2% of older adults in Canada live in LTCHs.(12) Residents in LTCHs have a wide range of complex physical and mental health needs. More and more residents have cognitive impairments, such as finding it hard to remember, learn new things, concentrate, or make decisions that affect their everyday life. Many also have several co-existing health conditions.

A profile of residents accessing long-term care services in 2019-2020 in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Newfoundland and Labrador, and the Yukon was recently published.(13) The report revealed that:

- long-term care residents have an average age of 83;
- approximately 6.7% of residents are under age 65;
- 65.2% of residents are female;
- the most commonly diagnosed health conditions are,
 - neurological diseases (for example, dementia and other conditions caused by cerebrovascular accidents),
 - heart and circulation diseases (for example, hypertension, cardiovascular disease, and congestive heart failure), and
 - musculoskeletal diseases (for example, arthritis and osteoporosis);
- 48.5% of residents are suffering with a mild/moderate form of cognitive impairment, and 32.7% of residents are suffering with a severe form;
- 43.9% of residents have reduced physical function (meaning the ability to perform activities of daily living such as using the telephone, dressing, managing medication, or managing finances);
- 82.8% are dependent or require extensive assistance when performing daily living activities (for example, personal hygiene, toileting, moving around, and eating); and
- 52.8% of residents may have possible depressive symptoms or depressive disorders.

Box 3: Mobilizing research evidence about the problem

The available research evidence about the problem was sought from a range of published and 'grey' research literature sources. Published literature that provided a comparative dimension to an understanding of the problem was sought using three health services research 'hedges' in MedLine, namely those for appropriateness, processes and outcomes of care (which increase the chances of us identifying administrative database studies and community surveys). Published literature that provided insights into alternative ways of framing the problem was sought using a fourth hedge in MedLine, namely the one for qualitative research. Grey literature was sought by reviewing the websites of a number of domestic and international organizations, such as Statistics Canada, the Canadian Institute for Health Information, and the National Institute on Ageing.

Priority was given to research evidence that was published more recently, that was locally applicable (in the sense of having been conducted in Canada), and that took equity considerations into account.

The last point highlights the important social, emotional, cultural and spiritual needs of residents in long-term care. The health needs of residents are often intertwined with social needs. Unmet social needs put residents at greater risk for poor health outcomes.(14-15) These residents may:

- lack social support;
- be lonely;
- be geographically isolated from their families and caregivers;
- be financially insecure;
- have limited access to services that are gender, linguistically, culturally or spiritually sensitive; or
- have marginalized identities that put them at greater risk for discrimination and being excluded.(16)

Addressing the wide range of health and social needs of residents is challenging, but must be considered when identifying and harnessing the potential of technology in long-term care homes.

There are many long-standing issues in the long-term care sector across Canada

There are many long-standing issues in the long-term care sector across Canada, including (but not limited to):

- a lack of coordination across the long-term care sector;
- failure to effectively use data as part of a learning health-system approach;
- limited staff training, satisfaction and retention; and
- limitations in the design and capacity of long-term care homes.

These long-standing issues have been made worse by the COVID-19 pandemic, with dramatic consequences. A federal report indicated that 82% of all COVID-19-related deaths in Canada were associated with long-term care homes.(1)

This is at least partially due to:

- long-term care home residents being at higher risk for COVID-19 because they live in close proximity to each other;
- exposure to staff who may be infected by COVID-19 (which is made worse by long-standing staffing problems); and
- most residents being frail and/or living with multiple complex conditions.(17)

Table 2 below describes some of the long-standing issues in the long-term care sector and how they have been made worse during the pandemic.

Table 2. Long-standing issues in the long-term care sector and the COVID-19 pandemic

Long-standing issue	Description
A lack of coordination across the long-term care sector	<ul style="list-style-type: none"> • The health system is fragmented across many sectors (for example, home and community care, hospital care, long-term care, public health) • There are cross-jurisdictional differences across the country (e.g., the different regulatory framework and oversight of the long-term care sector in each province and territory) • The acute-, community- and continuing-care sectors are not optimally integrated with the long-term care sector. These sectors tend to operate independently and do not account for frequent transitions across sectors (12) • The lack of coordination at a national level and within long-term care sectors in provinces and territories complicates the development of coordinated response strategies to address crises such as COVID-19 (e.g., Australia and

	South Korea both have strong national strategies addressing COVID-19 in long-term care and have comparatively favourable results) (12)
Failure to effectively use data as part of a learning health-system approach	<ul style="list-style-type: none"> • Canada lacks the data necessary to identify and respond to emerging issues in the long-term care sector in a timely manner • Standardized data collection and analysis largely remains inconsistent (or non-existent) across Canada, and data that does exist is not being used effectively to act as part of a learning health-system approach • As emphasized in a recent report about the future of LTC in Canada, any data that is collected must be accessible, understandable and have supports in place to help data users such as managers act appropriately and evaluate the impact of those actions (12) • Moreover, data that is integrated using a systems approach is especially valuable during a pandemic when organizations and providers must monitor and adapt rapidly to address potential threats
Limited staff training, satisfaction and retention	<ul style="list-style-type: none"> • The long-term care sector is heavily regulated, extremely reluctant to take risks, and lacks key pieces of regulation related to workforce standards and quality-of-work conditions (12; 18-19) • Understaffing, inadequate pay, burnout and stress, and poor working conditions add to widespread dissatisfaction among providers (18) • Staffing in long-term care homes has been made even more challenging during the COVID-19 pandemic <ul style="list-style-type: none"> ○ Higher-than-normal use of temporary staff who face challenges in learning and implementing protocols and processes in place in different long-term care homes ○ Staff members who need to work across multiple facilities increases the points of contact for COVID-19 and therefore increases risk to staff and residents across many long-term care homes
Limitations in the design and capacity of long-term care homes	<ul style="list-style-type: none"> • The COVID-19 pandemic exposed the impact of crowded long-term care homes and outdated infrastructure on COVID-19 outbreaks (17) • The pandemic has also strained capacity and resources in long-term care homes, including through: <ul style="list-style-type: none"> ○ Dealing with increased call volume from families ○ The existence of poor information-technology infrastructure and WiFi; ○ The lack of technology to support communication (for example, not enough computers and tablets to allow for video conferencing or virtual visits, and a lack of technology that lets residents communicate with each other (20)

The full potential of technology isn't being used to address these issues and to improve the quality of life for residents, caregivers and their families

Technology can play an important role in modernizing the long-term care sector in a way that contributes to person-centred care.(21) Despite some promising initiatives leveraging technology to improve the coordination and provision of care in long-term care homes, technology has not been consistently adopted to support core services in long-term care, including for:

- communication with caregivers, family and friends to help mitigate the feeling and effects of isolation; and
- provision of care as part of routine programs and services that were made more challenging during COVID-19 due to the need for physical distancing and isolation.

While technology has much potential for enhancing communication for the provision of care in LTCHs (e.g., by supporting coordinated care between primary-care clinicians, specialists and long-term care staff), its adoption in long-term care has been generally slower than other sectors in health systems such as acute care.⁽¹³⁾ This is at least partially due to slow regulatory approvals that are required to use new technologies. Other barriers could include:

- the view that older populations lack the ability to learn about (and advocate for) new technology;
- costs that prevent long-term care residents from buying smartphones and other smart devices; and
- lack of assistance and education on using technology and devices.⁽⁶⁾

Lastly, the COVID-19 pandemic has resulted in the ad hoc and random purchase and implementation of technologies across the long-term care sector. This situation illustrates the importance of being much more purposeful moving forward, as well as the need to untangle the good and reasonable technologies introduced during the pandemic from the random and unhelpful.

There are many barriers to designing and using technologies in long-term care homes

Features of governance, financial and delivery arrangements within health systems in Canada can shape whether and how technology can be adopted in long-term care homes. For example, regulatory challenges related to either a lack of oversight or cumbersome regulatory approval processes can limit how money can flow to pay for technological supports. In turn, this can constrain how care is organized. This includes the types of technologies that are available and how they can be used to support organizational capacity and care practices. Some of the key examples of system-level challenges are summarized in Table 3.

Table 3: Overview of key system-level factors that make it difficult to effectively adopt technology in long-term care

Health-system arrangements	Challenge	Description of the challenge
Governance arrangements <i>(who can make what types of decisions)</i>	Jurisdictional complexity	<ul style="list-style-type: none"> • The patchwork of provincial and territorial legislation and regulation of LTCHs presents a barrier to effectively coordinating and optimizing the uptake of technology in LTCHs in Canada • For example, many jurisdictions grapple with privacy legislation, and it leads to risk-averse policy process that delays or prevents technology implementation
	Implementing new technology under regulatory oversight	<ul style="list-style-type: none"> • Several factors can negatively affect quality of life and quality of care: <ul style="list-style-type: none"> ○ Slow regulatory approval processes may present a barrier to the uptake of new technologies or using existing technologies for new purposes ○ Canada has not consistently revisited regulation, monitoring and enforcement in the context of LTC at a systems level ○ LTCH care is heavily regulated and extremely risk-averse, yet missing key pieces of regulation related to workforce standards and quality-of-work conditions ○ These factors negatively affect quality of life and quality of care ⁽¹²⁾
Financial arrangements <i>(how money flows through the system)</i>	Lack of investments to support system-wide adoption of technology in LTC	<ul style="list-style-type: none"> • Given the finite pool of money available for LTC, investments in technology risk diverting attention and financial support from other areas in LTC • Trade-offs and potential savings from funding and implementing technology in LTC must be carefully considered so that decisions about implementing technology in LTC does not come at the expense of other crucial aspects of care such as new beds or creating smaller environments
	The patchwork of publicly and privately funded	<ul style="list-style-type: none"> • There is no coordinated financing plan for LTC in Canada, and the patchwork of regulations governing LTCH across jurisdictions means that

