Evidence Brief

Using Remote-monitoring and Associated Technologies to Enable People to Stay in their Homes or Existing Level of Care Settings in Canada

6 & 7 December 2022

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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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Conflict of interest

The authors declare that they have no professional or commercial interests relevant to the evidence brief. The funders played no role in the identification, selection, assessment, synthesis, or presentation of the research evidence profiled in the evidence brief.

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?

- There are growing calls to rethink health and social systems for the digital age, which could help to address long-standing challenges (e.g., improving access to care, ensuring that care is more coordinated and integrated, reducing health disparities, and providing optimal care to an aging population).
- Virtual care (including remote monitoring technologies) is increasingly becoming an important part of the solution as it has the potential to act as a disruptive force that could bring transformative change, including supporting people to "age in place."
- However, there are challenges that need to be addressed to harness the full potential of remote-monitoring technologies to enable people to stay in their homes or existing level of care settings in Canada, including:
  - identifying those who could benefit from which remote-monitoring technologies is challenging (and technologies are often implemented too late);
  - there are many areas of uncertainty regarding remote-monitoring technologies (e.g., how to reconcile the perspectives of users and other stakeholders, or are there limits of what should be remotely monitored);
  - existing programs do not leverage governance, financial and delivery arrangements to optimize the match of people to technologies; and
  - programs are not currently complemented with behavioural and implementation strategies to ensure that the technologies get to the people who need them.

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

- Element 1 – Supporting people, their caregivers and their families to use and adopt remote-monitoring technologies and associated technologies.
  - This element focuses on supporting people, their caregivers and their families to use and adopt remote-monitoring technologies, which include efforts to: a) proactively identify people who could benefit from remote-monitoring technologies; b) provide financial support to use and ensure the maintenance of these technologies (e.g., annual allowance to cover broadband internet, costs of hardware/software, and tech support); and c) adopt implementation strategies targeting older adults, caregivers and families.
  - We found several reviews documenting the views and experiences of patients (often older adults) using remote-monitoring technologies. These reviews highlighted several factors that may act as barriers or facilitators: health status, usability, convenience and accessibility, perceived utility (including perceived rewards, costs, and privacy), and motivation (intrinsic and extrinsic).
- Element 2 – Enabling organizations and providers to adopt and use remote-monitoring and associated technologies
  - This element could include: a) engaging older adults, caregivers, and families in co-designing technologies, programs and services (from ideation to implementation) along with organizations, providers, the industry and other key stakeholders; b) adopting organization-targeted implementation strategies; and c) adopting provider-targeted implementation strategies.
  - In general, the systematic reviews we identified found beneficial outcomes for co-design approaches (particularly at the idea-generation stage for technologies, and with older adults at moderate and severe stages of dementia); outlined principles and clinical leadership needed to foster the adoption and assimilation of technological innovations in the healthcare organizations; and identified clinician and institutional competencies needed to implement remote-monitoring technologies (and these competencies need to be clearly defined, measurable, implemented, and evaluated).
- Element 3 – Adopting a rapid-learning system approach to support the development, implementation and evaluation of remote-monitoring technologies
  - This element focuses on adopting a rapid-learning system approach given that health systems may benefit from adopting an approach that allows them to learn and improve rapidly to support the

development, evaluation and implementation of remote-monitoring technologies in Canada (while being responsive to health and social needs of older adults, caregivers and families).

- We were unable to find any systematic reviews that directly address the use of a rapid-learning system approach in the context of remote-monitoring technologies, however, we identified four reviews that related broadly to the characteristics of rapid-learning systems.

What implementation considerations need to be kept in mind?

- While there are many barriers to leveraging the potential of remote-monitoring technologies, perhaps one of the biggest barriers lies in the long history of not scaling up promising health innovations in Canada. There are also barriers to economic development and growth that may have an impact on the deployment of remote-monitoring technologies (e.g., supporting start-ups and industry growth, development of a local industry, as well as the development of highly qualified personnel).
- Windows of opportunity might include the COVID-19 pandemic that created a burning platform to harness the potential of virtual care (including remote-monitoring technologies) to improve the delivery of integrated, timely and personalized care.

REPORT

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 (e.g., increasing access to specialists);
- reducing health disparities (the most important relating to socio-economic status, Indigenous identity, gender and geographic location); or
- 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 increasingly being used to deliver health and social services to people outside of conventional care settings (e.g., at home) using telecommunication technology. It can be used to remotely monitor the health status, wellness and home environment of users.

The use of remote-monitoring technologies (and virtual care more broadly) has garnered interest in past decades among researchers, providers, policymakers and other stakeholders. The 2021 Digital Health Survey commissioned by Canada Health Infoway revealed that many Canadians have an interest in taking part in remote monitoring using a device to manage a chronic health condition (47.2% of respondents); and to manage symptoms related to COVID-19 (40.2% of respondents).(3)

Box 1: Background to the evidence brief

This evidence brief mobilizes both global and local research evidence about a problem, three elements of a 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 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 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 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.

Remote-monitoring technologies show great potential, including to support aging in place. However, there are still challenges that need to be addressed to harness the full potential of remote-monitoring technologies.

Aim of the evidence brief

This evidence brief was prepared to inform a stakeholder dialogue about the use of remote-monitoring and associated technologies to enable people to stay in their homes or existing level of care settings in Canada. It builds on a recent rapid synthesis requested by the AGE-WELL National Innovation Hub (APPTA) that synthesizes current research evidence about remote-patient monitoring (4) and expands on it to also consider remote-monitoring technologies in the context of 'ambient assisted living.'

The brief explores: 1) the challenges in adopting and deploying remote-monitoring technologies in Canada; 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 adopting and deploying remote-monitoring technologies, the evidence brief explores equity considerations from the perspective of: 1) communities without the technical, financial and social capital required to assess, procure and manage key digital infrastructures; and 2) historically underserved or otherwise marginalized communities (see Box 2). Many other groups warrant serious consideration as well, and a similar approach could be adopted for any of them.

Box 2: Equity considerations

A problem may disproportionately affect some groups in society. The benefits, harms and costs of elements 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 also gives particular attention to two communities:

- communities without the technical, financial and social capital required to assess, procure and manage key digital infrastructures; and
- historically underserved or otherwise marginalized communities.

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.

Two issues are considered beyond the scope of this evidence brief. First, the evidence brief does not provide an evaluation of specific technologies as this would require a health technology assessment approach. Second, the brief does not focus on technologies that can be directly bought by individuals (e.g., smart watches, health applications, or basic smart-home technologies) if they are not used to transmit data to their care team.

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.

Table 1. Key definitions

Term	Definition and description
Aging in place	• "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"(5)
Ambient assisted living	• An approach using technologies to monitor activities of daily living of individuals (often older adults) with the goal of tracking their health status and foreseeing the risks associated with aging in place (6) • This approach aims to extend the time people can live in their preferred environment by: o Increasing their autonomy, self-confidence, and mobility o Maintaining health and functional capability of the elderly individuals o Promoting a better and healthier lifestyle for individuals at risk o Enhancing security, preventing social isolation and supporting the maintenance of a multifunctional network around the individual o Supporting caregivers, families and care organizations o Increasing the efficiency and productivity of health and social-care resources (6)
Associated technologies	• Key digital infrastructures necessary for the functioning of remote-monitoring technologies (e.g., broadband internet, cellular network), and other technologies that are complementary (e.g., electronic health records and virtual-care services)
Caregiver	• An individual who provides ongoing care and assistance outside of formal care programs, for a family member or a friend in need of support due to physical, cognitive or mental health conditions • In addition to family members or significant others, friends, neighbours, or members of a faith community may be caregivers • Caregivers are increasingly recognized as 'care partners' and members of the 'care team'
Home	• A person's usual place of residence, which may include a personal residence, a retirement home, an assisted-living facility, a nursing home, a long-term care residence or a shelter (7)
Integrated care	• Care that addresses both the health and social needs of individuals, and that is provided in a seamless and coordinated way across providers, organizations and sectors
Rapid-learning systems	• 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 (8) • The focus of such a system would be on making small yet rapid changes that are centred on patients, caregivers and families to support the development, evaluation and implementation of remote-monitoring technologies
Remote patient monitoring	• Remote patient monitoring (RPM) is the delivery of healthcare services to people outside of conventional clinical settings (e.g., at home) using telecommunication technology (4) • RPM could involve asynchronous and/or synchronous transmission of health data, evaluation, and appropriate follow-up between a person and their care provider through a variety of technologies (e.g., videoconferencing, sensors, wearables, handheld devices, mobile smartphones, implantable devices, blood-pressure monitors, online portals) (4;9) • RPM technologies could be used by healthcare providers to observe a person's health status (e.g., biometric data and symptom scores) and behaviours (e.g., medication adherence) from a distance (9) • Through RPM, patients who are receiving care can become active participants in the management of their health through a variety of technologies (10-11)

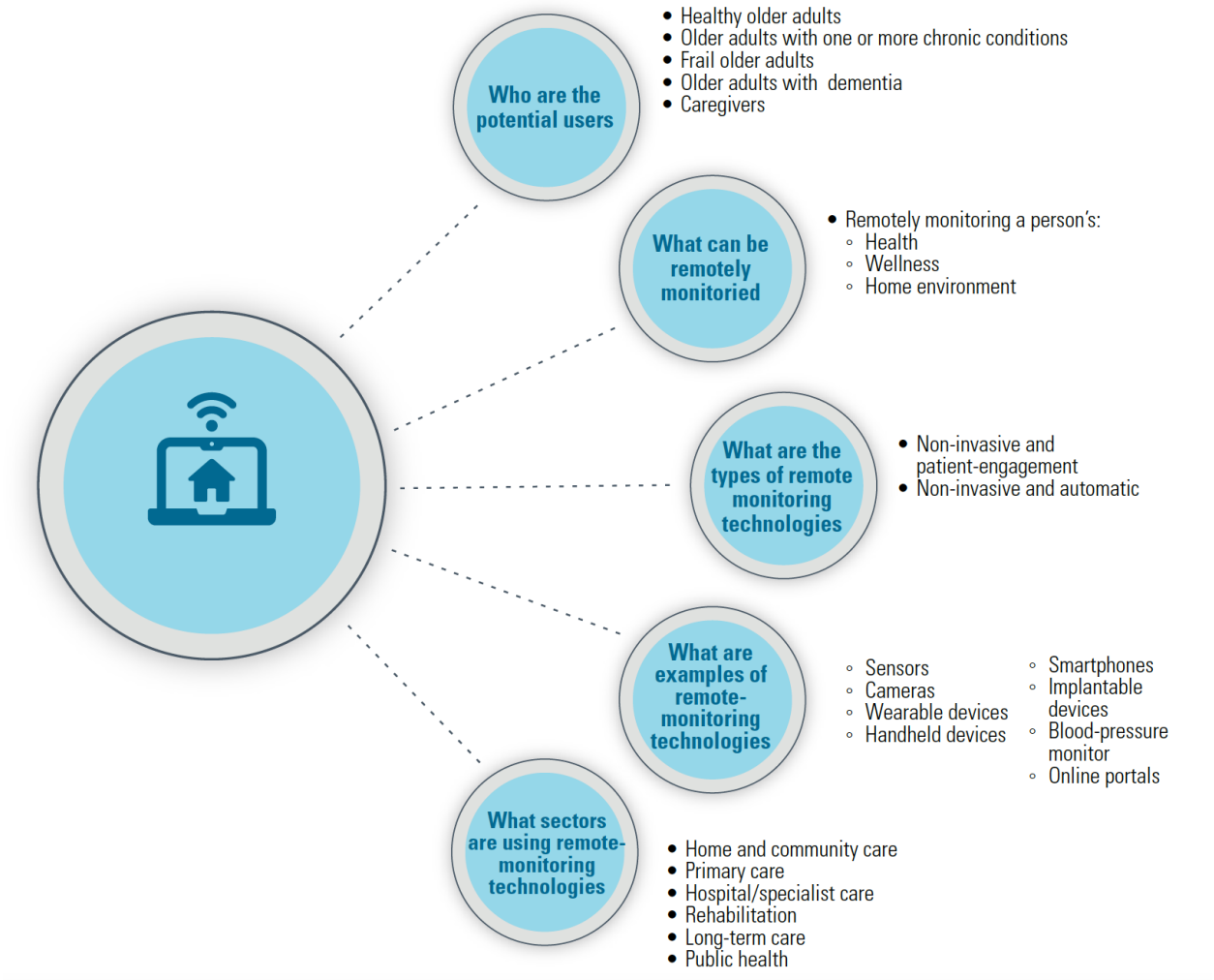
Term	Definition and description
Remote care management	• A model of care in which care teams and individual providers remotely support a patient's care plan via remote-monitoring technologies and other virtual tools
Virtual care	• "Any interaction between patients and/or members of their circle of care, 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)
Scaling up	• Scaling up refers to deliberate efforts to tackle "the infrastructural problems (across an organization, locality, or health system) that arise during full scale implementation"(12) • 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"(13) • We use the term here to mean ensuring that the potential of remote-monitoring technologies is harnessed to support people to stay in their homes, and thus support all of those who can benefit from it
Spreading	• Spread refers to "replicating an initiative somewhere else"(13)

In the following section, we examine what the evidence tells us about the potential roles and benefits of remote-monitoring technologies to enable people to stay in term their homes or existing level of care settings.

What is known about remote-monitoring technologies

A recent rapid synthesis examined how remote-monitoring and associated technologies could enable people to stay in their homes or existing level of care.(4) The organizing framework of the rapid synthesis illustrates the diversity of types of remote-monitoring technologies, sectors in which they are used, users, and purposes (Figures 1-3).

Figure 1. A snapshot of remote-monitoring technologies (4)



The following key messages can be drawn from this rapid synthesis:

- There are various uses for remote-monitoring technologies, such as improving home care, reducing falls and injuries, and preventing unnecessary visits to the emergency room.
- Clinical effectiveness of remote-monitoring technologies is still debated among researchers, but there is evidence of benefits for the following:
  - access to quality health information
  - making informed decisions
  - increasing feelings of security and autonomy
  - faster clinical decision-making
  - reduced incidence of hospital readmissions
  - self-monitoring assistance for patients living in rural areas and
  - support for medically unstable patients as they transition to stability.
- In terms of cost-effectiveness, the evidence indicates that cost outcomes of remote-monitoring technologies are associated with:
  - the size of the eligible population
  - the cost of monitoring equipment and

- the size of the predicted market share of the monitoring technology.

- Evidence also shows that remote-monitoring programs may be economically preferable for specific chronic conditions where only one or two vital signs need to be monitored (e.g., hypertension).

