

*Aging-related technologies: A multiple case
study of innovation processes*

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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ABSTRACT

Introduction: As part of a Canadian research network focused on aging and technology – Aging Gracefully across Environments using technology to support Wellness, Engagement, and Long Life (AGE-WELL) – this thesis explored how technologies currently being developed to support older adults and their caregivers fare through the processes of innovation. This included an exploration of the factors that might facilitate or constrain these new technologies from their initial development to implementation, as well as any policy, regulatory and/or health system issues that may be relevant.

Methods: A multiple case study was conducted of four AGE-WELL technology projects. For each, data were collected through: interviews with project members and key stakeholders (n=20); surveys (n=4); ethnographic observations at each project site (n=4); and document reviews. Data were analyzed using directed coding, guided by the ADOPT (Accelerating Diffusion of Proven Technologies for Older Adults) framework (Wang et al., 2010). The results were compared across sites using a cross-case analysis.

Results: Challenges related to the initial stages of the work included obtaining ethics clearance, recruitment of study participants, and getting small-scale studies completed. Challenges were also experienced in creating business models – including uncertainties around who might benefit from or pay for the technologies. Facilitators included collaboration among stakeholders (e.g. clinicians, industry, end-users) and support from the AGE-WELL network to form partnerships.

Conclusions:

Technologies have the potential to help older adults maintain their independence, health and quality of life. Understanding the factors that facilitate or constrain the development and implementation of these types of technologies can help promote their diffusion and adoption.

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Chapter 1: Introduction and Overview

“Innovation is essential to a high-performing economy, a sustainable health care system and ensuring Canadians have access to high quality health and social care” (Canadian Home Care Association, 2015, p. 1). Innovative solutions and technologies have increasing potential to enhance the health, engagement and quality of life of a growing population of older Canadians who are living longer with increasing chronic care needs (Sixsmith, 2013; Mattke et al., 2010). In addition to the potential individual benefits, investments and attention paid to technology-enabled solutions can benefit our health care system in terms of reducing the growth of health care costs, and improving productivity and health outcomes (Canadian Home Care Association, 2015).

Although technology presents an opportunity to improve both the health care system, and the health of an older population, Canadian innovators may face challenges in getting their innovations developed and used in health care systems, long-term care facilities or in the private homes of consumers. A recent advisory panel on health care innovation in Canada outlines that entrepreneurs in Canada find it difficult to introduce, sustain and scale up their innovations in the healthcare system (Naylor et al., 2015). They also find it more difficult to penetrate the Canadian healthcare market than to sell their ideas, products, and services in other countries (Naylor et al., 2015). There are several barriers such as access to funding, cumbersome approval processes, and fragmented purchasing processes (Naylor et al., 2015).

One initiative aimed at accelerating innovation in the field of technology and aging is a Network of Centres of Excellence created in 2015: Aging Gracefully across Environments using Technology to Support Wellness, Engagement and Long Life (AGE-WELL). This Pan-Canadian

network of industry, non-profit organizations, government, care providers, end-users and academic partners are using high-quality research to drive innovation and develop technologies that benefit older adults and their families through maintaining their independence, health and quality of life, increasing their safety and security, supporting their independent living and enhancing their social participation (AGE-WELL, 2016).

There are approximately 60 different AGE-WELL research projects (up from an original 25) that are organized into eight work-packages (WP):

WP1: Understanding the needs of older adults;

WP2: Understanding the needs of caregivers;

WP3-6: Technology for supporting functional autonomy and independence, Technology for active participation in society, Technology for prevention and reduction of disease and disability, and Technology for maintaining good mental and cognitive health;

WP7: Health systems, practice, policy and regulatory issues and;

WP8: Ethical, cultural and social aspects of technology.

One of the projects within work-package 7, named PRI-TECH, is tasked with identifying **P**olicy and **R**egulatory Issues in enabling **T**echnological innovation for older adults in Canada. This research proposal is an extension of this project and will utilize case study research to examine factors that facilitate or constrain the innovation journey (from development to implementation) of technologies that are being developed within the AGE-WELL NCE, including any policy, regulatory and health system issues that may be relevant. The information

gleaned from this thesis project will help inform the ways in which we can optimize the pathways for adoption and diffusion of aging-related technologies in Canada.

This thesis begins with a literature review and continues with the rationale and objectives of the case study. It then outlines the study methods and results, followed by a discussion of the implications of the study. In order to situate this project, the literature will be discussed next.

Chapter 2: Literature Review

2.1 Aging Population

For the first time in Canadian history, there are more people in Canada age 65 and over than there are under the age of 15 (Statistics Canada, 2015). This is an important milestone as it reflects the changing demographics of an aging baby boom generation. By 2036, it is projected that there will be approximately 10 million people, nearly one quarter of Canada's population, over the age of 65 (Statistics Canada, 2010). As Canadians live longer, the burden of chronic illness will continue to increase, through diseases such as diabetes, high blood pressure, congestive heart failure and dementia (Canadian Institute for Health Information, 2011). Currently 50% of Canadian seniors report having either one or two chronic conditions and almost one-quarter report being diagnosed with three or more chronic conditions (Canadian Institute for Health Information, 2011). The number of chronic conditions an individual has, not their age, largely drives the amount of health care services used (Canadian Institute for Health Information, 2011). The costs associated with chronic diseases (i.e. illness, disability and death) exceeds eighty billion dollars annually (Tran et al., 2008). Much has been written about these two major challenges: a rapidly growing aging population managing different chronic diseases and the unsustainable growth of health care costs (Challinor, 2016). Evidence suggests that technology and innovative health care solutions have the potential to address these major challenges and to create new options for care delivery (Canadian Home Care Association, 2015). In particular, there is potential to deploy various technologies to empower older adults to age in place (Peek et al., 2016).

2.2 Defining Innovation

The term ‘innovation’ has become a common buzzword with varied meanings (Naylor et al., 2015). According to Blomqvist and Busby (2016), in economics, innovation has typically referred to the invention of a new technology. However, other authors note a distinction between the terms ‘invention’ and ‘innovation’, where ‘invention’ is the first occurrence of a new product or process and ‘innovation’ is carrying it out in practice (Fagerberg, 2009). More broadly, innovation can refer to new or better ways of doing things and solutions (e.g. products, services, strategies, processes) that add some sort of value over the status quo, such as social or economic value (Conference Board of Canada 2015; Blomqvist & Busby 2015; Ontario Bioscience Innovation Organization, 2013; Naylor et al., 2015). For the purposes of this thesis, the definition of innovation in health care proposed by the federal Advisory Panel on Healthcare Innovation (the Naylor Panel), in their report *Unleashing Innovation: Excellent Healthcare for Canada*, will be used. The Panel adopted a broad definition that includes activities that “generate value in terms of quality and safety of care, administrative efficiency, the patient experience and patient outcomes” (2015, p. 5). This definition can encompass a broad range of things from technological innovation to social and policy innovation (Naylor et al., 2015).

2.3 Examples of Emerging Health Technologies for Older Adults

When looking at innovative strategies for addressing the health concerns of an aging population, advances in technologies that help prevent, detect and treat the complex health conditions of older adults living in the community are emerging as possible solutions. Novel approaches range from telehomecare, GPS/locating technology, mobile health, telemedicine, sensor technology such as wearables and motion sensors, smart-home systems, social networking and communication technologies, assistive robots, intelligent scooters, digital games and more

(Sixsmith, 2013; Dishman et al 2004; Savage, 2009; Canadian Home Care Association, 2015, Peek et al, 2016). These kinds of technologies may help promote physical function, facilitate early diagnosis, enable self-monitoring of health status, promote social interaction and assure adequate treatment (Dishman et al 2004). Examples of these benefits have been demonstrated in several studies that show technology can increase medication safety and adherence, reduce annual system costs and personal travels costs, increase quality of life through improvement of self-care and clinical management, and postpone institutional care by several months (Hayes, 2009; Gartner Inc. & Praxia Information Intelligence, 2011, Seto, 2012; Riikonen, 2010; Johansson, 2010; Canadian Healthcare Association, 2009; Wang, 2010; CIHI, 2011). It is important to note that many of these technologies are not necessarily ‘new’, meaning new applications are being made out of old technologies, for example, using a telephone for health information, reminders and monitoring (Dishman et al, 2004). However, some new emerging technologies involve new interaction paradigms and interfaces such as receiving information or reminders from multiple or even alternative sources such as the television, computer or household appliances and connected devices that record, transmit and store patient information (Dishman et al, 2004).

2.4 Many Hurdles in Canada

Although it is exciting to envision a future where our health care system is fully enabled by a range of technologies that improve care and reduce costs to the health care system, the challenge is in understanding how to achieve this reality when there are a number of hurdles and key questions. The Canadian Home Care Association (2015) outlines some critical questions around the awareness, scalability and sustainability of these technologies such as: how will decision-makers learn about new and emerging technologies, what evidence is required to make

investments in implementing a new technology, how will successful pilot projects be scaled, how will payment and incentive models sustain long-term adoption, how will regulatory frameworks support new technology and what strategies will promote patient receptiveness to new models of care.

These questions are important to think about because although there has been considerable research and development into new systems and devices to help older people, the uptake remains low (Sixsmith, 2013; Peek et al, 2016). The typical technology push and end-of-product dissemination approaches ignore the importance of business modeling and stakeholder participation during the research and development process so that technologies are congruent and in line with real-world opportunities and constraints (Sixsmith, 2013). Further, our health care system is not structured in a way that allows it to respond easily to change, for example, procurement policies in Canada are risk averse, focus on cost-containment as opposed to value generation and are generally disconnected from innovation activities (Ontario Health Innovation Council, 2015; Prada, 2011; Sebastianski, 2015). The result of this is a focus on the least expensive item in the short-term instead of an innovative technology that may have apparent value in the long term. In addition, Canada's multiple jurisdictions (13 provinces and territories) create separate privacy legislation, reimbursement hurdles, different priorities and different procurement systems across provinces (Snowdon, 2011). This creates scaling challenges for innovators trying to get their technologies adopted and diffused across Canada. Other implementation challenges for these types of technologies include difficulties in building sustainable business cases, a lack of interoperability between systems of different vendors and a lack of robust scientific evidence on cost and outcomes (Peek et al, 2016). Many of these issues are complicated by the involvement of multiple stakeholders such as older adults, care

professionals, technology designers and suppliers, funding bodies, managers within home care or social work organizations and policy makers (Peek et al, 2016; Sixsmith, 2013). Further, the different expectations of these various collaborators need to be effectively managed and reconciled during the research and development process (Sixsmith, 2013).

Beyond system level hurdles, health technology innovators and companies struggle with finding the necessary financial and human resources (Snowdon, 2011; Sebastianski, 2015). Acquiring the necessary clinical and specialized talents to help engage in innovation activities, such as moving from concept to prototype can be challenging (Sebastianski, 2015). Innovations in the health science sector are impacted greatly by constrained resources as their development cycles are long, achieving proof of concept is expensive and market access is regulated (Challinor, 2016). Further, user-centred design can be more challenging with older people than with other user groups (Newell et al, 2007). Researchers and innovators need to be aware of, and sensitive to, potential sensory and cognitive capabilities and attitudes towards technology that older people may have when included in research studies (Newell et al, 2007). In addition, even if older adults are involved, often the criticism is that a tokenistic approach to user involvement is adopted where users are rarely involved at every stage, particularly in the development of the technology at later stages (Sixsmith, 2013).

Because of these many challenges, promising ideas and pilot projects rarely turn into commercial products or are diffused across the health care system (Ontario Health Innovation Council, 2015).

2.5 Many Opportunities and Recommendations

Although there are considerable barriers to developing and implementing new health technologies in Canada, there is considerable opportunity to foster and create a climate conducive to health technology innovation in Canada. Canada possesses many key assets including: a stable financial system, strengths in information technology, strong research capacities within a public healthcare system, a strong track record for conducting clinical trials, a highly educated workforce and health care delivery and research capacity at the local level (Holmes, 2011; Snowden, 2011; Ontario Health Innovation Council, 2015).

Additionally, recommendations have been identified in the literature to facilitate the development and implementation of health technologies such as: ensure funding is provided at all stages of the innovation cycle, create a single point of entry for innovators, and gather feedback from health services and policy-makers about current needs and challenges and the potential innovation fit/misfit with the real-world (Challinor, 2016; Lehoux, 2008). Other facilitators include a shift to value-based procurement, direct/active cooperation between users and designers, a transdisciplinary approach in research and development, and support for start-ups, ranging from business strategy and clinical expertise to regulatory expertise and risk capital (Khayat, 2015; Lehoux, 2008, Ontario Health Innovation Council, 2015; Sixsmith, 2013).

More specifically, evidence suggests the growing promise of technology in Canada. For example, currently 5000 Canadians are enrolled (with continued growth of 15-20% annually) in 19 remote patient monitoring programs across seven provinces and territories (Canada Health Infoway, 2014). These monitoring programs use technologies with varying degrees of complexity to provide care along the different stages of the care continuum (Canada Health Infoway, 2014). In addition, a recent survey found that medical devices that captured or

transmitted data via internet or SMS to health care providers for post-surgical discharge monitoring or chronic disease monitoring were used by one percent of Canadians (Canada Health Infoway, 2014).

2.6 Networks of Centres of Excellence (NCE) and AGE-WELL

A program to support academic and industry relationships developed by Industry Canada called Networks of Centres of Excellence (NCE), is designed to support networks of researchers across Canada focused on a specific industry sector (Snowdon, 2011). The requirement for industry-academic research partnerships is a significant strength of NCEs as this funding structure provides opportunities and incentives for collaboration among industry partners and researchers (Snowdon, 2011). An example of an NCE is AGE-WELL, which is focused on technology and aging. AGE-WELL was created in 2015 with \$36 million dollars in funding over 5 years. The network brings together more than one hundred funded and affiliated researchers from twenty-nine universities and research centres across Canada and over one hundred governmental, industry and non-profit partners (AGE-WELL, 2016). The expected results of this network include improved health outcomes, increased independence and quality of life for older Canadians, reduced caregiver burden and economic growth in the technology and aging sector (Network of Centres of Excellence of Canada, 2016). It is expected that at least 12 of the technologies being developed within the network will be ready for transfer to market within the five-year funding period. Other longer-term benefits include the integration of these technologies into supportive housing environments, more affordable technologies that are better able to meet consumer needs, and creating changes to health care funding policies to support their use (Networks of Centres of Excellence of Canada, 2016).

2.7 Theoretical Perspectives and Conceptual Models in Healthcare Innovation Research

Several frameworks have conceptualized healthcare innovation along a pathway (Michell, 2014), cycle (Ontario Health Innovation Council, 2015) or journey (Naylor et al, 2015). These frameworks aim to map some of the key milestones and stages/phases that health innovations pass through from research and development all the way to adoption and diffusion (although these activities do not always happen in succession). (*See Figures 1, 2 and 3 below.*)

More specifically, the adoption and diffusion of new technologies has been examined from many perspectives (e.g., user, organizational, or environmental). Rogers' seminal work on diffusion of innovation has strongly influenced a large body of research on healthcare innovation. This approach highlights different stages of the diffusion process from the adopter standpoint and the five different adopter categories (Rogers, 1995). Some diffusion models have looked at the importance of opinion leaders and groups of people sharing common values in the spread of innovations and in the diffusion process (Cain & Mittman, 2002). Others have looked at the spread and sustainability of innovation in health service delivery, and important factors to consider during the research stage for the sustainability of health service innovation (Fox et al., 2015; Greenhalgh et al., 2004). Other models have looked at technology acceptance and the importance of perceived usefulness and ease of use in technology adoption (Davis, 1989).

