Citizen Brief

Using Remote-monitoring Technologies to Enable People to Stay in their Homes in Canada

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McMaster University | HEALTH FORUM

EVIDENCE >> INSIGHT >> ACTION

McMaster Health Forum

The McMaster Health Forum's goal is to generate action on the pressing health and social issues of our time. We do this based on the best-available research evidence, as well as experiences and insights from citizens, professionals, organizational leaders, and government policymakers. We undertake some of our work under the Forum banner, and other work in our role as secretariat for Rapid-Improvement Support and Exchange, COVID-19 Evidence Network to support Decision-making (COVID-END), and Global Commission on Evidence to Address Societal Challenges.

Citizen panels

A citizen panel is an innovative way to seek public input on high-priority issues. Each panel brings together 14 to 16 citizens from all walks of life. Panel members share their ideas and experiences on an issue, and learn from research evidence and from the views of others. A citizen panel can be used to elicit the values that citizens feel should inform future decisions about an issue, as well as to reveal new understandings about an issue and spark insights about how it should be addressed.

This brief

We produced this brief to help lead discussions with four panels bringing together citizens from across Canada.

Reviewing the context
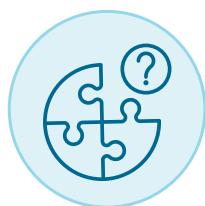
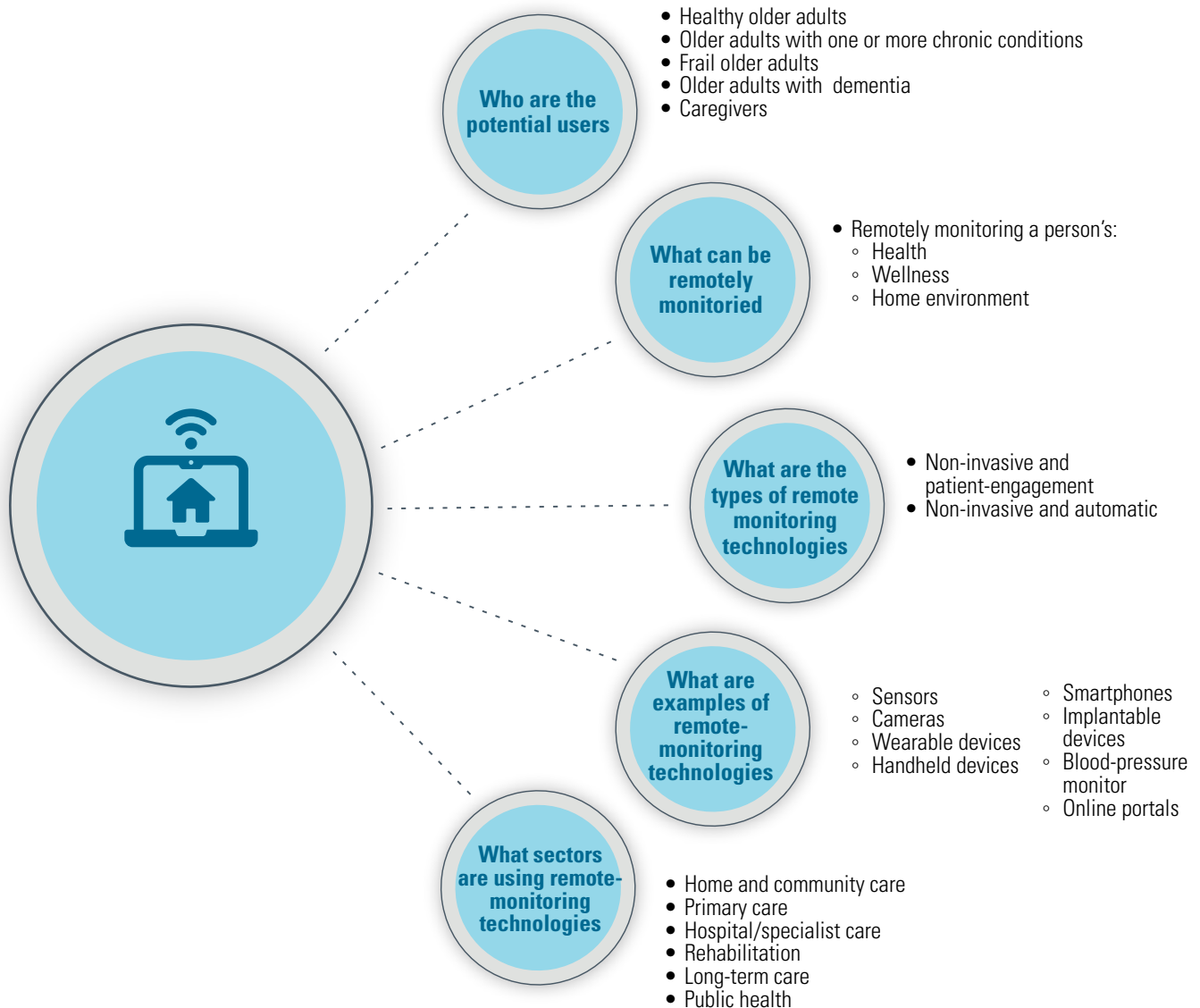Exploring the problem