The technological landscape has evolved rapidly, and the scope of possibilities has grown exponentially to also include wellness monitoring. Technologies are now increasingly used to remotely monitor activities of daily living of individuals (often older adults) with the goal of tracking their health status and foreseeing the risks associated with aging in place.(6) Such models of care, known as 'ambient assisted living', aim to identify issues in a timely manner and ultimately avoid or decrease the rate of decline in health status.(14)

We examined the body of evidence on remote-monitoring technologies embedded in ambient assisted living, based on systematic reviews that were deemed highly relevant. The following key messages can be drawn from these reviews. For example, there is a wide array of things that can be remotely monitored in ambient assisted living, including:

- physiological parameters (see Figure 2) (15-16)
- routine actions (see Figure 3) (16-17)
- home environment (see Figure 3).(18)

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

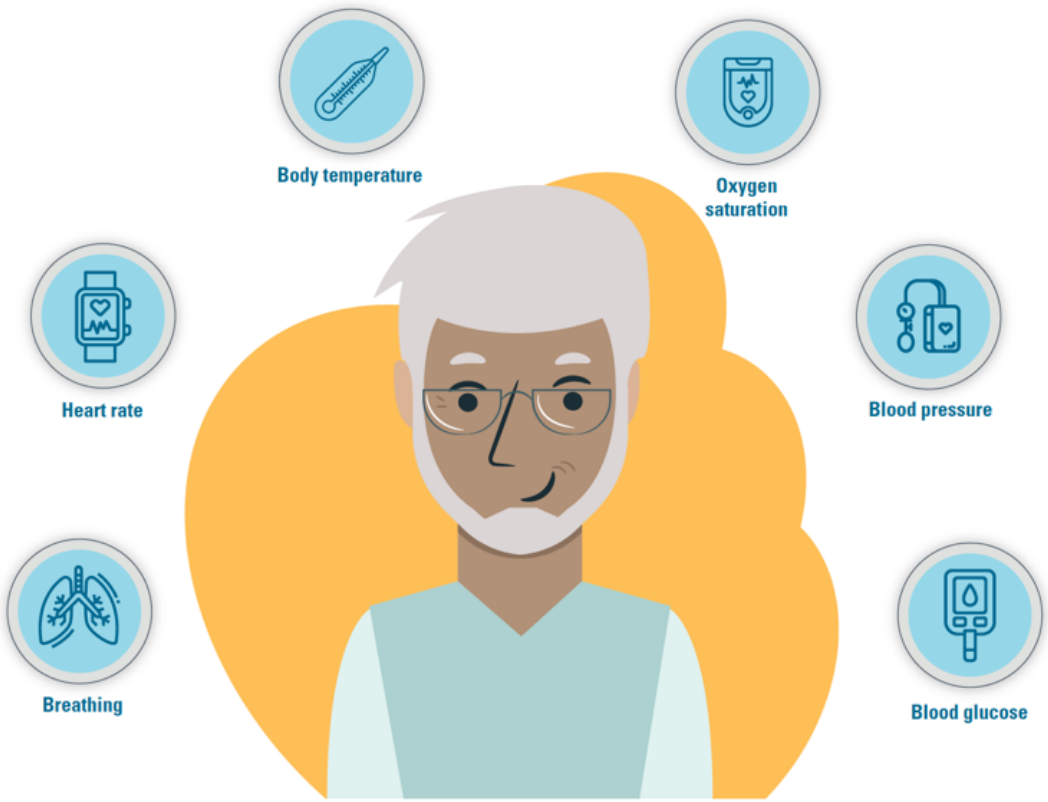
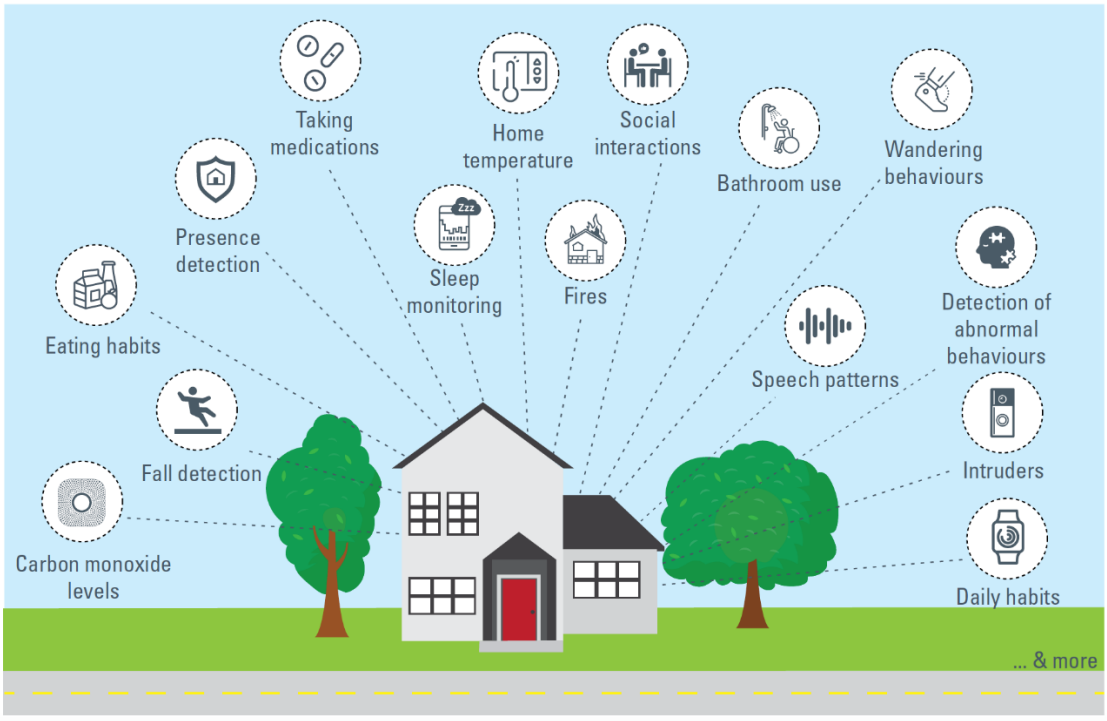


Figure 3. Technologies can remotely monitor many aspects of a person's wellness and home environment



In addition, remote-monitoring in ambient assisted living aims to achieve multiple purposes, including:

- helping people manage their care needs at home for as long as possible (e.g., increasing autonomy, improving medication adherence, or increasing comfort, convenience, and flexibility in chronic disease management);(19-22)
- supporting post-discharge monitoring to avoid hospital readmission or intervene earlier to mitigate health impacts (e.g., faster clinical decision-making, react to critical situations, call for help in the case of an emergency and issue warnings if unusual behaviours are detected);(18;23-25)
- enhancing safety (e.g., falls prevention, wandering);(16;20)
- improving access to specialist care (26) or overcoming workforce shortages (e.g., particularly in rural and remote areas;(27) and
- reducing or preventing the use of unnecessary care (e.g., hospitalization, hospital stay, consultations, outpatient visits and follow-up, and emergency department visits).(11;22;24;28-30)

Remote-monitoring programs in Canada and abroad

The recent rapid synthesis also provides a jurisdictional scan of remote-monitoring programs in Canada and abroad.(4) The jurisdictional scan found that several countries are investing in remote-monitoring solutions for their populations. In Canada, many initiatives are currently underway in several jurisdictions to implement and monitor remote-monitoring technologies and virtual care.

The implementation and adoption of remote-monitoring technologies accelerated in response to COVID-19 to reduce patient exposure to the virus and to relieve pressure on the health system. Significant investments have been made to accelerate efforts to provide virtual-care solutions across the country, along with the elaboration of a policy framework for virtual care produced by the Federal, Provincial and Territorial Virtual

Care/Digital Table,(31) and ongoing evaluations of the impact of virtual-care services provided during the pandemic. This led to an observed increase in uptake and use of such technologies compared to immediately before the pandemic. At present, during the recovery stage from the pandemic, provinces and territories are depending more and more on remote-monitoring technologies and virtual-care services as staffing challenges persist in healthcare.

A summary of the Canadian jurisdictional scan is presented in Appendix A.

THE PROBLEM

Several factors make it hard to use remote-monitoring and associated technologies to enable people to stay in their homes or existing level of care settings in Canada, including that:

- it is challenging to identify those who could benefit from which remote-monitoring technologies (and technologies are often implemented too late);
- there are many areas of uncertainty regarding remote-monitoring technologies (e.g., how to reconcile the perspective of users and other stakeholders, or are there limits of what should be remotely monitored);
- existing programs do not leverage governance, financial and delivery arrangements to optimize the match of people to technologies; and
- programs are not currently complemented with behavioural and implementation strategies to ensure that the technologies get to the people who need them.

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.

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 Ontario Telemedicine Network, Canada Health Infoway, and the Canadian Agency for Drugs and Technologies in Health.

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.

Identifying those who could benefit from which remote-monitoring technologies is challenging (and technologies are often implemented too late)

Identifying those who could benefit from which remote-monitoring technologies is challenging. This challenge may be explained by three factors: 1) case finding is difficult; 2) identifying the full range of health and social needs and navigating technologies to match those needs is difficult; and 3) the current landscape of remote-monitoring programs is a 'dog's breakfast'.

Case finding is difficult

A systematic review examining remote patient monitoring revealed that they are most effective when they are used by people early in their illness trajectory.(32) However, proactively identifying people who could benefit most from remote-monitoring technologies is a difficult prospect. And by the time people are facing the decision point of transitioning to a higher level of care setting, it may be too late in their illness trajectory to enable them to effectively use remote-monitoring technologies.

To better meet the needs of different populations and maximize the efficiency and impact of care-delivery approaches such as remote-monitoring technologies, it is important to identify those within the risk pyramid, including those with high-risk needs, emerging-risk needs, and low-risk needs.(33) Populations with high-risk needs include those who have complex-care needs, have greater service requirements, and may also face barriers to care. Populations identified as emerging-risk groups include people with multiple and poorly controlled chronic conditions. Finally, populations identified as low-risk include people with a well-managed chronic condition or risky health behaviour. When considering who can benefit most from remote-monitoring technologies, it is important to consider the potential of these technologies to address the needs

of those higher up on the risk pyramid, and also whether it can potentially help prevent transition of lower-risk groups into higher-risk categories.

Identifying the full range of health and social needs and navigating technologies to match those needs is difficult

Identifying the full range of heath and social needs and navigating which technologies can best match those needs also presents a considerable challenge. In Canada, more and more people are living with multimorbidity, which can potentially benefit from being monitored remotely. The health needs of people living with mulitimorbidity are often intertwined with social needs, which when left unmet puts them at greater risk for poor health outcomes.(34-35) Unmet social needs include: lack of social support; loneliness; being geographically isolated from their families and caregivers; being financially insecure; experiencing housing insecurity; having limited access to services that are gender, linguistically, culturally or spiritually sensitive; and having marginalized identities that put them at greater risk for discrimination and being excluded. Addressing the wide range of health and social needs of older adults is challenging, but must be considered when identifying and harnessing the potential of remote-monitoring technologies to enable them to stay at home. It may also help to distinguish health and social needs that lend and do not lend themselves to technological solutions, to find the right bundle of technologies to meet specific needs, or to develop custom technology solutions to meet their specific needs.(32)

The current landscape of remote-monitoring programs is a dog's breakfast'

The current landscape of remote-monitoring programs is a 'dog's breakfast' of unsecure applications being used in haphazard ways. This was particularly an issue during the COVID-19 pandemic during which providers were pressed to find technological solutions to provide virtual care.(36) Along with the challenges this presents for data security and patient privacy, many 'niche' programs being used for specific conditions means that users may struggle with the usability of remote-monitoring technologies. Individual differences moderating usability for remote-monitoring technologies include age, past experience with technology, how the system is designed to meet user needs, and exacerbations in health conditions and disability status.(37) If the systems used to facilitate remote monitoring are varied and haphazard in nature, more users are likely to struggle with the programs. Additionally, if exacerbations in health conditions and disability status are known to affect usability, it is likely that by the time people are facing the decision point of transitioning to a higher level of care setting (e.g., long-term care home), patients/caregivers may not be in a position where you can hand the technology to them to use independently. To ensure remote-monitoring programs are used optimally to better address user needs, their use must be organized in a coordinated way that takes into account a variety of conditions and the full continuum of care for which they may be useful.

There are many areas of uncertainty regarding remote-monitoring technologies

There is a growing body of synthesized research evidence on remote-monitoring technologies and ambient assisted living in the past two decades. However, there are still many areas of uncertainty, including (but not limited to): 1) gerontechnological research being 'data rich and theory poor'; 2) lack of clarity about where the need for remote monitoring should begin and end; 3) limited research in real-world settings; 4) how to align the standards for medical-grade and non-medical-grade technologies; and 5) a lack of consensus on fundamental issues about the data that remote-monitoring technologies generate.

Gerontechnological research is 'data rich and theory poor'

First, the field of gerontechnological research has been characterized as "data rich and theory poor."(14) Different stakeholders (e.g., older adults, caregivers, families, clinicians, computer scientists, data scientists, engineers, vendors, etc.) hold different assumptions, values, world views, and interests regarding remote-monitoring technologies. For example, engineering teams have often been focused on developing prototypes and algorithms and clinical teams often concentrated on outcome research.(25) However, many technological

solutions have not been grounded in the contexts, needs, values, preferences and expectations of older adults.(14)

There is a lack of clarity about where the need for remote monitoring should begin and end

Second, the technological possibilities are endless. There are many parameters that can be measured and remotely monitored, ranging from physiological, behavioural, wellness, or environmental. Yet, 'acceptance' research is still in its infancy and it is unclear where the need for remote monitoring should end.(38)

There is limited research in real-world settings

Third, there is limited research about remote-monitoring technologies and ambient assisted living in real-world settings. A recent low-quality review examining ambient assisted living technologies to support older adults' health and wellness revealed that most studies focused on prototypes (95%), and only a few solutions were commercialized (less than 5%).(16) These observations resonate with other systematic reviews reporting that many technological solutions have only been tested in laboratories or academic institutions.(6;18;39) Another review indicated that most evaluative studies had poor reference standards.(25) This may explain why there is still mixed evidence about the impact of remote-monitoring programs in the areas of population health, patient experience, provider experience, and value for money (i.e., the Quadruple Aim).(9)

Aligning the standards for medical-grade and non-medical-grade technologies is difficult

Fourth, there are uncertainties about how to handle technologies that do not meet the same standards. For example, there are standards associated with medical-grade technologies to monitor blood pressure. However, other technologies, in particular new and emerging technologies that are not medical-grade technologies (e.g., sensors monitoring older adults transitioning between different rooms in their house), do not have the same level of standards set in place yet.

It is unclear how to handle all the data that remote-monitoring technologies generate

Lastly, there is a lack of consensus on fundamental issues about the data that remote-monitoring technologies generate. There is a need to clarify who owns the data, who should be responsible for data aggregation and analysis, data storage and security, whether patients should have access to their own data, and whether the data can be used for planning policies, programs and services (e.g., being able to see population-health profiles and visualizing population trends).

It also remains unclear how and when members of a care team want data pushed to them for review. There is a need to clarify how to triage and package relevant data, and the timing of data dumps in a way that it will be optimal for care teams. In addition, care teams need to understand how to integrate data and welcome the information into their care process.

Existing programs do not leverage governance, financial and delivery arrangements to optimize the match of people to technologies

Features of governance, financial and delivery arrangements within health and social systems in Canada can shape whether and how remote-monitoring technologies can be used. Some key examples of system-level challenges are summarized in Table 3.

While there are many system-level challenges highlighted in Table 3, supporting the uptake of remote-monitoring technologies requires that these governance, financial and delivery arrangements be more aligned. These challenges must be addressed before the potential of remote-monitoring technologies can be fully leveraged.