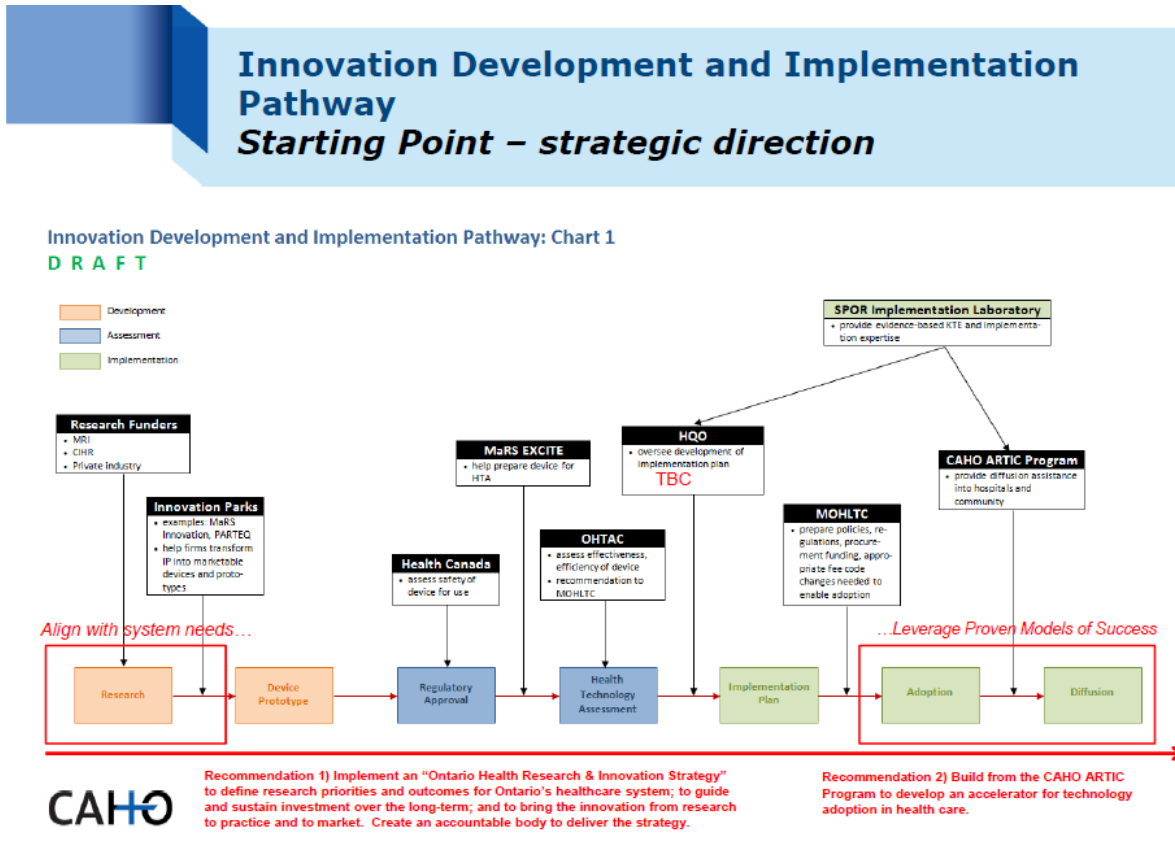
A more focused framework for technology diffusion within older adult health services is the ADOPT model: Accelerating Diffusion of Proven Technologies for Older Adults (Wang et al., 2010) (*Figure 4*). This model aims to address the critical success factors and strategies relevant for successful health technology diffusion for older adults. The centre of the model highlights factors that affect technology adoption and use relevant to older adults, their

collaborators and their context. For example, issues directly relating to the older adult such as their ability to use the technology and its perceived usefulness, the importance of collaborators to help facilitate use and access to technology, and wider contextual issues such as policy, interoperability and privacy considerations (Wang, et al., 2010). The model then overlays seven important factors/strategies: design user-friendly relevant technology, establish technology value, create a business model, promote technology, form partnerships, identify technology champions, and coach users. These are factors that older adults' collaborators (e.g., technology companies, aging services organizations, formal/informal caregivers, family members, medical providers, insurance companies and others) can undertake in designing and promoting use of technologies for older adults to help facilitate technology diffusion which will lead to improved health outcomes for older adults (Wang et al, 2010).

It is important to note that there are varied definitions when explaining the different activities that take place along the innovation pathway. *Table 5* below outlines some key definitions that help to characterize the different stages that may be important to new technology development.

Figure 1: Innovation Development and Implementation Pathway

This figure was developed by the Council of Academic Hospitals of Ontario and depicts the technology innovation adoption spectrum from research to innovation to implementation. It highlights key stages along the pathway to adoption and diffusion.

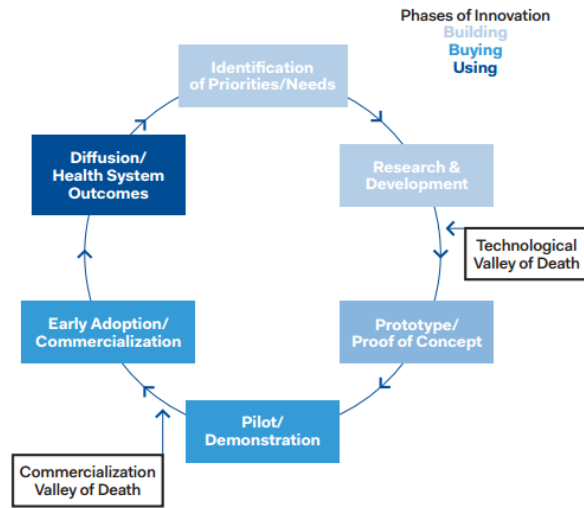


(Figure taken from the Council of Academic Hospitals of Ontario, Michell, 2014, with kind permission. See Appendix P).

Figure 2: The Health Technology Innovation Cycle

This diagram depicts the five stages in the health technology innovation cycle. The “Valleys of Death” identify stages that are particularly difficult to pass through

Figure 1: The Health Technology Innovation Cycle¹²

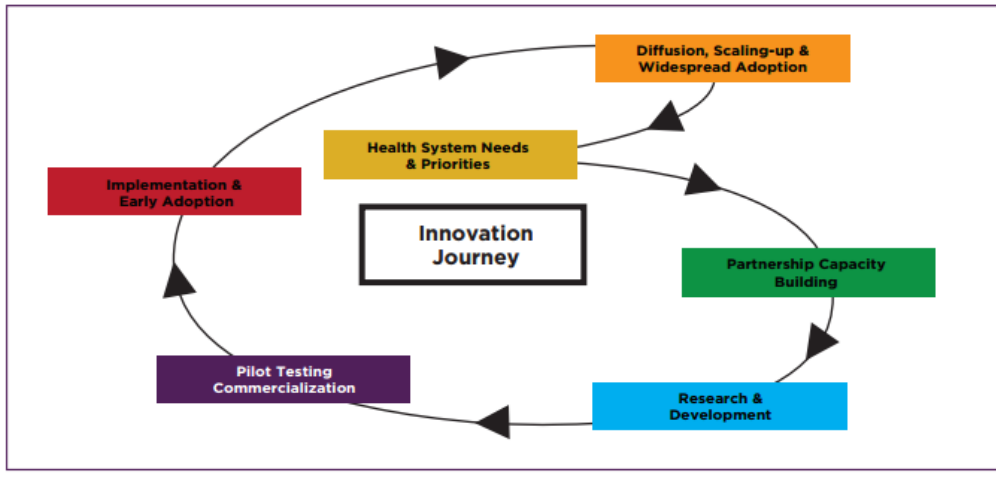


(Figure taken from Ontario Health Innovation Council, 2015, with kind permission. See Appendix P).

Figure 3: Innovation Journey

This figure highlights the stages of the innovation adoption journey.

Figure 9.2: Innovation Adoption Journey



Adapted from Ivey International Centre for Health Innovation. Advisory Panel on Healthcare Innovation Commissioned Research: An Overview of Canada's Health Innovation Architecture. London; c.2015.

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Figure 4: ADOPT for Aging Services

This figure highlights the ADOPT model. The centre of the model highlights factors that affect technology adoption and use relevant to older adults, their collaborators and their context. The model then overlays seven important factors/strategies. These are factors that older adults' collaborators (e.g., technology companies, aging services organizations, formal/informal caregivers, family members, medical providers, insurance companies and others) can undertake in designing and promoting use of technologies for older adults to help facilitate technology diffusion which will lead to improved health outcomes for older adults (Wang et al., 2010).



Fig. 1 The ADOPT (Accelerating Diffusion of Proven Technologies) model
(Figure taken from Wang et al, 2010, with kind permission. See Appendix P).

Table 1: Definitions of the different activities that take place along the innovation pathway

Common Stage	Definition
Research & Development	Developing new products; applied research that may facilitate future product development (Investopedia, 2017).
Regulatory Process	The process of obtaining regulatory approval from Health Canada or other government bodies for the health technology (Health Canada 2016).
Health Technology Assessment	The systematic evaluation of properties, effects, and/or impacts of health technology. It is a multidisciplinary process to evaluate the social, economic, organizational and ethical issues of a health intervention or health technology. The main purpose of conducting an assessment is to inform policy decision-making (World Health Organization, 2017).
Commercialization	The process of introducing a new product into commerce--making it available on the market (Investopedia, 2017).
Marketing	Promoting and selling products or services, including market research and advertising (Oxford Dictionaries, 2017).
Adoption, Diffusion & Procurement	The dissemination or implementation portion of the innovation process. Adoption is generally the selection of a technology for use by an organization or individual and diffusion generally refers to how, why and how quickly these new ideas and technologies proliferate. Procurement is the act of obtaining or buying goods and services (Wang et al, 2010; Business Dictionary 2017).
Reimbursement	Managed care payment by hospitals, group purchasing organizations, regional health authorities, third party payers and patients to a company/innovator/service provider (Investopedia, 2017).

Chapter 3: Rationale

3.1 Research Gap on Real-World Aging Related Technologies – The Innovation Journey from Concept to Realization

As the population ages, solutions that aid older adults in remaining at home are becoming a major interest and focus. Aging in place is a goal for many older adults and over 80% of middle-aged Canadians express a desire to stay in their homes, even with changes in their health and autonomy (Savage, 2009; Canada Mortgage and Housing Corporation, 2015). In addition, solutions that promote aging in place are of interest to health policy makers due to the potential cost savings to the health care system (Sixsmith, 2013). Although there is growing evidence that technological supports can provide benefits for older people, and the health system, there has been limited research on real-world products and services (Sixsmith, 2013). Additionally, the rapidly growing literature on aging and technology is lacking significantly in theory, with theories and principles remaining mostly tacit and unsystematic (Sixsmith, 2013). This is problematic as theories drive empirical research, ensure the advancement of knowledge, are helpful in interpreting research results and arranging our ideas, and can be useful in the creation of conceptual frameworks/models especially when the problem is complex (Sixsmith, 2013). Sixsmith (2013) suggests that a potential direction for the development of theory/conceptual approaches of innovation is to explain the way devices and systems emerge from concept to realization.

While this case study research does not aim to develop a new theory in this area, it uses a conceptual framework for analysis- the ADOPT model: Accelerating Diffusion of Proven Technologies for Older Adults. Although this study is not specifically focused on understanding diffusion or diffusion theories, the AGE-WELL NCE wants to develop commercializable

products that will be used and benefited from by older adults and their collaborators, thus in order to promote the spread of technology it is important to understand the factors that might facilitate or constrain their eventual adoption and diffusion. The ADOPT model was developed through literature review and is not specific to Canada, thus examining real-world cases moving from concept to realization has the potential to expand this current model and our understanding of the critical factors that impact the success of the development and implementation of technologies for older persons.

3.2 Study Objectives and Research Questions

The central aim of this study is to explore how AGE-WELL technologies selected for this study fare through the processes of innovation through development to implementation. This includes an exploration of the factors that might facilitate or constrain these new technologies, including policy, regulatory and health system issues that may be relevant in facilitating or constraining the innovation process. An additional piece that may prove to be integral to the cases is examining how operating within a Network of Centres of Excellence (NCE) changes or influences the innovation journey. These objectives are addressed through a multiple case study design. This study addresses the following research questions:

- 1) What factors facilitate or constrain the innovation journey (from development to implementation/adoption) of these new AGE-WELL technologies?
 - a. How do policy, regulatory and/or health system issues in Canada facilitate or constrain their innovation journey (from development to implementation/adoption)?

- b. How do participants perceive innovating within the AGE-WELL NCE as facilitating or constraining the innovation journey (from development to implementation) of these new technologies?

3.3 Addressing the Research Gap and Rationale for Approach

Conducting a case study of AGE-WELL technologies, currently being researched and developed, presents an opportunity to gather information about their innovation journey (from development to implementation) and the factors that facilitate or constrain this journey including relevant policy, regulatory, health system and NCE issues. A case study approach was selected because it allows for an “(up) close or otherwise in-depth understanding of a single or small number of “cases”, set in their real-world contexts” (Yin, 2012, p. 4). Case study methodology allows for the exploration of a contemporary phenomenon, as well as complex processes that unfold in a variety of settings using a variety of data sources (Baxter & Jack 2008; Yin 2014; Stake 2006). An in-depth focus on specific cases goes beyond the study of isolated variables, as there is a need to cover a broad range of contextual and other complex conditions (Yin, 2012). Case studies are different from other types of qualitative research as they are intensive analyses and descriptions of a single unit(s) or system that are bounded by space and time (Hancock & Algozzine, 2006).

This approach lends itself well to this project, as the technologies that were examined in this study are currently being researched and developed by teams in different provinces, and the technologies themselves provide different uses and functions. Further, innovation in health care is a complex issue meaning there is no simple formula for success (Plsek, 2003). Thus, case study research will aid in the exploration of this contemporary and complex phenomenon, that is, the innovation of technologies for older persons. By using various methods (interviews, surveys,

site visits, documents) to illuminate the different angles of these four technology cases within AGE-WELL, this thesis creates a detailed narrative about real world, aging-related technologies that are going through the innovation process in Canada. In addition, the AGE-WELL NCE is a relatively new network, so no case studies currently exist on these new technologies.

A richer understanding of the innovation journey in Canada, and the factors that facilitate or constrain this journey, will help AGE-WELL innovators understand the complex processes associated with developing new innovations in Canada, as well as similar technologies being developed outside the network. Further, an understanding of the current barriers, including the policy, regulatory and health system landscape may shed light on inadequate and unresponsive processes that impede the development and implementation of new technologies for older persons. A goal of the AGE-WELL NCE is to help older adults and their caregivers gain access to appropriate and safe technologies that will help their quality of life; this research helps to set the stage for this goal to be achieved.

Chapter 4: Methods

4.1 Study Design

There are varying and opposing approaches espoused by different research methodologists (e.g., Yin, Stake, Merriam), thus there is not full consensus on the design and implementation of case study research (Yazan, 2015; Yin, 2014; Stake, 1995; Merriam, 1998). These differing perspectives and the degree of flexibility with conducting case study research is often discussed as a drawback, as it may prevent researchers from developing a shared understanding of practice and rigour (Hyett et al., 2014). Despite this, in general, several important characteristics can be agreed on that define case study research. Case study research often examines a phenomenon such as an event, situation, program or activity that is studied in its natural context, although it can sometimes focus on an individual person (Hancock & Algozzine, 2006). Because case study research is grounded in deep and multiple sources of information (e.g., interviews, observations, existing documents), it is richly descriptive and may require the researcher to spend more time in the environment being investigated (Hancock & Algozzine, 2006).