Discussing solutions

Identifying barriers and windows of opportunity to moving forward

Reviewing the context

- There are growing calls to rethink health and social systems for the digital age. Technologies could help with long-standing challenges like:
  - Reducing wait times to receive care
  - Ensuring that care is more coordinated and integrated
  - Providing greater continuity of care
  - Addressing the workforce crisis (for example, increasing access to specialists)
  - Reducing health disparities (the most important relating to socio-economic status, Indigenous identity, gender and geographic location)
  - Providing optimal care to an aging population

- Virtual care is increasingly becoming an important part of the solution. Virtual care refers to "any interaction between patients and/or members of their circle of care, occurring remotely, using any forms of communication or information technologies with the aim of facilitating or maximizing the quality and effectiveness of patient care."(1)
  - In May 2020, the Government of Canada announced an investment of $240.5 million to increase access to virtual-care services and digital tools to support Canadians' health and well-being. From this funding, $150 million is earmarked for provinces and territories to expand virtual care across five priority areas, which include **remote-monitoring technologies**.(2)

- Remote-monitoring technologies are used to deliver services to people outside of traditional care settings (for example, at home) using telecommunication technologies.(3)
  - Remote-monitoring technologies show great potential, especially to support aging in place. Aging in place refers to "having the health and social supports and services you need to live safely and independently in your home or your community for as long as you wish and are able." (4)
  - However, there are still many challenges that need to be addressed in order to harness the full potential of remote-monitoring technologies.

- This document was developed to support a discussion about **'using remote-monitoring technologies to enable people to stay in their homes in Canada.'** More specifically, it includes information about:
  - The challenges of adopting remote-monitoring technologies
  - Possible solutions to address these challenges
  - Potential barriers and facilitators to move forward with these solutions

- **What is known about remote-monitoring technologies?**
  - In this section, we describe what is known about remote-monitoring technologies, with details about potential users, purposes and types of technologies (Figure 1), and different aspects that can be remotely monitored (for example, a person's health in Figure 2 and a person's wellness and home environment in Figure 3).

Figure 1. A snapshot of remote-monitoring technologies (3)

Who are the potential users
- Healthy older adults
- Older adults with one or more chronic conditions
- Frail older adults
- Older adults with dementia
- Caregivers

What can be remotely monitoried
- Remotely monitoring a person's:
  ○ Health
  ○ Wellness
  ○ Home environment

What are the types of remote monitoring technologies
- Non-invasive and patient-engagement
- Non-invasive and automatic

What are examples of remote-monitoring technologies
- ○ Sensors
- ○ Cameras
- ○ Wearable devices
- ○ Handheld devices
- ○ Smartphones
- ○ Implantable devices
- ○ Blood-pressure monitor
- ○ Online portals

What sectors are using remote-monitoring technologies
- Home and community care
- Primary care
- Hospital/specialist care
- Rehabilitation
- Long-term care
- Public health

- Remote-monitoring technologies collect and transmit data to all members of the care team (including the older adults themselves, their caregivers and their family members). The data can be transmitted as soon as they are collected (in real time), or they can be transmitted on a regular basis (with some time delay). These technologies are increasingly using artificial intelligence to rapidly analyze the data.

- What are the potential benefits of remote-monitoring technologies?
  ○ Users of remote-monitoring technologies can become active participants in the management of their health and care. (5-6)
  ○ It can improve the delivery of integrated, timely and personalized care, and improve health outcomes.(3;7)
  ○ It can help to identify problems in a timely manner, allow for rapid interventions, and thus ultimately avoid or decrease the rate of decline in health status.(8)
  ○ It can help to manage care needs at home and avoid a move to a more intensive level of care setting (for example, to a rehabilitation centre or a nursing home).(3)
  ○ It can help to support patient when they move back home after being hospitalized (for example, after a surgery), which can improve safety and avoid hospital readmission.(3)