Health-system arrangements	Challenge	Description of the challenge
	LTC services poses a challenge	decisions of specific LTCHs about what technologies to adopt, how and for what purposes, are likely to be inconsistent
	No coordinated group purchasing process for different LTCHs	<ul style="list-style-type: none"> • There is no process to leverage the purchasing power of different LTCHs to obtain discounts from technology vendors based on the collective buying power of LTCHs • Thus, procurement often happens at an organizational level, so one LTCH may adopt a technology but it will not be scaled to other LTCHs
Delivery arrangements <i>(how care is organized to reach those who need it)</i>	The gap between consumers and vendors who provide technology products	<ul style="list-style-type: none"> • LTCHs normally get involved with vendors when a technology product is available on the market, but to date there have been limited examples of technology developed specifically for LTCHs using a partnership approach that engages LTCH management, staff and residents • Such approaches may be useful during the design and developmental stages, so the technology products are tailored towards the specific needs of LTCHs, their staff and residents • Many technology interventions in LTCHs have involved the adaptation of resident needs to a particular technology that has garnered interest outside the facility (in other words, fitting residents into pre-selected solutions rather than starting with their needs and bringing in the technology to fit)
	LTC staff lack motivation or knowledge necessary to fully utilize certain technologies	<ul style="list-style-type: none"> • In some cases, staff in LTC may require training or incentive to use technology in their day-to-day work • Regulated staff in LTCHs has been reduced,(22) and the unregulated workforce (e.g., care aides and personal support workers) that provides approximately 90% of direct resident care has little input, and no consistent educational standards exist for this workforce across Canada (12) • Consistent training is required to effectively adopt and implement technology in LTCHs
	Infrastructure necessary to implement certain technologies varies across LTCHs	<ul style="list-style-type: none"> • Each LTCH has its own unique profile, infrastructure, capacities and needs, and therefore, adopting technology in LTCHs on a large scale requires that individual needs of LTCHs are considered including whether the technology will be useful and how it can be readily adopted by a specific LTCH • If the goal is to adopt technology across LTCHs, potential infrastructure and capacity barriers must first be considered, as well as potential solutions to address them
	Technologies are not integrated adequately	<ul style="list-style-type: none"> • Currently, many technologies are self-contained and either do not have the capacity to be integrated effectively with one another or simply have not been integrated as effectively as they could be (e.g., using in-room televisions as a medium that most residents are comfortable with as way to integrate other technological solutions) • Technology companies do not have access to LTCHs to be able to integrate their products effectively

While there are many system-level challenges highlighted in Table 3, moving towards a more innovative system requires that these governance, financial and delivery arrangements be more aligned. Moreover, greater alignment and coordination is necessary to develop rapid-learning and improvement systems that can support evidence-based uptake of technology in Canadian LTCs. These challenges must be addressed before the potential of technologies in LTCHs can be fully leveraged to strengthen the sector.

Additional equity-related observations about the problem

An important element of the problem that requires further discussion is how the problem may disproportionately affect certain groups. With respect to identifying and harnessing the potential of technology in LTC settings, many groups warrant particular attention. However, as noted above, this evidence brief explores equity considerations from two perspectives: 1) operators of older long-term care homes; and 2) residents with limited capacity to use technology.

Design features and the philosophy of care in LTCHs has changed significantly over the last 50 years. LTCHs with older designs generally have smaller room sizes, more shared washrooms and fewer single-occupancy rooms.⁽⁹⁾ Despite these important changes, many LTCHs in Canada do not meet provincial standards. For example, a study in Ontario found that 53.6% of for-profit LTCHs and 18.5% of non-profit LTCHs either meet or fall below the standards set out in Ontario's 1972 amendment to the *Nursing Home Act*, which included standards that permitted up to four beds per room with one flush toilet and one wash basin. These standards were subsequently updated in 1998 to allow only single and double rooms. LTCHs with older design classifications had greater outbreak severity in terms of the number of deaths.⁽⁹⁾ These LTCHs are also likely to face more challenges to adopting technologies than those with newer design features. The introduction of new technologies can be seen as interrupting existing workflows in LTCHs, and technology that captures additional data often requires additional training and/or staff to have enough knowledge and time to interpret the data.⁽¹⁰⁾ The workflows and staff capacity and skillsets in LTCHs with older design features could present an important barrier to the uptake of new technologies.

Residents with limited capacity or support to use technology are less likely to benefit from any existing or new technology taken up by LTCHs. Differences in levels of accessibility to technology and technology literacy skills based on social factors, often referred to as the 'digital divide', have been seen as perpetuating health inequality across social determinants of health related to factors such as the built environment, culture, education and economic status.⁽²³⁻²⁴⁾ With these considerations in mind, it is important to acknowledge and plan for the heterogeneity of LTCH residents in terms of their ability to use technology, including, but not limited to, their technology literacy skills, living in a rural area, and physical and cognitive capacities. For example, rural areas have lower internet and broadband connectivity (often attributed to the high costs of needed infrastructure in these areas, as well as the lower socio-economic status of rural residents that can diminish technology and health literacy). Those with lower health literacy are less likely to access electronic health records.⁽¹¹⁾ Although there is generally internet connectivity in LTCHs, the issue is that some residents may not have a device to use it, and, if they do, they may not be able to use it on their own which would require additional staff support in typically already understaffed settings. Addressing the digital divide in LTCH settings requires anticipating institutional needs across LTCHs and individual needs across residents, and planning effectively to ensure that technology benefits all residents.

Citizens' views about key challenges related to identifying and harnessing the potential of technology in long-term care settings in Canada

Four citizen panels were convened virtually – each engaging a diverse group of 8-15 citizens (in terms of age, gender, ethnocultural background and socio-economic status) – on 8 January 2021 (with anglophone panellists from British Columbia, Alberta, Saskatchewan and Manitoba), 11 January 2021 (with anglophone panellists from Ontario and Quebec), 14 January 2021 (with anglophone panellists from New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland), and 15 January 2021 (with francophone panellists from Ontario, Quebec and New Brunswick). The panellists had experiences with long-term care as caregivers or family members of residents of long-term care homes. Panellists were provided with a plain-language version of the evidence brief prior to the citizen panel, which served as an input into citizens' deliberations.

During the deliberation about the problem, citizens were asked to share what they perceived to be the main challenges to identifying and harnessing the potential of technology in long-term care settings. Panellists identified nine important challenges:

- long-term care homes do not take advantage of technologies;
- many older adults do not want to end up in a LTCH;
- social isolation and loneliness are common in LTCHs;
- the long-term care sector is under-funded;
- there are concerns that relying more on technology could reduce human contact;
- there is a persistent myth that older adults are not interested or unable to use technology;
- the uptake of technologies (if not supported across the system) could further increase inequity in the long-term care sector;
- community resources are not optimally leveraged; and
- some critical infrastructures are not in place.

These are all summarized in detail in Table 4.

Table 4. Summary of citizens’ views about challenges

Challenge	Description
Long-term care homes do not take advantage of technologies	<ul style="list-style-type: none"> • Panellists generally had positive views about the benefits of technologies to improve the quality of life of residents, while at the same time improving communication (with families, caregivers, LTCH operators and staff, and care providers) and improving the quality of care • Commonly used technologies (e.g., TVs) could be harnessed in lieu of (at least temporarily) infrastructure deficits (e.g., by networking TVs to support social interaction among residents, especially during times of isolation during the pandemic) • Panellists emphasized the importance of prioritizing technologies that will help staff (e.g., that will take tasks off their plate to enable them to spend more time with residents and caregivers) • More specifically, they emphasized the need to better harness the benefits of technologies in the following areas: <ul style="list-style-type: none"> ○ improving social engagement (e.g., communication with caregivers and family outside LTCHs, as well as social engagement with other residents such as live-streaming cultural events or online programming from within or outside the LTCH (e.g., from public libraries) so that residents can still feel a part of their community) ○ overcoming impairments (e.g., voice activation technology could be particularly helpful for residents to help overcome the functional impairments that many live with that make using touch-based technology difficult) ○ bridging cultural and linguistic barriers between residents and staff ○ supporting staff training ○ accessing information about residents (e.g., their health records, as well as brief summaries of daily activities so that caregivers can be aware of any emerging issues and can address the current limited ability for caregivers and families to know what’s happening and where they may need to provide support) ○ improving transparency and overall accountability of LTCHs (although, some panellists pointed out that LTCH staff may view some technologies as surveillance, which could be detrimental to providing quality care) ○ improving resident safety
Many older adults do not want to end up in a LTCH	<ul style="list-style-type: none"> • Several panellists indicated that many older adults do not want to end up in a long-term care home, a sentiment that may have been exacerbated by the “appalling conditions” of residents during the COVID-19 pandemic • These panellists emphasized that older adults wish to stay at home for as long as possible, and that technologies should ideally help to keep people at home for as long as possible to reduce LTCH admissions and the burden on LTCHs (cheaper and more beneficial for quality of life)
Social isolation and loneliness are	<ul style="list-style-type: none"> • Panellists discussed at great length the social isolation and loneliness as a major issue for LTCH residents, which has been made much worse during the COVID-19 pandemic