The important steps to conducting case study research are outlined in “A Practical Guide for Beginning Researchers: Doing Case Study Research” by Hancock and Algozzine (2006) which include considerations for case study designs, different sources/strategies for gathering data, guidelines for summarizing and interpreting information, reporting results, and confirming case study findings. This guide was used as the primary reference point for designing this study as it provides a useful entry point to the approach without assuming extensive prior knowledge of qualitative and quantitative methods. In addition, books dedicated specifically to case study

research are often hard to apply in practice, thus this guide is a helpful resource to operationalize case study research especially for a novice researcher (Hancock & Algozzine, 2006). Other resources on case study research were consulted as needed for further clarification.

There are many different case study designs and approaches. They can be based on their function, disciplinary perspective or characteristics. The most congruent design to allow for a full investigation of the research questions set out by this proposal is a collective design (also sometimes referred to as a multiple case study) (Hancock & Algozzine, 2006; Stake, 1995). Collective case studies involve several instrumental cases. Instrumental cases are performed when there is a research question, a puzzlement, or a need for a general understanding of a particular situation or phenomenon and the researcher feels that insight will be gained by studying a particular case (Hancock & Algozzine, 2006; Stake, 1995). Collective case study designs aim to examine an issue in question and to enhance the ability to theorize about some larger collection of cases (Hancock & Algozzine, 2006). This design also allows the researcher to analyze within each case setting and across settings (Baxtor & Jack, 2008). This approach aligns with the research objectives of this proposal, as there are specific issues in question, as well as the desire to theorize about a larger collection of cases (i.e., AGE-WELL technologies /emerging technologies that will be utilized by an older population).

4.2 Inquiry Paradigm

Different epistemological and ontological orientations can be embraced in case study research. For this study, the researcher adopted a post-positivist theoretical perspective. Post-positivists believe that there is an independent reality to be studied but that observations are inherently fallible and we can only approximate the truth (Gray, 2013). A post-positive perspective commonly assumes a critical realist ontology, and a modified dualist/objectivist

epistemology (Guba & Lincoln, 1994). In critical realism, reality must be subjected to the widest critical examination to facilitate understanding of reality as closely as possible (but never perfectly) (Guba & Lincoln, 1994). A post-positivist critical realist acknowledges that all observation has error and is fallible and that all theory is revisable (Trochim, 2006).

Additionally, critical realism accounts for the ways in which the social world is constructed through language while also recognizing the existence of an external-to-discourse reality (Sims-Schouten & Riley, 2007). This reality is constituted by the possibilities and constraints inherent in the material and institutional world. The advantage of taking a critical realist approach, as opposed to a relativist approach, is that analysis can locate people's experiences within the broader material and institutional contexts in which they operate (Sims-Schouton & Riley, 2007). This perspective also highlights the importance of objectivity with emphasis placed on external critical traditions such as whether or not findings fit with pre-existing knowledge and the critical community such as professional peers and referees (Guba & Lincoln, 1994). In a post-positivist tradition, objectivity can never be achieved perfectly but it can be approached (Trochim, 2006).

4.3 Bounding the Cases

A common step with case studies is to 'bound the case', which is to ensure that researchers do not attempt to cover too many objectives for one study or answer questions that are too broad. In order to prevent this from happening, several authors provide suggestions for ways of binding the case such as by time and place, time and activity or definition and context (Yin, 2014; Stake 1995; Hancock and Algozzine, 2006; Baxtor and Jack, 2008). The cases in this research project were bound by the specific research questions, and by time, (usual term limits for completion of a Master's degree). This means that the case studies only cover some part of the life cycle of each of the AGE-WELL projects.

4.4 Case Selection, Recruitment, and Ethics

A purposeful approach to case selection was used; information rich cases were selected purposefully and strategically (Patton, 2002). Four AGE-WELL projects developing technology products within the network were selected. These technology projects or ‘cases’ were selected because they are generally representative of the types of technologies that are being developed throughout the network (e.g. they assist, monitor or assess with the aim to help older adults/caregivers maintain independence, health and quality of life) and they represent different contexts/locations - three universities in two provinces. Seven AGE-WELL project leads were contacted and asked if they would like to participate as a ‘case’; (in three of the cases two project leads were recruited; in one case one project lead was recruited). Four cases were selected in order to provide varied details of the phenomenon under study.

Key informants beyond the network were also recruited to participate in semi-structured interviews. Purposeful strategies for sampling were used, as subjects were selected due to their understanding of the health technology field from a policy, research or industry perspective. Three key informants per case (beyond the participants from the AGE-WELL projects) was seen as a feasible target for this project and as helpful to provide additional information/insights relevant to the study’s research questions, particularly research question 1a). Those who actively participated in interviews were provided with an informed consent form.

It is important to note that there are some limitations of not including cases outside of the AGE-WELL network (i.e., other technology groups/companies that are developing health technologies or technologies for an older population). The AGE-WELL network is a well funded/supported network that is able to provide research groups with financial and other resources such as workshops on commercialization. The network also promotes

transdisciplinarity, collaboration between academic and industry partners, and working together as a network to produce outputs. Additionally, the project leads of the AGE-WELL projects are predominantly academic researchers, thus they may not have direct experience with commercializing and bringing technologies to market. Therefore, this particular innovation environment may not be representative of other technology groups or small/medium enterprises that are developing health technology innovations outside of an NCE. This may affect the generalizability of findings to other groups outside of AGE-WELL. However, despite these limitations, only selecting AGE-WELL cases allows for an in-depth understanding of the technologies being developed within this network, and an understanding of using the NCE structure as a mechanism to develop and implement technologies for older adults. Although not all the findings may be readily transferable to other cases outside the network, certainly some aspects of the innovation journey will be similar, which may help technology developers beyond the network.

This study has obtained ethics clearance (under the larger study PRI-TECH: Policy and Regulatory Issues in Enabling Technical Innovation) from the University of Waterloo's Office of Research Ethics (ORE # 21006). The recruitment script, information letter, consent form, feedback letter and interview guides were created for PRI-TECH with the case study research/approaches in mind. As this study evolved since initial ethics clearance, revisions and ethics modifications were developed to include the specific components of this multiple case study thesis (Appendices A, B, C, D, E, F, G, H, I, J, K).

4.5 Data Collection

One of the main features of case study research is the use of multiple data sources to facilitate a holistic understanding of the phenomenon being studied (Baxtor & Jack, 2008).

Additionally, within a post-positivist perspective, since all measurement is fallible an emphasis is placed on multiple measures/observations and the need to use triangulation across multiple sources to try to get a better idea of what is happening in reality (Trochim, 2015). Data were collected using document review, surveys, semi-structured interviews, and site visits. It is important to note that the data were collected at different time-points. For example, the surveys were distributed first to use as a starting point for the first interviews with project leads. The second interviews with project leads were conducted 6-8 months after the first interviews. Some site visits occurred during the first interview while some site visits occurred during the second visit, depending on the availability of the projects.

4.5.1 Document Review

Documents relevant to the case were collected. The types of documents that were collected were outputs found on the AGE-WELL forum (intranet site for information-sharing within the network) such as publications and presentations. Document reviews are helpful as they can serve as substitutes for records of activity that the researcher cannot observe directly (Stake, 1995). In addition, documents provide information different from, or not available in, spoken communication, and they may provide historical insight (Hodder, 1994). Documents are generally easy to access and can be low cost sources of information (Hodder, 1994).

4.5.2 Surveys

Surveys were developed to understand and characterize the four projects. Instruments created by the researcher often are a powerful way to collect information pertaining to the research questions (Hancock & Algozzine, 2006). The surveys were designed to collect information about current/new developments about the technology that is not captured in the

original description, including the intended use and end-user of the technology, the intended purchaser of the technology; which innovation phase the technology is at; past or anticipated obstacles and enablers in the innovation process (specific to each step - research and development, regulatory process, health technology assessment, commercialization etc.); what resources would help the team through the different phases; and finally what types of people will be involved in the research, development, testing, and commercialization of the technology (e.g. older adults, patients, health care providers). Four surveys were collected, one from each AGE-WELL project/case. The primary function of this survey was to get descriptive content rather than quantitative data. Surveys were examined for face and content validity by members of the PRI-TECH team, but were not otherwise validated prior to use. This is because the surveys are intended to provide basic descriptive information and there were opportunities in subsequent data collection (e.g., interviews) to correct any incorrectly reported information (Appendix L).

4.5.3 Semi-Structured Interviews

Interviews are helpful for obtaining the descriptions and interpretations of others, as the case will not be viewed in the same way by everyone (Stake, 1995). Semi-structured interview approaches are well suited for case study research. With this approach, researchers ask predetermined and flexibly worded questions and in addition ask follow up questions designed to probe more deeply on issues of interest (Hancock & Algozzine, 2006).

Semi-structured interviews were conducted with AGE-WELL project leaders. The interviews were an iterative process, as project leaders were interviewed twice for a total of eight interviews. Most interviews with project leads were done face-to-face, with one of the interviews coinciding with the site visits for observation. When possible, interviews were done with both project leads at the same time. Interviews lasted no more than sixty minutes. Interviews with

project leads helped to answer research questions 1), 1a) and 1b) (Appendices E & F). Additional interviews were conducted with stakeholders specifically to inform research question 1a) (i.e., stakeholders relevant to technology innovation from a policy, researcher or industry perspective in both Ontario and Alberta). Three relevant stakeholders were interviewed for each case (n=12) (Appendices C & D). Informed consent for participation and audiotaping was obtained prior to conducting the semi-structured interviews (Appendix B). The student researcher conducted the interviews with a second researcher, as it was helpful to have an additional researcher to assist with probing questions if clarification was needed and for taking notes.

4.5.4 Site Visits

Site visits for observation at the different project sites in Ontario and Alberta helped to gain more information about the technologies being developed. It also provided an opportunity to speak informally with other project members (e.g., students) and observe their lab spaces. Site visits happened within the academic institution in which the project leads worked; three of the four cases had physical lab spaces to walk through and observe where they test and trial technologies. The other case did not have a physical lab but the researcher was still able to discuss with members of the project about the technologies that they are working on and fill out an observation guide.

An observational guide was developed prior to the site visit, as it is best to have some topics and questions in mind before beginning participant observation (Mack et al, 2011; Hancock & Algozzine, 2006) (Appendix I). Observations often include what is experienced, what is learned through interaction with others, and what is observed (Mack et al, 2011).

4.6 Data Analysis

Understanding the information collected from multiple sources is a recursive process in case study research, where the researcher interacts with the information throughout the investigative process (Hancock & Algozzine, 2006). Case study research involves an ongoing examination and interpretation of the data, as opposed to other forms of research in which the data are only examined at the end of the collection period (Hancock & Algozzine, 2006). This allows tentative conclusions to be reached during the process and for refinement of research questions (Hancock & Algozzine, 2006). In addition to the recursive process described above, a formal analysis commenced at the end of the data collection period and consisted of two phases.

4.6.1 Phase 1

Phase 1 included a directed approach to content analysis. A directed approach can be used when prior research or an existing theory could benefit from further description (Hsieh & Shannon, 2005). Within a directed approach, the analysis starts with relevant research findings or a theory/conceptual framework as guidance for initial codes (Hsieh & Shannon, 2005). This directed/deductive approach was used to both identify if/how the data collected aligns with an existing conceptual framework (the ADOPT model) and to answer the research questions (factors that facilitate or constrain the development and implementation of the AGE-WELL technologies, including policy, regulatory, health system and NCE issues). The data were first coded into the ADOPT framework categories, and then within each category barriers and facilitators were identified in order to address the research questions. Once the data were coded into the conceptual model and barriers/facilitators were identified within each category, a thematic analysis was done to identify the emerging themes within each of the ADOPT

categories (Braun & Clarke, 2006). Phases of thematic analysis include familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes and producing the report (Braun & Clarke, 2006). Data that did not readily fit into the ADOPT categories were identified and analyzed later to determine if they represented a new category or a subcategory of an existing code (Hsieh & Shannon, 2005).

A codebook was developed with the operational definitions for each category/pre-determined code (e.g., what is meant by facilitating and constraining factors outlined by the research questions and the categories in the conceptual framework) (Appendix M). Given the amount of data that were analyzed (survey, documents, observation guides and interview transcripts); QSR International's (2015) NVivo 11 software was used.

4.6.2 Phase 2

Phase 2 included a cross-case analysis of the findings that emerged from the individual AGE-WELL projects. A cross-case analysis helps to understand processes at work across cases (Huberman & Miles, 1994). The researcher compiled the data from the multiple projects/cases to examine the results for each individual case and to observe the pattern of results across cases (Yin, 2014). The collected data was compiled in a table to display the concepts talked about under each of the ADOPT domains within each case, as well as other general descriptive information about the projects. Two researchers reviewed the table to generate the similarities and differences found between the cases.

4.7 Confirming the Case Study Findings

Several frameworks exist to evaluate the rigour or trustworthiness of qualitative data. The criteria appropriate for judging the goodness or quality of the research from a post-positive and

realist position are the conventional standards of ‘rigour’: internal validity, external validity, reliability and objectivity which run parallel to the constructivism trustworthiness criteria of credibility, transferability, dependability and confirmability (Baxtor & Jack, 2008 & Guba & Lincoln, 1994). To ensure the validity or credibility of the work there are several foundations in case study research to achieve this such as: the case study research questions are clearly written, case study design is appropriate for the research question, appropriate purposeful sampling strategies for case study have been applied, data are collected and managed systematically, and the data are analyzed correctly (Baxtor & Jack, 2008). Findings based on evidence collected from multiple sources of evidence (triangulation), as well as strategies such as member checking, help to confirm case study results (Hancock & Algozzine, 2006). Member checking with AGE-WELL projects happened iteratively; during each interaction, the researcher shared what was learned from the previous interaction and/or data collection activity (e.g. survey, interview or site visit) to ensure that interpretations and results matched the understandings of the participants. Member checking with the key stakeholders beyond the network has not happened yet, but will happen with the larger PRI-TECH project to seek feedback about their agreement with the results.

Additionally, external validity or generalizability can be enhanced in case study research by conducting a multiple case study, and by providing a thick description that includes detailed descriptions of things such as the context/situation, setting, the number of participants or organizations taking part, the data collection methods, the number and length of data collection sessions and the time period (Huberman & Miles, 1994 & Lincoln & Guba, 1985). This increases the potential for the reader to transfer the findings to another setting. During the analysis stage, one researcher coded the data, however to promote reliability and dependability of the analysis,

multiple researchers worked together to come to a consensus on categorizing and theming the data (Baxter & Jack, 2008). Finally, throughout the data collection and analysis process, the researcher was reflective and reflexive. An audit trail was kept where notes about changes to the study were documented and the researcher's thoughts, experiences, observations and assumptions were reported in terms of how they may affect the research work (Patton, 2002). These strategies were employed in this research study to ensure quality and rigour.