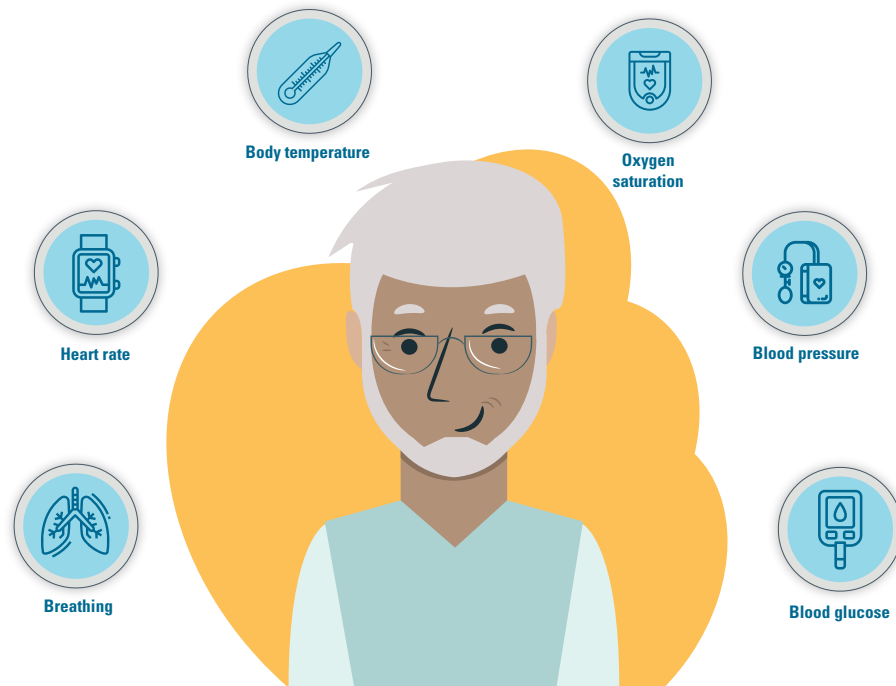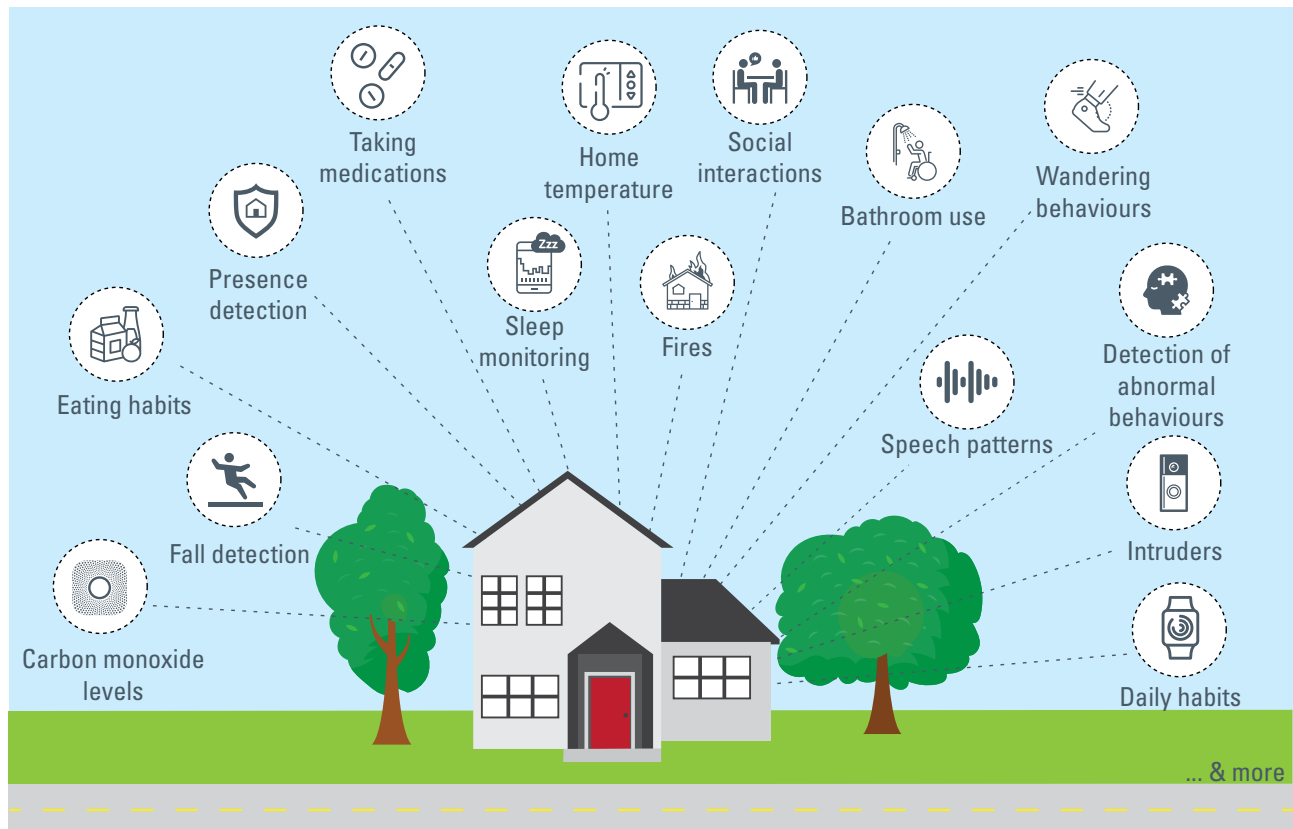**Figure 2. Technologies can remotely monitor many aspects of a person's health**

Body temperature

Oxygen saturation

Heart rate

Blood pressure

Breathing

Blood glucose

Figure 3. Technologies can remotely monitor many aspects of a person's wellness and home environment

Taking medications

Home temperature

Social interactions

Bathroom use

Wandering behaviours

Presence detection

Sleep monitoring

Fires

Detection of abnormal behaviours

Eating habits

Speech patterns

Intruders

Fall detection

Carbon monoxide levels

Daily habits

... & more

Reviewing the context (cont'd)

Have you (or your loved ones) ever used remote-monitoring technologies?

How could remote-monitoring technologies help you (or your loved ones) to age in place?

Who do you feel could benefit the most from remote-monitoring technologies?

In the following pages...

...we will look at the challenges of adopting remote-monitoring technologies to enable people to stay in their homes. Then, we will look at potential solutions and ask you about the pros and cons of each solution (and give you an opportunity to think about other solutions too).

Exploring the problem

Why is it challenging to adopt remote-monitoring technologies to enable people to stay in their homes?