Table 3: Overview of key system-level factors that make it difficult to effectively adopt and deploy remote-monitoring technologies

Health- and social-system arrangements	Challenge	Description of the challenge

Governance arrangements (*who can make what types of decisions*)	Lack of an overarching framework to guide the development and evaluation of remote-monitoring technologies	• The use of remote-monitoring technologies will not automatically translate to care that is more integrated (9)
		• Their adoption must be intentionally planned and implemented to achieve more integrated care, meaning to "create connectivity, alignment, and collaboration within and between the cure and care sectors"(9)
		• A framework for evaluating and benchmarking remote-monitoring programs is also essential to strengthen the body of evidence, but also for quality-improvement purposes (9)
		• The lack of framework may exacerbate already fragmented policies, programs and services (9)
		• Efforts are currently underway to develop such frameworks, including:
		  ○ a maturity-model framework describing the features of remote-monitoring technologies that can advance integrated care (9)
		  ○ a framework identifying key policy pillars to enable the longer-term adoption of virtual care:
		  ▪ patient- and community-centred approaches
		  ▪ equity in access to virtual-care services
		  ▪ remuneration/compensation
		  ▪ change management
		  ▪ appropriateness, safety and quality of services
		  ▪ licensure (for the delivery of virtual care across jurisdictional boundaries) (31)

	There is no real 'home' for remote monitoring' in health systems in Canada	• Many stakeholders expressed the lack of clarity about who should steer the work to foster the development, evaluation and deployment of remote-monitoring technologies • Many providers and care organizations are not keen to getting a feed of raw data (and may not have data analytics capacity)
	Lack of quality standards for remote-monitoring technologies (and ambient assisted living)	• Frameworks, platforms, standards and quality attributes are used in a limited and isolated manner (44) • This exacerbates the challenge of interoperability of remote-monitoring and associated technologies discussed below (42) • However, it is worth noting that Health Standards Organizations has done work in the area of virtual care (40) • Future standards and subsequent policy development in remote-monitoring technologies will be within the purview of organizations like Health Standards Organizations, Accreditation Canada, Canadian Standards Association, the Canadian Agency for Drugs and Technologies in Health
	Difficulty aligning standards and legislation	• It is challenging to align various standards in the context of remote monitoring ○ For example, clinical standards, digital-health standards, standards for medical-grade technologies, standards for non-medical-grade technologies, building code standards, privacy laws, or security standards given the increased susceptibility to privacy breaches of digital data

Health- and social-system arrangements	Challenge	Description of the challenge
	Difficulty in scaling up and spreading innovations	• Many remote-monitoring programs have been purposefully built for specific conditions (e.g., heart failure, chronic obstructive pulmonary disease, diabetes) • Existing remote-monitoring programs are considered 'niche' solutions that may be difficult to scale up and spread
	Remote-monitoring technologies require changes in the culture of care, scope of practices, and training	• Remote-monitoring technologies could change the culture of care and training, with possibly more time for engagement, continuity of experience, and dynamic data for decision-making for both patients and providers (41) • There is a need to review scope of practices and identify who will be responsible for remote monitoring and follow-up
Financial arrangements (*how money flows through the system*)	The budgets are often siloed and are not conducive to remote monitoring	• How hospital care and home care are funded in most provinces and territories do not encourage remote monitoring of patients • The funding does not follow the patients
	There is no clear procurement model	• Despite increased supply of remote-monitoring technologies, procurement policies have lagged in responding to innovation and growing user demand • It is unclear how people will access remote-monitoring technologies (leasing versus purchasing, out-of-pockets versus co-payments, bring your own device) • Efforts are currently underway, notably Canada Health Infoway which developed a toolkit to streamline the procurement process and help hospitals, clinics and other organizations procuring virtual-visit or remote-monitoring solutions
	Lack of funding	• Care-delivery organizations often do not have a budget line to purchase these types of technologies
Delivery arrangements (*how care is organized to reach those who need it*)	Limited interoperability of remote-monitoring technologies	• Many remote-monitoring technologies are 'niche' solutions designed for a specific problem or task (and necessitating an ad hoc architecture) which contributes to limited interoperability (6) • A reference architecture is needed to ensure that all remote-monitoring technologies are interoperable and to establish standards to deal with the heterogeneity of technologies and domains (42)
	Lack of dedicated resources for remote-monitoring programs	• There is a scarce number of remote-care specialists, which is not conducive to success and sustainability ▪ There are limited communities of practice to support remote-care specialists
	Lack of consensus about the role of care providers	• There is a lack of consensus about who should play the role of informing older adults and caregivers about the need for and use of remote-monitoring technologies and trying to match their needs to the appropriate technologies • One systematic review highlighted concerns about role ambiguity, who should be the 'gatekeeper' to these technologies, and perceived conflicts of interest among providers (43)

Programs are not currently complemented with behavioural and implementation strategies to ensure that the technologies get to the people who need them

While there is a need to address system-level barriers that can impede the uptake of remote-monitoring technologies, there is also a need to address barriers at the level of users (including older adults, caregivers, care providers, and organizational leaders).

Indeed, a growing body of evidence highlights the need for accompanying remote-monitoring technologies with behaviour-change interventions and implementation strategies.(10) These conclusions resonate with evidence indicating that:

- there are variations in the acceptance of remote-monitoring technologies and ambient assisted living among potential users (including older adults, caregivers, and family members); (38)
- there is a lack of awareness regarding remote-monitoring technologies among potential users and care providers;(43) and
- remote-monitoring technologies could change the culture of care, redefine roles and responsibilities, and require new skills and competences.(41)

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. Adopting and deploying remote-monitoring technologies has the potential to both decrease inequities, but also increase them in different situations and for different reasons.(44) While many groups warrant particular attention, this evidence brief explores equity considerations from two perspectives for illustrative purposes: 1) communities without the technical, financial and social capital required to assess, procure and manage key digital infrastructures; and 2) historically underserved or otherwise marginalized communities.

Communities without the technical, financial and social capital required to assess, procure and manage key digital infrastructure

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.(45-46) In Canada, the COVID-19 pandemic has exacerbated this divide by increasing the reliance of individuals and communities on digital infrastructure. Moreover, equity-seeking groups are disproportionately affected by the digital divide, including those experiencing homelessness or inadequate housing conditions; precariously employed or economically disempowered people; Indigenous, Black, and people of colour; and rural, remote or other underserved communities.(46)

We learned from the COVID-19 pandemic the significant impacts that inequitable policy responses can have. Given this, it is important to consider the use of remote-monitoring technologies in terms of the communities it is likely to work for and help, those communities it is less likely to benefit, and how to ensure policy responses are tailored to ensure equity-seeking groups also benefit. This will require a focus on reducing the inequities in access to and use of technologies that can benefit populations. For rural and remote communities, universally available, affordable, and reliable high-speed internet is crucial for ensuring that these communities can benefit from remote-monitoring technologies. This is important not only to provide the necessary infrastructure for such technologies, but also because access to adequate internet services is necessary for individuals and communities to develop the digital literacy skills required to successfully navigate and participate in increasingly digitally mediated social, economic, and health systems.(45-46) For

these reasons, pushing forward remote-monitoring technologies without addressing the digital divide could reinforce a two-tiered system, in which those on one side of the digital divide have access while those on the other do not.

Historically underserved or otherwise marginalized communities

Trust is a fundamental factor that may influence the acceptance and use of remote-monitoring technologies.(47) Research has noted the important role that trust plays both in terms of the patient trusting the technology,(48) as well as the system behind the technology (e.g., to protect privacy).(49) However, in the context of communities who have faced a history of oppression and discrimination, an additional form of trust may play an important role in the uptake and acceptance of remote-monitoring technologies. For example, in Canada there is longstanding evidence of health inequalities that racialized groups and racialized healthcare users often experience everyday racism when receiving healthcare. Experiences of racism when receiving healthcare often leads to reduced trust in the health system and with healthcare providers, reduced adherence to medical regimens, and delays in healthcare or health-seeking behaviours.(50) In the context of remote-monitoring technologies, patients in underserved and marginalized communities may be more likely to feel that they cannot openly communicate with their care providers, may be concerned about 'being watched' by remote-monitoring technologies, and have a broader sense of distrust in the health system behind these technologies that leads to reduced acceptance and use.

Citizens' views about key challenges related to remote-monitoring technologies

Four citizen panels were convened virtually – each engaging a diverse group of eight to 15 citizens (in terms of age, gender, ethnocultural background and socio-economic status) – two panels on 4 November 2022 (one with anglophone panellists from British Columbia, Alberta, Saskatchewan, Manitoba, Yukon Territory and Northwest Territories; and the other with anglophone panellists from Ontario and Quebec), one panel on 10 November 2022 (with anglophone panellists from New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland), and one on 11 November 2022 (with francophone panellists from Ontario, Quebec and New Brunswick). The majority of panellists (57%) had experiences with remote-monitoring technologies, either for their own health or as a caregiver for others while the remaining 43% did not have experience with remote-monitoring technologies prior to the panels. 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.

Overall, panellists were positive about the potential remote-monitoring technologies to support aging in place, empower users, improve timely access to care, as well as relieve pressure on caregivers and the health and social systems.

While panellists were generally enthusiastic (e.g., one panellist noted that we "should embrace remote-monitoring technologies"), they identified 10 challenges to adopting remote-monitoring technologies to help people to stay in their homes in Canada:

- there is a lack of public awareness about remote-monitoring technologies and how they can support aging in place;
- the idea of remotely monitoring people could raise concerns and fears (e.g., being under surveillance in their own home, loss of privacy, breach to personal data);
- the individual costs associated with remote-monitoring and associated technologies could reinforce a two-tiered system of care;
- there is uncertainty whether there is a threshold where remote-monitoring technologies are no longer cost-effective;
- privacy concerns can evolve over time and along their illness trajectories;
- there are divergent views about the protection of personal data that may be hard to reconcile;
- it is challenging to navigate what technologies/services are publicly funded or not;
- there are concerns that these technologies will replace human contacts;

- there is a need to ensure the validity and reliability of remote-monitoring technologies; and
- there are many attitudinal barriers making it hard to innovate.

These are all summarized in Table 4

Table 4. Summary of citizens' views about challenges

Challenge	Description
A lack of public awareness about remote-monitoring technologies and how they can support aging in place	• Few panellists had experience with remote-monitoring technologies, but most were familiar with technologies available on the market that can monitor health conditions and the home environment (e.g., smart watches and smart-home technologies) • The idea of "aging in place" resonated with panellists, and they indicated that remote-monitoring technologies seem to have potential to contribute to this (with home modifications, the use of assistive devices, income support, etc.) • A few panellists indicated that they wished to advocate for the use of remote-monitoring technologies, but to achieve this, there is a need to raise public awareness about these technologies
The idea of remotely monitoring people could raise concerns and fears	• As one panellist said, the idea of remotely monitoring people gives the impression that everyone would be "chipped" (meaning the use of microchip implants in the body) and monitored by "Big Brother" • Panellists in the French panel said that the commonly used term "télésurveillance" could reinforce these concerns and fears, particularly among historically disadvantage populations • Some panellists indicated the need for a more positive "branding" of these technologies
The individual costs associated with remote-monitoring and associated technologies could reinforce a two-tiered system	• Several panellists expressed concerns about the potential costs for individuals: accessing the technologies, adapting the home to install the technologies, having affordable access to broadband internet, obtaining tech support, changing technologies when they become obsolete • One panellist talked about a paradox: those who could benefit the most from remote-monitoring technologies seem to be the ones facing the greatest challenges (e.g., the burden of multimorbidity is known to be associated with socio-economic status and those from rural/remote regions are the ones with the most limited digital infrastructures) • Panellists feared that the costs for individuals could reinforce a two-tiered system • A few panellists were also concerned about cross-jurisdictional disparities in terms of their capacity to spread and scale up remote-monitoring and associated technologies (e.g., some provinces and territories may face more challenges when tackling the infrastructure problems)

There is uncertainty whether there is a threshold where remote-monitoring technologies are no longer cost-effective	• Panellists generally envisioned the potential cost savings of using remote-monitoring technologies, especially among high-risk individuals
	• However, some panellists wondered if there was a threshold where these technologies are no longer cost-effective
	  ○ e.g., if everyone has access to such technologies, could it increase the number of people seeking care and put additional pressures on health and social systems (thus increasing system costs)
	  ○ e.g., the "cognitive overload" of professionals is already considerable and there are concerns that it could become worse if remote-monitoring technologies are deployed at large scale

Privacy concerns can evolve over time and along their illness trajectories	• Panellists discussed at length privacy concerns related to remote-monitoring technologies • Some pointed out that trade-offs needed to be made between complete privacy and optimal care • These trade-offs may evolve over time (and changing personal circumstances), as well as along their illness trajectories • As one panellist said: "We need a framework where you can decide what you want to share. As it stands, everyone is afraid of offending somebody. Personally, if I'm found lying on the street, I would want my full medical history made available."
There are divergent views about the protection of personal data that	• Panellists agreed that there was a need to protect personal data collected via remote-monitoring technologies from any criminal use (for example, stealing someone's identity)

Challenge	Description
may be hard to reconcile	• A few panellists were concerned that some Canadian and foreign companies developing these technologies may use the data for other purposes than providing optimal care • One panellist raised questions about how collected data would be handled given the structures, processes and protocols used for First Nations, Inuit, Métis data • However, panellists expressed divergent views about potential uses of the personal data o Some panellists believed that the data should only be used to provide optimal care to the individual (as one panellist said: "the primary use of the data must not be diverted"), while others saw an opportunity to use the data at the population level to analyze trends, or to be used to support innovation and economic development • As one panellist said: "People need to know how data will be used, stored, and whether it will be anonymous"
It is challenging to navigate what technologies/services are publicly covered or not	• Some panellists indicated that navigating what technologies/services are publicly covered or not was challenging • One panellist indicated that technologies with the capacity to do remote monitoring were not covered (only the basic model without remote monitoring was) o One panellist talked about her experience buying a CPAP machine (continuous positive airway pressure for sleep apnea). The Régie de l'assurance maladie du Québec was only covering the basic model (without remote-monitoring capacity) and indicated that the model with remote-monitoring capacity was considered as "comfort."
There are concerns that these technologies will replace human contacts	• Some panellists worried that health and social-care professionals could lean too much on remote-monitoring technologies • They pointed out that care is about communication and relationships • Relying on technologies alone may miss out on the necessary human-to-human contacts when providing care
There is a need to ensure the validity and reliability of remote-monitoring technologies	• A few panellists expressed concerns about our capacity to ensure that remote-monitoring technologies are valid and reliable • As one panellist said: "Not all devices are created equal"
There are many attitudinal barriers making it hard to innovate	• Panellists generally agreed that it was time to bring health and social systems to the digital age • However, several panellists indicated that the country was slow to innovate o One panellist recalled that there were dialysis machines back in the 1980s that were reporting back to the care team via a phone line: "If we were there then, we should be further now" • Many panellists pointed to attitudinal barriers from the public and professionals as major roadblocks to innovation • As one panellist said: "Sometimes we should step outside of the box and ease up on that rigidity"

THREE ELEMENTS OF A POTENTIALLY COMPREHENSIVE APPROACH FOR ADDRESSING THE PROBLEM

Many approaches could be selected as a starting point for deliberations about using remote-monitoring and associated technologies to enable people to stay in their homes or existing level of 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 to using remote-monitoring and associated 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 elements are:

1) supporting people, their caregivers and their families to use and adopt remote-monitoring technologies and associated technologies;
2) enabling organizations and providers to use and adopt remote-monitoring and associated technologies; and
3) adopting a rapid-learning system approach to support the development, implementation and evaluation of remote-monitoring and associated technologies.