Chapter 5: Results

Table 2 provides a summary of the data sources obtained for each of the cases:

Table 2 Summary of Data Collection

	Survey	Documents	Interviews: Project lead(s)	Interviews: Other Stakeholders (1 Industry, 1 Researcher and 1 Government representative per case)	Site Visit
Case 1 (Two project leads)	1	2	2	3	1
Case 2 (Two project leads)	1	1	2	3	1
Case 3 (One project lead)	1	1	2	3	1
Case 4 (Two project leads)	1	2	2	3	1
n=7	n=4	n=6	n=8	n=12	n=4

5.1 Sample Description

5.1.1 AGE-WELL Projects

The survey results and information gathered from the AGE-WELL forum helped to characterize and understand the four projects. To ensure that the four projects are not readily identifiable, their descriptions will remain general. The four projects span three academic institutions in two provinces. All four projects have two project leads assigned to the project, (although within one of the projects examined only one project lead was engaged in this study, for a total of 7 project leads), a project coordinator and a team of trainees including Masters, PhD

and Post-Doctoral Fellows. Project leads had expertise in many disciplines including clinical practice, engineering and design, computing science, health informatics, and public health. The types of technologies being used/developed in the projects range from smart devices, wearables, web-based games, and sensor systems, all with different aims including supporting functional autonomy and independence, preventing or reducing disease and disability, and maintaining good mental and cognitive health. All four projects have subprojects, meaning they are not just working on one specific technology solution; they have many ‘products’ that they are working towards developing. The following table summarizes some of the survey question answers to help characterize the four projects:

Table 3: Summary of Survey answers to characterize the four projects

Survey Question	Case 1	Case 2	Case 3	Case 4
Q3: The intended use of your health technology is to:	Diagnose, mitigate or prevent a disease, disorder, or symptom Screen or assess	Mitigate a disease, disorder or symptom Promote healthy behaviour	Diagnose, or prevent a disease, disorder, or symptom Screen or assess	Screen or assess Promote healthy behaviour
Q4: Does your health technology use software? If yes, please indicate if your software is involved in:	Data collection, monitoring, analysis, and editing Image generation/ Identification of a region of interest Determination of measurements Identification through an alarm if results are outside of a range	Data monitoring and analysis Image generation/ Identification of a region of interest Identification through an alarm if results are outside of a range	Data collection, monitoring, analysis, and editing	Data collection and monitoring
Q5: The intended end-user of your health technology is:	Informal or family caregiver, older adults, community care/home-care workers, long-term care staff, health care	Informal or family caregiver, older adults	Older adults, community care/home-care workers, healthcare provider (primary care physician)	Informal or family caregiver, older adults, long term care staff, healthcare provider (e.g. PT/OT, exercise therapists, physicians nurses), Other:

	provider (community care nurse/physician)			housing providers and administrators
Q6: The intended purchaser of your health technology is:	Health region/health authority, hospital, long-term care, home/community care, consumers	Long-term care, home/community care, older adults, informal or family caregivers, consumers	Health region/health authority, long-term care, home/community care, older adults	Health region, long-term care, older adults, informal or family caregivers
Q7: Which phase is your health technology at?	Research and development Health technology assessment	Research and development	Research and development	Research and development
Q11: Who will be involved in the research, development, testing or commercialization of your health technology?	Older adults, patients, healthcare providers (community care nurses), manufacturers	Older adults (individuals with dementia/mild cognitive impairment), patients, informal and family caregivers	Older adults, healthcare providers (potentially primary care physicians or related specialists)	Older adults, informal and family caregivers, healthcare providers (physiotherapists, occupational therapists, exercise therapist, nurses, physicians, administrators of facilities and organizations that provide housing and care to older adults), manufacturers, University students

Further, projects identified to what extent they feel prepared to navigate various innovation processes:

Table 4: Level of preparedness for different innovation stages by case

Survey Question	Case 1	Case 2	Case 3	Case 4
Q8: To what extent do you (and your team) feel prepared to navigate each of the following phases:				
Research and Development	Very well prepared	Very well prepared	Very well prepared	Very well prepared
Regulatory Process	Somewhat prepared	Not at all prepared	Somewhat prepared	Not at all prepared
Health Technology Assessment	Moderately prepared	Not at all prepared	Very well prepared	Moderately prepared
Commercialization	Somewhat prepared	Somewhat prepared	Somewhat prepared	Not at all prepared
Marketing	Somewhat prepared	Somewhat prepared	Somewhat prepared	Not at all prepared
Procurement/Adoption	Not at all prepared	Somewhat prepared	Moderately prepared	Not at all prepared
Reimbursement	Not at all prepared	Not at all prepared	Not at all prepared	Not at all prepared

All groups feel most prepared for the research and development stage, while all groups felt they were ‘not at all’ prepared for the potential reimbursement phase. A more detailed table of survey answers can be found in the appendices (Appendix N).

5.1.2 Additional Stakeholders

The twelve additional stakeholders who were interviewed beyond the projects belong to three different groups: government (n=4), industry (n=4) and researcher (n=4). The stakeholders who were interviewed are not directly affiliated with the projects, however were selected due to their relevance to the cases (e.g. context Ontario/Alberta) and their knowledge of the medical/health technology sector in Canada. The government stakeholders who were interviewed have experience in the health technology sector in Canada and cover three different areas: community, provincial (Ontario and Alberta) and federal. The industry stakeholders who were interviewed span both Ontario and Alberta and have expertise in a variety of areas, including: non-profit organizations that help with technology transfer, commercialization, advocacy and education around medical/health technology, research and innovation consultancy at a rehabilitation facility, and leadership in the global medical technology industry and health research commercialization in Canada, the US and the UK. The researchers are from both the Ontario and Alberta context with expertise in innovation procurement, health technology assessment, health policy, medical devices, and information technology systems.

5.2 Phase 1: Qualitative Findings

A directed approach to content analysis of the interviews, documents, surveys and observation guides within the ADOPT model and the subsequent thematic analysis identified themes within the ten domains of the model (Design User-Friendly Relevant Technology,

Establish Technology Value, Create Business Model, Promote Technology, Form Partnerships, Identify Technology Champions, Coach Users, Context, Older Adults, and Collaborators) plus one additional domain (AGE-WELL) that is a unique category that emerged from these cases. Barriers and facilitators were identified under each of the ADOPT domains to answer the main research question: *What factors facilitate or constrain the innovation journey (from development to implementation/adoption) of these AGE-WELL technologies?*

Sub research questions are addressed throughout many domains but mainly research question 1a) will be answered in the ‘Context’ domain (*How do policy, regulatory and/or health system issues in Canada facilitate or constrain their innovation journey (from development to implementation/adoption?)*). Sub research question 1b) is primarily answered within the newly identified AGE-WELL domain (*How do participants perceive innovating within the AGE-WELL NCE as facilitating or constraining the innovation journey (from development to implementation) of these new technologies?*). The themes described in the sections below were developed by looking across all interview transcripts, documents, surveys and observation guides to gain the perspective of all informant groups and materials collected. Additionally, each project was coded separately so that comparisons could be identified between cases in phase 2 of the analysis. It is important to note that because the projects were and are fairly early in their process, some commentary on the research questions was forward thinking in terms of facilitators or barriers with the project or in general terms based on their experiences.

Themes identified within each of the ADOPT domains/categories: Barriers and Facilitators

5.2.1 Design User- Friendly Relevant Technology

Theme 1: Designing for the end-user

A facilitator identified in this theme highlights the importance of the end-user being involved not only in the idea generation but also in the development itself to avoid technology that is irrelevant or built as a one size fits all solution for the individual or group that is going to use it:

“It's becoming more and more obvious in all areas of research, but you have to involve the ultimate user...The ultimate user does not only have to provide some ideas. He or she, or it, if it's a ministry or a health service provider, has to be part of the development itself. If not, they, it, will not conclude the same way the researchers would.”
(Stakeholder-Researcher)

Similarly, many participants talked about the need for designing easy to use, personalized, tailored and customizable technologies that align with the individual's physical location, personality, state, and physical condition. For example, Case 4 talked about physiological differences that may impact the way older adults use technology:

“...reaction times are different, precision and movement is different so when you're talking about touch screens, you know it's – it's much more difficult when you're not precise and you may have tremors so you may have arthritis. Uhh, so there are many physiological things, physiological parameters that are never discussed when you are doing usability status with normal people quote unquote. If your normal people are first year psychology students, you ain't seen nothing yet.” (AGE-WELL Project Lead)

In addition, participants talked about designing assistive technology within the trends of the market (e.g. smart phones, iPads, video games etc.), as this may help to not stigmatize people based on disability or condition. It was suggested that these simple and widely used technologies, such as Skype and iPads might even be the most relevant and user-friendly.

Another facilitator is understanding that designing technology requires constant refinement and is an iterative process. Case 1 talked about the process of testing the technology out on a 'dummy' first, then with students, and then with real patients, describing this as an organic process. Similarly, at the Case 4 site visit they described testing technologies out on

students first, then standardized patients and then trialing it with real patients (from field note Case 4: *First they want to know “does it work”; test it out with students; test it out with standardized patients and then trial it at x hospital*). Along the same vein, Case 3 identified, through a review on smart devices for older adults, that it is important to have a risk mitigation strategy when trialing technology with end-users. Technology failure is unavoidable, so it is helpful to have a strategy in place to keep motivations and positivity high when using technology.

A main barrier that emerged within this theme is the recruitment of community research participants, especially older adults. All projects talked about the difficulty of finding older adults to engage in the technology design and trialing process, even for simple processes such as interviews. The Case 2 project lead discussed this as a slow and laborious process, and described a need to have connections or a dedicated partner that can find and manage these relationships:

“... at the end of the day it’s like engagement with end-users that seems to be the thing that is not working very well at all, so...Yea I think it’s finding the participant pool but I think it is a bit more than that it’s...I think I am lacking a good partner in trying to take care of that whole aspect of the research I think the bottom line is that setting all that up and maintaining it is a BIG effort right? And it requires somebody who that is their research focus...doing that user engagement stuff...”

Ultimately designing for the end-user and recognizing the willingness to accept the technology/solution before moving on with the research is critical, as is recognizing that technology solutions may not be for all older adults as it may not be an intervention they are willing to integrate into their lives. The Case 3 project lead talked about this idea in terms of prioritizing and figuring out which problems can be solved through technology before moving on with the research:

“...but for AGE-WELL in general right like we are trying to apply technology to solve aging problems, we won't be able to solve all problems, so I think it is important to identify which ones are solvable, prioritize right and um like technology and older people usually don't go hand and hand as I said... if older people are not willing to wear these...devices in the first place, the rest won't come right we cannot even collect data, we cannot, what's the point of developing algorithms that will tell you blah right because we can't even have them wear these devices in the first place.”

Theme 2: Complexity of designing and trialing technology in different settings/contexts

Complementary with the first theme, a challenge identified within the design process is moving the technology theory from the lab, to the reality of trialing the technology with real people as the context and settings are much different. A project lead from Case 1 talked about this challenge:

“It is sometimes a challenge when you go from the lab which is a very friendly environment, the students are highly motivated, were very motivated, you know we have a lot of freedom, we have space, we try things, we play with them and that is great for innovation and creativity, when it comes to doing the next step, which is proving that it works in real life, it is a lot messier”

This is particularly true when thinking about trialing new technologies with older adults who may have multiple health conditions:

“...the reality of very frail older adults that have multiple health conditions we can't do a 100 tests on, so when you try to bring sort of the theory from the lab, it's a very friendly environment where almost anything can be done to the reality of a complex environment like the hospital...” (Case 1: AGE-WELL project lead)

Similarly, in moving from the lab to the reality of trailing technology with real people, many projects talked about the challenges of obtaining ethics and having research ethics boards understand research studies that involve people and technology:

“...it's not that research ethics boards are difficult, they have a very very important role to protect people from crazy scientists, and I totally understand that, it makes perfect sense, but the process to design a study in a way that you think you can sell to the research ethics board and then to involve real patients and real clinicians, it's not at all an easy thing...” (Case 1: AGE-WELL Project Lead)

Another project said:

“...and then ethics, um, I’m sure a lot of, AGE-WELL researchers have gone through this, when we actually apply the technologies to real people and we have to go through ethics, um, at university, more often than not this is the first time the ethics committee has dealt with it. It’s hard enough for even AGE-WELL researchers to understand each other’s work when we’re not in each other’s area of technology but for an ethics committee consisting of people who have no knowledge whatsoever, all they know is that they are being monitored, there’s tech, there is information...” (Case 4: AGE-WELL Project Lead)

Beyond the complexity of working with real people, once a technology is moved from the lab there is the challenge of designing and re-designing for different settings as information will travel differently and the physical space will differ depending on where the technology will be used (e.g., in the community versus in the hospital):

“...we have to redesign it because in the community the information is going to travel differently than in a hospital. In a hospital....we were fortunate, they were doing some construction anyways, so we actually put a computer in the ceiling in a storage room and we ran cables all through the ceiling down into people’s rooms so there was nothing wireless. It was all completely connected. But that only happens once every 25 years that a hospital gets renovated and that you happen to be there with technology that they can plug in. In the community, obviously, there’s other challenges. We have to redesign it. We have to look at wireless or whatever. Where does that information go, where does it get analyzed and all those things....” (Case 1: AGE-WELL Project Lead)

Similarly, it is important to think ahead about all the moving pieces of the technology when in the design phase to avoid delays and frustrations:

“...so this group came to us....they have a great idea, it’s really what people need in the community but their expectations were that, they tell us about it, we write up a small protocol, we submit it to research ethics and within a month or two it is in people’s homes... well we have been working on that for eight months because there were little little pieces missing like how does the information go from the person’s home to the cloud, what kind of data is there, how can we use that data, how do we know how frequently the sensor is actually measuring what it is supposed to measure, what does that mean to what we think is happening in the person’s home, so all these little things came up and this created frustration because the other people said ‘no no we don’t want to do all that, we just want to like plug it, tell us its good and we can distribute it’ but that’s not the reality...” (Case 1: AGE-WELL Project Lead)

Other projects talked about design considerations being different in a personal home versus in long-term care facilities as there are many older adults and care staff walking around the long-term care facilities and this may affect design considerations for technology. Other practical infrastructure issues were raised during the site visits with Case 1 and Case 4 such as knowing where plugs, control, and power panels are when bringing technology into new settings (e.g. field note from Case 1: *Not enough outlets in the hospital (other considerations-hospital standard extension cord; hospital safety requirements)*).

Theme 3: Connections and communication to build technology that is more relevant

A facilitator identified in this theme is the importance of working in a transdisciplinary way, this idea of a continuous partnership to incrementally work on designing a more relevant technology solution, for example between somebody in a clinical field and somebody in an engineering or computer science field:

“I think the idea that you take different disciplines, which the whole trans-disciplinary idea is that you take different disciplines, you bring them together, you all learn together, and as you learn together, I start thinking more about why this won't work from an engineering point of view. He's thinking more about ... even though this isn't the greatest sensor ever, it's not going to be necessarily fitting into a hospital setting, because we've rubbed off on each other.”(Case 1: AGE-WELL Project Lead)

Similarly, the Case 4 project leads talked about the relationships between their students who are paired up from different disciplines:

“There is a lot of crossover which is great. They, we are seeing sometimes going to a conference or watching the students interact, we are seeing that um, right off the bat, it may not be obvious to the uh, listener whether this person is a health professional or a computing scientist and we, I, I'm very proud of that because it meant that we are starting to see language and communication crossing over.”

Further, staying abreast with what other fields are doing was seen as facilitative:

“...every field knowing what’s doing in the other field or engineering knowing what the problem is, and then knowing from psychology what is the acceptance of the technology going to be with industrial design, and user-centered design, and human computer interface, to try to... build the right interface for it as well...”(Case 1: AGE-WELL Project Lead)

Lastly, in order to design user-friendly relevant technology, talking to the end-user, for example a health care organization to understand their priorities will help create technology that is more relevant and adapted to a particular need:

“Instead of a technology push, it’s a technology pull. Because the user is pulling the technology exactly where they want it to be, instead of a vendor or even a researcher trying to push technology where they think it should be but might not be where the user might think it would be” (Stakeholder- Researcher)

Theme 4: Resources

The final theme identified in the first ADOPT domain ‘Design User-Friendly Relevant Technology’ is centred on resources. For example, Case 4 identified in their survey the challenge of limited budgets especially for research that involves patients or people in the development of the technology, as the time it takes to develop, deploy, test and improve the product can be longer than the funding period provided by an agency or university. Case 3 also identified in their survey a limited budget as a barrier in the research and development stage which can especially be challenging if there are negative study results or worse than expected performance in the initial stages. Additionally, Case 1 talked about the expense of expertise that may be needed for example, many start-ups do not have a physician on staff because it would cost too much money. Finally, through observations via the site visits, projects that have labs to trial their technologies (Case 1, 2, 4) seemed to appreciate a dedicated space to trial technologies with their students, standardized patients or ‘dummies’ first before bringing them out into the ‘real world’ (e.g. field note from Case 4: *Having a dedicated space to trial technologies out was seen as facilitative by various members at the site visit*).