We have identified four reasons:
- it is challenging to identify those who could benefit from different remote-monitoring technologies (and technologies are often implemented too late)
- there are some areas of uncertainty regarding remote-monitoring technologies (for example, how to reconcile the perspective of users and other stakeholders, are there limits of what should be remotely monitored, and could these technologies decrease or increase inequities)
- system-level challenges make it difficult to adopt remote-monitoring technologies
- there is a need to change behaviours of potential users to foster the adoption of remote-monitoring technologies

Problem 1: It is challenging to identify those who could benefit from different remote-monitoring technologies (and technologies are often implemented too late)

Remote-monitoring technologies are most effective when they are used by people early.(9) However, identifying people who could benefit the most from remote-monitoring technologies is difficult. For example, many people are not seeking care, and professionals do not always discuss with their patients all their health and social needs (which could benefit from these technologies).

> By the time people are facing the decision to go to a nursing home, it may be too late to provide them with remote-monitoring technologies to enable them to stay in their homes.

Many programs relying on remote-monitoring technologies have been created across the country.

> However, most programs monitor a single condition (for example, remotely monitoring heart failure, diabetes, or chronic obstructive pulmonary disease, or remotely monitoring surgery patients when they go back home).

> Finding the right package of technologies to meet the older adults' health and social needs, or developing custom technology solutions to meet their specific needs, is challenging.

Problem 2: There are some areas of uncertainty regarding remote-monitoring technologies

Not everyone shares the same views regarding remote-monitoring technologies (whether you are an older adult, a caregiver, a family member, a clinician, a computer scientist, a data scientist, an engineer, a vendor, etc.)

> There is a need for greater collaboration among all these groups when designing remote-monitoring technologies (from ideation to implementation).

> There is also a need for more research about remote-monitoring technologies in real contexts (as opposed to laboratories or academic institutions).(10-12)

- The range of things that can be remotely monitored is almost endless (whether it is about health, wellness, or the home environment).

	Research about the acceptance of remote-monitoring technologies is still in its infancy and it is unclear where the need for remote monitoring should end.(13)

- Remote-monitoring technologies have the potential to both decrease inequities, but also increase them in different situations and for different reasons.(14)
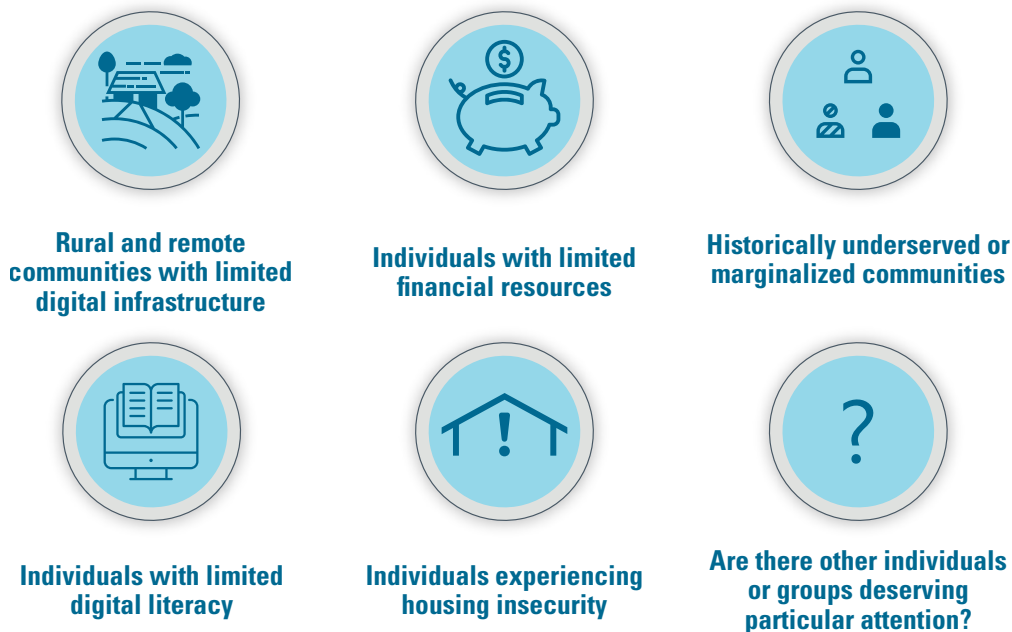
	The 'digital divide' is often used to describe socio-economic and demographic factors such as age, income, ethnicity, place of residence, education and health status, that contribute to unequal access to digital infrastructure and technical capacity of individuals and communities to access information and use the internet (15-16)
	Figure 4 illustrates different individuals and groups who are often experiencing health inequalities (and who may deserve particular attention when adopting remote-monitoring technologies).

Figure 4. Individuals and groups experiencing health inequalities

Rural and remote communities with limited digital infrastructure

Individuals with limited financial resources

Historically underserved or marginalized communities

Individuals with limited digital literacy

Individuals experiencing housing insecurity

Are there other individuals or groups deserving particular attention?

Problem 3: System-level challenges make it difficult to adopt remote-monitoring technologies

- How health and social systems are set up can influence whether and how remote-monitoring technologies are adopted.
- We need to pay attention to governance arrangements (for example, who can make different types of decisions in these systems), financial arrangements (for example, how money flows in these systems), and delivery arrangements (for example, how care is organized to reach those who need it).
- We provide some examples of system-level challenges in Table 1.