Challenge	Description
common in LTCHs	<ul style="list-style-type: none"> • It was critical to find ways to engage residents and enhance their quality of life
The long-term care sector is under-funded	<ul style="list-style-type: none"> • Panellists generally agreed that the long-term care sector is under-funded which affects the quality of life for residents and staff • They indicated that the needs of seniors and those in LTCHs in particular seem to be consistently left behind in society • This has resulted in consistent neglect that has contributed to the long-standing issues that have come to light so prominently during the COVID-19 pandemic, including: <ul style="list-style-type: none"> ○ Understaffing (driven by years of under-funding and limited resources, and low pay leading to high staff turnover) ○ Overcrowding and poor conditions ○ Isolation ○ Infrastructure deficits (which are limiting factors both for overall quality of life of residents and the adoption of technologies that can further enhance care and quality of life) ○ Focus on the physical health and mobility of residents given limited resources and hours per resident (and thus neglecting the importance of mental health and social needs) • Harnessing the potential of technologies will require investment to get the technologies, resources needed to train staff, a tech person in each LTCH to (at least initially) support adoption, plus any changes to infrastructure in any given LTCHs
There are concerns that relying more on technology could reduce human contact	<ul style="list-style-type: none"> • While technology could have many benefits, its adoption could be challenging given the staff time and resources that might be needed, which could further take away from in-person care and support • Several panellists indicated that we need to “be careful that technology doesn’t replace people” and that staff doesn’t spend more time supporting the use of technology as opposed to providing direct care
There is a persistent myth that older adults are not interested in or unable to use technology	<ul style="list-style-type: none"> • Panellists highlighted the persistent myth that older adults are not interested in or are unable to use technology <ul style="list-style-type: none"> ○ Many residents could use some technologies with some basic support ○ Many technologies have not been developed to meet the specific needs of residents and LTCH staff • Several panellists indicated the need to adopt a long-term vision for LTC (and technology use in LTCHs) aligned with the expectations of the next generation of residents (the next generation being most likely tech-savvy)
The uptake of technologies (if not supported across the system) could further increase inequity in the long-term care sector	<ul style="list-style-type: none"> • Access to technology remains a challenge and raises equity considerations • Some LTCH and residents may not be able to afford certain technologies, and thus may not be able to benefit from them without specific policy action • For example, panellists pointed out that technologies can support communication and recreation by residents, but that many cannot afford smart phones, tablets and other devices as well as staff time to support their use, with many LTCHs often only having a TV in a communal room • Without basic standards, most panellists highlighted that disparity in access will persist
Community resources are not optimally leveraged	<ul style="list-style-type: none"> • Community supports are often not leveraged to fill gaps in LTCHs (e.g., school-based inter-generational programs, programs and services offered by public libraries)
Some critical infrastructures are not in place	<ul style="list-style-type: none"> • Panellists pointed out that the lack of internet access in some areas across the country is a key upstream barrier that will need to be addressed • Others also pointed out that when internet access was available in a LTCH, it was often for administrative purposes only, and no WiFi was available for all residents (either in communal rooms or in residents’ rooms)

THREE ELEMENTS OF A POTENTIALLY COMPREHENSIVE APPROACH FOR ADDRESSING THE PROBLEM

Many approaches could be selected as a starting point for deliberations about an approach for identifying and harnessing the potential of technology in long-term care settings in Canada. To promote discussion about the pros and cons of potentially viable approaches, we have selected three elements of a larger, more comprehensive approach. These elements are:

- 1) ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies;
- 2) engage long-term care home operators, staff, residents and their caregivers in developing and adopting technologies; and
- 3) enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies.

The three elements were developed and refined through consultation with the Steering Committee and key informants who we interviewed during the development of this evidence brief. The focus of the elements below is on how to use technology in long-term care in a way that enhances the experiences of residents and their caregivers, family and friends, and optimizes health outcomes at manageable costs and with positive provider experiences. In this context, a guiding principle for the use of technology is that it is not implemented in a way that it diminishes the provision of person-centred care and supports.

The elements could be pursued separately or simultaneously, or components could be drawn from each element to create a new (fourth) element. They are presented separately to foster deliberations about their respective components, the relative importance or priority of each, their interconnectedness and potential of or need for sequencing, and their feasibility.

The principal focus in this section is on what is known about these elements based on findings from systematic reviews. We present the findings from systematic reviews along with an appraisal of whether their methodological quality (using the AMSTAR tool) (9) is high (scores of 8 or higher out of a possible 11), medium (scores of 4-7) or low (scores less than 4) (see the appendix for more details about the quality-appraisal process). We also highlight whether they were conducted recently, which we define as the search being conducted within the last five years. In the next section, the focus turns to the barriers to adopting and implementing these elements, and to possible implementation strategies to address the barriers.

Box 4: Mobilizing research evidence about elements of a potentially comprehensive approach for addressing the problem

The available research evidence about approach elements for addressing the problem was sought primarily from Health Systems Evidence (www.healthsystemsevidence.org), which is a continuously updated database containing more than 8,400 systematic reviews and more than 2,800 economic evaluations of delivery, financial and governance arrangements within health systems. The reviews and economic evaluations were identified by searching the database for reviews addressing features of each of the approach elements.

The authors' conclusions were extracted from the reviews whenever possible. Some reviews contained no studies despite an exhaustive search (i.e., they were 'empty' reviews), while others concluded that there was substantial uncertainty about the approach element based on the identified studies. Where relevant, caveats were introduced about these authors' conclusions based on assessments of the reviews' quality, the local applicability of the reviews' findings, equity considerations, and relevance to the issue. (See the appendices for a complete description of these assessments.)

Being aware of what is not known can be as important as being aware of what is known. When faced with an empty review, substantial uncertainty, or concerns about quality and local applicability or lack of attention to equity considerations, primary research could be commissioned, or an approach element could be pursued and a monitoring and evaluation plan designed as part of its implementation. When faced with a review that was published many years ago, an updating of the review could be commissioned if time allows.

No additional research evidence was sought beyond what was included in the systematic review. Those interested in pursuing a particular approach element may want to search for a more detailed description of the approach element or for additional research evidence about the approach element.

Citizens' values and preferences related to the three elements

We included in the citizen brief the same three elements of a potentially comprehensive approach to address the problem as are included in this evidence brief. For the purpose of the citizen brief, the elements were re-worded to be more accessible to a group of citizens. These elements were used as a jumping-off point for the panel deliberations, in which the facilitator prompted panellists to consider their role in supporting the adoption and implementation of the elements.

During the deliberations several values and preferences were identified from citizens in relation to these elements, which we summarize in Table 5. Overall, three key themes emerged:

- there is a need for national standards and guidelines for enhancing long-term care that need to be met provincially (and a reflection about how technologies could help to meet these standards and guidelines);
- some of the challenges facing LTC (particularly challenges revealed during the COVID-19 pandemic) could be addressed with technological solutions that are cheap and simple (many panellists emphasized that minimal investments could go a long way); and
- the scope and sequencing of element 1 could be revised (e.g., co-design approaches should also be used to plan the renovation of existing LTCHs and the building of new ones; and the context of LTCHs should consider not only the physical/technological environment, but also the broader social, cultural and policy environments that can support the adoption of appropriate technologies).

Table 5. Summary of citizens' values and preferences related to the elements

Element	Values expressed	Preferences for how to implement the element
Element 1 - Ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies	<ul style="list-style-type: none"> • Collaboration among patients, providers and organizations within the health system (collaboration) • Collaboration between the health system and other sectors (collaboration between sectors) • Excellent patient experience (patient, family, and community-centred) • Based on citizens' values and preferences 	<ul style="list-style-type: none"> • Co-design approaches (like those described in element 2) should be used to plan the renovation of existing LTCHs and the building of new ones, as well as determining priorities (e.g., through community advisory committees) • The context of LTCHs should consider not only the physical/technological environment (e.g., broadband internet access), but also the broader social, cultural and policy environments that can support the adoption of appropriate technologies • LTCHs should collaborate with community-based organizations (e.g., schools, public libraries and other non-governmental organizations) to get support • Community supports can go beyond internet access, and could include social programming that could be delivered online to support social engagement (e.g., leveraging online programming of public libraries), engaging volunteers (e.g., high-school students) to help teach residents to use technology, and adopting a device-sharing program such as what was done for school-aged children where devices were made available to enable education <ul style="list-style-type: none"> ○ Basic WiFi access is critical and not just in common rooms, but throughout an LTC to enable staff, residents and caregivers to use it. This needs to be combined with a commitment to basic access to internet across the country • Need for ongoing and meaningful engagement in determining what's needed for upgrading existing buildings, requirements for new buildings and community supports. Such design practices will ensure person-centredness in everything that's done in LTC, not just for tech use • Care homes need advisory boards that are comprised of residents, caregivers and families (i.e., people with lived experience) to inform and support decisions

Element	Values expressed	Preferences for how to implement the element
<p>Element 2 - Engage long-term care home operators, staff, residents and their caregivers in developing and adopting technologies</p>	<ul style="list-style-type: none"> • Innovation • Excellent patient experience (patient, family, and community-centred) • Collaboration among patients, providers and organizations within the health system (collaboration) • Flexibility/adaptability • Based on citizens' values and preferences • Efficiency/value for money (resource stewardship) 	<ul style="list-style-type: none"> • Panellists strongly support the need for co-design approaches, not just for designing and adopting innovative technologies, but also for the types of activities included in elements 1 and 3 • Co-design approaches are key to improve the experiences of residents, caregivers, and family members • Co-design approaches were viewed as supporting greater collaboration among all those involved (LTC staff and operators, as well as residents, caregivers and families), and could thus support greater buy-in using the resulting technology • Co-design was identified as being important for helping to account for differences in needs (e.g., needs of a dementia patient will be different than those for someone with functional impairments, and this needs to be accounted for in the design process) <ul style="list-style-type: none"> ○ “one design will not fit all” ○ technologies that can't be tailored and adapted to specific residents and LTC needs, and to accommodate disabilities, will not be able to be used as much as those that are designed with this in mind ○ co-design needs to adopt a disability lens to ensure • Co-design approaches may be more expensive, but the large upfront investments were viewed as likely to pay off given that the alternative is producing sub-optimally designed products, that are not taken up
<p>Element 3 - Enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies</p>	<ul style="list-style-type: none"> • Standardization • Fairness (equity) • Based on citizens' values and preferences • Collaboration among patients, providers and organizations within the health system (collaboration) • Collaboration between the health system and other sectors (collaboration between sectors) • Innovation • Leadership • Accountability • Continuously improving (quality) 	<ul style="list-style-type: none"> • Panellists expressed a strong preference for national standards and guidelines for enhancing long-term care that need to be met provincially <ul style="list-style-type: none"> ○ Such standards were viewed as also needed for associated areas that would impact use of technology such as enhancing access to internet that would have many positive societal-level spill-over effects ○ These standards could be used for baseline approval for public funding ○ Without minimum requirements, it will support the creation of a multi-tiered system and ultimately exacerbate equity issues • Social equity considerations were identified by many as being important to be built into any sort of rapid-learning model • Several panellists across the panels also emphasized the important role that a coordinating body and information-sharing platform for sharing innovative solutions could play for enabling others to adapt and implement innovations according to local contexts across the country, and it was viewed as being needed across LTC ownership models (public, private for-profit and private not-for-profit) • A coordinating body and information-sharing platform was also suggested for sharing innovative solutions across government sectors (e.g., community and social services, education, health, justice) given that many sectors may have developed/adopted innovative solutions to address problems during the COVID-19 pandemic, and these solutions may be relevant to the LTC sector) • Flexible programs, services and policies were viewed as important to be put in place to incentivize, rather than inhibit, the adoption, evaluation and modification of technological innovations • Leadership was also highlighted as being essential within each LTCH and at the regional/provincial level (e.g., a Chief Technology Officer, or an independent body) to support scale up and spread of technological innovations, and to monitor improvements

Element 1 – Ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies

This element focuses on ensuring that long-term care homes operate in a context that can support the adoption of appropriate technologies. This element could include efforts to:

- upgrade existing buildings;
- ensure future buildings are designed and built in a way that is appropriate for enabling the adoption of technologies; and
- ensure community supports for technology use are available (e.g., availability of affordable broadband internet connections).