5.2.2 Establish Technology Value

Theme 1: Early conversations about value and knowing what data to collect

Challenges with establishing technology value start with the difficulty of designing an evaluation. In particular, knowing if you need to do a randomized controlled trial or not, as well as the costs associated with this. There is variability in evidence requirements between regulatory bodies, formal health technology assessment bodies and organizations that will potentially purchase the technology, which can be confusing for innovators:

“I don’t know if you found the same thing but man oh man you talk to one person and they’re like yeah you have to do randomized controlled trials you talk to another person no you don’t need to do an RCT like there is a lot of variability...” (Government-Provincial Ontario)

Additionally, there are challenges in understanding and choosing the correct health outcomes or data to measure. For example, this stakeholder talks about a group outside of AGE-WELL that trialed their technology/product in the hospital but only recorded the presence or absence of pressure ulcers, when there was other data that would have been important to collect to determine its value:

“What the problem was is that they did a six week study of patients on (product), but what they didn’t do was they didn’t calculate the number of minutes the nurses spent putting these things on or off; they didn’t calculate whether these patients were still rotated or turned. So, in other words, what was also happening to these patients? The fascinating thing is that there were no pressure ulcers in the entire six weeks, which is huge when you consider the number one cost item to long-term care facilities are pressure ulcers. So phenomenal idea, but made it look like it was kind of useless because they didn’t collect the right information...” (Stakeholder- Researcher)

Not only is knowing what health outcomes to measure or collect important, but also the timing of when to collect this data:

“Do you know what data to collect? Depends on where you are on this readiness scale. I mean, the beginning, none of this is relevant because, as I told you, things are not robust there’s no point in actually harassing the nurses for something that’s not there...”
(Case 4: AGE-WELL Researcher)

Knowing what data to measure or collect can be particularly difficult for these AGE-WELL projects as one project lead from Case 4 talked about the divide between the evidence that the ‘real world’ wants versus what academia wants:

“...So there’s this – this pendulum thing between what the real world wants which is robustness and boring in terms of research. And what the publications want, which is, you know...a whole lot of whisker plots with lots of noisy data, but you have your averages and means and they’re nice.”

Further, it can be difficult to translate metrics into real value, many key questions were raised by participants on determining the value, for example: does your technology help increase the case-load of a nurse but help triage patients more effectively? Does it help reduce caregiver time with the patient? Does it increase how far the patient can walk and what does that mean for the patient; can they now open the door or do other tasks they could not before? In addition, what if your technology helps to prevent falls, how do you prove savings through prevention without doing a long-term statistical analysis?

These difficult discussions around value and knowing what data to collect are important to think about early on in the innovation process. Early conversations with whomever is responsible for making decisions on technology adoption and what their evidence expectations are is extremely important, along with understanding if you are going to need stakeholder buy in, in terms of being a part of the evaluation (e.g. nurses, helping with recording information throughout the day):

“So talk to the rehab centers, talk to the folks who make the decisions regarding what they are going to spend money on and what they’re not and what they look for in terms of

what's good value and what isn't. So, you know in rehab hospitals, at least in Alberta, it's not that they would do a formal health technology assessment but they certainly want to know what they're getting for their spend. So it might be important to talk to the CEO or talk to whomever is responsible for making those decisions around what technologies they bring in and see what their evidence expectations would be.”(Stakeholder-Researcher)

Beyond technology that may be used within an organization, in-home technology or wearables have the potential to have value but it will be important to demonstrate the utility of these types of devices, particularly if the information/data generated can be used to determine appropriate interventions, when they should occur, and whether or not health care outcomes have improved:

“In-home technologies I think are going to be key, and that's everything from new types of sensors, to how they architect, how you can collect the information...what's important is, what you can do with that information. What interventions are you going to put in? That's an area, we don't have the data yet to allow us to assess whether or not there's an appropriate intervention and when the intervention should occur... if you can monitor someone's activity, or balance, is there a certain point in time, can you identify something from the data that says their increase of falls just shot up dramatically, because of something? Can we intervene? Can we send someone in there to provide some rehab, or provide some exercise services, or something like that? We don't have the data to give us early indicators...” (Government-Community Ontario)

Finally, a facilitator within this theme is understanding that measuring outcomes and value happens incrementally. This idea of working on things in smaller pieces, small sample studies, and continuously finding better applications for technology and then eventually scaling up to larger populations. Because many of the projects were/are in the research and development stage they talked about this concept of working incrementally on smaller pieces to gather information that would help them move on to the next stage, recognizing that establishing value does not happen overnight.

Theme 2: Cost-savings in the context

Depending on where the technology is implemented there could be unintended costs generated from the technology, as well as implications to workflow. Two examples illustrate this:

“...Depending on how it’s implemented you may just increase your costs... if it’s done well you’ll get the benefits but a lot of the times the benefits are obtained outside of that area. I know our diagnostic imaging folks they appreciate all our efforts to reduce our length of stay, for instance. So a lot of tests or technology will promise a lower length of stay. So even if that’s true, that department or that unit with those beds aren’t going to reduce the number of beds, they are just going to see more patients come through which is good. On the other hand, for diagnostic imaging often it’s the exact same work-up no matter the patient. Alright, so say you have 100 patients a year instead of 80 patients a year, so they’re now doing a 100 of those work ups...So their costs go up elsewhere which is what we’re after but that’s not budgeted or factored into it or it can create waitlists for those services if it’s not managed well. The cascading implications of changes in workflow is one of the things I think we need to get better at, around the operational impact of the technologies. A lot of times I’ve heard industry say ‘if you keep doing it the way you’ve always done, where you just give them the new tool and new technology, you’ve done nothing to improve it.’ So you have to change how you deliver the care and that’s hard, that’s really hard...” (Government- Provincial-Alberta)

“...When a new device comes to the market, they need to be able to demonstrate clearly what its benefits are, how it will help the healthcare system, and how the healthcare system can reap benefits from that device... One example that we use all the time is cataract surgery where you have a new procedure as a result of a new laser surgery, we have a new device that helps you to...that has clear benefits for the patient, it ensures a less invasive surgery, recovery time is better. It’s a plus, plus, plus, but when it was put into the system, they kept paying the ophthalmologist the same price for the procedure as when it took him or her an hour or two hours to do the procedure. All the benefits of the technology actually went to the practitioner, and the healthcare system did not reap any benefits...” (Government-Provincial-Ontario)

This idea of establishing value when cost is incurred by one entity while savings are seen by another entity was also talked about by the project leads from Case 1 who gave a concrete example with a type of technology that may be used in the community to help older adults:

“Sometimes you have a new approach or a new technology that everybody agrees, no single one disagrees, that this is very, very helpful to people. It will save a tremendous

amount of life, and it will provide better care. You would think in a regular market environment that this would sell really great, but the problem here is it saves money to entity A but entity B has to spend money...the CCAC¹ buys fall detection equipment. The people don't fall, the fall was prevented. Where the money is saved is in the emergency room because that's where they're not going."

Many of these issues stem from our health care system which is focused on cost-containment and the impact of siloed budgets:

"...Another huge barrier is the silo funding that you can bring forward an innovation that will actually cost the purchaser of it, like say the operating room, a lot more, but it will have the patient home in two days, not two weeks. Well that should be adopted immediately from a system point of view, but the OR's only got a fixed budget. So you can replicate that over homecare and healthcare and long-term care so long as you have these highly siloed funding where people have got a fixed budget and their goal is to find, you know, buy whatever they absolutely need for less money than they paid the year before. That's the antithesis of an innovation program..." (Stakeholder-Industry)

One of the facilitators to address the challenge of unknown implications of technology in a particular setting, as one of the industry participants discussed, are policies that allow for trialing technology for a certain amount of time before buying it, or concepts like risk-sharing where the company is not paid until the results are seen of the value they suggest the technology provides. This allows the people who are going to use the technology to determine the value for themselves. In addition, related to the first theme, having early conversations with organizations about potential value and recognizing that some of these technologies require a whole new way of thinking and doing business was seen as an opportunity:

"Well, you have to encourage these kinds of discussions when you try to sell your device. Tell the hospital what you're working with... that once you adopt this technology, there are savings by doing this, by changing perhaps the fee codes for a procedure and things like that. To go beyond...sort of like the IBM model where it's a business transformation exercise. You're not just selling the photocopier. You're selling a whole new way of doing business, so that you can really save. Normally in other industries, if you look at the aviation industry, automobile industry, when you use more technology, it creates savings and you have more... you can buy a car now at a more reasonable price with more

¹ Community Care Access Centres (CCACs) coordinated home care and long-term care placement in Ontario

features to it, and the manufacturer makes more money with it. You have to adopt this type of thinking when bringing in a new technology. Health has to start following this sort of model... ” (Government- Provincial-Ontario).

Theme 3: Considerations beyond cost

The last theme under the ADOPT domain ‘Establish Technology Value’ highlights the importance of looking beyond what the health care system will buy and understanding what the well-informed consumer will pay for. For example, technology can show value not just through cost-savings but by removing burden from family caregivers:

“Yea I guess the (technology) is going to show value by removing burden from informal caregivers I think, so people are able to put it in their homes and then like oh yea this allows me to sleep through the night because I don’t have to get up in the middle of the night to help my wife find the bathroom. Then my life, my quality of life, the quality of the informal caregiver’s life is improved right? Just because of this reduction in burden, so that is not really a cost thing...” (Case 2: AGE-WELL Project Lead).

Additionally, other facilitators, which were discussed by many participants, center on the shift to value-based procurement, the idea of looking at other long-term factors of success and patient preferences instead of only the upfront cost of the technology.

5.2.3 Create Business Model

Theme 1: Resources and expertise

Many of the AGE-WELL projects had not started to think about their business model throughout the process of data collection for this project. Many felt it was too soon, as they were still conducting preliminary research, or talked about their lack of capacity to commercialize, lack of business expertise, and lack of desire to develop their own company. Some of the projects talked about filling out a business model canvas as an exercise but did not find it overall very useful, for example:

“You know we went through the exercise with a workshop...and I started doing the business canvas maps and that stuff, but really, I don’t think that it is truly meaningful uhm I could make it up...but practically speaking, this business canvas doesn’t mean anything if you don’t have anybody who means it and I certainly do not mean that I’m gonna do a company. I’m not gonna do it, I just know I can’t. I don’t have the capacity...” (Case 4 AGE-WELL Project Lead).

Some of the projects talked about potential industry partners as outlets to the ‘real’ world, but it is still too early in the process to determine how these relationships may evolve and how the technologies might be commercialized.

Commentary from the stakeholders beyond the projects about business models centred on examples of technology companies that were unable to put together the business and economic pieces for their technology, for example:

“...because you mentioned home monitoring, in our research we’ve looked at one spinoff that created home monitoring and what really hit this spinoff very hard was that they could not articulate a business model, it was really hard for them, they had a great team, they really worked closely with clinicians and, the whole idea was to reduce unnecessary hospitalization and, emergency room visits, so two things that we would love to be able to address, and at the same time, they really struggled to find who’s going to pay for this system” (Stakeholder-Researcher)

This may be a particular challenge for some of the AGE-WELL technologies and require business models that are rethought entirely:

“...that was puzzling to me... if the hospital has a strong incentive to reduce hospitalization and unnecessary emergency room visits, could they create a business model in which, for instance it could be a monthly fee based on hospital utilization data to adjust what should be payed to the company offering the monitoring system, so I think we need to rethink how economic value could be first measured and I think the business model will be the biggest challenge for several of the technologies you mentioned if the technology is not costly and, small, residential or hospice type of care, organizations could buy it, then it’s a matter of how do you convince this organization that the device will pay off, and this is where it’s tricky because, if you make the argument that the technology will reduce the need for a nurse, nursing staff or a number of people taking care of the elderly, I think you are entering a very dangerous zone because what you do is put the technology against human-delivered care and you put this in tension with how human resources are managed...I would be very careful, I know it will be tempting to do what will save costs, a bit like they did with telemedicine in the nineties, they said that telemedicine will reduce costs, it will reduce geographical barriers and so on, they said

the same thing for computerized medical records, and, what we know from research is that, information technology may reduce some costs, but it adds to other costs and it's not less people intensive, um, you still need people to, to provide home care. I think there is a need and AGE-WELL might be an exemplar on, for doing field work around those devices creating categories of potential devices that would, some of them, might be in need of a business model that is re-thought entirely..." (Stakeholder-Researcher)

Finally, many key considerations for a business model have been covered in the previous domain, 'Establish Technology Value', such as understanding financial/budget constraints for potential purchasers of the technology, and understanding the financial or other benefits of the technology for the purchaser.

5.2.4 Promote Technology

Theme 1: Awareness of the types of technology

One challenge identified within this domain is being aware of what types of technologies are available as there are many different technologies on the market:

"One of the barriers would be access to information about what technology is available. So just even knowing...people just don't know that they are available, even when things are on the market and how to access it...you can say well just go and google it, but I don't even think seniors think of that as a strategy and even if they do I'm not sure that they actually trust what is on there...vendors upload them, so it's been very vendor-specific right? So there is no real, um third party or filter that actually screens right? So lack of information..." (Case 4: AGE-WELL Project Lead)

A facilitating opportunity that was identified was to develop some sort of registry of potential technologies, for example of home care technologies that could be deployed.

Theme 2: Transparency of the function of the technology

The second main theme that relates to this domain is how technology companies promote themselves. One challenge for regulators and innovators is determining whether or not the technology falls on the medical side or health and wellness side. With many new emerging

technologies, this may be a grey area and it often comes down to how the company/product is promoted:

“That’s what it really comes down to, is how the manufacturer, represents the product in terms of labeling, website, promotion material, the whole spectrum. We take all that information into consideration and then determine whether or not it qualifies under the regulations. A lot of the emerging general health and wellness-type technologies that we’re seeing, that’s a big challenge right now for us to determine on which side of the fence those land. A lot of it is certainly geared towards the mobile, medical device applications, but there’s also the wearable sensors and things of that nature that are...it’s tricky...” (Stakeholder-Government-Federal)

Further, it is important for innovators and developers to be realistic about their technology product, and what it is used for. It is better to be forthcoming and upfront in their representation of it as it makes the regulatory path clearer:

“I have just one quick thing, back to the classification piece. It’s just looking at it from the developer’s side or the innovator’s side. I think one barrier is them being unrealistic about their product and what it’s for. We often see the representation that we get is different maybe than how it’s being represented...similar technologies being represented in other places by other groups which is a challenging endeavor for us. It’s like, “Where does this sit? Is it or is it not a medical device?” ...If they’re truly realistic about, and truthful about what their product is for...because the companies that are realistic, upfront and really know where they’re going, then we can really clearly define the regulatory path. It’s the ones that are...They sit on that fence that it’s uncertain. Then they experience the regulatory drift or different interpretations down the line, because they didn’t do the work upfront or they weren’t really forthcoming up front.” (Stakeholder-Government-Federal).

Lastly, there was commentary on there being many consumer-directed type technologies but no guidance on which ones are appropriate or good to use and reluctance from providers to promote any off-the shelf devices.

Theme 3: Marketing

Marketing was not talked about very much by participants but was brought up as a potential obstacle in the future in terms of cost, and the packaging/delivery of the final product.

Because none of the projects are at this stage yet, this will likely be explored further as the projects progress.