Table 1. Examples of system-level challenges that make it difficult to adopt remote-monitoring technologies

Health- and social-system arrangements	Challenges

Governance arrangements *(who can make what types of decisions)*	• There is no framework to guide the development, evaluation and deployment of remote-monitoring technologies
	   ◦ Without a framework, we may exacerbate already fragmented policies, programs and services (7)
	• It is unclear who should be responsible to lead or steer this work
	• It is challenging to align various standards in the context of remote-monitoring technologies, for example:
	   ◦ clinical standards
	   ◦ digital-health standards
	   ◦ standards for medical-grade technologies
	   ◦ standards for non-medical-grade technologies
	   ◦ building-code standards
	   ◦ security standards (given the risk of data breaches)
	   ◦ privacy laws
	• Remote-monitoring technologies will require changes in the culture of care and training, with more time for engaging users, ensuring the continuity of care, and analyzing data (17)
	• There will be a need to review professional scope of practices, meaning what the various professionals are permitted to do (and are responsible for) when remotely monitoring patients

Financial arrangements *(how money flows through the system)*	• How hospital care and home care are funded in most provinces and territories do not encourage remote monitoring of patients • It is unclear how people will access remote-monitoring technologies (leasing or purchasing, out-of-pocket expenses or co-payments, using your own devices or not)
Delivery arrangements *(how care is organized to reach those who need it)*	• Many remote-monitoring technologies are designed for a specific problem or task, which contributes to the limited interoperability of these technologies (12) • There is a limited number of remote-care specialists and remote-care training has not been integrated into learning curriculums (which is not conducive to success and sustainability) • There is a lack of consensus about who should play the role of informing clients and caregivers about the need for and use of remote-monitoring technologies and trying to match their needs to the appropriate technologies • Professionals have expressed concerns about "role ambiguity" and about who should be the 'gatekeeper' to these technologies (18)

Problem 4: There is a need to change behaviours of potential users to foster the adoption of remote-monitoring technologies

• There is a need to address barriers at the level of users (for example, older adults and caregivers), care providers, and leaders of organizations delivering care.

• A growing body of evidence indicates that:

	There are variations in the acceptance of remote-monitoring technologies among users(13)
	There is a lack of awareness regarding remote-monitoring technologies among potential users, including care providers and organizational leaders
	Remote-monitoring technologies require changes in the culture of care, redefinition of roles and responsibilities, and training(17)

• To successfully adopt remote-monitoring technologies, there is a need for strategies that will encourage behaviour change among potential users.(5) However, such strategies are often lacking.

Exploring the problem (cont'd)

Do the challenges presented here resonate with you?

If you (or a loved one) have used remote-monitoring technologies in the past:

- What challenges came up?
- Have you had any concerns?

If you (or a loved one) had to use remote-monitoring technologies in the near future:

- Do you anticipate any challenges?
- Do you have any concerns?

Do you feel some individuals or groups may experience more challenges than others (to the point that it could create inequalities)?

Discussing solutions

To promote discussion about the pros and cons of potential solutions, we have selected three solutions that could help the adoption of remote-monitoring technologies.

Many solutions could be selected as a starting point for discussion. We have selected the following three solutions for which we are seeking your input:

1. Supporting people, their caregivers and their families to use remote-monitoring technologies
2. Supporting organizations and providers to use remote-monitoring technologies
3. Helping the system to learn and improve rapidly to support the use of remote-monitoring technologies

We want to hear from you about the pros and cons of each solution (and give you an opportunity to think about other solutions too).

We present below the three solutions and look at what we know so far about them based on the best evidence we found. If you are curious, we included a technical appendix at the end of this document. It describes how we found the evidence and provides more details about each solution.

Solution 1: Supporting people, their caregivers and their families to use remote-monitoring technologies

Imagine that you (or your loved one) had health or social needs that could benefit from remote-monitoring technologies, but to use them, you may need different types of support.

This solution could include ideas like:

1a financial support to use these technologies (for example, an annual allowance for broadband internet access)
1b activities to improve your knowledge, skills and behaviours, such as:
  ○ activities to provide you with information or education about remote-monitoring technologies;
  ○ activities to help you change your behaviours towards remote-monitoring technologies;
  ○ activities to develop your skills to use remote-monitoring technologies;
  ○ activities to communicate with your care team and make decisions about remote-monitoring technologies (for example, identifying your health and social needs, discussing the potential benefits of remote-monitoring technologies, and supporting you to navigate the technological options)

We used evidence to generate these ideas. More specifically, we looked for what's called "systematic reviews". A systematic review is an overview of all research studies that have been done on a specific topic and draws conclusion on all the results (not just one study).

We found several reviews relevant to **ideas 1a and 1b**. Some reviews explored factors that may influence the adoption of remote-monitoring technologies:

• the user's health status
• the usability, convenience and accessibility of the remote-monitoring technologies
• the perceived utility (including perceived rewards, costs, and privacy)
• the motivation to use these technologies
• how the use of such technologies can impact the users' identity

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- the capacity to customize the technologies
- the capacity to adapt the technologies to address the evolving needs of users (like the users' disease progression or illness trajectories)(19-21)

Other reviews identified strategies to improve knowledge, skills and behaviours. These included:

- information or education provision about the health condition, self-management strategies, and the remote-monitoring technologies (for example, providing an educational booklet about the health condition and a manual for the technology) (22-23)
- training to improve the users' digital skills(22-23)
- providing financial and technical support (for example, financial support to access the technologies, initial home training provided by a technician, and technical support if users are having problems)(22;24)
- engaging users and the care team in discussions related to their health and social needs, their values and preferences, and the care options (including the technological options)(24-25)
- engaging users in developing and implementing technologies(19)

Solution 2: Supporting organizations and providers to use remote-monitoring technologies

This solution aims to support organizations delivering care and providers to use remote-monitoring technologies.