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) (51) 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 comprehensive approach for addressing the problem

The available research evidence about elements of a comprehensive approach for addressing the problem was sought primarily from Health Systems Evidence, Social Systems Evidence, and COVID-END Inventory of Evidence Syntheses, which are the most comprehensive and continuously updated databases of synthesized evidence on the delivery, financial and governance arrangements within health and social systems. The reviews were identified by searching these databases for reviews addressing features of each of the 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 elements 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 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 element may want to search for a more detailed description of the element or for additional research evidence about the 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 reworded to be more accessible to a group of citizens. These elements were used as a jumping-off point for the panel deliberations.

During the deliberations several values and preferences were identified from citizens in relation to these elements, which we summarize in Table 5. A few panellists suggested that the sequencing of elements should be revised. We should start with element 3 (adopting a rapid-learning system approach and address all system-level challenges), then pursue element 2 (enabling organizations and providers to use and adopt remote-monitoring technologies), and finally focus on element 1 (supporting people, their caregivers and their families to use and adopt remote-monitoring technologies). These panellists were concerned about creating expectations that could not be met if the providers, organizations and systems were not ready.

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

Element	Values expressed	Preferences for how to implement the element
Element 1 - Supporting people, their caregivers and their families to use and adopt remote-monitoring technologies and associated technologies	• Fairness • Collaboration (among users, providers and organizations delivering care) • Privacy • Adaptive • Trusting relationships • Competence • Collaboration (among peers) • Empowerment	• Access to remote-monitoring technologies should be based on needs, not the ability to pay (thus emphasizing the need for financial support) • Older adults, their caregivers, their families and the care team should be proactively engaged in advance care planning conversations in the context of aging in place o These conversations could help to identify goals of care (meaning their values, wishes, and goals in the context of aging in place) o A bundle of remote-monitoring technologies could be proposed to meet these goals of care o Each technology could be mapped along a continuum of privacy to ensure it reflects the user's values and wishes (e.g., technologies having limited impact on privacy versus those more intrusive) o A consent process should be put in place to ensure that users are fully informed about the implications of each technology o These conversations and decisions should be revisited over time and when there is a change in the illness trajectories • Users would need private onboarding sessions offered by competent IT staff • Additional training opportunities should be offered to users, possibly in group settings and with "super-users" • Strategies initially proposed in element 1 are aiming to "push" these technologies instead of relying on strategies to create a demand for them ("user-pull") and empower users o There is a need to think carefully about the "branding" of these technologies since it may impact acceptance, attitudes, and identity of users (e.g., focusing on how these technologies will help users achieve their values, wishes, and goals) o There is a need to raise awareness among potential users about the potential of such technologies to age in

Element	Values expressed	Preferences for how to implement the element
		place (e.g., focusing on the various federations of older adults and retirees across Canada)
Element 2 - Enabling organizations and providers to use and adopt remote-monitoring and associated technologies	• Collaboration among patients, providers and organizations within the health system (collaboration) • Competence • Fairness • Innovation	• Panellists were favourable to engaging users, their caregivers, and their families along with providers/organization in co-designing remote-monitoring programs, but a few questioned whether it could slow down the innovation process • Curriculums should now include virtual care, and continuous learning activities should be created to improve the knowledge, skills, and behaviours of providers towards remote-monitoring technologies o There is a need for mechanisms (such as audit and feedback) to "ensure that the knowledge and skills are synchronized so that all care providers know what they need." o Panellists acknowledged the need to re-examine scopes of practice to ensure that roles are all clear o Many panellists wondered what role personal-support workers (PSWs) could play to support the use of remote-monitoring technologies since they are regularly in the users' homes • Financial incentives may be required to support providers and organizations in adopting remote-monitoring technologies ("This is extra work somebody is going to need to take on. Doctors, nurse practitioners, and clinical leads are already overburdened." o Some panellists pointed out that this was particularly important for non-governmental organizations delivering home and community care ("NGOs are often the last to get funding for technology. They need to have a seat at this table early on because a lot of NGOs are who are actually going to be implementing and supporting vulnerable groups.")
Element 3 - Adopting a rapid-learning system approach to support the development, implementation and evaluation of remote-monitoring technologies	• Empowerment • Based on users' values and preferences • Based on data and evidence • Continuously improving (quality) • Fairness (equity) across jurisdictions • Collaboration across jurisdictions	• We should empower the public in order to advocate for 'aging in place' and the use of remote-monitoring technologies • Users should guide the development, evaluation and implementation of remote-monitoring programs o They need channels to rapidly communicate their concerns, challenges or ideas (via phone lines, emails, questionnaires/surveys or user panels) • We should support the implementation of robust pilot-projects across multiple demographics, and with an emphasis on rural/remote and vulnerable communities (to build the body of evidence in real-world contexts) • We should create a network of regional "hubs" that could support collaboration across jurisdictions, and foster rapid learning and improvement (which was perceived as especially important for provinces and territories that may be lacking capacity and digital infrastructure)

Element 1 – Supporting people, their caregivers and their families to use and adopt remote-monitoring technologies and associated technologies

This element focuses on supporting people, their caregivers and their families to use and adopt remote-monitoring technologies. This element could include efforts to:

- proactively identify people who could benefit from remote-monitoring technologies
- provide financial support to use and ensure the maintenance of these technologies (e.g., annual allowance to cover broadband internet, costs of hardware/software, and tech support)
- adopt implementation strategies targeting patients, families and caregivers, such as:
  - information or education provision
  - behaviour-change support
  - skills and competencies development
  - (personal) support
  - communication and decision-making facilitation (e.g., identifying their health and social needs, raising awareness about the potential of remote-monitoring technologies, and supporting them to navigate their technological options)
  - system participation (already covered in elements 2 and 3).

Key insights from systematic reviews about adopting implementation strategies targeting older adults, families and caregivers

We found no systematic reviews relevant to the first two sub-elements (proactively identifying people who could benefit from remote-monitoring technologies, and providing financial support for the use and maintenance of remote-monitoring technologies).

However, we found several systematic reviews relevant to adopting implementation strategies targeting patients, families and caregivers. Several reviews documented the views and experiences of patients (often older adults), families and caregivers using remote-monitoring technologies. These reviews highlighted several factors that may act as barriers or facilitators: health status, usability, convenience and accessibility, perceived utility (including perceived rewards, costs, and privacy), and motivation (intrinsic and extrinsic).(37) Two reviews also highlighted the importance of addressing the users' perceptions and attitudes,(52) and addressing how the use of such technologies could impact their identity.(53)

Two reviews also highlighted the importance of being able to customize technological solutions to match the needs of various aging societies, such as those living alone, with others, in community homes or in assisted living facilities,(25) and being able to adapt those technological solutions to address the evolving needs of users (e.g., the patients' disease progression or illness trajectories).(53)

Several other reviews documented implementation strategies targeting the end users to support the uptake of remote-monitoring technologies. These were often part of multi-component strategies and included:

- information or education provision about the health condition, self-management strategies, and the remote-monitoring technologies (e.g., educational booklet about their condition and a telehealth manual);(23;54)
- skills and competencies development training to improve digital skills;(23;54)
- providing financial and technical support (e.g., financial support to access the hardware, initial home training provided by technicians);(23;55)
- communication and decision-making facilitation to ensure that users are meaningfully engaged in all relevant decisions and to be kept aware of their treatment decisions;(55-56) and
- system participation by engaging users in product development and implementation.(37)

Lastly, we found a relevant protocol of a review being conducted. This review will examine the effectiveness of smart living environments to support older adults to age in place in their community and gather evidence on what factors and strategies were identified as influencing the implementation process.(57)

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 6 (or obtain citations for the reviews), a fuller description of the systematic reviews is provided in Appendix B1.

Table 6. Summary of key findings from systematic reviews relevant to Element 1 – Supporting people, their caregivers and their families to use and adopt remote-monitoring technologies and associated technologies

Category of finding	Summary of key findings
Benefits	• None identified
Potential harms	• None identified
Costs and/or cost-effectiveness in relation to the status quo	• 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 (22)
Uncertainty regarding benefits and potential harms (so monitoring and evaluation could be warranted if the option were pursued)	• Uncertainty because no systematic reviews were identified o **Proactively identifying people who could benefit from remote-monitoring technologies** o **Providing financial support to use and ensure the maintenance of remote-monitoring technologies** • Uncertainty because no studies were identified despite an exhaustive search as part of a systematic review o None identified • No clear message from studies included in a systematic review o None identified
Key elements of the policy option if it was tried elsewhere	**Adopting implementation strategies targeting patients, families and caregivers** • Several reviews identified implementation strategies targeting the end users and included: o Information or education provision about the health condition, self-management strategies, and the remote-monitoring technologies (e.g., educational booklet about their condition and a telehealth manual) (23;54) o Skills and competencies development training to improve digital skills (23;54) o Provision of financial and technical support (e.g., financial support to access the hardware, initial home training provided by technicians) (23;55) o Communication and decision-making facilitation to ensure that users are meaningfully engaged in all relevant decisions and to be kept aware of their treatment decisions,(55-56) and o System participation by engaging users in product development and implementation (37)
Stakeholders' views and experiences	**Adopting implementation strategies targeting patients, families and caregivers** • Several reviews highlighted factors that may act as barriers or facilitators to the uptake of remote-monitoring technologies: o Health status o Usability o Convenience and accessibility o Perceived utility (including perceived rewards, costs, and privacy) o Motivation (intrinsic and extrinsic)(37) • Two reviews highlighted the importance of addressing the users' perceptions and attitudes,(52) and how the use of such technologies could have an impact on their identity(53) • Two reviews highlighted the importance of being able to customize technological solutions to match the needs of various aging societies,(25) and being able to adapt those technological solutions to address the evolving needs of users (e.g., the patients' disease progression or illness trajectories) (53)

Element 2 – Enabling organizations and providers to use and adopt remote-monitoring and associated technologies

As mentioned earlier, remote-monitoring programs are not currently complemented with behavioural and implementation strategies to ensure that the technologies get to the people who need them. This element aims to address this challenge, with a particular focus on care organizations and individual providers. This element could include:

- engaging patients, caregivers, and families in co-designing programs and services (from ideation to implementation) along with organizations, providers, the industry and other key stakeholders;
- adopting organization-targeted implementation strategies; and
- adopting provider-targeted implementation strategies, such as:
  - educational material
  - educational meeting
  - educational outreach visit
  - local opinion leader
  - local consensus process
  - peer review
  - audit and feedback
  - reminder and prompts
  - tailored intervention
  - patient-mediated intervention
  - multi-faceted intervention.

Key insights from systematic reviews about co-designing remote-monitoring programs and services

There is a growing body of synthesized research evidence about co-design processes for technologies. In total, we found six systematic reviews (58-63) and one systematic review in progress (64) 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,(58) and with patients at moderate and severe stages of dementia.(59)

Key insights from systematic reviews about adopting organization-targeted implementation strategies

We found two systematic reviews about organization-targeted implementation strategies that focused on the uptake of new technologies. The first review identified a series of principles that can foster the adoption and assimilation of technological innovations in the National Health Service (United Kingdom).(65) The second review revealed the importance of clinical leadership in the successful adoption of new technologies in healthcare organizations.(66)

Key insights from systematic reviews about adopting provider-targeted implementation strategies

We found one recent systematic review that was deemed highly relevant. The review identified the clinician and institutional competencies needed to implement remote-monitoring technologies.(41) These competencies must be clearly defined, measurable, implemented, and evaluated.

A summary of the key findings from the synthesized research evidence is provided in Table 7. 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 B2.

Table 7. Summary of key findings from systematic reviews relevant to Element 2 – Enabling organizations and providers to use and adopt remote-monitoring and associated technologies

Category of finding	Summary of key findings
Benefits	**Engaging patients, caregivers, and families in co-designing remote-monitoring programs and services** • 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)(62) • Engaging older adults led to several beneficial outcomes, including: o Improved mutual learning o Improved knowledge about the needs and daily practices of older adults (e.g., maintaining social connections, housekeeping routines, and medications) o Enhanced information to develop new prototypes and lead to the intended design outcome o 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 (60) • 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 (59) • One systematic review examined the effects of co-creation and co-production with citizens (with no specific focus on older adults) (61) • 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 (63)
Potential harms	• None identified
Costs and/or cost-effectiveness in relation to the status quo	• None identified
Uncertainty regarding benefits and potential harms (so monitoring and evaluation could be warranted if the option were pursued)	• Uncertainty because no systematic reviews were identified o None identified • Uncertainty because no studies were identified despite an exhaustive search as part of a systematic review o None identified • No clear message from studies included in a systematic review o None identified
Key elements of the policy option if it was tried elsewhere	**Engaging patients, caregivers, and families in co-designing remote-monitoring programs and services** • 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 (62)

Category of finding	Summary of key findings
	• 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 (58)
Stakeholders' views and experiences	**Engaging patients, caregivers, and families in co-designing remote-monitoring programs and services** • One systematic review examined the effects, facilitators, and barriers of co-designed technology supporting community-dwelling older adults (58) • The review identified several barriers to co-design, including: o hierarchy and attitudes, unrealistic expectations, heterogeneity, and lack of commitment to co-design o time and money constraints and lack of buy-in from senior leadership o limited resources for implementation and collaboration (at the policy level) o limited skills in co-design, small sample size, bias in methods, and poor mock-ups • The review identified several facilitators to co-design, including: o building relationship and trust, empowering the user by improving knowledge, and establishing value and interest o multiple communication approaches, provision of flexibility, and appropriate project resourcing o philosophy of co-design o use of effective prototypes o use of familiar environments o 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 (60) • One systematic review examined the involvement of people with dementia in research design,(59) and identified a series of recommendations: o offer a quiet, familiar environment with minimal travelling o commit to values of flexibility, empathy, patience, knowledgeable about life experiences of patients with dementia o provide information on research ethics o contact patients and caregivers directly with the option to recruit throughout the project o organize smaller groups with informal breaks during sessions o concentrate workshops, interviews, and focus groups with the intent to give space for feedback, identifying needs, and creating content together o note observations of the interaction between the patients and the prototype while providing space for feedback o 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: o caregiver burden o stress and distress in patient with dementia o verbal limitations o time-consuming and resource-intensive processes for researchers o difficulty to generate findings o small sample sizes o short duration of sessions o bias from researchers o 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)