5.2.5 Form Partnerships

Theme 1: Navigating relationships with health care systems and health care providers

If a technology will be used in a health setting by health care providers, or would benefit from clinical expertise, it may be challenging to navigate these relationships and partnerships. To start, during the Case 1 and Case 4 site visit, many talked about the difficulty of gaining access to clinicians to get their expertise and even if access is possible, it can be difficult to sustain a committed partnership, as long-term attention to the project may be needed. Additionally, it can be challenging to form relationships with providers if they have negative reactions to the technology or if they do not see trialing or engaging with the technology as part of their job:

“One of the big obstacles...is fear, fear that the care staff have about technology. They envision it very differently from what it actually looks like...where the initial reaction is very negative and essentially they think you’re building something that’s going to steal their job from them.” (Case 2: AGE-WELL Project Lead)

Further, Case 3 discussed the challenges of getting the attention of different health care organizations as research may not be a top priority for them, they may not have sufficient resources or capacity to begin with, and processes such as obtaining data transfer agreements, for example, with a home care agency, can be time-consuming. Another barrier that was discussed by one of the government stakeholders is the miscommunication that can occur between the different fields of business and health, for example:

“I think the other barrier that I’ve heard is that, in some cases, there is healthcare organizations that will ask for all this evidence and all these hoops to be jumped through and in the end it was just them trying to give a soft no to the company, but they just bring up tons of barriers... because they’re like “look we can’t take you on but we are not allowed to say no”...I’ve been following up with what I’ve been hearing sort of

frustrating stories from companies and have actually gone back to (x organizations)...checking um you know what's the issue and they're like... "we don't think they're actually hitting the mark on what we value...we tried to tell them that, so we just told them that they had to demonstrate more value and blah blah"and then the company interprets that as them requiring more evidence...my role right now is being kind of like a government relations personnel on behalf of these smaller companies that maybe aren't sophisticated enough or can't afford to invest in government relations full time, so you know I hear certain words in the healthcare space and I understand what they mean "no", but in business language that's not a clear no because they're used to hearing no because no is an ok thing to say in business" (Government-Provincial-Ontario).

Facilitators identified within this theme that help to address some of the challenges mentioned above are programs or people that help with linking clinicians and start-ups, as well as capacity-building and brokering in health care, for example:

"...connecting receptors to help delivery organizations to choose technology directly... brokering and facilitating and a lot of capacity-building, in hospitals and retail pharmacies, long term care homes and CCAC's to help them understand innovation, do innovation, work with start-ups and have a structured process to test pilots and then ultimately procure technologies..." (Stakeholder-Industry).

Theme 2: Leveraging expertise

Varied expertise is needed during the innovation process. For example, early engagement with regulatory authorities is needed to understand what the obligations are for the technology:

"...what's working well as it pertains to innovators, people that are coming out with these new technologies, I'd say what you're involved with which is early engagement with regulatory authorities and asking the right questions to understand the obligations of an innovator who's entering into this space that's maybe uncharted territory for them. They might not be looking long-term about aspects related to regulations, uptake, and reimbursement. They're more focused in on the development aspect of things. Again having those early discussion and developing a regulatory strategy early on in the process is something that is very positive." (Stakeholder-Government-Federal).

Similarly, Case 4 talked about bringing in insurance companies or third party payers, for example, to an AGE-WELL conference, instead of every project figuring it out on their own.

Having industry partners to help move innovations along and university commercialization offices were seen as important partnerships to form to leverage their expertise. These partnerships may be particularly important for the AGE-WELL projects if they do not have expertise in these varied areas, as many of them are researchers and may be focused predominately on the scientific problem:

“I mean, it is nothing simple to start a new company and even launch a new project etcetera...so all these things are outside of my expertise and as long as I have access to the people who can help me and you know universities those provide some of those people especially at (University Commercialization office) for example but um even when it comes to market research like is there room for a product like this? Because when I do scientific research I am not really thinking about that I am just thinking about the scientific problem, but even if I come up with a perfect solution is there even a market for it? Well I don't know...” (Case 3: AGE-WELL Project Lead)

Partnering with other countries with good models to learn from was also seen as a facilitating factor:

“I'm a strong believer in international collaboration, putting Canada as a full member of many European initiatives. Why European? Because in Europe they developed, better than anywhere else in the world, joint programming initiatives, where different countries come together and there's calls to look at different things. These calls or the application, the rule is they always have to comprise researchers from at least three of the participating countries, so it forces collaboration...the one in your area, it's the Joint Programming Active Assisted Living. This one is special because each application has to include industry and small medium enterprises...so this is really kind of an innovation community, but internationally oriented.” (Stakeholder-Researcher).

Theme 3: Specific setting or program to facilitate partnerships/working synergistically

In conjunction with the above theme, great ideas can go nowhere if you do not have the right people together. Many participants brought up the importance of creating innovation communities, hubs or ecosystems to facilitate face-to-face opportunities to meet potential collaborators, working in a synergistic way with different disciplines and helping translate ideas into permanent products:

“Well, you have to create a community, an innovation community, where you have the researchers, you have potential industrial partners, because SMEs² might be in there, or big companies. You have users, you have clinicians, you have health service providers, and you have policy makers. If you want it to be working, let's have it run by the policy minded...” (Stakeholder-Researcher).

Another participant said:

“The beauty of what ... sort of a hub concept would be is we'd have a whole group of clinicians, a whole group of engineers, academic engineers, a whole group of engineers that have companies that know how to make things ... take the proof of concept and build the prototype and get it to market. If you bring all those people together, hopefully we all will get better at translating what we're doing academically into permanent products.”(Case 1: AGE-WELL Project Lead).

Particularly in terms of the device side (compared to pharma), there is a lack of communication across the ecosystem because of the number of players involved:

“The difference that I see between pharmaceuticals and devices is just the ecosystem and the lack of communication across the ecosystem because of the number of different players that are involved. There's not a poll from the healthcare system right now saying “Here's what we really need.” On the one hand you have companies or academics working away on something that they think is cool. Then on the other end of the line you've got people who are like, “Well, it might be cool, but it doesn't actually help me solve the problems that I have right now.” Then in the middle you've got the regulator who's going, “Well, here's how I classify it and will approve it” ... I think there's a lot of room within the devices industry and the ecosystem at large for better communication between patient groups, the healthcare system, the reimbursers, the regulators, and the companies to sit together to try to achieve a list of the ten priorities for the healthcare system and see if there's a way for everyone to move together...” (Government-Provincial-Ontario)

The AGE-WELL NCE was also described as a good vehicle to form partnerships and encourage interdisciplinary working as there are face-to-face opportunities, for example at the AGE-WELL conference every year to meet potential collaborators who are doing similar work. Further, the nature of NCE funding allows for interdisciplinary working, as opposed to the natural funding system for Universities that tends to be very siloed. Some projects talked about

² Small and Medium-sized Enterprises

the synergistic partnership with their co-project lead, as they rely on each other's expertise to continuously come up with, and refine, solutions that are more relevant. Additionally, some spoke about the importance of their students and the different multidisciplinary perspectives that they bring to the projects.

A program trying to bring together multiple groups to form partnerships in Ontario is called the Health Technology Fund, which supports health innovation teams (interdisciplinary and collaborative teams of providers of publicly funded healthcare services, technology partners and academic researchers) in pre-market evaluation and early adoption of innovative technology in healthcare settings across Ontario:

“...the health technologies fund, the way it is designed, is that the lead applicant will be the healthcare setting...it could be private healthcare delivery organization that delivers care on behalf of the province...so it could be a GP's office or it could be a private long term care home that's providing publically funded long term care and we're pairing them up with...basically they'll identify healthcare challenges that they are trying to address and in order to have an Ontario based company that they're working with, um they can work with them directly or if they need some help match making or pairing uh with Ontario based companies we have what's called the Ontario Networks of Entrepreneurs... so the Communitech, the MaRS, the Ontario Centres for Excellence for example will be working with their member companies that they work with and matching them basically with the healthcare settings across Ontario to basically build evaluation projects so the idea is that they have 6 to 18 months to try out the technology in the actual clinical setting and they form teams which we're calling HITs, health innovation teams, where it includes obviously the entrepreneurs, the clinicians, if appropriate patients but whoever the end users are so if it's something which is improving let's say workflow or something and maybe it's not the patients that actually have to weigh in but whoever the end-users are and a bit of a twist on this is actually the health procurement professionals so the people who let's say are working in a LHIN³, the LHINs will actually involve the people who would actually be filling out the paperwork to be buying this product...” (Government-Provincial-Ontario).

³ Local Health Integration Networks are regional health authorities in Ontario

Theme 4: Different goals and motivations

Although forming partnerships and seeking the expertise of different stakeholders is helpful in the innovation process and is part of doing good research, these relationships cannot be forced, as research agendas and motivations need to align:

“..., you know you have to form them yourself right and you have to make them work, and so in a sense part of research is discovering these connections right? I mean part of doing good research is formed through strong collaborations and strong collaborations are not things you can force, they sort of happen, um its uh, its you know people’s research agendas have to sort of be fairly well aligned in order to pull it off, especially if it’s really across disciplines” (Case 2: AGE-WELL Project Lead)

Similarly, it can be difficult to align if groups are motivated by different things, for example the competing interests of academia and industry:

“...so I am an academic researcher so I want publications and I want money to operate my research but everything will be in the public domain because I want to publish but private companies are the opposite they want to patent the invention, they want to make money without telling anybody else right, so that is always the conflict...” (Case 3: AGE-WELL Project Lead).

Finally, Case 1 described additional collaborations and partnerships as valuable but also a double-edged sword in that it creates additional pressure to meet multiple technology transfer objectives.

5.2.6 Identify Technology Champions

Theme 1: Varied Technology Champions

Many technology champions were identified by the various participants. Many identified the importance of family caregivers, especially those that are passionate and willing to engage in the process of using technology, along with volunteers, in particular students or grandchildren to promote intergenerational benefits. Additionally, anybody that has a stake in healthcare could be

a potential technology champion, such as caregivers, clinicians, health care providers, all people trying to stay healthy at any age, as well as organizations such as retirement, assistive and long term care communities where these technologies could be prescribed and used.

5.2.7 Coach Users

Theme 1: User education and training

One of the publications produced by Case 3 identified lack of patient education, training and follow-up assistance for end-users, in particular for older adults, as a barrier to coaching users. Lack of support for users can have a number of negative impacts such as creating frustrating and discouraging feelings for the end-user. Additionally, if the technology provides things like metrics for self-management of a particular condition, lack of education to support interpretation of the metrics could cause confusion among end-users and create potential increase in workload for healthcare providers if they need to spend more time on explanations with individual patients. Thus, a facilitator that came out of this Case 3 publication is coming up with standard procedures or practices of continued user education and training once the end-user is given the technology. Another facilitator under this theme is identifying a ‘coach’ with a continuing relationship with the end-user:

“But I think the tricky part on who the right person is, somebody who has some continuative relationship. So family members have continuative but if they’re far away, not so much...care providers...so somebody who has frequent or regular and not infrequent meetings with the people. Because they will be in a position to see, if it fits...they would be in a position to teach people.” (Case 4: AGE-WELL Project Lead).

Theme 2: Impact of technology on workflow

Coaching users can be difficult for those that have to overcome workflow challenges to use the technology or if they need to use the technology on behalf of the older adult (e.g.,

caregiver or a health care organization). For example, an industry stakeholder mentioned that there may be devices that cannot be used by the older adult themselves so in a homecare setting, they may need the support of the visiting nurse which can be difficult to organize or in the case of a hospital setting, it can be difficult to overcome workflow challenges if there are shift changes that do not fit the pattern of use for the technology. Additionally, if technology is seen as replacing jobs, health care professionals may not want to adopt it:

“That’s the problem. That is one of the fundamental problems, is that we’re talking about people’s jobs right? If we find a new way of diagnosing potentially breast cancer with thermal imaging, that doesn’t involve radiologists, there would be zero pickup on this...or maybe they’ll start learning thermal cameras. They’ll come to us and go “Okay teach me about thermal cameras”. (Case 1: AGE-WELL Project Lead).

5.2.8 Older Adults

Theme 1: Perceptions/Assumptions about older adults and technology

Barriers still exist around perceptions or assumptions about older adults and their use of technology:

“...there is still a cultural barrier in terms of perceptions of what seniors can do in terms of technology adoption...I speak with some colleagues in the Ministry of Health and they’re like ‘oh, I see another company saying that there is an app that they can use for home monitoring that’s on an iPhone like really? My grandma’s not going to be able to use an iPhone’ and I’m like have you given an iPhone to your grandma? Because if a three-year-old can use it I’m pretty sure grandma can use it as long as she can see it and hear it” (Government- Provincial-Ontario)

Further, a project lead from Case 3 commented that off-the-shelf technology, such as wearables, may be geared towards a younger generation; from a private company perspective, perhaps aging is not a ‘sexy’ problem to work on. Additionally, there may be a perception that older adults are not engaged in their own healthcare:

“...can technology help in that sort of remote monitoring also just that patient engagement level, I think a lot of people become more dismissive of people as they get older... that they are not as...wouldn’t be able to be as engaged in their own healthcare

but as you know with the increases in UIUX (user interface, user experience) designers you know the simplification of the advent of apps, the interfaces are more simplified now but at the same time I don't see a lot of apps actually targeting the senior market and understanding things like, I don't know, vision or hearing... ” (Government-Provincial-Ontario)

Another perception from one of the AGE-WELL project leads is that older adults may be more conservative in their use of technology when compared to younger people which may have implications for how you design and trial your technology:

“...also the experience, the relationship with old people today, this is going to change to a degree but not fundamentally. I think older people are more conservative and they don't want to break things. And, therefore the training is just much slower...You know if you're using mobile applications on young people, they're going to reset it and they're going to tell you what's wrong with it and you know it's all golden. But seniors will not. They will be afraid that they broke it. So if the thing does anything that is not right, you just lost them. So basically there's no – there's no room for any error anywhere. Everything kind of matters, which is kind – And that's the thing, the pilot studies are very slow. All these usability problems...” (Case 4: AGE-WELL Project Lead)

Finally, another AGE-WELL project lead talked about how his assumptions were challenged by one of their studies where they did not see a large difference between the comments of younger and older people on wearable technology:

“...maybe this had something to do with a biased sample... but um we didn't actually see a whole lot of difference between younger and older people. I mean we asked them about what do you like about these devices, what do you not like about these devices and the answers are actually pretty much the same as what younger people would have said, what I would say I expected something like you know maybe the font is too small, you know I can't really push that small button there and so on, but we didn't really get that kind of thing. It was all just general comments about technology, I wish the you know like the screen was bigger, but not in the sense that because they are old but that the device had a very small screen even from my standpoint so um and also like you know the how comfortable was it to wear the device, I wore them and I made the same comments...” (Case 3: AGE-WELL Project Lead)

Theme 2: Engagement of older adults and caregivers

Similar barriers have been mentioned in other domains such as the complexities of trying technologies out with very frail older adults, tailoring technology to the needs of each individual

with differing physiological needs, as well as, understanding the complexities of designing for different care settings in which older adults may reside (LTC, home, hospital, assisted living, etc). Facilitators identified to deal with some of these challenges are including the end-user and caregiver when developing the technology and throughout the innovation process, and including the patient voice in making decisions about health technology:

“So a big priority right now is around, you know, a much more fully loaded value equation when making decisions about health technology. But today there still is a very black and white system orientation, so you know, clinical effectiveness and cost effectiveness is a pretty black and white number - um cost per QALY, or something like that, and that doesn't consider the ultimate stakeholder and the patient. So there's a lot of policy move and re-engineering the model of how we look at technology to really bring the patient lens at least on an equal footing, I would suggest it should lead, because they're the reason we all have jobs. So we're working pretty hard now to make sure we have patients on our board, patients decide what gets approved, patients review the protocols, etcetera, etcetera. So it's not always the system voice. I think that is a very big one, and that's everywhere from reimbursement, adoption, regulatory, everything.”
(Stakeholder-Industry)

Speaking directly with older adults, patients, and caregivers is important for understanding the complexities that they may be dealing with on a day-to-day basis. Many brought up barriers such as older adults having to retell their stories between different care providers because of lack of information sharing between providers and the potential anxiety/stress that is involved with various conditions such as Alzheimer's disease:

“so I think the problem with Alzheimer's disease and a lot of illness is that there is a big emotional baggage that comes along with it. People....dealing with Alzheimer's disease have a huge amount of anxiety, a lot of stress. There is a lot of uncertainty and I think that that's uh, that anxiety makes it much, much more difficult to spend the sort of cognitive resources to learn how to use a piece of technology that you normally otherwise want to use. My gut feeling is that people basically retreat from that kind of thing because, like I don't have the time to deal with this and I don't have the mental/emotional capacity to put any kind of focus into it right, and so they retreat to other things, I think, talking to humans or reading printed material or something else right. Which maybe makes more sense...” (Case 2: AGE-WELL Project Lead).