A summary of the key findings from the synthesized research evidence is provided in Table 4. For those who want to know more about the systematic reviews contained in Table 6 (or obtain citations for the reviews), a fuller description of the systematic reviews is provided in Appendix 1. We provide below a brief summary of the key insights from the citizen panels and from the systematic reviews that we identified.

Key insights from systematic reviews

We found four systematic reviews (25-28) and one systematic review in progress (29) relevant to upgrading existing buildings. These reviews examined how some long-term care home characteristics and environment design may improve patient outcomes (particularly among residents with dementia). However, no review focused explicitly on how upgrading existing buildings may help to harness the potential of technology.

We found no review relevant to ensuring that future buildings are designed and built in a way that is appropriate for enabling the adoption of technologies, or ensuring community supports for technology use are available (e.g., availability of affordable broadband internet connections).

Table 6: Summary of key findings from systematic reviews relevant to Element 1 – Ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies

Category of finding	Summary of key findings
Benefits	<p>Upgrade existing buildings</p> <ul style="list-style-type: none"> • An older, low-quality review found that not-for-profit nursing-home facilities, provision of individualized or personal care, and a higher proportion of private rooms are all associated with an increase in quality-of-life outcomes for residents (25) • An older, medium-quality review examined how LTC-setting characteristics (organizational characteristics, such as size, cost and location; structures such as private rooms and human resources; and processes of care such as assistance programs and services) affect outcomes for those living with dementia and their caregivers (26) • The review found that the following improved patient outcomes: <ul style="list-style-type: none"> ○ the use of pleasant sensory stimulation ○ individualized care protocols ○ functional skill training and engaging activities • A recent rapid review examined design changes that can help infection prevention-and-control management in LTCHs,(27) notably: <ul style="list-style-type: none"> ○ heating, ventilation, and air conditioning (HVAC) systems ○ hand hygiene promotion ○ physical-distancing devices ○ single and private resident rooms ○ housekeeping room

Category of finding	Summary of key findings
Potential harms	<ul style="list-style-type: none"> • None identified
Costs and/or cost-effectiveness in relation to the status quo	<p>Upgrade existing buildings</p> <ul style="list-style-type: none"> • One systematic review examined economic evaluations of residential aged-care infrastructures and found that changes to the environment are expensive and provide limited benefits in relation to patient outcomes such as agitation and social interactions (28)
Uncertainty regarding benefits and potential harms (so monitoring and evaluation could be warranted if the option were pursued)	<p>Upgrade existing buildings</p> <ul style="list-style-type: none"> • One review protocol that is registered with the Cochrane Collaboration will examine how physical-environment design changes can improve the quality of life of LTCH residents, including: (29) <ul style="list-style-type: none"> ○ whole-facility model (e.g., Green House model) ○ outdoor modifications (e.g., sensory gardens and outdoor dining spaces) ○ building layout (e.g., helpful stimuli) ○ equipment (e.g., paint and familiar furniture) ○ privacy changes (e.g., single rooms and scaling down seating areas) • Uncertainty because no systematic reviews were identified <ul style="list-style-type: none"> ○ Ensure future buildings are designed and built in a way that is appropriate for enabling the adoption of technologies ○ Ensure community supports for technology use are available
Key elements of the policy option if it was tried elsewhere	<ul style="list-style-type: none"> • None identified
Stakeholders' views and experience	<ul style="list-style-type: none"> • None identified

Element 2 – Engage long-term care home operators, staff, residents and their caregivers in developing and adopting technologies

This element could include requirements for co-design processes with residents and their caregivers and long-term care operators to develop technologies that:

- meet the needs of residents or caregivers (e.g., for communication with caregivers and with clinicians, and keeping residents safe),
- support the operation of long-term care homes (e.g., providing training for staff), and
- strengthen integration with the broader health system (e.g., integrated electronic health records, and remote monitoring).

A summary of the key findings from the synthesized research evidence is provided in Table 5. For those who want to know more about the systematic reviews contained in Table 7 (or obtain citations for the reviews), a fuller description of the systematic reviews is provided in Appendix 2. We provide below a brief summary of the key insights from the citizen panels and from the systematic reviews that we identified. Note the focus for identifying and synthesizing findings from systematic reviews was on those that included insights about co-design processes, and not on evaluations of specific technologies.

Key insights from systematic reviews

There is a growing body of synthesized research evidence about co-design processes for technologies. In total, we found six systematic reviews (30-35) and one systematic review in progress (36) that can inform co-design processes. There were variations among the reviews in terms of population focus (e.g., older adults in long-term care, older adults with dementia, community-dwelling older adults, patients in acute-care settings, or the general public), and the focus of co-design processes (e.g., for co-designing research, technologies, or programs and services). In general, most reviews found beneficial outcomes for co-design approaches particularly at the idea-generation stage for technologies,(30) and with patients at moderate and severe stages of dementia.(31)

Table 7: Summary of key findings from systematic reviews relevant to Element 2 – Engage long-term care home operators, staff, residents and their caregivers in developing and adopting technologies

Category of finding	Summary of key findings
Benefits	<p>Requiring co-design processes to develop technologies</p> <ul style="list-style-type: none"> • One systematic review examined the involvement of older adults in residential care homes during the design of technologies (e.g., assisted living systems, service robots, and a smart wallet for digital picture exchange)(34) • Engaging older adults led to several beneficial outcomes, including: <ul style="list-style-type: none"> ○ improved mutual learning ○ improved knowledge about the needs and daily practices of older adults (e.g., maintaining social connections, housekeeping routines, and medications) ○ enhanced information to develop new prototypes and lead to the intended design outcome ○ strong sense of participation (ownership, voice, participation) • However, the same review concluded that it was unclear whether the involvement of older adults improved acceptance and adoption (i.e., uptake and preference of the product) • One systematic review examining the involvement of people with dementia in developing supportive technologies found that it led to at least one change in the development (conceptual idea, functionality, interface design, implementation), and brought feelings of fulfilment and enjoyment among participants (32)

Category of finding	Summary of key findings
	<ul style="list-style-type: none"> • One systematic review evaluated the effects of involving people with dementia in research design and reported that involving individuals with dementia is beneficial to the design process and to the patients (31) • One systematic review examined the effects of co-creation and co-production with citizens (with no specific focus on older adults) (33) • Most of the reported outcomes from this review focused on increased effectiveness and citizen involvement, and other less frequently reported outcomes included increased efficiency and customer satisfaction, and strengthening social cohesion • The same review noted that future studies should specifically describe the role of citizens (such as co-implementer, co-designer, co-initiator) and assess long-term effects • One systematic review found mixed effects of research co-design approaches on the research process, with reported positive emotions from individuals participating in the process (35)
Potential harms	<ul style="list-style-type: none"> • None identified
Costs and/or cost-effectiveness in relation to the status quo	<ul style="list-style-type: none"> • None identified
Uncertainty regarding benefits and potential harms (so monitoring and evaluation could be warranted if the option were pursued)	<ul style="list-style-type: none"> • Uncertainty because no systematic reviews were identified <ul style="list-style-type: none"> ○ None identified • Uncertainty because no studies were identified despite an exhaustive search as part of a systematic review <ul style="list-style-type: none"> ○ None identified • No clear message from studies included in a systematic review <ul style="list-style-type: none"> ○ None identified
Key elements of the policy option if it was tried elsewhere	<p>Requiring co-design processes to develop technologies</p> <ul style="list-style-type: none"> • One systematic review examined the involvement of older adults in residential care homes during the design of technologies, and found that older adults were involved at different stages (requirements gathering, design ideation, development, re-design, prototype, evaluation), with most involvement at the requirement and design-ideation stages (34) • One systematic review examined the effects, facilitators, and barriers of co-designed technology supporting community-dwelling older adults (e.g., robots, online applications, computer games for exercise, televisions and smart home systems), and the review generally described co-design approaches in relation to needs-identification and idea-generation processes (through workshops, focus groups, interviews), as well as for prototyping and pilot testing (30)
Stakeholders' views and experience	<p>Requiring co-design processes to develop technologies</p> <ul style="list-style-type: none"> • One systematic review examined the effects, facilitators, and barriers of co-designed technology supporting community-dwelling older adults (30) • The review identified several barriers to co-design, including: <ul style="list-style-type: none"> ○ hierarchy and attitudes, unrealistic expectations, heterogeneity, and lack of commitment to co-design ○ time and money constraints and lack of buy-in from senior leadership ○ limited resources for implementation and collaboration (at the policy level) ○ limited skills in co-design, small sample size, bias in methods, and poor mock-ups • The review identified several facilitators to co-design, including:

Category of finding	Summary of key findings
	<ul style="list-style-type: none"> ○ building relationship and trust, empowering the end-user by improving knowledge, and establishing value and interest ○ multiple communication approaches, provision of flexibility, and appropriate project resourcing ○ philosophy of co-design ○ use of effective prototypes ○ use of familiar environments ○ allowing adequate time between each phase ● One systematic review examining the involvement of people with dementia in developing supportive technologies concluded that designers should provide a space for empowerment, support, and empathy towards individuals with dementia (32) ● One systematic review examined the involvement of people with dementia in research design,(31) and identified a series of recommendations: <ul style="list-style-type: none"> ○ offer a quiet, familiar environment with minimal travelling ○ commit to values of flexibility, empathy, patience, knowledgeable about life experiences of patients with dementia ○ provide information on research ethics ○ contact patients and caregivers directly with the option to recruit throughout the project ○ organize smaller groups with informal breaks during sessions ○ concentrate workshops, interviews, and focus groups with the intent to give space for feedback, identifying needs, and creating content together ○ note observations of the interaction between the patients and the prototype while providing space for feedback ○ create specific tools and designs according to dementia stage (mild, moderate, severe) ● The same review reported a range of limitations of involving patients with dementia in research design, such as: <ul style="list-style-type: none"> ○ caregiver burden ○ stress and distress in patient with dementia ○ verbal limitations ○ time-consuming and resource-intensive processes for researchers ○ difficulty to generate findings ○ small sample sizes ○ short duration of sessions ○ bias from researchers ○ high drop-out rates among patients with dementia ● One systematic review examined the effects of co-creation and co-production with citizens (with no specific focus on older adults) and identified factors related to co-creation and co-production with citizens (with no specific focus on older adults). ● The influential organizational factors that the review attributed to co-creation and co-production include organization compatibility and openness with citizen participation, risk-averse culture, and the use of incentives, and from the citizen perspective, contributing factors to co-production included participant characteristics (skills, socio-economic status), awareness and ownership of product, social capital, and risk aversion by citizens (33)

Element 3 – Enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies

This element focuses on adopting a rapid-learning approach to support the development, evaluation and implementation of new technologies in long-term care homes in Canada. Rapid-learning health and social systems have seven characteristics within which related assets can be developed and subsequently ‘linked up’ to support iterative cycles of learning and improvement. These are:

- 1) engaged patients/clients;
- 2) digital capture, linkage and timely sharing of relevant data (which corresponds to ‘data and analytics’);
- 3) timely production of research evidence (which corresponds to ‘support to grow and share best practices’);
- 4) appropriate decision supports (which corresponds to ‘tools and templates’ and ‘digital health supports’);
- 5) aligned governance, financial and delivery arrangements (which corresponds to ‘incentives’ and ‘legislative, regulatory and policy or other enablers’);
- 6) culture of rapid learning and improvement; and
- 7) competencies for rapid learning and improvement (which corresponds to ‘change-management support’).(37)

Supporting a rapid-learning and improvement cycle that enables efforts to identify and harness the potential of technology in long-term care settings in Canada could be operationalized by:

- 1) being centred on residents and caregivers by,
 - a. engaging in co-design processes as described in element 2 to ensure the design of and approach to using technology is person centred, and
 - b. building acceptance for using technology among residents and their caregivers;
- 2) driving the cycle using data and evidence by creating centralized platforms to share data and evidence about technologies that can be adopted in long-term care, and insights about their use that can be used to drive learning and improvement cycles;
- 3) supporting changes through aligned system arrangements by changing system arrangements that limit the ability to adopt, evaluate and incorporate changes to the use of technology, such as,
 - a. governance arrangements (e.g., revising regulations that do not foster innovation and the use of technology)
 - b. financial arrangements (e.g., enhancing flexibility for the use of existing long-term care funding in ways that enable the sector to be more creative and adopt innovative pilots and programs), and
 - c. delivery arrangements (e.g., allowing long-term care homes to be creative and adopt innovative pilots and programs that have the potential to enhance the outcomes of residents); and
- 4) building competencies and a culture for rapid-learning and improvement cycles, such as through a long-term-care learning collaborative.

A summary of the key findings from the synthesized research evidence is provided in Table 6. For those who want to know more about the systematic reviews contained in Table 8 (or obtain citations for the reviews), a fuller description of the systematic reviews is provided in Appendix 3. We provide below a brief summary of the key insights from the citizen panels and from the systematic reviews that we identified.

Key insights from systematic reviews about rapid-learning and improvement

We identified two systematic reviews and one series of descriptive case studies that were deemed to be most relevant to adopting a rapid-learning and improvement approach. While they relate broadly to the characteristics of a rapid-learning health and social system, they do not specifically address its development to support the adoption of new technologies in LTCHs. In addition, the McMaster Health Forum also completed two rapid syntheses and a provincial stakeholder dialogue (including the development of an evidence brief), which we used to inform this element.(7; 37-38) The first rapid synthesis and stakeholder dialogue focused on creating a rapid-learning health system in Ontario, and the other rapid synthesis focused on creating rapid-learning health systems in Canada.

The most recent rapid synthesis (from December 2018) was focused on creating rapid-learning health systems in Canada.⁽⁷⁾ While the findings are too detailed to report in full here, three high-level points, directly from the report, are worth noting:

- the list of assets is remarkably rich for the health system as a whole and for the long-term care sector and elderly population specifically, even in small jurisdictions, but there are a number of notable gaps across a number of jurisdictions, such as data about patient experiences often not being linked and shared in a timely way to inform rapid learning and improvement;
- long-term care, home and community care, and other sectors have been or will be the focus of sustained efforts to create rapid-learning health systems in some jurisdictions; and
- some strong connections have been made among assets, although frequently the connections among sets linked to a single characteristic of rapid-learning health and social systems (not among assets linked to many different characteristics), and rarely were the connections made explicitly to support rapid learning and improvement.

We also identified two recent low-quality systematic reviews related to rapid learning. The first review examined attempts to adopt the rapid-learning health-system paradigm, with an emphasis on implementation and evaluating the impact on current medical practices.⁽³⁹⁾ The review identified three main themes to adopt a rapid-learning health system:

- clinical data reuse (i.e., building learning health systems by extracting knowledge from geographically distributed data collected in daily clinical practice);
- patient-reported outcome measures (i.e., using patient reporting mechanisms for collecting health-related quality indicators); and
- collaborative learning (i.e., using peer specialists for both capturing the indicators of healthcare delivery and encouraging changes through support and pressure).⁽³⁹⁾

The second review focused on the ethical issues that can arise in a rapid-learning health system and grouped 67 ethical issues within four phases of rapid learning:

- designing activities: the risk of negative outcomes (e.g., reducing the quality and usability of results) from designing learning activities less rigorously so they are not classified as research, and the risk of inadequate engagement of stakeholders (which can affect the success of the learning activity due to a lack of established trust and support);
- ethical oversight of activities: the conflict between current oversight regulations and a learning health system, which can delay or even prevent learning activities from being conducted due to confusion regarding which learning activities require ethical oversight, and an inconsistent and burdensome oversight process;
- conducting activities: risks of misguided judgments regarding when and how participants should be notified and asked for consent, and the conflict between current data-management practices and regulations and the goals of a learning health system; and
- implementing learning: difficulties with changing practice in a timely manner (e.g., due to conflict with the current research infrastructure or current financial incentives), issue of transparency (e.g., due to underperforming providers or commercial interests), and unintended negative consequences from implementation (e.g., widening health disparities or increasing the risk of liability).⁽⁴⁰⁾

The same review identified the following strategies to address these issues:

- establishing clear and systematic policies and procedures to determine which learning health-system activities require ethical review, how data sharing and data protection should be handled, and how to inform patients in routine and systematic ways about the learning system;
- training and guidance for ethics committee members to learn how to apply ethical principles in the context of learning health-system activities and for researchers to learn about ethics guidelines; and

- simplified ethical review and consent process to make it easier for learning health-system activities to be conducted, including implementing a dedicated ethical-review process and streamlining the consent process.

The descriptive case studies showcased various rapid-learning health systems, including for a health system as a whole, as well as some implemented in specific organizations (e.g., academic health centres) and sectors (e.g., specialty care), and for specific categories of treatment (e.g., surgery and palliative care) and populations (e.g., children and youth). The case studies showed a number of key factors influencing successful implementation of rapid-learning health systems, including:

- meaningful stakeholder engagement, partnership and co-production being key pillars in the development and implementation of rapid-learning health systems;
- robust data infrastructure being a central component (e.g., data needs to be systematically and consistently captured, readily available, and shared);
- leadership-instilled culture of learning;
- strategic and operational assistance required to support the development of core competencies; and
- a clear set of performance and quality measures required to evaluate the development and implementation of rapid learning (including public reporting on performance and quality).(7)

Key insights from systematic reviews about person-centredness

Element 3 also highlights the importance for a rapid-learning and improvement approach to be centred on residents and caregivers by engaging in co-design processes (as described in element 2), as well as building acceptance for using technology among residents and their caregivers.

We found three systematic reviews that may provide insights about person-centredness and the acceptance of technologies among older adults. The first is an old, moderate-quality review examining ‘person-centredness’ in the care of older adults. The review revealed several measurement instruments, each focusing on various attributes of person-centredness.(41) These findings reveal the need to better understand how person-centredness may be defined by residents, families, caregivers and providers, but also how harnessing technology may actually improve patient-centredness.

The two other systematic reviews highlight the importance of understanding older adults’ perceptions of technologies,(42) but also how they perceive themselves.(43) These are critical factors that may affect the uptake of technologies by residents in long-term care homes.