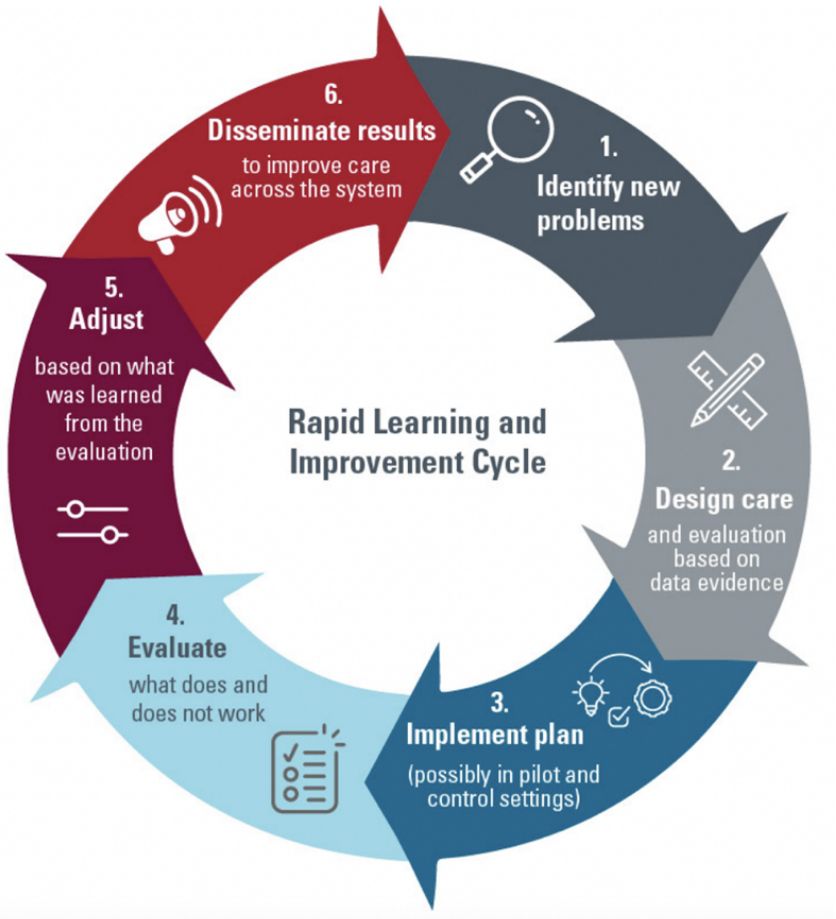
Category of finding	Summary of key findings
	• The influential organizational factors that the review attributed to co-creation and co-production include organization compatibility and openness with citizen participation, risk-averse culture, and the use of incentives, and from the citizen perspective, contributing factors to co-production included participant characteristics (skills, socio-economic status), awareness and ownership of product, social capital, and risk aversion by citizens (61) **Adopting organization-targeted implementation strategies** • An old review revealed that clinical leaders can positively contribute to successful IT adoption in healthcare organizations, by doing the following: o Cultivating the necessary IT competencies o Establishing mutual partnerships with IT professionals o Executing proactive IT behaviours to achieve successful IT adoption (66) • An older and medium-quality systematic review identified a series of principles that can foster the adoption and assimilation of technological innovations in the NHS,(65) notably: o How to improve an organization's decision-making processes and readiness for a particular technological innovation o How to ensure an organizational context is receptive to technological innovations o How to promote an organization's capacity to absorb knowledge about technological innovations **Adopting provider-targeted implementation strategies** • A recent systematic review explored clinician and institutional competencies needed to implement remote-monitoring technologies (41) o These competencies must be clearly defined, measurable, implemented, and evaluated o 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

Element 3 – Adopting a rapid-learning system approach to support the development, implementation and evaluation of remote-monitoring technologies

The technological landscape is evolving rapidly, yet the spread and scale of remote-monitoring technologies (and virtual care more broadly) has been challenging. Health systems may benefit from adopting an approach that allows them to learn and improve rapidly to support the development, implementation and evaluation of remote-monitoring technologies in Canada (while being responsive to health and social needs of patients, caregivers and families).

This element focuses on adopting a rapid-learning system approach. This approach works through rapid cycles such as what is depicted in Figure 4.

Figure 4. Rapid-learning and improvement cycle



Key insights from systematic reviews about adopting a rapid-learning system approach

We identified four systematic reviews that were deemed to be most relevant to adopting a rapid-learning system approach. 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.(8;67-68) 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.(8) While the findings are too detailed to report in full here, two high-level points, directly from the report, are worth noting:

- rapid-learning systems have seven key characteristics (Table 8); and
- the list of assets to support rapid learning and improvement (across the seven characteristics) is remarkably rich.

Table 8. Characteristics of rapid-learning systems (68)

Category	Characteristic	Examples
Patient centred	**Engaged patients:** Systems are anchored on patient needs, perspectives and aspirations (at all levels) and focused on improving their care experiences and health at manageable per capita costs and with positive provider experiences	1) Set and regularly adjust patient-relevant targets for rapid learning and improvement (e.g., improvements to a particular type of patient experience or in a particular health outcome) 2) Engage patients, families and citizens in: a) their own health (e.g., goal setting; self-management and living well with conditions; access to personal health information, including data collected by remote-monitoring technologies) b) their own care (e.g., shared decision-making; use of patient decision aids) c) the organizations that deliver care (e.g., patient-experience surveys; co-design of remote-monitoring programs and services; membership of quality-improvement committees and advisory councils) d) the organizations that oversee the professionals and other organizations in the system (e.g., professional regulatory bodies; quality-improvement bodies; ombudsman; and complaint processes) e) policymaking (e.g., committees making decisions about the public coverage of remote-monitoring technologies; government advisory councils that set direction for (parts of) the system; co-designing process to develop an overarching framework for remote-monitoring technologies with quality standards; citizen panels to elicit citizen values) f) research (e.g., engaging patients as research partners; eliciting patients' input on research priorities) 3) Build patient/citizen capacity to engage in all of the above
Data and evidence driven	**Digital capture, linkage and timely sharing of relevant data**: Systems capture, link and share (with individuals at all levels) data (from real-life, not ideal conditions) about patient experiences (with services, transitions and longitudinally) and provider engagement alongside data about other process indicators (e.g., clinical encounters and costs) and outcome indicators (e.g., health status)	1) Data infrastructure (e.g., interoperable remote-monitoring and associate technologies; privacy policies that enable data collection and sharing) 2) Capacity to capture patient-reported experiences (for both services and transitions), outcomes and costs 3) Capacity to capture data across time and settings 4) Capacity to link data about health, healthcare, social care and the social determinants of health 5) Capacity to analyze data (e.g., staff and resources) 6) Capacity to share 'local' data (alone and against relevant comparators) – in both patient- and provider-friendly formats and in a timely way – at the point of care, for providers and practices (e.g., audit and feedback), and through a centralized platform (to support patient decision-making and provider, organization and system-wide rapid learning and improvement)
	Timely production of research evidence: Systems produce,	1) Distributed capacity to produce and share research (including evaluations) in a timely way

Category	Characteristic	Examples
	synthesize, curate and share (with individuals at all levels) research about problems, improvement options and implementation considerations	2) Distributed research ethics infrastructure that can support rapid-cycle evaluations 3) Capacity to synthesize research evidence in a timely way 4) One-stop shops for local evaluations and pre-appraised syntheses 5) Capacity to access, adapt and apply research evidence 6) Incentives and requirements for research groups to collaborate with one another, with patients, and with decision-makers
System supported	**Appropriate decision supports**: Systems support informed decision-making at all levels with appropriate data, evidence, and decision-making frameworks	1) Decision supports at all levels – self-management, clinical encounter, program, organization, regional health authority and government – such as a) patient-targeted evidence-based resources b) patient decision aids c) patient goal-setting supports d) clinical practice guidelines e) clinical decision support systems (including those embedded in electronic health records) f) quality standards g) care pathways h) health technology assessments (to assess remote-monitoring technologies) i) descriptions of remote-monitoring programs in Canada and abroad
	Aligned governance, financial and delivery arrangements: Systems adjust who can make what decisions (e.g., about joint learning priorities), how money flows and how the systems are organized and aligned to support rapid learning and improvement at all levels	1) Leveraging the work of the Federal, Provincial and Territorial Virtual Care/Digital Table to develop an overarching framework and quality standards for remote-monitoring technologies 2) Revising regulations that do not foster innovation and the use of remote-monitoring technologies 3) Adapting training, licensure requirements and scope of practice for care providers 4) Centralized coordination of efforts to support the uptake of remote-monitoring technologies, incrementally join up assets and fill gaps, and periodically update the status of assets and gaps 5) Mandates for preparing, sharing and reporting on quality-improvement plans 6) Mandates for accreditation 7) Funding and remuneration models that have the potential to incentivize the use of remote-monitoring technologies 8) Value-based innovation-procurement model 9) Funding and active support to spread effective remote-monitoring practices across sites 10) Mechanisms to jointly set rapid-learning and improvement priorities 11) Mechanisms to identify and share the 'reproducible building blocks' of a rapid-learning health system
Culture and competencies enabled	**Culture of rapid learning and improvement**: Systems are stewarded at all levels by leaders committed to a culture of teamwork, collaboration and adaptability	1) Explicit mechanisms to develop a culture of teamwork, collaboration and adaptability in all operations, to develop and maintain trusted relationships with the full range of partners needed to support rapid learning and improvement, and to acknowledge, learn from and move on from 'failure'
	Competencies for rapid learning and improvement: Systems are rapidly improved by teams at all levels who have the competencies needed to	1) Public reporting on rapid learning and improvement 2) Distributed competencies for rapid learning and improvement (e.g., data and research literacy, co-design, scaling up, leadership) 3) In-house capacity for supporting rapid learning and improvement 4) Centralized specialized expertise in supporting rapid learning and improvement

Category	Characteristic	Examples
	identify and characterize problems, design data- and evidence-informed approaches (and learn from other comparable programs, organizations, regions, and sub-regional communities about proven approaches), implement these approaches, monitor their implementation, evaluate their impact, make further adjustments as needed, sustain proven approaches locally, and support their spread widely	5) Rapid-learning infrastructure (e.g., learning collaboratives and communities of practice on remote-monitoring technologies)

A summary of the key findings from the synthesized research evidence is provided in Table 9. For those who want to know more about the systematic reviews contained in Table 9 (or obtain citations for the reviews), a fuller description of the systematic reviews is provided in Appendix B3.

Table 9. Summary of key findings from systematic reviews relevant to Element 3 – Adopting a rapid-learning system approach to support the development, implementation and evaluation of remote-monitoring technologies

Category of finding	Summary of key findings
Benefits	**Adopting a rapid-learning and improvement approach** • A review exploring the effects of learning health systems on patient care and service delivery outcomes identified several benefits (69) o Long-term tracking of care allowed for changes in patient data to be captured (e.g., wait times, post-operative outcomes, remission, and polypharmacy) o 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 o 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 o 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 (69)
Potential harms	**Adopting a rapid-learning and improvement approach** • One recent low-quality review identified 67 ethical issues that can arise in a rapid-learning health system within the following four phases (70) o Risk of negative outcomes as a result of designing activities o Ethical oversight of activities can lead to a conflict between current oversight regulations and learning systems o In conducting activities there is the risk of misguided judgments regarding when and how participants should be notified and asked for consent o Implementing learning can create challenges in timeliness, transparency and unintended negative consequences from implementation
Costs and/or cost-effectiveness in	• No cost-related information was identified

relation to the status quo	
Uncertainty regarding benefits and potential harms (so monitoring and evaluation could be warranted if the option were pursued)	**Adopting a rapid-learning and improvement approach** • 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 (71)
Key elements of the policy option if it was tried elsewhere	**Adopting a rapid-learning and improvement approach** • 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 (72)
Stakeholders' views and experience	• None identified

Additional equity-related observations about the elements

The research evidence identified for each of the three elements provide limited equity-related observations about: 1) communities without the technical, financial and social capital required to assess, procure and manage key digital infrastructures; and 2) historically underserved or otherwise marginalized communities.

Most of the equity observations were made during the citizen panels. When discussing element 1, panellists emphasized that access to remote-monitoring technologies should be based on needs, not the ability to pay (thus emphasizing the need for financial support). This was consistent with findings from systematic reviews documenting the need to provide financial and technical support to users of remote-monitoring technologies (e.g., financial support to access the hardware, initial home training provided by technicians).(23;55)

When discussing element 2, panellists pointed out that that financial support was particularly important for non-governmental organizations (NGOs) delivering home and community care. Since these NGOs often provide care to underserved or otherwise marginalized communities, it was important to financially support them to use and adopt remote-monitoring technologies. As one panellist said: "NGOs are often the last to get funding for technology. They need to have a seat at this table early on because a lot of NGOs are who are actually going to be implementing and supporting vulnerable groups."

Lastly, when discussing element 3, panellists discussed equity considerations in two ways: 1) we should support the implementation of robust pilot projects across multiple demographics, and with an emphasis on rural/remote and vulnerable communities (to build the body of evidence in real-world contexts); and 2) we should create a network of regional "hubs" that could support collaboration across jurisdictions, and foster rapid learning and improvement. The latter point was perceived as especially important for provinces and territories that may be lacking capacity and digital infrastructure to use and adopt remote-monitoring technologies (and potentially reducing inequities across jurisdictions).

IMPLEMENTATION CONSIDERATIONS

Several barriers might hinder our capacity to implement any of the three elements of a potentially comprehensive approach to support the use of remote-monitoring technologies to enable people to stay in their homes or existing level of care settings in Canada. These barriers need to be factored into any decision about whether and how to pursue any given element. These potential barriers could exist at the levels of patients/families/caregivers, care providers, provider organizations and systems (Table 10).

Perhaps one of the biggest barriers 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:(73)

- 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.

There are also barriers to economic development and growth that may have an impact on the deployment of remote-monitoring technologies (e.g., supporting start-ups and industry growth, development of a local industry, as well as the development of highly qualified personnel).

Table 10. Potential barriers to implementing the elements

Levels	Element 1 – Supporting people, their caregivers and their families to use and adopt remote-monitoring technologies and associated technologies	Element 2 – Enabling organizations and providers to use and adopt remote-monitoring and associated technologies	Element 3 – Adopting a rapid-learning system approach to support the development, implementation and evaluation of remote-monitoring associated technologies
Patient, family or caregiver	• Some patients, families and caregivers may be hesitant to adopt remote-monitoring technologies if they perceive them as a threat to their privacy and autonomy • The previous barrier may be particularly salient among the many communities that do not trust healthcare institutions because of a history of trauma, oppression and discrimination • Many patients, families and caregivers have limited literacy levels (including health and digital literacy) that may limit their capacity	• Meaningful engagement requires significant commitment (e.g., time and other resources), which can be challenging given an individual's health state	• Meaningful engagement requires significant commitment (e.g., time and other resources), which can be challenging given an individual's health state

	to use some remote-monitoring technologies • Some patients, families and caregivers may be hesitant towards what could be perceived as a 'technological fix' for circumventing problems commonly conceived as social, political, or cultural (e.g., replacing personal care by technologies, or using technologies to respond to the disengagement of caregivers) • Some patients, families and caregivers may become disengaged in their own health and care and rely exclusively on remote-monitoring technologies to tell them that they are OK even when they don't feel OK		
Care provider	• None identified	• Many care providers have limited digital literacy levels that may limit their capacity to use some remote-monitoring technologies (e.g., many are still relying on low-tech communication like faxes) • Care providers (and their professional associations or unions) may express ethical and legal concerns about the adoption of remote-monitoring technologies that could be used to assess employees' performance • Those who may become the gatekeepers for remote-monitoring programs (e.g., the social workers, nurses, cases workers) are often burned out with huge caseloads (may not have the knowledge and capacity to engage in conversation about the range of health and social needs that could be addressed by technological solutions)	• Care providers who are already overburdened with work may have limited time to engage in rapid learning and improvement
Organization	• None identified	• Organizations normally get involved with vendors when a technology product is available on the market,	• Some organizational leaders may be hesitant to engage in leveraging remote-monitoring technology

		instead of being engaged in co-designing technologies • 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	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 • Organizations could view this element as one that requires substantial investment in terms of infrastructure and analytic capacity
System	• None identified	• None identified	• Making changes in the system (even small and rapid changes) may be perceived as challenging, especially if no large investments are made in some areas • Many barriers go beyond the health and social systems (e.g., no or limited broadband internet in some regions has been a long-standing infrastructure issue in rural and remote regions in Canada, need to review building codes to facilitate the use and adoption of remote-monitoring technologies, privacy laws and security concerns may be stalling advancements) • Many jurisdictions lack the resources (e.g., technology, infrastructure and personnel) for timely data collection and system monitoring

On the other hand, several potential windows of opportunity could be capitalized upon (Table 11), which also need to be factored into any decision about whether and how to pursue one or more of the elements.