This solution could include ideas like:

2a engaging users, their caregivers, and their families in co-designing remote-monitoring technologies, along with organizations, providers, the industry and other key stakeholders

2b activities to improve the knowledge, skills and behaviours of providers, such as:
- providing educational material
- hosting educational meetings
- relying on local opinion leader (or champion)
- conducting audit and feedback
- providing reminders and prompts

For idea 2a, there is a growing body of evidence about co-designing technologies. There is evidence that many groups could be engaged in co-designing technologies (including, older adults in long-term care, older adults with dementia, community-dwelling older adults, patients in acute-care settings, or the general public). In general, there are benefits for co-design approaches particularly at the idea-generation stage for technologies.(26)

For idea 2b, we found a review focusing on the competencies that providers and organizations need to implement remote-monitoring technologies.(17) These competencies must be clearly defined, measurable, implemented, and evaluated. These competencies focus on six domains:

- patient care
- medical knowledge
- practice-based learning and improvement (which means the capacity of providers to evaluate their care, appraise and assimilate scientific evidence, and continuously improve patient care based on constant self-evaluation and life-long learning)
- systems-based practice (which means the capacity to demonstrate an awareness of and responsiveness to the larger

context and system, as well as the ability to call effectively on other resources in health and social systems to provide optimal care)
• professionalism
• interpersonal skills communication

Solution 3: Helping the system to learn and improve rapidly to support the use of remote-monitoring technologies

Bringing about change in health and social systems is challenging and can be extremely slow. It can take too much time for those working in these systems to act on new evidence and lessons learned that could improve patient experience and health. For example, it is frequently stated that it takes an average of 17 years for new research evidence to change medical practices.(27)

Health and social systems may benefit from adopting an approach that allows them to learn and improve rapidly (or at least more rapidly than the current pace). This could help to support the development, evaluation and implementation of remote-monitoring technologies in Canada (while being responsive to health and social needs of older adults, their caregivers and their families).

The "rapid-learning and improvement" approach works through rapid cycles such as what is depicted in Figure 5.

Figure 5. Individuals and groups experiencing health inequalities
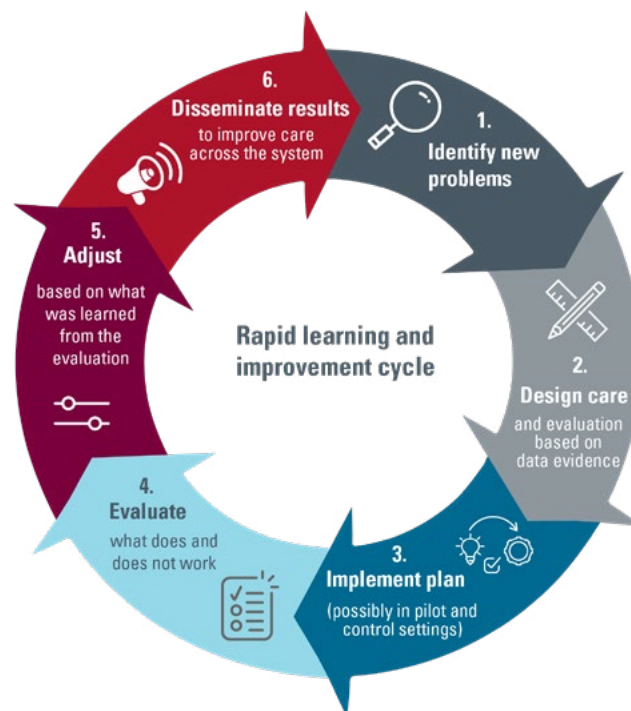
We found several reviews about helping systems to learn and improve rapidly. The reviews highlight that rapid-learning systems have seven characteristics:
1. they engage older adults, their caregivers and their families to ensure that they are anchored on their needs, perspectives and aspirations
2. they capture and share relevant data
3. they produce research in a timely way

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4. they use appropriate decision supports
5. they adjust who can make what decisions, how money flows, and how the systems are organized
6. they foster a culture of rapid learning and improvement
7. they build the competencies for rapid learning and improvement(28)

Regarding the first characteristic, evidence suggests that older adults, their caregivers and their families can be engaged in:

- the organizations that deliver care (for example, patient-experience surveys; co-designing programs and services; members of quality-improvement committees and advisory councils)
- the organizations that oversee the professionals and other organizations in the systems (for example, professional regulatory bodies; quality-improvement bodies; ombudsman; and complaint processes)
- policymaking (for example, committees making decisions about which technologies are covered; government advisory councils that set direction for the systems; sharing stories to kick off key meetings with policymakers)
- research (for example, engaging patients as partners in research teams studying remote-monitoring technologies; or engaging patients in identifying research priorities)

Discussing solutions (cont'd)

What support would you (or your loved one) need to use remote-monitoring technologies?

- Do you think some individuals or groups may require additional support?

What support would providers and organizations need to use remote-monitoring technologies?

What role could older adults, their caregivers and their families play to help the system to learn and improve rapidly regarding remote-monitoring technologies?

Of everything that you have heard about the proposed solutions …:

- What do you like?   • What do you wish?   • What do you wonder?