Table 8: Summary of key findings from systematic reviews relevant to Element 3 – Enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies

Category of finding	Summary of key findings
Benefits	<p>Adopting a rapid-learning and improvement approach</p> <ul style="list-style-type: none"> • No evaluations of benefits to a rapid-learning approach were explicitly identified in included systematic reviews
Potential harms	<p>Adopting a rapid-learning and improvement approach</p> <ul style="list-style-type: none"> • One recent low-quality review identified 67 ethical issues that can arise in a rapid-learning health system within the following four phases: 1) risk of negative outcomes as a result of designing activities; 2) ethical oversight of activities can lead to a conflict between current oversight regulations and learning systems; 3) in conducting activities there is the risk of misguided judgments regarding when and how participants should be notified and asked for consent; and 4) implementing learning can create challenges in timeliness, transparency and unintended negative consequences from implementation (39)

Category of finding	Summary of key findings
Costs and/or cost-effectiveness in relation to the status quo	<ul style="list-style-type: none"> • No cost-related information was identified
Uncertainty regarding benefits and potential harms (so monitoring and evaluation could be warranted if the option were pursued)	<ul style="list-style-type: none"> • No evaluations were identified
Key elements of the policy option if it was tried elsewhere	<p>Adopting a rapid-learning and improvement approach</p> <ul style="list-style-type: none"> • A series of case studies summarized in one of the rapid syntheses documenting the implementation of rapid-learning health systems showed a number of key factors influencing implementation, including: meaningful stakeholder engagement, partnership and co-production; robust data infrastructure; leadership-instilled culture of learning; strategic and operation assistance required to support the development of care competencies; and a clear set of performance and quality measures required to evaluate the development and implementation of rapid learning (7)
Stakeholders' views and experience	<p>Adopting a rapid-learning and improvement approach</p> <ul style="list-style-type: none"> • One low-quality systematic review examined attempts to adopt the learning-health-system approach, with an emphasis on implementation and evaluating the impact on current medical practices, and found minimal focus on evaluating impacts on healthcare delivery (40) <p>Person-centredness in the care of older adults</p> <ul style="list-style-type: none"> • An old, moderate-quality review examining 'person-centredness' in the care of older adults identified several measurement instruments, each focusing on various attributes of person-centredness.(41) These attributes include, but are not limited to: <ul style="list-style-type: none"> ○ knowing the person ○ autonomy ○ communication and information sharing (between staff and residents, and among staff) ○ extent of personalized care ○ amount of organizational support ○ degree of environmental accessibility ○ involvement in care planning (and identifying goals of care) ○ family involvement ○ supportive working environment ○ coordinated contacts ○ meeting practice needs ○ comfort ○ support relations ○ a climate of safety, everydayness, hospitality and community ○ enabling partnership • An old, high-quality review examined older adults' perceptions of technologies aimed at falls prevention, detection or monitoring, and found that certain intrinsic factors such as control over the technology, independence and the perceived need/requirement for safety were deemed very important for older adults' motivation to use such technologies, and that extrinsic factors such as usability, feedback and cost are also very important in their attitudes to continued use of these technologies (42) • A recent review examined how older adults' self-image and their desire to maintain this influence their decision-making processes regarding assistive technology adoption, and found that older adults showed a strong desire to preserve an identity associated with self-reliance, competence and independence, and that this desire sometimes caused them to reject beneficial and helpful technologies if they felt they were being stigmatized as being "old" (43)

Additional equity-related observations about the three elements of a potentially comprehensive approach to address the problem

The research evidence identified for each of the three elements provide limited equity-related observations about operators of older long-term care homes and residents with limited capacity to use technology. Some of the evidence for element 2 highlighted that residents with dementia could benefit from being engaged in co-design approaches, which reveal that residents with limited cognitive capacity can use technology.

Most of the equity observations were made during the citizen panels. For instance, panellists advocated for standards and guidelines to improve long-term care (and set minimum requirements for the use of technologies). Without minimum requirements, a multi-tiered system was viewed as likely to endure and exacerbate existing equity issues. In addition, panellists indicated that social equity considerations should be built into any sort of rapid-learning model.

IMPLEMENTATION CONSIDERATIONS

A number of barriers might hinder our capacity to leverage technology in LTC settings in Canada, and these barriers need to be factored into any decision about whether and how to pursue any given scaling-up strategy (Table 9). These potential barriers could exist at the levels of patients/individuals, providers, provider organizations and systems. These barriers may also affect the capacity to address the three groupings of decisional needs discussed earlier. Perhaps the biggest barrier lies in policymakers’ long history of not scaling up promising health innovations in Canada. The 2015 report of the federal Advisory Panel on Healthcare Innovation noted that most health systems lack the ability to scale up and spread innovation, and that common barriers include:(44)

- lack of meaningful patient engagement;
- outmoded human resource models;
- system fragmentation;
- inadequate health data and information-management capacity;
- lack of effective deployment of digital technology;
- barriers for entrepreneurs;
- a risk-averse culture; and
- inadequate focus on understanding and optimizing innovation.

Table 9: Potential barriers to implementing the elements

Levels	Element 1 – Ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies	Element 2 – Engage long-term care home operators and residents in developing and adopting technologies	Element 3 – Enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies
Patient/Individual	<ul style="list-style-type: none"> • Some residents, families and caregivers may be hesitant towards what could be perceived as a ‘technological fix’ (i.e., an attempt to solve long-standing issues in long-term care with new and better technologies) 	<ul style="list-style-type: none"> • Patient, family and caregiver engagement requires significant inputs from patients (e.g., time and other resources), which can be challenging given an individual’s health state 	<ul style="list-style-type: none"> • Patient, family and caregiver engagement requires significant inputs from patients (e.g., time and other resources), which can be challenging given an individual’s health state • Some residents, families and caregivers may be hesitant to adopt technologies if they perceive them as a threat to their privacy and autonomy
Care provider	<ul style="list-style-type: none"> • Many care providers still rely on low-tech communication (e.g., through faxed documents), which requires a significant shift in the processes before higher-tech solutions can be adopted 	<ul style="list-style-type: none"> • Care providers (and their professional associations or unions) may express ethical and legal concerns about the adoption of technologies that could be used to assess employees’ performance • Care providers who are already overburdened with work may have limited time to engage in co-designing technologies • Some care providers may grapple with prevalent and 	<ul style="list-style-type: none"> • Care providers (and their professional associations or unions) may express ethical and legal concerns about the adoption of technologies that could be used to assess employees’ performance • Care providers who are already overburdened with work may have limited time to engage in rapid learning and improvement • Some care providers may worry about increasing unmonitored communications

Levels	Element 1 – Ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies	Element 2 – Engage long-term care home operators and residents in developing and adopting technologies	Element 3 – Enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies
		persistent misconceptions about what ‘co-design’ means	between residents, families and caregivers
Organization	<ul style="list-style-type: none"> • Many organizations in Canadian provincial and territorial health systems still rely on low-tech communication (e.g., through faxed documents), which requires a significant shift in the processes before higher-tech solutions can be adopted and integrated both within and between organizations • Some LTCH operators may be hesitant to engage in leveraging technology when: 1) financial arrangements have already left them feeling overstretched and then aren’t adjusted to accommodate new technologies; and 2) it takes them beyond their perceived service-delivery mandate 	<ul style="list-style-type: none"> • Some LTCH operators may face difficulties in developing a shared vision, quality guidelines and metrics about co-design given their constraints and competing priorities • Some LTCH operators may grapple with prevalent and persistent misconceptions about what ‘co-design’ means • Some LTCH operators may express ethical and legal concerns about the adoption of technologies that could be used to assess organizational performance • LTCHs normally get involved with vendors when a technology product is available on the market, instead of being engaged in co-designing technologies 	<ul style="list-style-type: none"> • Some LTCH operators may also be hesitant to engage in leveraging technology when the challenges in coordinating all organizations from the LTC sector haven’t been addressed • Organizations could view this element as one that requires substantial investment in terms of infrastructure and analytic capacity • Some LTCH operators may worry about increasing unmonitored communications between residents, families and caregivers
System	<ul style="list-style-type: none"> • Some of these issues go beyond the health sector (e.g., no or limited broadband internet in some regions has been a long-standing infrastructure issue in rural and remote regions in Canada) 		<ul style="list-style-type: none"> • Many jurisdictions lack the resources (e.g., technology, infrastructure and personnel) for timely data collection and system monitoring • Legislations around personal health information may restrict the sharing of information and data collection

On the other hand, a number of potential windows of opportunity could be capitalized upon (Table 10), which also need to be factored into any decision about whether and how to pursue one or more of the elements.

Table 10: Potential windows of opportunity for implementing the elements

Type	Element 1 – Ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies	Element 2 – Engage long-term care home operators and residents in developing and adopting technologies	Element 3 – Enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies
General	<ul style="list-style-type: none"> • The COVID-19 pandemic exposed the long-standing issues in the long-term care sector and has created a burning platform to strengthen the sector (including harnessing the potential of technology to optimize communication and care) • In January 2021, the Prime Minister of Canada mandated the federal Health Minister to work with the Minister of Seniors, and with the provinces and territories to set new, national standards for long-term care so that seniors get the best support possible (although it appears to be a contentious issue with provinces and territories) (45) • A recent survey commissioned by AGE-WELL indicated that a vast majority of older Canadians are feeling confident about using technology and many feel the impact on society is positive (46) • The long-term care sector has been or will be the focus of sustained efforts to create rapid-learning health systems in some Canadian jurisdictions, which could help harness the potential of technology (7) 		
Element-specific	<ul style="list-style-type: none"> • Recent funding announcements have been made in the past year to strengthen the long-term care sector, including improving infrastructure (e.g., the new “maisons des aînés” model being planned in Quebec which could facilitate the adoption of technology) (47) 	<ul style="list-style-type: none"> • Canada has remarkable assets in terms of patient, family and caregiver engagement (and increasingly in co-design approaches) in both health systems and research systems • Tech companies may see LTCHs as a potential market that has been under explored, and could thus be opened to partnerships in developing and adopting technologies in LTCHs 	<ul style="list-style-type: none"> • Recent developments have created an opportunity for a dramatic scale-up in rapid learning and improvement: <ul style="list-style-type: none"> ○ Canada-wide moves to this framework in provincial and territorial health systems (and hopefully through pan-Canadian health organizations) ○ Provincial, national and international work led by several groups to inform this movement towards rapid-learning health (and social) systems (e.g., Ontario’s Rapid Improvement Support and Exchange, B.C. Academic Health Sciences Network, Canadian Health Services and Policy Research Alliance’s Learning Health System Working Group)

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APPENDICES

The following tables provide detailed information about the systematic reviews identified for each option. Each row in a table corresponds to a particular systematic review and the reviews are organized by element (first column). The focus of the review is described in the second column. Key findings from the review that relate to the option are listed in the third column, while the fourth column records the last year the literature was searched as part of the review.