Table 11. Potential windows of opportunity for implementing the elements

Type	Element 1 – Supporting people, their caregivers and their families to use and adopt remote-monitoring technologies and associated technologies	Element 2 – Enabling organizations and providers to use and adopt remote-monitoring and associated technologies	Element 3 – Adopting a rapid-learning system approach to support the development, implementation and evaluation of remote-monitoring associated technologies
General	• Uptake of virtual care has accelerated in recent years,(9) and particularly in response to the COVID-19 pandemic which has created a burning platform to harness the potential of virtual care (including remote-monitoring technologies) to improve the delivery of integrated, timely and personalized care • Governments have made aging in place a priority and are interested in ways to delay or prevent people from going into subsidized care • The 2021 Digital Health Survey commissioned by Canada Health Infoway revealed that many Canadians have an interest in: o Taking part in a remote patient monitoring/telehomecare program using a device to manage a chronic health condition (47.2% of respondents); and o Taking part in a remote patient monitoring/telehomecare program using a device to manage symptoms related to COVID-19 (40.2% of respondents) (3) • 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 (74) • Tech companies may see remote monitoring as a potential market that has been under explored, and could thus be opened to partnerships in developing and adopting such technologies • The increasing availability of the broadband internet, cellular communication technologies, internet-of-things apps that connect multiple devices, and the decreasing cost of sensors have transformed various industries and markets (25) • There is an opportunity to leverage the work done by the Federal, Provincial and Territorial Virtual Care/Digital Table to develop a policy framework for virtual care • There is also an opportunity to leverage many ongoing research project evaluations of the impact of virtual-care services provided during the pandemic o Some evaluations are being done by the Centre of Digital Health Evaluation, Women's College Hospital, Canada Health Infoway, the Canadian Institute for Health Information, and the Canadian Agency for Drugs and Technologies in Health		
Element-specific	• Many caregivers (especially those living remotely) have difficulty fulfilling their role and may be interested in adopting remote-monitoring technologies • Existing digital health literacy programs, like the one launched by Canada Health Infoway, could help to support the use and adoption of such technologies • Using remote-monitoring technologies aligns with the goals of Canadians in their healthcare journey (i.e., higher level of agency, knowledge and know-how, greater empowerment on their health and care) • Many people already own smart devices with capabilities that can be leveraged	• 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	• Recent developments have created an opportunity for a dramatic scale-up in rapid learning and improvement: o Canada-wide moves to this framework in provincial and territorial health systems (and hopefully through pan-Canadian health organizations) o 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, Canadian Health Services and Policy Research Alliance's Learning Health System Working Group)

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APPENDIX A – Experiences from Canadian provinces and territories with using remote-monitoring and associated technologies to enable people to stay in their homes or existing level of care

Province/territory	Description of remote-monitoring technologies and associated technologies
Pan-Canadian	*Development and financial support for remote-monitoring programs during the COVID-19 pandemic* • At the onset of the COVID-19 pandemic, the National Research Council of Canada Industrial Research Assistance Program (NRC IRAP) supported Seamless Mobile Health Inc. (Seamless MD) to pivot its chronic disease management technology to a COVID-19 remote monitoring tool that would require patients to complete a daily symptom survey remotely, and then would provide a recommendation for next steps (e.g., continue isolation or seek medical attention) o Employees of healthcare institutions can also be remotely monitored using this tool to determine whether they should continue isolating or return to work o Seamless MD provides a centralized dashboard and alerts in real time to the patient's healthcare provider or the employer o The remote monitoring tool has been used by St. Joseph's Homecare in Ontario and SE Health, one of Canada's largest home-care agencies • In May 2020, the Government of Canada announced that an investment of $200 million would be made to help provinces and territories to accelerate their efforts to provide virtual-care solutions for their residents, including secure information-sharing and videoconferencing platforms, and remote patient-monitoring tools o $50 million of this investment was given to Canada Health Infoway to support the provinces and territories with implementation of new related initiatives • According to the government's Policy Framework for Virtual Care, evaluations of the impact of virtual-care services in provinces and territories during the COVID-19 pandemic and for the longer term will be supported by the Centre of Digital Health Evaluation (CDHE) and Women's College Hospital in partnership with Infoway, the Canadian Institute for Health Information (CIHI), and the Canadian Agency for Drugs and Technologies in Health (23) o Through these supports, a pan-Canadian approach through a digital-health evaluation framework will be established as well as a network to enable knowledge translation and conduct evaluations of new digital-health investments • The Policy Framework described several "pillars" for the long-term adoption of virtual-care services within Canada's publicly funded health systems: patient- and community-centred approaches, provider remuneration/incentive structures, appropriateness, safety and quality of care, licensure, provider change management, and equity in access to care
British Columbia	*Helping people manage their care at home* • Through a $42 million investment from the provincial government, Island Health expanded its existing remote monitoring program to develop the Hospital at Home model, which provides remote patient monitoring, daily in-person visits, virtual visits, and medication management to any acute-care patients who meet the eligibility criteria o Patients are provided with appropriate devices, a tablet, and a virtual call bell • In October 2021, a collaboration between BC Cancer, the Office of Virtual Care at the Provincial Health Services Authority, and the Ministry of Health led to the implementation of a remote patient-monitoring service using the TELUS Home Health Monitoring platform for cancer patients receiving chemotherapy and radiation therapy for head, neck, or lung cancer o Patients are remotely monitored for temperature, heart rate, weight, physical activity, and treatment side effects o Patients receive a heart-rate monitor, electronic thermometer, tablet, pedometer, and scale

	• In 2017, the Fraser Health Authority Cardiac Services Program partnered with the BC Alliance on Telehealth Policy and Research to expand the Virtual Cardiac Rehabilitation Program, a remote patient-monitoring approach for patients with ischemic heart disease that was trialed as a research intervention o The expansion of the program aimed to provide remote patient-monitoring services for cardiovascular disease patients o Patients involved would receive a heart-rate monitor, blood-pressure monitor, weekly education sessions, one-on-one meetings with a nurse, exercise specialist, and dietitian, and monthly group chat sessions *Development and financial support for remote-monitoring programs during the COVID-19 pandemic* • In May 2020, the Government of Canada agreed to support the province in the development and scale up of remote patient-monitoring technologies as a virtual-care priority during the COVID-19 pandemic under the British Columbia Virtual Care Action Plan, an $18 million investment from the federal government that will build on the province's existing virtual-care initiatives • The TELUS Home Health Monitoring platform is a collaboration between the Provincial Health Services Authority and TELUS that provides remote patient monitoring for patients, including tracking vital signs, symptoms or general health, and has been utilized for COVID-19 patients, those with chronic conditions, and those on surgical waitlists
Alberta	*Development and financial support for remote-monitoring programs during the COVID-19 pandemic* • As of March 2021, an initiative called the Alberta Central Zone Primary Care Network Home Health Monitoring Project uses teams of Primary Care Network (PCN) nurses and physicians to remotely monitor care for patients with chronic health conditions within the context of minimizing risk of exposure to COVID-19 and easing stresses on the health system o The initiative uses remote monitoring technologies, such as blood pressure cuffs, weigh scales, glucometers, pulse oximeters and thermometers, for patients to monitor their health status at home, and the measurements are stored in an online system monitored by their health team o The initiative is a collaboration between the Government of Alberta, Alberta Health Services (AHS), Alberta Central Zone Primary Care Networks (PCNs), Boehringer Ingelheim (2) Ltd., TELUS Health, Alberta Innovates (Alberta's largest research and innovation agency), and Health Cities (a not-for-profit organization that works with clinicians and companies to develop new models of care) o As of July 2020, two Alberta Central Zone Primary Care Networks (PCNs) have successfully trialed the home health-monitoring initiative, and the current phase includes an expansion to six additional central Alberta PCNs
Saskatchewan	*Helping people manage their care at home* • The COPD Home Health Monitoring Program is a pilot program to help patients manage care at home o Patients measure and submit health details daily via a program app accessible through a non-invasive device, such as a phone, tablet, or computer o The program loans non-invasive devices, such as pulse oximeters, to patients who need them *Development and financial support for remote-monitoring programs during the COVID-19 pandemic* • On 7 May, 2020, the Saskatchewan Health Authority announced the expansion of home health monitoring to help patients with chronic conditions avoid hospitalization and emergency-room visits during the COVID-19 pandemic o The Saskatchewan Health Authority and eHealth Saskatchewan partnered with Telus Health to expand the Home Health Monitoring system to help clinicians remotely monitor and support patients via a digital-health dashboard and identify patients in need of immediate care o Remote patient monitoring is largely being used to monitor lung transplant patients, chronic obstructive pulmonary disease, and support community paramedicine

	• On January 26, 2021, the Saskatchewan Health Authority announced the expansion of the home-monitoring program to include patients who have tested positive for COVID-19 and are self-isolating • On April 20, 2021, the Government of Saskatchewan announced a bilateral agreement with the Government of Canada that would help to invest in, and expand the use of, virtual healthcare services including: videoconferencing technologies, remote patient monitoring, eHealth, and an auto-dialer system

Manitoba	*Development and financial support for remote-monitoring programs during the COVID-19 pandemic*
	• The adoption of remote care due to COVID-19 has caused a change in the health system to implement more remote care
	• In December 2020, the Manitoba government issued a request for proposals to support remote home monitoring for COVID-19 patients discharged from hospital, and for Manitobans managing chronic conditions in the community
	  ○ Remote-monitoring solutions would build upon a Virtual Outpatient COVID Monitoring initiative that provides services to patients with COVID-19 who have been discharged
	  ○ Remote monitoring will support patients with COVID-19, chronic obstructive pulmonary disease, and congestive heart failure, with the potential expansion of the service to those with Type 2 diabetes and other chronic conditions
	  ○ The remote monitoring solution would supply in-home biometric health devices, such as thermometers, pulse oximeters, scales, spirometers, and blood-pressure monitors, to support patients in monitoring their health status, and the information will be collected centrally for review by health professionals to monitor results and communicate with patients
	  ○ This would reduce the need for hospital admissions and support faster discharge of patients
	• An environmental scan conducted in 2021 found that Manitoba did not have a remote-monitoring program, although a program is currently in development
	  ○ Common barriers to implementation included general funding implications from the federal and provincial level, program approach, connectivity and infrastructure considerations, program dissemination considerations at the regional level, concerns surrounding the *Personal Health Information Act*, and considerations for the development of a remuneration model for remote activities
	  ○ Barriers also included a general preference for in-person healthcare, adequate patient management strategies, lack of proficiency with technology, and access to program essentials such as the internet
	  ○ Facilitators that would contribute to the implementation of a remote-monitoring program include the adoption of a patient-centred approach to care, development of culturally sensitive program tools, and consideration of the development of resources for caregivers
	  ○ Access to funding for staff to improve patient support, widespread availability of high-speed internet, and the use of electronic medical record metrics would also facilitate the implementation of a remote-monitoring program

Ontario	*Helping people manage their care at home* • In April 2021, OntarioMD and Ontario Ministry of Health piloted a remote patient-monitoring program for high-risk patients in Northern Ontario who have lung, heart, and other chronic conditions, through an existing Insights4Care Program (which enables healthcare providers to identify patients for a referral to remote monitoring or the provincial telehomecare program) *Development and financial support for remote-monitoring programs during the COVID-19 pandemic* • Ontario Telemedicine Network (OTN) works to maximize access to specialized care, reduce pressure on hospitals, and modernize consumer access to care • As part of the Fall Preparedness Plan 2020 and the Digital First for Health Strategy, the government invested $14.5 million to support the expansion of virtual care, which includes an investment of $9.5 million towards remote patient-monitoring programs delivered by healthcare organizations including Ontario Health Teams

	○ The proposed implementation plan would involve patients connecting with a virtual healthcare provider for routine checkups, symptom monitoring, referrals to specialists, and any further follow-up ○ The Ministry of Health and Ontario Health are reviewing needs-based application for reviewing virtual-care investment proposals
Québec	*Helping people manage their care at home* • According to a jurisdictional scan conducted in 2018, a home telemonitoring solution established by Jardins-Roussillon Health and Social Services Centre has served elderly clients with cystic fibrosis, hypertension, uncontrolled diabetes, and COPD that lead to a significant reduction in the number of hospitalizations and ER visits, and shorter hospital stays ○ Through the program, the patient received one-hour of training by a nurse as to how to document health parameters using a touchscreen device, and nursing case managers consult the data and compliance with their individually prescribed care plan ○ Built-in alerts are automatically generated and pushed out to both the patient and case manager when data falls outside thresholds • The Telehealth Coordination Center Health Monitoring Services aims to provide telehomecare services for clients with one or more complex and/or chronic conditions ○ Monitoring services are accessed with an online app, and a tablet can also be provided to be used by patients to access telehomecare ○ A healthcare professional or case worker explains how to access the service and then the professionals analyze patient responses and determine appropriate treatment ○ Advantages included a regular follow-up by a multidisciplinary team of health professionals, a customer approach focused on self-management, potential decrease in complications and emergency visits, and secure communications and confidentiality
New Brunswick	*Helping people manage their care at home* • The province is receiving $5.3 million through a bilateral agreement with the Government of Canada to support remote patient-monitoring technologies • The New Brunswick Extra-Mural Program is a publicly funded provincial government program delivered by Extra-Mural/Ambulance New Brunswick Inc., that provides primary healthcare services to people in their homes and communities, including remote patient-monitoring services
Nova Scotia	*Help people manage their care at home* • The Department of Health and Wellness provides financial supports in the form of a reimbursement of up to $480 per year to low-income seniors aged 65 and older and adults aged 19 and older with acquired brain injury to assist with the cost of personal alert-assistance services (including falls alert pendants or wrist devices) ○ Additional eligibility requirements include those who live alone, require long-term home-care services, use mobility devices, and have a recent history of falls *Development and financial support for remote-monitoring programs during the COVID-19 pandemic* • The COVID Community Virtual Care Team (CCVCT) provides 24-hour phone support for people who tested positive for COVID-19 ○ Patients who are at high risk for hospitalization or who have recently been discharged from emergency departments are referred to the CCVCT by public health or clinical-care units ○ Portable pulse oximeters are provided to patients to monitor oxygen levels at home, twice daily, until they are determined to be in recovery • The Nova Scotia Virtual Care Action Plan was launched as a pilot project to monitor non-severe COVID-19 cases at home ○ Non-invasive devices are to help patients self-manage care at home and provide regular updates about health status to healthcare providers