Identifying barriers and windows of opportunity to moving forward

Solutions are great, but only if they can be put into action. There are often barriers in the way. Some of these barriers can be overcome. Others might be so big that we might need to rethink the solution. We have outlined some potential barriers below in table 2. Help us identify up to three more barriers for each solution.

Table 2. Potential barriers to move forward

	Solution 1. Supporting people, their caregivers and their families to use remote-monitoring technologies	Solution 2. Supporting organizations and providers to use remote-monitoring technologies	Solution 3. Helping the system to learn and improve rapidly to support the use of remote-monitoring technologies
Examples of barriers	• Some older adults, families and caregivers may be concerned that the system is replacing personal care with technologies • Some people may be hesitant to adopt remote-monitoring technologies if they perceive them as a threat to their privacy and autonomy	• Many providers have limited digital literacy skills (for example, many are still relying on low-tech communication like faxes) • Organizations normally get involved with vendors when a technology product is available on the market, instead of being engaged in co-designing technologies	• Making changes in the system (even small and rapid changes) may be perceived as challenging, especially if no large investments are made • Many barriers go beyond the health and social systems (for example, no or limited broadband internet in many regions)

Identifying barriers and windows of opportunity to moving forward (cont'd)

Solutions can benefit from a window of opportunity to make them happen. A window of opportunity could be an event that brings an issue into the forefront (a news story, a crisis, a new public opinion poll, an election, etc.). We have outlined some potential windows of opportunity below. Help us identify up to three more for each solution.

Table 3. Potential windows of opportunity to moving forward

	Solution 1. Supporting people, their caregivers and their families to use remote-monitoring technologies	Solution 2. Supporting organizations and providers to use remote-monitoring technologies	Solution 3. Helping the system to learn and improve rapidly to support the use of remote-monitoring technologies
Examples of windows of opportunity	• The 2021 Digital Health Survey commissioned by Canada Health Infoway revealed that many Canadians have an interest in: ○ Taking part in remote patient monitoring using a device to manage a chronic health condition (47.2% of respondents); and ○ Taking part in remote patient monitoring using a device to manage symptoms related to COVID-19 (40.2% of respondents) (29) • A 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 (30)	• There is an opportunity to leverage promising initiatives like those from Canada Health Infoway to co-design and co-develop remote-monitoring programs with vulnerable populations	• Uptake of virtual care has accelerated in recent years,(7) and particularly in response to the COVID-19 pandemic • Governments have made "aging in place" a priority and are interested in ways to delay or prevent people from going into assisted-living facilities or nursing homes

Identifying barriers and windows of opportunity to moving forward (cont'd)

What might be the **biggest barrier** to these solutions?

What might be the **biggest window of opportunity** for these solutions?

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Acknowledgments

Technical appendix

Identification, selection and synthesis of evidence presented in this brief

- Whenever possible, we describe what is known about each element based on systematic reviews.
- A systematic review is a summary of all the studies that looked at a specific topic.
- A systematic review uses very rigorous methods to identify, select and appraise the quality of all the studies, and to summarize the key findings from these studies.
- A systematic review gives a much more complete and reliable picture of the key research findings, as opposed to looking at just a few individual studies.
- We identified systematic reviews in three databases that are the world's most comprehensive databases of evidence on health and social systems, as well as evidence on interventions to respond to the COVID-19 pandemic:
  - Health Systems Evidence (www.healthsystemsevidence.org)
  - Social Systems Evidence (www.socialsystemsevidence.org)
  - COVID-END (www.covid-end.org)
- A systematic review was included if it was relevant to one of the elements covered in the brief.
- We summarize below the key findings from all the relevant systematic reviews.

Technical appendix

Solution 1: Supporting people, their caregivers and their families to use remote-monitoring technologies

Category of finding	Summary of key findings
Benefits	• None reported in the systematic reviews found
Harms	• None reported in the systematic reviews found
Cost and/or cost-effectiveness	• One systematic review highlighted that most remote-monitoring technologies are limited in their purpose, with many solely focusing on a single domain, which means that users would have to rely on multiple different technologies for different purposes, which increases complexity and costs (31)
Uncertainty regarding benefits and potential harms	• None reported in the systematic reviews found
Key characteristics if it was tried elsewhere	• Several reviews identified strategies targeting the users and included: ○ Information or education provision about the health condition, self-management strategies, and the remote-monitoring technologies (for example, educational booklet about their condition and a manual about the technology) (22-23) ○ Skills and competencies development training to improve digital skills (22-23) ○ Provision of financial and technical support (for example, financial support to access the technology, initial home training provided by a technician) (22;24) ○ Engaging users and the care team in discussions related to their health and social needs, their values and preferences, and the care options (including the technological option)(24-25) ○ Engaging users in developing and implementing technologies (19)
Stakeholders' views and experiences	• Several reviews highlighted factors that may act as barriers or facilitators to the uptake of remote-monitoring technologies: ○ The user's health status ○ The usability, convenience and accessibility of the remote-monitoring technologies ○ The perceived utility (including perceived rewards, costs, and privacy) ○ The motivation to use these technologies (19) • Two reviews highlighted the importance of addressing the end-users' perceptions and attitudes,(32) and how the use of such technologies could have an impact on their identity (21) • Two reviews highlighted the importance of being able to customize technological solutions to match the needs of various aging societies,(20) and being able to adapt those technological solutions to address the evolving needs of end-users (for example, the users' disease progression or illness trajectories) (21)