The fifth column presents a rating of the overall quality of the review. The quality of each review has been assessed using AMSTAR (A Measurement Tool to Assess Reviews), which rates overall quality on a scale of 0 to 11, where 11/11 represents a review of the highest quality. It is important to note that the AMSTAR tool was developed to assess reviews focused on clinical interventions, so not all criteria apply to systematic reviews pertaining to delivery, financial, or governance arrangements within health systems. Where the denominator is not 11, an aspect of the tool was considered not relevant by the raters. In comparing ratings, it is therefore important to keep both parts of the score (i.e., the numerator and denominator) in mind. For example, a review that scores 8/8 is generally of comparable quality to a review scoring 11/11; both ratings are considered “high scores.” A high score signals that readers of the review can have a high level of confidence in its findings. A low score, on the other hand, does not mean that the review should be discarded, merely that less confidence can be placed in its findings and that the review needs to be examined closely to identify its limitations. (Lewin S, Oxman AD, Lavis JN, Fretheim A. SUPPORT Tools for evidence-informed health Policymaking (STP): 8. Deciding how much confidence to place in a systematic review. *Health Research Policy and Systems* 2009; 7 (Suppl1):S8.

The last three columns convey information about the utility of the review in terms of local applicability, applicability concerning prioritized groups, and issue applicability. The third-from-last column notes the proportion of studies that were conducted in Canada, while the second-from-last column shows the proportion of studies included in the review that deal explicitly with one of the prioritized groups. The last column indicates the review’s issue applicability in terms of the proportion of studies focused on technology in long-term care. Similarly, for each economic evaluation and costing study, the last three columns note whether the country focus is Canada, if it deals explicitly with one of the prioritized groups and if it focuses on technology in long-term care.

All of the information provided in the appendix tables was taken into account by the evidence brief’s authors in compiling Tables 6-8 in the main text of the brief.

Appendix 1: Systematic reviews relevant to Element 1 - Ensure that long-term care homes operate in a context that can support the adoption of appropriate technologies

Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
Upgrade existing buildings	Examining the influence of nursing home characteristics on the quality of life of residents (25)	<p>The primary objective of this systematic review was to assess nursing home characteristics and evaluate their effects on the quality of life of residents.</p> <p>This review identified a total of 11 articles, 10 of which were cross-sectional studies, while the final study had a longitudinal quasi-experimental design.</p> <p>Characteristics measured in the review included, but were not limited to, nursing home ownership, facility size, allocation of private rooms, and staffing.</p> <p>The findings from the review suggest that not-for-profit nursing home facilities, individualized or personal care, and a higher proportion of private rooms are all associated with an increase in quality-of-life outcomes for residents.</p> <p>While several key findings were noted, the authors do acknowledge a few limitations associated with their review, including heterogeneity in the evidence pieces and a lack of included randomized controlled trials.</p>	2012	4/9 (AMSTAR rating from McMaster Health Forum)	0/11	0/11	0/11
	Examining how long-term care setting characteristics affect outcomes for those living with dementia and their caregivers (26)	<p>The primary aim of this systematic review was to examine the organizational characteristics (e.g., size, cost and location), structures (e.g., private rooms and human resources), and processes of care (e.g., assistance programs and services) of different long-term care facilities, and assess their impact on the health and psychosocial outcomes for people with dementia and their caregivers.</p> <p>The review included a total of 14 articles, of which nine were randomized controlled trials, one non-randomized controlled trial, and four prospective cohort studies.</p> <p>Measured health outcomes included, but were not limited to, pain, cognitive decline, falls, and symptoms of depression; psychosocial outcomes included agitation, satisfaction, autonomy and engagement.</p>	2012	7/9 (AMSTAR rating from McMaster Health Forum)	0/14	14/14	0/14

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Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
		<p>The authors noted that: 1) the use of pleasant sensory stimulation was able to decrease resident agitation; and 2) individualized care protocols helped to improve both measured outcomes. Additionally, other care processes, such as functional skill training and engaging activities, were also reported to be effective in improving patient outcomes.</p> <p>It is worth highlighting that the only time health and psychosocial outcomes varied among different long-term care settings was when medical care needed to be administered.</p>					
	Examining existing literature on the economic evaluation of residential aged-care infrastructure (28)	<p>This main aim of this systematic review was to collate the existing literature regarding the economic evaluation of residential aged-care infrastructure.</p> <p>This review was comprised of 14 studies; 11 of which used a cross-sectional study design, while the remaining three were a cluster-randomized controlled trial, cross-sectional time series, or prospective cohort study.</p> <p>The authors evaluated the organizational (e.g., ownership, affiliation, size, and location) and environmental (e.g., functional modifications and home-like environments) characteristics of residential care. The measured health outcomes included quality of care, agitation, emotional responses, and quality of life.</p> <p>Key findings from the review suggest that: 1) for-profit facilities function at a reduced cost when compared to not-for-profit or government-owned homes; and 2) changes to the environment are expensive and only weakly benefit patient outcomes, such as agitation and social interactions.</p> <p>While several of the authors found notable findings, they do recognize the limitations associated with their study, namely the heterogeneity of interventions and outcomes within the included studies.</p>	2015	7/10 (AMSTAR rating from McMaster Health Forum)	0/14	0/14	0/14
	Examining design changes that can help infection prevention-and-control management	<p>The primary objective of this rapid response was to investigate the existing evidence surrounding improvements to long-term care home designs that can help with infection prevention-and-control management.</p>	2020	No quality rating tool available for this type of	Not reported in detail	Not reported in detail	Not reported in detail

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Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
	in long-term care homes (27)	While the evidence pieces pertaining to long-term care home facility designs were limited, the author does note that heating, ventilation, and air conditioning (HVAC) systems, hand hygiene promotion, physical distancing devices, single and private resident rooms, and a housekeeping room can help control and prevent infections.		document			
	Designing an approach to investigate how physical environment design changes can improve the quality of life of long-term care residents (29)	<p>This protocol outlines a proposed approach for a systematic review on how physical-environment design changes can improve the quality of life of long-term care residents.</p> <p>This protocol has the primary objective of examining how the alteration of long-term care environments can impact the quality of life of residents – a notable interest is placed on evaluating these effects on residents living with dementia.</p> <p>With respect to the inclusion criteria for the review, two reviewers will search electronic databases and grey literature with the aim of including a variety of studies, such as randomized trials, cluster-randomized trials, non-randomized trials, and interrupted time series studies.</p> <p>The review will focus on interventions (i.e., design features) that alter the physical design or care model of long-term care facilities, and thus encourage independence and promote the positive well-being of residents.</p> <p>The protocol mentions that the targeted interventions can all be grouped under a “delivery arrangements” category. This includes a whole-facility model (e.g., Green House model), outdoor modifications (e.g., sensory gardens and outdoor dining spaces), building layout (e.g., helpful stimuli), equipment (e.g., paint and familiar furniture), and privacy changes (e.g., single rooms and scaling down seating areas).</p> <p>The primary measured outcomes will consist of quality of life, behaviour and mood, and function, while secondary outcomes will include cognitive functioning, quality of care, side effects, and staffing and carer outcomes.</p>	Not available for this type of document	No quality rating tool available for this type of document	Not available for this type of document	Not available for this type of document	Not available for this type of document

Identifying and Harnessing the Potential of Technology in Long-term Care Settings in Canada

Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
Ensure future buildings are designed and built in a way that is appropriate for enabling the adoption of technologies	None identified						
Ensure community supports for technology use are available (e.g., availability of affordable broadband internet connections)	None identified						

Appendix 2: Systematic reviews relevant to Element 2 – Engage long-term care home operators, staff, residents and their caregivers in developing and adopting technologies

Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
Requirements for co-design processes with residents, their caregivers and long-term care operators to develop technologies	Examining the effects, facilitators, and barriers of co-designed technology supporting community-dwelling older adults (30)	<p>The review examined 34 projects (from 43 studies) that focused on technology that supported older adults. Most of the projects focused on general needs, while 14 projects focused on specific health conditions. The use of robots, online applications, computer games for exercise, televisions and smart home systems were the most frequently mentioned technology among the studies.</p> <p>The review generally described co-design approaches as needs and ideation (through workshops, focus groups, and interviews), prototyping and pilot testing.</p> <p>The authors reported facilitators and barriers and categorized them into four domains (collaboration, processes, organization, methods). Overall, they found no barriers to the implementation of a co-designed project, however they found barriers when it came to co-designing. For collaboration, hierarchy and attitudes, unrealistic expectations, heterogeneity, and lack of commitment to co-design were identified barriers. Facilitators included building relationship and trust, empowering the end-user by improving knowledge, and establishing value and interest.</p> <p>For processes, time and money constraints and lack of buy-in from senior leadership were considered barriers. Facilitators included access to multiple communication approaches, provision of flexibility, and appropriate project resourcing. For organization, barriers include limited resources for implementation and collaboration (at the policy level), but the philosophy of co-design was an important facilitator. For methods, limited skills in co-design, small sample size, bias in methods, and poor mock-ups were considered barriers. Facilitators included use of effective prototypes, use of familiar environments, and allowing adequate time between each phase.</p>	2019	6/9 (AMSTAR rating from McMaster Health Forum)	0/43	0/43	0/43

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Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
		Overall, the authors concluded that while the effect of co-designed technology for aging on health outcomes is unclear, the studies described the value of involving older adults during the ideation phase.					
	Evaluating the effects of involving people with dementia (PwD) in research design (31)	<p>The review aimed to evaluate the effects of involving people with dementia (PwD) in research design, and identify recommendations and limitations to the process. Based on 26 studies, the authors reported a list of recommendations, which includes: 1) offer a quiet, familiar environment with minimal travelling; 2) commit to values of flexibility, empathy, patience, and knowledgeable about life experiences of PwD, and provide information on research ethics; 3) contact patients and caregivers directly with the option to recruit throughout the project; 4) organize smaller groups with informal breaks during sessions; 5) concentrate workshops, interviews and focus groups with the intent to give space for feedback, identifying needs, and creating content together; 6) note observations of the interaction between the PwD and the prototype while providing space for feedback; and 7) create specific tools and designs according to dementia stage (mild, moderate, severe). Examples of the specific tools and recommendations according to dementia stage included using auditory stimuli, caregiver support, and familiar activities.</p> <p>The review reported a range of limitations of involving PwD in research design, such as caregiver burden, stress and distress in PwD, verbal limitations, time-consuming for researchers, expensive, difficulty to generate findings, small sample size, short duration of sessions, bias from researchers, and high drop-out rate among PwD.</p> <p>The review reported that involving individuals with dementia is beneficial to the design process and to the patients, and there has been a growing trend to engage PwD in research design (especially among moderate and severe dementia stages).</p>	2018	4/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	3/26	3/26