Prince Edward Island	*Help people manage their care at home*
	• A report by Canada Health Infoway evaluates the benefits of the Remote Patient Monitoring (RPM) program in P.E.I.
	  o After being referred to the program, patients were given an RPM kit and training on how to use the monitoring equipment
	  o Patients were monitored remotely for 12 weeks for heart failure and eight weeks for chronic obstructive pulmonary disease (COPD)
	  o Heart failure and COPD symptoms and vitals were monitored using a blood-pressure cuff, weight scale, and pulse oximeter
	  o Clinical information is transmitted to healthcare providers through an analog phone line, wi-fi, or 3G/4G network
	  o RPM nurses interacted with patients for support, advice and coordination of resources, and provided self-management education
	  o Family physicians and nurse practitioners received regular letters with monitored trends for their patients
	  o To optimize monitoring, RPM was integrated within existing Health PEI Clinical Information System (CIS)
	  o Benefits included a 45% decrease in number of emergency visits post-program; a decrease in total number of acute-care admissions for heart failure patients; a 74% decrease in the total length of stay in acute care; a 19% decrease in the number of primary-care visits; a 38% decrease in MLFH score whereby a lower score reflects improved quality of life; and increased knowledge of the disease condition
	  o 92% of participants were highly satisfied with the RPM services they received
	• On 1 June 2022, the PEI government made a glucose sensor program available to eligible PEI residents that provides glucose sensor technology conveniently at their local pharmacy at a subsidized cost
	  o Only specific glucose-sensor supplies are eligible for coverage and the number of sensors provided are based on the wear time of the selected glucose-sensor supplier
	  o The out-of-pocket cost to those who are eligible is based on household income and the existence of private insurance
	  o Benefits for the program last up to a maximum of one year and must be renewed annually by 30 June

Newfoundland and Labrador	*Helping people manage their care at home*
	• In 2018-19, the government of Newfoundland and Labrador announced that it would expand the use of the Health at Home program, which helps to reduce the need for travel for thousands of patients and their families by using remote patient-monitoring technology to enable patients to check, record and transmit their personal health indicators (e.g., blood pressure or blood sugar levels)
	  o The government also planned to collaborate with the Newfoundland and Labrador Centre for Health Information to develop electronic ordering processes for diagnostic imaging procedures and expand telehealth services into new settings
	• Eastern Health announced in June 2019 that rural communities on the Northern Peninsula and in Labrador would gain access to remote-monitoring technology through a partnership with Labrador-Grenfell Health to allow healthcare providers to receive accurate health measurements from patients while in their homes
	  o This initiative was supported by the province's Department of Health and Community Services and Canada Health Infoway
	
	Development and financial support for remote-monitoring programs during the COVID-19 pandemic
	• Work is underway in several government programs for improving remote access to care:
	  o An e-ordering solution in the province's electronic health record, HEALTHe NL, is being developed for diagnostic services
	  o MyCCath is a web-based referral system for cardiac catheterization services that has been deployed provincially through HEALTHe NL to help expedite referrals for cardiac procedures
	• Another collaborative initiative of the province and Canada Health Infoway is the Telepathology Network which will enable all healthcare providers across the province to share and store digital pathology images electronically, as well as other related data on a secure computer system
	• On 6 August 2021, the Government of Canada announced a bilateral agreement with the province to invest over $4.5 million to expand virtual healthcare services, including remote-monitoring technologies

Yukon	*Help people manage their care at home*
	• Yukon offers virtual health monitoring for chronic conditions through the Chronic Conditions Support Program
	  o After being assessed for suitability, the client will be supplied with a 'Connected Health Kit' from Cloud DX that includes an android tablet, a wrist blood pressure cuff, Bluetooth body weight scale, and Bluetooth pulse oximeter to connect to a tablet and record the client's vitals
	  o The client will record their blood pressure, heart rate, body weight, and oxygen saturation levels on the Cloud DX software platform and reply to clinical symptom surveys
	
	Development and financial support for remote-monitoring programs during the COVID-19 pandemic
	• An online self-assessment tool to help Yukoners determine if they need to be tested for COVID-19 is now available
	  o The screening tool asks a series of questions and takes users through steps to help determine whether they should call the HealthLine at 811 or take other actions
	• 1Health initiative will give Yukoners access to modern health technologies, including a patient portal, which provides them with direct access to their health information
	  o The patient portal will enable virtual visits with and between providers, secure message exchange, remote client monitoring and telehealth services

Northwest Territories	*Development and financial support for remote-monitoring programs during the COVID-19 pandemic* • In May 2020, the federal government committed $3.11 million to the Northwest Territories to support virtual care and remote patient monitoring • Northwest Territories entered into a Bilateral Agreement with Canada to deploy virtual-care solutions and remote-monitoring technologies to ensure Canadians can continue to access high-quality care during COVID-19
Nunavut	*Development and financial support for remote-monitoring programs during the COVID-19 pandemic* • In May 2020, the government committed $3.11 million to Nunavut to support virtual care and remote patient monitoring • The federal government's Rapid Adoptions Virtual Care Fund allocation of $1 million in funding to Nunavut led to a series of projects that expanded access to virtual-care supports for residents in the province, including messaging and videoconferencing platforms and remote patient monitoring • Nunavut entered into a Bilateral Agreement with Canada to deploy virtual-care solutions to ensure Canadians can continue to access high-quality care during COVID-19 o It was agreed to allocate funds provided by Canada under this agreement toward remote patient-monitoring technologies

APPENDIX B – Synthesized evidence about the three elements

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 remote-monitoring technologies. 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 remote-monitoring technologies.

All of the information provided in the appendix tables was taken into account by the evidence brief's authors in compiling Tables 1-3 in the main text of the brief.

Appendix B1: Systematic reviews relevant to Element 1 – Supporting people, their caregivers and their families to use and adopt remote-monitoring technologies and associated technologies

Sub-elements	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 remote-monitoring technologies
Proactively identifying people who could benefit from remote-monitoring technologies	None identified						
Providing financial support to use and ensure the maintenance of these technologies (e.g., annual allowance)	None identified						
Adopting implementation strategies targeting patients, families and caregivers	Reviewing ehealth wearable devices for the remote management and assessment of COVID-19 while considering the device's reliability (54)	This review included 70 studies in a qualitative synthesis to examine the role of wearable technology in the assessment of COVID-19. It was found that wearable technology was mainly utilized to track patient symptoms related to fever, high heart rate, cough, and oxygen level during the beginning of the pandemic. As the pandemic progressed, the use of wearable devices expanded to further include wearable sensors that detect airborne pathogens which were useful for the screening, tracking, and prevention of COVID-19. The review further discusses that if health systems were to use wearable technologies more commonly, then the pandemic would have been less severe. The authors suggest that use of wearable devices can be supported further by the integration with other technologies and with education for primary users (e.g., older adults) for increased digital literacy. The wearable technology still needs to be enhanced to be made more usable for more practical use.	2021	3/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	Not reported in detail	Not reported in detail

Sub-elements	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 remote-monitoring technologies
	Assessing aspects of remote monitoring programs that allow for successful implementation in patients with cardiac conditions (23)	The objective of this review was to provide an insight to Canadian healthcare decision-makers on the benefits and potential issues of remote-monitoring programs. The review focused on gathering data via a realist review (including 91 studies), perspectives and experiences review (including 30 reports) and ethical issues analysis. In terms of cardiac conditions, majority of patients, caregivers and providers found telehealth systems easy to use. However a few barriers were also found. Larger equipment was found to get in the way of daily activities, while the main issues found regarding remote monitoring systems revolved around unstable connectivity and poor battery life. When encountered with a technological barrier, users expressed feeling discouraged to further use the remote monitoring. Remote-monitoring programs were found to be most effective when the patients received highly individualized program content. Programs specifically meant for heart failure were useful in terms of providing knowledge to interpret symptoms and guide self-care. Many individuals living with chronic cardiac conditions expressed openness to taking greater responsibility for their own health through self-management programs. It was found that individuals saw remote monitoring programs as a sense of being watched and felt security. Lastly it was reported that there is not a lot of data from rural and remote settings (e.g., Indigenous communities) in terms of remote-monitoring programs. Cost-effectiveness also remains unknown. Providers have indicated that the remote programs can be both time-consuming and time-saving. Patients who do not want their data used in certain ways may find limited options available.	2020	8/9 (AMSTAR rating from McMaster Health Forum)	9/91 - Realist Review 4/30 - Perspectives and Experiences Review	Not reported in detail - Realist Review 30/30 - Perspectives and Experiences Review	Not reported in detail - Realist Review 0/30 - Perspectives and Experiences Review

Sub-elements	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 remote-monitoring technologies
	Addressing research on the barriers and user experience in the engagement of digital health interventions (55)	The review included 19 studies to help analyze the barriers to analyze digital health interventions (DHI). It was found that many people lacked awareness of DHIs and saw no value in it. Digital literacy was also found to be a leading barrier. Individuals with lack of computers or mobile phones also have issues engaging with DHIs. Many individuals are too busy to be engaging with DHIs. Further individuals felt that if their healthcare provider was not promoting the DHI then it had low value, thus lack of clinical endorsement was also a clear barrier. Others also felt that the care became poorer due to its impersonal touch. On the other hand, patients saw DHIs as a good way to maintain dedication to be physically active and prevent the onset of disease. Many people using DHIs like having the choice to access their health information, giving them a certain level of control. Active, personalized promotions were beneficial in recruitment strategies for DHI users. Many saw DHIs as a way to minimize mistakes and improve health data.	2015	6/9 (AMSTAR rating from McMaster Health Forum)	4/19	2/19	19/19
	Identifying evidence on assistive technology such as remote patient monitoring, smart homes, telecare, and artificially intelligent monitoring systems for aging societies (25)	This review included 42 publications. Its key findings included research on aging-in-place technology revolving around technology acceptance, smart home technologies, intelligent algorithm development, robotic technologies and software engineering. The level of evidence found for the technology systems stated above were found to be poor. Most of the reviewed studies had poor references that were not assessed for quality. The review found that before 2010, most studies examined the way elders perceived technology while those studies published after 2010 began to focus more on the prototype and implementation of new smart home and AI technology. The interest for remote patient monitoring also began to increase in the studies published after 2010. Using manual techniques to monitor home-care patients and analyze data is not an option anymore. It was proposed that technology should be customized in order to match the needs of various aging societies, such as those living alone, with others, in community homes or in assisted living facilities.	2019	3/9	6/42	Not reported in detail	Not reported in detail

Sub-elements	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 remote-monitoring technologies
	Summarizing research on telehealth interventions that remotely monitor blood glucose levels (56)	The review included 15 studies and found that implemented self-monitoring blood glucose (SMBG) elements resulted in overall improved hemoglobin (A1C). The authors suggest that patients and healthcare providers should be educated on SMBG. SMBG also allow for shared decision-making which is essential for individuals with diabetes to be kept aware of their treatment decisions. It is important that SMBG profiles are presented in a way that both the patients and the healthcare providers can understand. The review also identified that many remote patient-monitoring interventions were used in advanced diabetes management. Remote patient-monitoring interventions that focused on SMBG profiles had the greatest impact on A1C.	2012	4/10	0/15	0/15	15/15
	Assessing the effectiveness of telehealth interventions, such as providing healthcare remotely through monitoring and consultations, in improving health outcomes in people with COPD (75)	This review defines telehealth interventions as remote monitoring of physiological changes via telephone or video, storing and transferring of patient data for offline assessments, and internet-based communications and consultations. The authors reviewed 29 randomized controlled trials which reported on 5,654 people with moderate to very severe COPD. Studies assessed the effectiveness of remote-monitoring technologies plus usual care, remote-monitoring technologies alone, as well as multi-component interventions. The authors reported that no important benefits or harms were found in number of exacerbations, quality of life, distress symptoms, hospitalizations, or death for patients. However, a moderate certainty in reduction of hospital re-admission was seen in people monitored through telehealth technology plus usual care. There was uncertainty in any harms of stand-alone monitoring, and any benefits or harms of stand-alone monitoring of patient experiences or breathing distress. Cost-effectiveness of telehealth interventions was not investigated thoroughly.	2020	11/11 (AMSTAR rating from McMaster Health Forum)	2/29	0/29	29/29

Sub-elements	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 remote-monitoring technologies
	Exploring specific factors of remote patient monitoring (RPM) interventions that could decrease, increase or have an equivocal effect on acute-care use (hospitalizations, length of stay, emergency department presentations) (11)	The authors discuss results from their previous systematic review, citing that RPM could have a positive impact on reducing acute-care use, but more guidance is needed for stakeholders in implementing RPM-facilitated models to garner the most benefits. RPM interventions that were used to monitor an individual's biometrics (such as heart rate, blood pressure, etc.) outside of the hospital were of particular interest in this review. This review included 91 articles, which were all reviewed previously for the authors' systematic review. The key findings from these studies were synthesized into themes and factors of RPM related to either increased hospital use or reduced hospital use. The authors found that RPM interventions were beneficial when they accurately predict a decline in health or disease exacerbation, respond timely to alerts, personalize patient parameters, and focus on enhancing patient self-management. The authors suggest that reducing hospital admissions through RPM interventions may shift associated costs related to primary care, although this could simply result in additional pressure and stress to different aspects of the system. It is imperative that RPM interventions aim to include families and caregivers as stakeholders in the management of a person's condition.	2020	3/9 (AMSTAR rating from McMaster Health Forum)	2/91	No list of included studies	No list of included studies
	Reviewing the literature on quality aspects of patient-generated health data (PGHD) in remote patient monitoring, specifically with wearable medical devices (76)	This review looked at eight studies that discussed quality of PGHD with the use of wearable medical devices. Factors or dimensions related to PGHD quality were identified through this qualitative review. Accuracy, data timeliness and accessibility were the most common data quality management dimensions in the selected studies. In general, however, it was found that there was a lack of understanding in quality management of PGHD as most selected studies focused on conceptual models rather than real-world examples. Specifically, human factors (particularly those involving the patient) were the least understood with the authors suggesting that further research should identify and avoid these factors (e.g., human error).	2017	4/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	Not reported in detail	8/8
	Reviewing the literature on information and communication technologies (ICTs)	This review examines studies about ICTs related specifically to falls prevention, detection and monitoring designed for usage by older adults (aged 50 and above). In particular, the authors were interested in exploring the experiences, attitudes and feedback older adults had	2013	7/10 (AMSTAR rating from McMaster	2/21	0/21	18/21