Solution 2: Enabling organizations and providers to use remote-monitoring technologies

Category of finding	Summary of key findings

Benefits	• One systematic review examined the involvement of older adults in residential-care homes during the design of technologies (for example, assisted-living systems, service robots, and a smart wallet for digital picture exchange).(33) Engaging older adults led to several beneficial outcomes, including:
	  ○ Improved mutual learning
	  ○ Improved knowledge about the needs and daily practices of older adults (for example, 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 of technologies
	• 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 (34)
	• 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 (35)
	• One systematic review examined the effects of co-creation and co-production with citizens (with no specific focus on older adults).(36) 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 (37)

Harms	• None reported in the systematic reviews found
Cost and/or cost-effectiveness	• None reported in the systematic reviews found
Uncertainty regarding benefits and potential harms	• None reported in the systematic reviews found

Solution 2: Enabling organizations and providers to use remote-monitoring technologies *(continued from previous page)*

Category of finding	Summary of key findings
Key characteristics if it was tried elsewhere	• 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 (33) • One systematic review examined the effects, facilitators, and barriers of co-designed technology supporting community-dwelling older adults (for example, robots, online applications, computer games for exercise, televisions and smart-home systems), and the review generally described co-design approaches in relation to identifying needs and generating ideas (through workshops, focus groups, interviews), as well as for developing prototypes and pilot testing (26)

Stakeholders' views and experiences	• One systematic review examined the effects, facilitators, and barriers of co-designed technology supporting community-dwelling older adults.(26) The review identified several barriers to co-design, including:
	  ○ 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 same review identified several facilitators to co-design, including:
	  ○ 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 (34)
	• One systematic review examined the involvement of people with dementia in research design,(35) and identified a series of recommendations:
	  ○ 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)

Solution 2: Enabling organizations and providers to use remote-monitoring technologies *(continued from previous page)*

Category of finding	Summary of key findings

Stakeholders' views and experiences	• The same review reported a range of limitations of involving patients with dementia in research design, such as:
	  ○ Caregiver burden
	  ○ Stress and distress in patients 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 (36)
	 • An old review revealed that clinical leaders can positively contribute to the successful adoption of information technologies (IT) in healthcare organizations, by doing the following:
	  ○ Cultivating the necessary IT competencies
	  ○ Establishing mutual partnerships with IT professionals
	  ○ Executing proactive IT behaviours to achieve successful IT adoption (38)
	 • An older and medium-quality systematic review identified a series of principles that can foster the adoption and assimilation of technological innovations in the National Health Service in the United Kingdom,(39) notably:
	  ○ How to improve an organization's decision-making processes and readiness for a particular technological innovation
	  ○ How to ensure an organizational context is receptive to technological innovations
	  ○ How to promote an organization's capacity to absorb knowledge about technological innovations
	 • A recent systematic review explored clinician and institutional competencies needed to implement remote-monitoring technologies (17)
	  ○ These competencies must be clearly defined, measurable, implemented, and evaluated
	  ○ The clinician competencies are aligned with the six domains identified by the Accreditation Council for Graduate Medical Education
	    ▪ Patient care
	    ▪ Medical knowledge
	    ▪ Practice-based learning and improvement
	    ▪ Systems-based practice
	    ▪ Professionalism
	    ▪ Interpersonal skills communication

Technical appendix

Solution 3: Helping the system to learn and improve rapidly to support the use of remote-monitoring technologies

Category of finding	Summary of key findings

Benefits	• A review exploring the effects of learning health systems on patient-care and service-delivery outcomes identified several benefits:(40)
	  ○ Long-term tracking of care allowed for changes in patient data to be captured (for example, wait times, post-operative outcomes, remission, and polypharmacy)
	  ○ Patients were able to track and manage their own health, and provide additional health information during clinician-patient interactions that informed a national registry with population health data
	  ○ Time savings gained from learning health systems allowed for automatic transferring of data, increased adherence to evidence-based clinical guidelines, the efficient identification of patients for care and clinical trials, and increased vaccination and colorectal cancer screening
	  ○ In terms of research development, learning health systems allowed for participation in comparison effectiveness trials and identification of adverse drug effects with reduced burden on patients, health services and research teams during trial data collection (40)

Harms	• One recent and low-quality review identified 67 ethical issues that can arise in a rapid-learning health system within the following four phases:(41)
	  ○ Risk of negative outcomes as a result of designing activities
	  ○ Ethical oversight of activities can lead to a conflict between current oversight regulations and learning systems
	  ○ In conducting activities there is the risk of misguided judgments regarding when and how participants should be notified and asked for consent
	  ○ Implementing learning can create challenges in timeliness, transparency and unintended negative consequences from implementation

Cost and/or cost-effectiveness	• None reported in the systematic reviews found
Uncertainty regarding benefits and potential harms	• 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 (42)
Key characteristics if it was tried elsewhere	• One systematic review of 272 studies on the bibliometric trends of learning health systems identified 15 common terms and 11 frequently discussed keywords from the included studies, and suggests that there are ethical concerns in determining whether the line between clinical care and research exists, and also that a majority of literature primarily focused on the information technology capacity of learning health systems, rather than on human and organizational factors (43)
Stakeholders' views and experiences	• None reported in the systematic reviews found