McMaster Health Forum

Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
	Examining factors related to co-creation and co-production with citizens (33)	<p>The review identified factors related to co-creation and co-production with citizens (with no specific focus on older adults). Influential organizational factors that are attributed to co-creation and co-production include organization compatibility and openness with citizen participation, risk-averse culture, and the use of incentives. From the citizen perspective, contributing factors to co-production included participant characteristics (skills, socio-economic status), awareness and ownership of product, social capital, and risk aversion by citizens.</p> <p>Additionally, the authors identified types of outcomes related to co-production with citizens. Most of the reported outcomes were increased effectiveness and citizen involvement. Other less frequently reported outcomes included increased efficiency and customer satisfaction, and strengthening social cohesion. Future studies should specifically describe the role of citizens (such as co-implementer, co-designer, co-initiator) and assess long-term effects.</p>	2013	4/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	Not reported in detail	Not reported in detail
	Examining the involvement of older adults during the design of technologies (34)	<p>The reviews that focused on older adults (on average, 70 years or older) in residential care homes reported a variety of technology-based interventions such as assisted living systems, service robots, and a smart wallet for digital picture exchange.</p> <p>Older adults were involved at different stages (requirements gathering, design ideation, development, re-design, prototype, evaluation), with most involvement at the requirement and design-ideation stages. Engaging older adults improved mutual learning and knowledge of the designers on the needs and daily practices of older adults, such as maintaining social connections, housekeeping routines, and medications. Additionally, insights from older adults provided information to develop new prototypes and lead to the intended design outcome. The involvement of older adults in co-design led to a strong sense of participation (ownership, voice, participation). However, the authors concluded that it was unclear whether the involvement of older adults improved acceptance and adoption (uptake and preference of the product). Further research is</p>	2018	5/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	7/40	7/40

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Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that dealt explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
		needed on the involvement of older adults at different design stages from different backgrounds and roles.					
	Examining the involvement of people with dementia to develop supportive technology (32)	There were four phases of technology development: a pre-design phase, generative phase, evaluative phase, and post-design phase. Within the review, 37 studies described active involvement of the caregivers during technology development. Most of the studies conducted their research through interviews and observations with elicitation material (scenarios, mock-ups, pictures). Among 38 studies, the involvement of people with dementia on technology led to at least one change in the development (conceptual idea, functionality, interface design, implementation). Some studies described participant experiences, most of which were feelings of fulfilment and enjoyment. Overall, there is heterogeneity in the methods and lack of evaluations related to involving people with dementia in technology development. The authors concluded that designers should provide a space for empowerment, support, and empathy towards individuals with dementia when involving them in future technology development projects.	2017	5/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	15/49	15/49
	Identifying research co-design approaches and its effectiveness (35)	Co-design activities included contributions and review of the research agenda, proposal, study design, outcomes, and materials. Existing co-design approaches include patient and public involvement, stakeholder engagement, participatory research and methods, consumer engagement, community-based participatory research, and patient engagement. The most frequently mentioned types of activity for co-design approaches involved focus groups, interviews, surveys, and rating processes, but the frequency and intensity of engagement varied greatly across the studies. The authors reported mixed impact of research co-design on the research process, with reported positive emotions from individuals participating in the process. Researchers are recommended to use existing checklists (Guidance for Reporting Involvement of Patients and Public checklist) and methodologies (ECOUTER).	2019	10/10 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	0/26	0/26
	Examining co-design approaches within acute-care settings (36)	The review is a protocol.	Not reported in detail	Not available for this type of document	Not available for this type of document	Not available for this type of document	Not available for this type of document

Appendix 3: Systematic reviews relevant to Element 3 – Enable rapid-learning and improvement cycles to support the development, evaluation and implementation of new technologies

Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
Rapid learning and improvement	Examining attempts to adopt the Learning Health System paradigm, with an emphasis on implementations and evaluating the impact on current medical practices (39)	<p>The review examined a total of 32 documents (a range of reports, scientific publications and other related grey literature), which included 13 studies, in order to examine the attempts to adopt the Learning Health System paradigm.</p> <p>A learning healthcare system is driven to generate and apply the best evidence for collaborative healthcare, while focusing on innovation, quality, safety and value. Patients are a major factor in this model of health provision, given the emphasis on collaboration and collective decision-making. This review examines the attempts to implement this model of medicine.</p> <p>The results of this review indicate that there has been very little action in terms of implementing learning health systems, despite a great deal of interest. It is possible that there is great trust placed in the learning health system without proper assessment of impact. This may have contributed to the low number of studies qualifying for inclusion in the review. A major focus should be placed on assessment and reporting, considering that many attempts to adopt this system of health have been attempted and not reported. Existing frameworks for assessing medicine applications can be used to assess the efficacy of learning health systems. Further, reporting of the evaluation of these systems must be comprehensive. Lack of consistency across studies diminishes quality and effectiveness, and makes it difficult to assess outcomes. Taken together, the Learning Health System paradigm must be of central focus to researchers moving forward. While the central tenets of this approach are supported by researchers, there is a lack of assessment. The impact of such a system must be evaluated in order to boost adoption.</p>	2015	3/10 (AMSTAR rating from McMaster Health Forum)	0/13	Not reported in detail	0/13
	Examining the spectrum of ethical issues that is raised for stakeholders in a Learning Health System (40)	The review examined 65 studies in order to determine the spectrum of ethical issues raised for stakeholders in a “Learning Health Care System”.	2015	1/9 (AMSTAR rating)	Not reported in detail	Not reported in detail	65/65

Identifying and Harnessing the Potential of Technology in Long-term Care Settings in Canada

Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
		<p>A Learning Health Care System embodies an approach for integrating clinical research and clinical practice, in order to address problems of effectiveness and efficiency in the healthcare system. In such a system, knowledge generation should be embedded so that health systems can learn and grow. However, this blend of research and practice raises ethical dilemmas such as confidentiality and consent. This review aimed to summarize pertinent ethical issues in order to guide decision-making among healthcare professionals and policymakers.</p> <p>The ethical issues arising in Learning Health Care Systems can be broken down into different phases. In the phase of designing activities, ethical issues include the risk of negative outcomes that may result from activities that are not academically rigorous. As well, it is possible that stakeholders will not engage with this stage, which can affect trust and support in a learning activity. In the ethical oversight of activities, confusion surrounding ethical obligations and regulations can hinder progress. In conducting activities, the involvement of participants can lead to ethical difficulties with consent and data management. In implementing learning, main difficulties arise in changing practice efficiently, maintaining transparency, and reducing unintended negative consequences.</p> <p>The distinction between “research” and “practice” often creates ethical confusion, as many learning healthcare activities do not fit this dichotomy. Strategies to cope with these ethical problems include implementing policies and procedures, providing training and guidance for ethical committee members, and streamlining ethical-review processes. The rights of individuals must be protected as healthcare quality improves.</p> <p>Future research should focus on clarifying these ethical dilemmas and contribute to improving the quality of healthcare.</p>		from McMaster Health Forum)			

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Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
Patient-centredness	Examining person-centredness in the care of older adults based on existing questionnaire-based scales and their measurement properties (41)	Long-term care for older adults requires the central feature of person-centredness. Certain measures are needed to assist researchers and service planners in assessing this feature of quality of care. A total of 11 measures coming from 22 references were included in this systematic review. Six measures were designed for long-term residential facilities and four were for ambulatory hospital or clinic services. Although some instruments showed promising measurement properties, poor methodological quality rendered the general quality score as low. Due to the instrument's low ratings, the authors could not recommend any measures of person-centredness for use in long-term care facilities with older adults. The authors also recommend more integration of service users and families' feedback in the development of future measurement instruments.	2015	4/9 (AMSTAR rating from McMaster Health Forum)	4/22	n/a	16/22
	Examining older adults' perceptions of technologies aimed at falls prevention, detection or monitoring (42)	This systematic review aimed to gather older adults' perceptions of fall technologies, specifically information and communication technologies focused on fall prevention. A total of 21 studies were included in this review. Certain intrinsic factors such as control over the technology, independence and the perceived need/requirement for safety were deemed very important for older adults' motivation to use such technologies. Extrinsic factors such as usability, feedback and cost are also very important in their attitudes to continued use of these technologies. The review suggests that technologies should be easily integrated into the home and have large buttons, clear screens and both visual and auditory messages available. One limitation stated by the authors is the exploratory nature of this evidence, making it difficult to provide robust conclusions and recommendations.	2013	7/10 (AMSTAR rating from McMaster Health Forum)	2/21	n/a	1/21
	Examining how older adults' self-image and their desire to maintain this influence their decision-making processes regarding assistive technology adoption (43)	This review aimed to understand how the self-image of older adults and their desire to maintain this image can influence their decision-making when it comes to assistive-technology adoption. A total of 49 studies were included and categorized into five themes: resisting the negative reality of aging; the importance of independence and control; the esthetics of usability; assistive technology as a last resort; and privacy matters. One common theme among all studies was that	2017	4/9 (AMSTAR rating from McMaster Health Forum)	Not specified	n/a	0/49

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Element	Focus of systematic review	Key findings	Year of last search	AMSTAR (quality) rating	Proportion of studies that were conducted in Canada	Proportion of studies that deal explicitly with one of the prioritized groups	Proportion of studies that focused on technology in long-term care
		<p>older adults showed a strong desire to preserve an identity associated with self-reliance, competence and independence. This desire sometimes caused them to reject beneficial and helpful technologies if they felt they were being stigmatized as being “old”. The authors recommend that technology developers encourage the active involvement of the end-user, in this case, older adults, in the design of new technologies. Older adults are known to be left out of these processes, however the evidence shows that their integration results in a more successful product design and higher acceptance rate among users.</p>					



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