Sub-elements	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 remote-monitoring technologies
	interventions for falls prevention and detection in older adults, focusing specifically on older adults' perceptions and attitudes (52)	towards these technologies. This review ultimately included 21 qualitative, quantitative, and mixed methods studies. These studies mainly focused on emergency alarms and home automation systems (with video monitoring). The authors reported that older adults felt the technologies improved safety, confidence, and independence. Most preferred having control over the technology and situation, particularly regarding privacy, and choice in turning off false alarms. As well, perception of overall health, outside influences, technology type and redundancy of technology were found to influence perception of who needed these interventions. Usability and adaptation in homes was also a big factor for older adults when considering whether the technology was reliable. Finally, cost was an additional concern for the older adults and stakeholders. Given that a majority of the included studies were exploratory and many studies differed in results, the authors reported that it is difficult to provide robust conclusions. However, this review gives insight into some prevailing attitudes amongst older adults, which can be applied to furthering research and technology interventions.		Health Forum)			
	Examining the key barriers and facilitators of engagement with remote-measurement technology (RMT) (37)	The authors defined RMT as any mobile technology that allows monitoring of health status and data transmission to a health provider or the user themselves. Thirty-three articles met the inclusion criteria and were included in the review. Through quantitative analysis, it was found that average percentage of time used and dropout rates were variable and incomparable across studies. In addition, five major themes of barriers and facilitators were identified for qualitative analysis. These included health status, usability, convenience and accessibility, perceived utility (including perceived rewards, costs, and privacy), and motivation (intrinsic and extrinsic). Overall, the experiences of individuals throughout the studies highlighted many factors that may have an impact on adherence and engagement to RMT.	2017	5/10 (AMSTAR rating from McMaster Health Forum)	1/33	Unable to access list of included studies	Unable to access list of included studies
	Exploring information and communication technologies (ICTs) in	This review included 123 studies focusing on informal (not professional) adult carers of older adults using a support intervention such as ICT. Many studies dealt with family members caring for older adults with dementia or memory impairment.	2016	4/9 (AMSTAR rating from McMaster	13/123	9/123	123/123

Sub-elements	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 remote-monitoring technologies
	relation to supporting carers of older adults (77)	The authors reported that studies varied in carers' relationship to the care recipient (e.g., adult child, spouses, etc.) and ethnicity/race, which suggests that a general ICT intervention may not wholly serve all populations. In the same sense, different carers had their own individual needs and outcomes of interest (e.g., depression, negative mood, perceived burden). Rather, multi-faceted or multi-component programs that offer a variety of options and individualized goal setting may have a more positive impact on carers. Studies also showed that intervention groups may be more cost beneficial due to usage of fewer healthcare resources. Overall, this review highlights the experiences and important considerations for both carers and older adults in using ICT.		Health Forum)			
	Summarizing available evidence on patients' experience of telemonitoring for heart failure in order to inform development of telemonitoring services (53)	This review examined studies investigating heart failure patients and their experience with telemonitoring as a means of management. Particularly, rural patients were of interest. Eleven studies were identified for analysis. The analysis revealed three major themes influencing patient perception, adherence, and acceptance of telemonitoring, including operation of telemonitoring equipment, stability/severity of patient's chronic disease, and patient identity/autonomy/daily living. Patients' inability to operate telemonitoring equipment was a common theme, highlighting a gap in understanding technology and potential misunderstandings. The authors suggested that it is likely that consideration of a patient's disease progression and severity should be considered to tailor telemonitoring to their needs. Additional research is needed to assess telemonitoring and its impact on patient identity, however, telemonitoring was overall identified as a barrier to adherence and disrupted daily living. The authors noted that a limitation was the lack of studies specifically investigating patient experience, especially that of rural or remote patients.	2014	3/9 (AMSTAR rating from McMaster Health Forum)	1/11	0/11	11/11
	Determining the clinical effectiveness and cost-effectiveness of home telemonitoring or structured telephone support strategies	This systematic review and economic evaluation of 21 RCTs sought to determine the clinical effectiveness and cost-effectiveness of home telemonitoring or structured telephone support strategies compared to usual care for adults who had recently been discharged from hospital following treatment for heart failure.	2012	10/11 (AMSTAR rating from McMaster Health Forum)			

Sub-elements	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 remote-monitoring technologies
	compared to usual care for adults recently discharged from hospital following acute heart failure treatment (78)	This review found that, compared with usual care, remote monitoring was beneficial in reducing all-cause mortality, specifically for telemonitoring (TM) with medical support provided during office hours, and TM 24/7. The authors state that the results for TM 24/7 should be interpreted with caution due to the poor methodology of the one study that studied this type of technology. TM with medical support during office hours and TM 24/7 were associated with a 25% and 19% reduction in all-cause hospitalizations, respectively. No cardiovascular implanted monitoring devices or observational studies met the inclusion criteria. Overall, TM was found to be the most cost-effective strategy. For all-cause hospitalizations and heart failure-cause hospitalization, the effects of each intervention were not consistent, although remote monitoring appears to be generally beneficial. Limitations include the heterogeneity of the remote-monitoring interventions. Due to the variation among the population who experience heart failure, the true estimate of treatment effects is unclear. It was not possible to model the heterogeneity between studies using meta-regression due to the lack of appropriate data. The review notes that heart failure selection lacked detail in the components of the remote-monitoring care packages and usual care (such as communication protocols, routine staff visits, and resources used). As a result, uncertainties remain about the estimation of these costs. This model also assumed the effectiveness was constant over time and that intervention was equally effective in different age/severity groups, when, in reality this may not be the case.					
	Examining the effectiveness of smart living environments to support older adults to age in place in their community and gather evidence on what factors and strategies were identified as influencing the implementation process (57)	This protocol for an umbrella review seeks to establish the effectiveness of smart living environments to support aging in place for frail older adults and collect evidence on the factors and strategies that have an impact on implementation process. Two independent reviewers will search MEDLINE, Embase, CINAHL, Web of Science, and PsycINFO. The AMSTAR-2 quality assessment and extraction will be conducted in duplicate. The inclusion criteria consists of peer-reviewed reviews published in either English or French before 1 June 2021. Both qualitative and	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

Sub-elements	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 remote-monitoring technologies
		quantitative reviews (including scoping and systematic reviews) with or without meta-analyses will be considered, provided they include a reproducible, systematic search strategy with a clear definition of the inclusion and exclusion criteria, as well as outcomes. Reviews focused on the implementation of devices will be specifically included. Populations will include adults older than 65 living at home with telemonitoring. Included interventions will focus on Smart Living Environments, which are behaviour remote monitoring with inconspicuous devices. Specifically, devices do not require the constant attention of the user and blend into the environment. Wearables, smartphones, and camera-based systems will not be included. These inventions must support aging in place and assess effectiveness for the target population and/or caregivers. Included outcomes will assess effectiveness of smart living technology on the target population. In addition, reviews will also provide strategies affecting the implementation process. This review will not consider smart devices used for medical monitoring with specific diseases, such as measuring blood sugar levels for diabetes. Reviews focusing solely on medical monitoring, non-health-related outcomes, and the use of smart homes by caregivers not considering efficiency will be excluded. The analysis of results will be presented in narrative form based on the initial questions. The results will be included by relevance to supporting aging at home, technological maturity, elements of implementation, and evidence from the research syntheses included in the study. Summary data tables will be presented.					
	Describing and summarizing literature on technologies for dementia care, fall detection and home supports (22)	This scoping review examined the usability of ambient assisted living (AAL) technologies in relation to the three domains of dementia care, fall detection and home supports. The authors define AAL as a means to use technologies (e.g., smart devices, wireless networks, medical sensors) in a way that supports a person's daily living and home environment. Twenty-seven studies focused on older adults (65 years or older) within home-based environments that explored the usage of AAL or	2020	5/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	54/54	54/54

Sub-elements	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 remote-monitoring technologies
		other related technologies in respect to the three domains. Generally, users as well as caregivers found the technologies usable and beneficial. Particular benefits identified included improved cognitive and physio-social function in the users, and increased sense of security in caregivers. The authors suggest that AAL may reduce reliance on long-term care homes (thus reducing expenses) and improve independent living. Aside from these benefits, the authors also acknowledged that there are some concerns surrounding privacy and cost barriers for older adults. Two included studies did find that the interventions of included studies were more cost-effective, however, the cost of these assistive technologies are high up-front. Finally, most of these technologies are limited in their purpose, with many solely focusing on a single domain. This may indicate that older adults would have to rely on multiple different technologies for different purposes, which increases complexity and costs.					

Appendix B2: Systematic reviews relevant to Element 2 – Enabling organizations and providers to use and adopt remote-monitoring and associated technologies

Sub-elements	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 remote-monitoring technologies
Engaging users, patients, caregivers and care providers in co-designing programs and services (from ideation to implementation)	Examining the effects, facilitators, and barriers of co-designed technology supporting community-dwelling older adults (58)	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. The review generally described co-design approaches as needs and ideation (through workshops, focus groups, and interviews), prototyping and pilot testing. 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. 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. 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.	2019	6/9 (AMSTAR rating from McMaster Health Forum)	0/43	0/43	0/43

Sub-elements	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 remote-monitoring technologies
	Evaluating the effects of involving people with dementia (PwD) in research design (59)	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. 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. 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).	2018	4/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	3/26	3/26

Sub-elements	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 remote-monitoring technologies
Adopting organization-targeted implementation strategies	Identifying, and providing recommendations based upon the barriers and facilitators to adopting and assimilating technological innovations in the NHS (65)	This review defined technological innovation as an intentionally introduced device/procedure/organizational structure that is perceived by healthcare stakeholders to be discontinuous with previous practices. One hundred and six sources were included. There is not sufficient evidence on how or why National Health Services (U.K.) decide to adopt certain technological innovations, nor is the evidence on implementing and assimilating technological innovation clear. Using the 33 studies of proficient quality, this review begins to inform practice and future research. Evidence-informed 'design principles' for successful technological adoption and assimilation in the NHS were identified. The principles address 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, and how to promote an organization's capacity to absorb knowledge about technological innovations.	2008	7/9 (AMSTAR rating from McMaster Health Forum)	8/106	Not reported in detail	Not reported in detail
	Identifying associations between leadership roles and the outcomes of IT adoption in healthcare-providing organizations (66)	The review revealed important associations between the attributes of clinical leaders and IT adoption. Clinical leaders who aim for improvements in the processes and quality of care should: • cultivate the necessary IT competencies • establish mutual partnerships with IT professionals • execute proactive IT behaviours to achieve successful IT adoption	2013	Not available	4/32	Not reported in detail	Not reported in detail
Adopting provider-targeted implementation strategies	Identifying the competencies needed to ensure quality care for professionals and organizations to implement remote-monitoring technologies (41)	This scoping review of 111 studies identifies the clinical skills needed to ensure quality care and strategies for organizations to implement and test sensors, wearables and remote patient-monitoring technologies. This review focused on the four concept areas: competencies; wearables, and remote patient monitoring; mobile, asynchronous and synchronous technologies; and behavioural health. This review found the most common technologies included smartphones, smartwatches, and wristbands. The most common sensors included accelerometers, phones, GPS, microphones, actigraphs, implantable medical devices, and electrocardiograms.	2020	1/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	Not reported in detail	Not reported in detail

Sub-elements	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 remote-monitoring technologies
		To evaluate effectiveness, studies used questionnaires, ecological momentary assessment, and clinical assessments. There was variation in the frequency of these evaluations across studies. It was recommended to use a variety of methods layered and adjusted for the varying levels of skill. This review recommends case-based learning using real life examples through interactive role plays, seminars, or case conferences to practise making the appropriate decisions and proposing solutions to the patients. The study found that professional organizations have made decisions about how to integrate video, phones, and e-mail into clinical training. However, mobile health through applications and wearable technology is scarcely mentioned. In addition, boards, agencies and other government sectors are not engaging with mobile health technologies despite society's increasing reliance on these technologies. Overall, this review recommends the implementation and evaluation of institutional competencies to ensure the successful implementation of remote patient-monitoring technologies. Currently, this review found that skill development with these new technologies has fallen behind our changing societal landscape. The authors call for the collaboration of clinicians, teachers, informaticians, developers, and engineers in this changing culture and increasing reliance on technology. While the review acknowledges that competencies may change depending on the context, competencies must be clearly defined, implemented and evaluated to provide quality of care. (41)					

Appendix B3: Systematic reviews relevant to Element 3 – Adopting a rapid-learning system approach to support the development, implementation and evaluation of remote-monitoring technologies

Sub-elements	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 remote-monitoring technologies
Adopting a rapid-learning system approach	Examining attempts to adopt the learning health system paradigm, with an emphasis on implementations and evaluating the impact on current medical practices (70)	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. 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. 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 efforts 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.	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 (71)	The review examined 65 studies in order to determine the spectrum of ethical issues raised for stakeholders in a "learning healthcare system". A learning healthcare 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	2015	1/9 (AMSTAR rating from McMaster Health Forum)	Not reported in detail	Not reported in detail	Not reported in detail

Sub-elements	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 remote-monitoring technologies
		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. The ethical issues arising in learning healthcare 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. 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. Future research should focus on clarifying these ethical dilemmas and contribute to improving the quality of healthcare.					
	Exploring the benefits of learning health systems on a patient, provider, organizational and systems levels (69)	This review aimed to explore the effects of learning health systems data hubs on healthcare outcomes, as well as process and delivery of healthcare services. Twenty-three studies were included in this review. This review reported several benefits in the context of patient outcomes, clinician-patient interactions, organization and systems-level performance and research development. With respect to patient benefits, long-term tracking of care captured decreased distress, decreased post-operative outcomes, increased patient remission, shorter wait times for treatment following referral, and decreased polypharmacy among cancer patients. Patient questionnaires were used by	2019	N/A	2/23	Not specified	Not specified

Sub-elements	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 remote-monitoring technologies
		clinicians to record clinically elevated symptoms and provide appropriate referrals and care. In relation to clinician-patient interactions, learning health systems allowed patients to track and manage their own health, and provided additional evidence for evidence-informed clinical care. In some studies, data was publicly reported to a national registry as clinical research evidence to further improve population health. Regarding organizational and system-level performance, time savings were noted in that learning health systems allowed for automatic transferring of data, increased adherence to evidence-based clinical guidelines, and increased vaccination and colorectal cancer screening. Collaborative platforms that bridged across providers and organizations also enabled the efficient identification of patients for appropriate care, clinical trials or follow-up. In two included studies, improved patient satisfaction, improved population health screenings, improved education and patient engagement were reported as long-term effects. With respect to research development, learning health systems allowed participation in comparison effectiveness trials and identification of adverse drug effects. Learning health systems also enabled adherence to data-based guidelines and the collection of data for trials with reduced burden on patients, health services and research teams. Electronic medical records, linked data and clinical registers were pinpointed as key components to learning health systems. Other key components included strong partnerships, shared stakeholder vision and understanding, agreed principles and governance, longitudinal benchmarking and patient tracking, long-term feedback to patient, clinician and health services, and processes to allow for improvements. This review concludes that learning health systems can range in size and that individual systems can be linked to other learning health systems.					
	Exploring key topic areas and trends across the literature focused on learning health systems (72)	This review aimed to identify key topic areas and bibliometric trends of learning health systems. A total of 272 studies were included. This review found 15 common terms used across most included studies in defining learning health systems: improvement, patient, data, continuously, knowledge, practices, delivery, research, evidence, process, generate, clinical,	2020	N/A	22/272	Not specified	Not specified

Sub-elements	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 remote-monitoring technologies
		new, best and integral. Best care at lower cost: The path to continuously learning healthcare in America, a report published by the Institute of Medicine, was the most commonly cited publication across studies when defining learning health systems. With respect to key topic areas, this review found 11 keywords frequently discussed by included studies on learning health systems: learning health systems, healthcare sciences and services, humans, electronic health records, quality improvement, research ethics, medical informatics, delivery of healthcare, general and internal medicine, research and oncology. This review suggests that a majority of literature primarily focuses on the information technology capacity of learning health systems, rather than on human and organization factors. The review additionally identified ethical concerns in determining whether the line between clinical care and research exists, and where structures need to be placed to ensure informed consent.					

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