When developing and implementing technologies for older adults/patients/caregivers it is important to let their voices lead to make sure things are useful and relevant for their needs and circumstances.

Theme 3: Understanding motivations for using technology

Successful integration of technology into daily life routines and not being resistant to trying something new was seen as a potential barrier with older adults. Similarly, Case 2 identified in their survey that non-adoption of technology might occur if the user still perceives themselves as healthy, active, busy, and not needing assistance. A facilitator identified is understanding people's motivations for using technology, for example, participants commented that older adults accept technology more often if they perceive it as useful, improving their quality of life and not replacing interpersonal relationships. Further, one AGE-WELL project lead with a clinical background talked about the importance people place on maintaining functional abilities:

"It's a functional thing that makes the difference. It's not the bacteria. At the end of the day, it's the functional change that drives us. People might injure their hands, there might be a hairline fracture, if it doesn't turn black and I'm going "Every time I move my finger, it hurts", I might not know. The day I go to see the doctor is when I go "I got this black hand. I had a bad injury. It hurts so much, I can't play piano. Can you do an x-ray?" Then we do an x-ray and say "Oh yeah, there's a hairline fracture". At the end of the day, what patients care about most isn't the diagnosis, it's about function. I still want to be able to do whatever."(Case 1: AGE-WELL Project Lead)

Finally, many stressed the motivation for individuals to age at home and that older adults may be more likely to accept technologies if they allow them age in place:

"Because that's what, in fact when you ask Canadians, researchers, policy makers, whoever if you ask on the street, if you ask someone, "What's the most important for you when you think about your old age?" It's aging at home. It's recurrent. Even at our (event), I was absolutely struck by the fact that even a molecular biologist who attended the town-hall, who sometimes would be tempted saying, "Most important is to look at this molecule here and how to, because that's what I'm working on." When the question is asked, "What do you think? Not in terms of your research, but what do you think?" It's

aging at home. It's the same. Even the molecular biologist wants to age at home... ”
(Stakeholder- Researcher).

5.2.9 Collaborators

Theme 1: Various key stakeholders in developing and implementing technology

Participants identified many individuals involved in creating and deploying technology such as end-users, technology developers, manufacturers, telecom vendors, caregivers, health providers, aging service organizations, among others. It can be difficult to access any one of these collaborators for their expertise, so similar to facilitators identified in ‘Forming Partnerships’, many felt it is important to bring different older adult collaborators together to form hubs and ecosystems to facilitate collaboration.

Another barrier identified is managing the expectations of multiple people, as many collaborators do not understand the complexity involved in designing technology solutions, particularly those with a health focus:

“...we get companies and even sometimes researchers or sometimes even people from the medical community coming in and thinking that, here is a cool idea, let’s try it right away, can we do that next week and then we tell them that there is a process, there is a protocol that has to be written, they get frustrated and think these are ways to slow down things, I think people need to understand it’s not like developing a commercial product, that has nothing to do with hospitals and so on, when you want to go to the hospital and test it on patients, it is a far more complex process, also costs a lot of money, it is not just an application that you put in because you have to have someone who meets the patients, help them understand the consent forms, recruitment, choose the right population, inclusions and exclusions and so on” (Case 1: AGE-WELL Project Lead).”

Theme 2: Weighted influences of collaborators

Collaborators can have a lot of influence on whether technology solutions are developed and implemented. To start, certain established players may have their interests heard over others,

which can influence which technologies are adopted, for example acute care and the tools they use versus home and community care:

“...It’s also the power of the purchase, it’s the interest in the...and I don’t mean this in a mean way, I just mean that there are established players with a seat at various tables and their interests therefore, not necessarily in any nefarious way, umm, are heard, and so physicians and surgeons, the tools that they use and their mechanisms, to get them used. If they’re home and community care, it’s just a total... So yes so you’re in the messiest space of all for technology adoption.” (Stakeholder- Researcher)

Additionally, if collaborators do not buy into the technology or have skepticism about its importance and appropriateness, it will be difficult for older adults or other end-users to see the benefits from it:

“Like you talk to the wound care people, as I have done recently trying to figure out whether it makes sense for me to investigate procurement of wound care products, and I was interested in just how dismissive they were in the range of technologies. They were just not about the technologies. Ya there’s a lot, you know, there’s a couple of core things you need but it really is about the judgement, the appropriateness, the coordination of care, to support people to use these technologies correctly...”(Stakeholder-Researcher)

Finally, it is important for collaborators to understand the motivations of the end-user to use the technology, if they use their influence to push or prescribe use of a technology but the end-user is not intrinsically motivated to use it, then continued adoption may be hampered:

“The other thing is, what is the motivator. If people are intrinsically motivated to do the exercise or to train their mind, then they may use these tools and that’s great. But if they’re not intrinsically motivated and we’re just prescribing them, then there has to be the social element to continue adoption. So I don’t really, you know, I don’t think that, I don’t think that they make sense completely independent. They make sense in a context of care regimen...” (Case 4: AGE-WELL Project Lead)

Theme 3: Caregiver benefits

Health technology oriented towards supporting caregivers, and involving family and other stakeholders, is important for the success of technology (e.g., smart homes, home

monitoring). Technology can aid family caregivers in dealing with symptoms of physical and cognitive limitations so it is important for developers to consider the role of the care providers:

“the applications of technologies in rehabilitation and particularly in the home environment, even if an individual is in an assisted living facility, we always approach it from the perspective that this is the individual’s home... we naturally take into consideration the role of care providers that are at various levels, but primarily the family members. Um, and so at their level, how does technology influence them...” (Case 4: AGE-WELL Project Lead)

Through their work, Case 2 identified a challenge for caregivers may be framing the technology in a positive way, for example, as a way to prolong independent living and relieve the burden to family caregivers, as opposed to the perception that technology is going to replace highly valued interpersonal relationships between the older person and their caregiver.

5.2.10 Context

Theme 1: Fragmentation in Canada

Industry participants talked about how the thirteen provincial and territorial jurisdictions in Canada, create a challenging policy context. For example, reimbursement decisions are different in every province, as are assistive device programs. This may create issues for innovators, as it is comparable to bringing technology into 13 different countries. Additionally, a government stakeholder discussed health technology assessments, especially ones done at the national level are difficult to apply in different contexts as it is very difficult to come up with recommendations that will apply to sites across the country and even sites within a province. However, a frequent facilitator that was mentioned within this theme is that many participants feel that Health Canada, which is at the federal level, works quite well and is generally pretty timely and responsive.

Another identified facilitator is having a national strategy to support the medical device industry in Canada:

“What we don’t have is a national strategy to bring medical technologies in the system and to support the medical device industry in Canada. Both, you know, from a health care system perspective and an economic development perspective. So one of the things that we’re starting to look at is the federal leadership around health innovation and how, and what role can the federal government play... You know, we think they can play a big role....if I jump into the world of regulatory as well, there’s lots that can be improved in the way we regulate, which is at the jurisdiction of the federal level...but it’s about looking at all of those different pieces. Whether it’s funding with the provinces, whether it’s you know um federal leadership around procurement, whether it’s federal leadership on, on the regulatory framework...but we don’t have a national strategy...so there’s coordinating initiatives across the country. We’re trying to make each provincial jurisdiction aware of the good things that other provinces are doing.” (Stakeholder-Industry).

Thus, building a national strategy and streamlining processes within each province to limit fragmentation was seen as an important opportunity to build a stronger medical tech/health tech sector.

Theme 2: Decision-making

Related to fragmentation, a barrier identified is the complexity of understanding decision pathways in government. One participant said:

“One of the challenges...is we’re a very large organization. Very hard for anyone in their silo to know a lot outside of that silo. Some of them, like in rehab, you can set-up structures where they work province wide or with colleagues across the province, but generally our systems aren’t set up that way so you have to kind of create other networks of trying to work across the administrative and geographic boundaries and professional boundaries. But it’s still very, very difficult. My...team, one of their agreements is to know who’s who in the zoo all over and try to connect people that way; be a bit of a wayfinder and a navigator of our system and staying on top of changes in staffing, changes in work structures. We also interact a lot with external agencies...So again on our team one of our roles is to be a connector, so I think that’s useful for folks because it’s very, very difficult to stay on top of our organization and the diversity of people and who can actually make a decision.” (Government-Provincial-Alberta)

Another participant echoed this while talking about decision making in health care

organizations:

“I will say just the amount of time that it takes for decision making is really difficult within these organizations ...so when dealing with these large organizations like LHINs, CCACs even in some cases like Family Health Teams... depending on how big their networks are, or hospitals are undoubtedly the most complicated system it just takes a long time for people to make a decision...I’ve kind of figured out that there is a couple of issues one of them is depending on which healthcare organization and sometimes like within hospitals even within a different department the pathway to decision making about whether or not to adopt a technology or an innovation or a new process is completely different...sort of an ad hoc process...some organizations actually have these tables that are formed and only meet quarterly to decide which innovations are the new ones that are coming in... and like literally within the same hospital you’ll see that like cardiology works differently than the neuro unit or the community health section of a hospital completely different process and that’s just within one hospital and the different sectors have different pull ... you know general barriers to innovation and adoption, if I was to summarize them again 1) is the wayfinding not even knowing, like having the variability in the decision pathways in each healthcare organization 2) like having people feel comfortable enough to make a decision and feel like they have the autonomy or they’re empowered enough to make the decision...”(Government-Provincial-Ontario)

Theme 3: Funding

In relation to the first two themes, within government there is a lack of inter-ministerial coordination and support, for example Canada was seen as doing a poor job of thinking about the full continuum of investments:

“...Canada’s a good place to do research. We actually have some great programs at the federal level, there’s a Scientific Research and Experimental Development tax credit, that’s complemented for example in Ontario. We’ve got great smart researchers, great hospitals, that sort of thing. What happens is the government will invest a lot of money into research, but often that ends up being primarily to the benefit of patients in other countries...we invest in a company that’s going to make a great technology, a start-up or whatever it is, they create the great technology and then they go to bring it into Canada and then they can’t get into the system so they go to the United States, or Germany, or Japan or wherever. Um which is a little- you know, from a taxpayer dollar perspective, is... not fully capitalizing on that taxpayer dollar investment. I think when we think about investing in medical technology companies, one thing that we don’t do well is to think about the full continuum of that investment. So saving some of that dollar for the backend of the process to ensure that we’re adopting the technology into the system, so sort of

when you're getting research and innovation and the Ministry of Health coordinating their efforts..." (Industry)

Similarly, one participant described a lack of continuity of the funding that is available in this space. Funding does not allow for the “hack for discovery to translation and commercialization”; other than AGE-WELL, there are not any collaborations to help create more than the individual funding components, unless you are able to align with mandates of other programs or organizations that may have transitional funding. Further to this point, a participant from a community care organization commented that they do not have money to fund innovation activities or healthcare research as they do not have a foundation to provide funds, for example, that hospitals may have access to, and they cannot take money out of their operating budgets so they have to find creative ways to fund any technology trials or research they decide to do.

Some of the AGE-WELL projects also mentioned several funding barriers. One project talked about the fact that there is a lot of funding available for research but there is absolutely no funding available to move from proof of concept to prototype. Finally, many health technology projects fall in no-man’s land in terms of funding, for example:

“...there's a lot of funding available at NSERC. There's a lot of funding available at CIHR. Then when you have a project, like this type of project, you go to NSERC and they say "Oh, this is health related, go to CIHR". You go to CIHR, "But you developed technology here, go to NSERC". There's the big gap. There is a gap from the topics perspective that's really serious..."(Case 1: AGE-WELL Project Lead)

Theme 4: Culture of payment in health

Similar to the domain, ‘Establish Technology Value’, many participants talked about the difficulty in understanding who pays for the technology and who benefits, and in understanding the culture of payment in Canada, which is generally around cost containment. The culture of innovation in health in Canada shapes how we view technology:

“...I think there is just generally...a commitment, a culture to innovation in general would go a long way, and we don't have that really in health. We have a culture of improvement and risk mitigation, well that's completely inconsistent with innovation. So, um, you know, processes and methodologies to, to be the first to want to try new stuff, and to pull stuff through, to test it, to refine it, all those things are fundamentally missing. And I contrast that with places like the Cleveland Clinic and Mayo Clinic who are just so hungry to be on the edge of what's out there and to always know and to be the first to try, and I wouldn't say their patients fare any worse, I bet you they do better than ours, just by the fact that they want to be on the edge and try new stuff. And they feel like they are missing out in their mission if they're behind on new technology, where here, you know, we still view new technology as a bad thing called a cost centre and it's just a completely different orientation. And I think there is just a whole cultural barrier that is the root cause of why we're so behind on the adoption side...” (Stakeholder-Industry)

Additionally, participants suggested that our health care system is based on the wrong incentives for purchasing; one participant provides two concrete examples:

“So I often use the example that if the Ministry of Health was buying TVs for everyone, you'd still be looking at twenty inch large black and white TVs from fifty years ago because they would do the job.... We didn't leap from those kind of TVs, you know massive tube ones? To today's sixty inch flat screen, we didn't leap in a base swing. It was fifty years of TV improvement, incremental, driven by consumers wanting better products...” (Stakeholder-Researcher)

The participant goes on to say:

“...the most out-of-date, uh obscure and wrong program is the assistive devices program, right? So I get a bit mad about that. Of all the procurement that went on, the piece that drove people insane was the Ontario Assistive Devices program, because it was geared to try to get the lowest costing possible cost, to the lowest possible technology, uh and even if something new was cheaper, it wouldn't get on the list because it had to get on as a new product, and if it was new and more expensive that could save the system a massive amount of money it definitely wouldn't get on...”(Stakeholder-Researcher)

Further, procurement that is focused on the cheapest alternative and siloed budgets create no incentive to align with other parts of the health care system for example hospitals and community care:

“...because we are a fully publicly funded, or near full publicly funded health care system, you know people are always looking at how to save money. And they go for the low-hanging fruit with medical devices and they try to drive price down. And you know when you're purchasing the cheapest technologies, it actually ends up costing the system a lot more money in a lot of other areas. But because we have such a siloed healthcare system, um a lot of people purchasing the technologies are not thinking about how you

can- how the technologies are either going to save or cost money in other areas. So for example, if a hospital were to purchase something that would, you know, that would benefit a patient once they get into the community, there is no incentive for a hospital to do that, to make that investment. Because the community care budget, if they're saving money in that budget, they have no alignment with that budget, they have nothing to do with that budget. So I would say on the procurement side, the fact that we're not sort of mandating that when we procure in health care, we have to use a value-based procurement model..." (Government-Provincial Ontario)

Another barrier that many participants talked about is how procurement policies can be very restrictive and hamper the drive for innovation and creativity:

"So in the public sector, for good reason, there are rules about how we interact with industry so for instance if we are going to put in a new telephone system in the hospital we can't just sort of call up our friends at TELUS...because maybe TELUS isn't the best one in the market maybe they are going to charge us too much so...we need to get at least three quotes and they have to be posted for so long blah blah which is all very important and makes perfect sense, so when you want to spend public sector dollars you want to make sure you get best value for money, you get a good product in, so having those kinds of rules that you can't have the private sector and the public sector be too cozy um make perfect sense...BUT ha, when it comes to trying to be creative and doing things that are innovative and outside of the box thinking, um those kind of rules are really going to bog you down right? If you say look we have over the last 12 years nourished a relationship with a producer of x, they have created this cool new little device that we think can really revolutionize health care, um and then we sort of bring it into the healthcare setting and then someone says well 'wait a minute but you can't have a relationship with this sensor-maker, we need to go to at least three different sensor makers, we want to get a sense of you know which-who has the best one, what's the cheapest price point...but that completely interferes with sort of the drive for innovation and creativity ...if you can sit down and you know these engineers and they understand what it is you are trying to do, you create this new thing...it has come up a number of times especially this last year people have felt very uncomfortable that we have close relationships with a certain organization um that is great for creativity, innovation and driving things forward ... (Case 1: AGE-WELL Project Lead)

Additionally, an industry participant discussed how physicians are compensated may affect new technologies or innovations if there is no billing code attached to the new technology or procedure. Particularly with aging in general or community care, there may be many devices that could greatly enhance the wellbeing, safety and health in general but if physicians cannot

make money and that particular procedure or application has not been incentivized then they may not use it. This also may influence what sorts of technologies are developed in the first place:

“And this is a big, big, big challenge in innovation uh, development in general, because if those that create innovation only respond where there is a reimbursement on a fee for service basis. It means that only um, strengthening what medical uh, specialist can do at this moment and this is not exactly what you need especially in ageing, you know, you need strong home care, you need strong primary care and, probably community interventions and, this is far away from reimbursement models that are centred around what is medically required” (Stakeholder- Researcher)

Main facilitators identified by participants in this theme relate to moving towards consumer, innovation or value based procurement by health care and for health care providers to look for value beyond cost. Additionally, thinking about different ways to finance health care, moving away primarily from global budgets to either quality based procedures, bundled care, or capitation models which look at funding patients based on their continuum of care:

“Just imagine for a region, if the cost of the health system is under capitation, so each head. Let's say in a small village there's one source of money, which is a mean of what it costs to keep health in the ... The money is attached to the person, not to the institution. The money follows the person. If there's savings, everybody will benefit from the savings. It might need a re-look at how the health system is financed.” (Stakeholder-Researcher)

Another participant said:

“...there are some movements towards things liked quality-based procedures, which is good because that's when the government is just funding one particular procedure instead of a hospital paying for procedures through their global budget. Um but really where we need to go with health care funding is we need to be funding patients based on their full continuum of care or measuring that. So that we know if along the patient pathway we make an investment in a technology along a certain point - a case can be made about, you know, sort of how that case will save money along the patient-pathway continuum, right? And I think particularly along the space you're in, with seniors and community care and all that sort of thing, you know, that is a huge barrier um the fact that- that we're not, for the most part, measuring that and funding based on a patient pathway”(Stakeholder-Industry)

Theme 5: Differences based on the type of technology

The adoption issues for ‘low tech’ versus ‘high tech’ may be different. For example, there are established mechanisms for technologies such as MRI machines to get into the health care system, but for more small-scale devices, such as those that may benefit home care clients, the mechanisms may be less clear. One participant talked about the differences:

“...so there are a bunch of technologies that are relevant to aging that are in the acute care sector, and those are technologies that are going to be expensive, they are going to mobilize a powerful sector of the health system -both hospitals and the surgeon and other specialists who use them - and they are therefore likely to come to the attention of HTA and also more likely to be overseen by the clinical governance regimes that exist in areas of cardiology like Cardiac Care Network or Renal Care Network, etc. And then there are a whole slew of other technologies that I think may be more important really for any kind of equitable distribution of benefits for the population of aging persons and those are home and community based supports and those are assistive and rehabilitative technologies. And those are often low tech and potentially consumer direct purchase or with, marginal public subsidy through for example Ontario’s Assistive Devices program... so you know, the aging space is...the technology adoption questions are radically different for, and I’m over simplifying, um to put it into two buckets, but even just to do that, um there’s just no comparison to the way they’ll proceed. On the one hand they’ll proceed as all technol- like the high tech stuff will you know, whatever, there is a mechanism as it were, or mechanisms. On the other side you’re dealing with, not only the limitations of the mechanisms of technology adoption and the limited alignment between statutory regulation and HTA and procurement, and, and use. But you’re also dealing with the very patchy nature of public subsidy that exists to address these needs... So that that is a very, very different market that the public sector that we have all constructed for ourselves, into which the technology adoption issues are just, you know, far more complex...” (Stakeholder-Researcher)

This participant also talked about where the interest and capacity lies between low and high tech:

“I’m very interested, um, in the low tech stuff, I mean despite, although I’m looking at case studies that are high tech stuff where the, that’s where the data are, that’s where the clinical interests are, that’s where the clinical governance capacity lies. I mean, it’s a real challenge for getting attention to, to lower tech needs, or lower acuity needs. It’s just the misalignments of so many of our institutions with respect to attention and interest and capacity...”(Stakeholder-Researcher)

Additionally, with new and emerging technologies, the regulatory path may be less clear. Some of the AGE-WELL technologies may be considered lower tech or lower risk and may not have as many regulatory considerations, but often there can be grey areas between health and wellness type technologies and medical devices. Because regulations are broad in scope, they may not deal well with disruptive technologies, or hybrid technologies that may have many components:

“Just the sheer challenges in terms of where devices fit right now, because it's just becoming ... There's more and more things shoved into each submission, and you're trying to figure out what the different component parts are and what's approved and what's not approved. Then moving forward, it's a pharmaceutical, plus a natural health product, plus a device, plus it's actually three different types of device in the device, and how you manage that from a regulatory perspective.” (Stakeholder-Government-Federal)

Theme 6: Privacy, interoperability and standards

Similar to the challenges mentioned previously in terms of complexities in trialing technology in a variety of settings, issues and complexities were mentioned around procedures for certifying software and standards for wireless communications, for example for in-home technologies, if it is collecting sensor data (will it use internet, c-wave, Bluetooth, etc). Also understanding privacy issues was discussed by many participants. Examples include, trusting vendors with data that will go to their servers, if a home health technology is collecting data or monitoring for example via a camera or a sensor, what questions does this bring up about privacy and data ownership.

Additionally, one of the industry stakeholders identified the many logistical complexities within a hospital, for example the technology parts need to be Canadian Standards Association (CSA) approved and infection control approved, how the software connects to the broader hospital network needs to be understood, cyber security issues and interoperability issues, are all

important considerations. Similarly, Case 3 discussed that fact that many hospitals do not have proper electronic record systems and may still be using paper to collect data, and even in hospitals that do have electronic systems, often these are not integrated and need to be logged into separately. Thus, many privacy, interoperability and standards issues need to be considered depending on the setting that the technology is deployed.

Theme 7: Aging and health-Understanding the role of technology

A facilitator identified within this theme is changing our vision or paradigm of health from curative to managing longer-term conditions, understanding that older adults are dealing with chronic conditions for longer periods and that technology will be important in the home to help manage disease and keep people at home longer. Similarly, shifts in health care allow technology to meet people where their values are:

“...the overall shift, of decentralization and dephysicalization or dematerialization of health care...it’s no surprise that technology is allowing, you know, stuff to move to the home to be continuous and to meet people where their values are. And it’s particular because a lot of the people who demand services are the older population, then by default I think the center of gravity is shifting there...” (Stakeholder-Industry)

Although technology has potential and may play a role in helping an aging population, one participant cautioned against how much we invest in technology and its ability to help with the challenges of an aging population. In fact, it may only be very small part of the solution to support an aging population:

“... So yes so you’re in the messiest space of all for technology adoption (home and community care). And you’re also in a space where, there is justifiable skepticism about the need, the relevance of technology...often there’s been some really nice effort in the UK to sort of catalyze the production of really low tech, low cost products for senile ostomies and these sort of unsexy, ignored areas that matter for a lot of people, but not withstanding that, there are going to be the challenges of home and community care, the challenges of supporting an aging population, and the growing multimorbidity, and it’s not just aging, it’s growing wealth and disparities that is compounding all of the

problems of sustaining any health and wellness. Technology is an absolute pimple on the ass of the solution. Like, it's just not relevant...

... I think it's a factor in technology adoption in this wider sector that there is going to be, in my view well deserved, skepticism in how important technology is going to be to solve these problems...this sector is significantly underfunded in every way shape and form, significantly under-resourced, massively complicated. No meaningful leadership, you know just a nightmare to organize, but deeply mission driven, hundreds of little organizations, trying to do the best they can, they're not going to believe this is important, technology adoption...

...the most nefarious kind of vision that we keep, you know "We're gonna deal with our aging population by giving them robots..". It's just gruesome... Technology is always, and should always be seen as supportive to the wider purpose and the aim. Um, but it also can be seen as a problem, politically, because so far as people think there's a technological solution to this, they're missing just how organizationally, and politically complicated and messy this is. And how much, we need a base—think umm we need decent pensions, and we need like, urban infrastructure, it's like, housing, and its layers and layers and layers of things that are needed before we can get to any of that..."
(Stakeholder- Researcher)

Thus, understanding and being critical of the role of technology to support aging was a factor that was brought up within this particular theme.

5.2.11 AGE-WELL

Theme 1: Emphasis on commercialization

Points were raised about the major emphasis on commercialization within AGE-WELL.

Concerns were mentioned about too much pressure being placed on projects to commercialize prematurely as five years may not be long enough to go from research to commercialization:

"...There is too much pressure suddenly to just commercialize and I think that there has been too much pressure, um, prematurely placed on entities that look like they have the potential and I'm not sure that's the idea either. Because that's a lot of work involved. Because the science is missing, everybody is in love with what it looks like it could do...the potential, but it keeps being preached...but when you dig down and you actually look and you realize there is a big gap and it's actually not even going to come to fruition in the next five years, let alone two years, so I think that we have to be careful about the hype, too much hype because, then the science and the evidence is gone and then once

you cry wolf once, then the next time you say well that one failed and then the people won't believe that you actually have this because people are ready to buy it and it's not even a prototype yet." (Case 4: AGE-WELL Project Leader)

It can be difficult to think about commercialization early in the process, especially if a project is just starting up and not very much research has been done. Particularly for AGE-WELL project leads, who are predominately academics, Case 3 and 4 commented that commercialization is a relatively new concept and they have not been trained or encouraged to do that before.

Therefore, they may not feel motivated to build a company or feel they do not have the skills to do so:

"...I'll speak to commercialization. I, most of us are not motivated by building a company...well if we were we wouldn't be here primarily and our day lives do not care about commercialization. It's only recently that commercialization became an indicator of impacts and success, relatively recently in our academic lives. So having not been trained in that and having not been encouraged to do that, it's kind of strange to think about that. At the same time, I'm interested in having a real impact and it would be nice if someone was actually selling my stuff, my ideas. Um, I think that you need a particular kind of person and um, I'm not sure that our academic environment has many of these people. I do not know in science, maybe in engineering and business more, um, I know that our engineering students are better..."(Case 4: AGE-WELL Project Lead)

Thus, similar to points mentioned earlier, many talked about needing outside help such as leveraging the right skills because starting a company or launching a product is not simple. Examples included, seeking expertise from business because research on scientific problems is much different than market research, utilizing university commercialization offices, as well as legal and other expertise if pursuing a patent. Additionally, working with commercial entities or entrepreneurs that already have momentum that could benefit from research could be an opportunity.

There is also some skepticism about what AGE-WELL will achieve in its time, but that commercialization may happen in the periphery of the real work. One project lead said:

“So, I’m thinking that even if, even though I don’t really expect any of the core projects to actually do something from research to commercialization, I would be terribly surprised if any [long pause]. How do I say – it really takes time. Everybody’s very smart and everybody actually wants to have real world impact. But ain’t gonna happen. What is more likely to happen is accidentally we’ll get, because of this broad breadth of programs accidentally hot on somebody who really is not the proper academic. But you can get them funding through something else and they can do something. So, I think the commercialization will happen in the periphery of the real work. You need this community to babble to have good people and go out and talk and travel and schmooze.” (Case 4: AGE-WELL Project Lead)

Similarly, one of the industry stakeholders talked about the potential issue of looking for hard outcome measures to test commercialization too soon:

“Um...actually AGE-WELL is one of the best things I’ve been associated with in this space, and the challenge will come...I guess the timing, again, you think what’s it realistically achieving in its time, and what can it realistically achieve in a set space. It probably will take 15 years before it can really say we’ve got more jobs, more companies. Um and my fear is that people will look for hard outcome measures to test commercialization too soon. And that could cause us to chase some low-hanging fruit when we would be better off- the more important thing would be build really strong collaborations and culture change.” (Stakeholder-Industry)

Finally, one of the AGE-WELL project leads questioned the whole academic-industry model, if commercialization is the main goal:

“If the Canadian government wants to really go big on commercialization I think they should be investing money in start-up companies rather than academic researchers, and it’s always, like academic researchers will get grants and then we are supposed to get like partnership or industry partnerships and we have to convince them to give us something either cash or in-kind, I don’t know how well that works for anybody to be honest, and I think all the innovation like all the actual products in the market, you know, they come from either start-ups or other big guys... big companies and you know like I understand why the government wants to see academic and industry working together, but I don’t know if that’s the best model...because if my end goal is to bring a product to the market, which is AGE-WELL’s goal actually, if that is my top goal, then I would do that outside of academia because that’s way faster, I can get you know better people, to work on it, because if I use my student now I run into problems because they have to do like thesis work and it takes them two, three, four years to get something out there, but they are not developing products either it is just a like a research concept, proof of concept type of thing. If you want a finished product then I mean like I need full time people working on it right now, there’s a lot of non-research components of it to when it

comes to product development so um lets speed things up by just doing it outside of the university.” (Case 3: AGE-WELL Project Lead)

Theme 2: Promoting collaborations and transdisciplinarity

Despite concerns about commercialization, there were many facilitators mentioned about AGE-WELL promoting collaborations and transdisciplinarity. For example, the AGE-WELL funding fills a gap as it provides funding for interdisciplinary research, whereas other traditional modes of funding in an academic setting tend to be very siloed. Additionally the infusion of funding and the long-term engagement/commitment is helpful for focusing, as five years is generally long for research funding.

Beyond funding, AGE-WELL conferences, teleconferences and meetings provide an opportunity to network, share knowledge, get feedback on ideas/projects and plan for the future:

“the, the way the conference is organized... that gives lots of opportunity for networking as well as information sharing and then the top down requirement or mandate, um, which at first was a little bit surprising where you know, people are, who have got an award, put into your work package, I think that actually works really well because it forces us to go beyond our comfort zone and then we realize my gosh this is really important to us because there is so much we don’t realize and then what the face-to-face conference-opportunity does is then it allows us to network and then form a future going forward, uh, projects on a year-to-year basis. So I think all of those the way it’s organized is very facilitating.”(Case 4: AGE-WELL Project Lead).

Another project commented that the network has helped identify partnerships with industry, which have helped support the identification of new uses for their technologies.

Although there were many facilitators identified in this area, one project lead from Case 2 did not feel the same way and suggested that the network could do a better job of connecting people on different ends of the spectrum (e.g., clinical side vs. technology side) and although the AGE-WELL online forum platform exists where you can find linkages, they felt like it was very “foreign” and it may not be pushed far enough to facilitate linkages.

Theme 3: NCE structure

One barrier identified in this theme is the rigid framework for reporting that is often required in NCEs:

“...whenever you are a part of a complex organization such as AGE-WELL is or such as any NCE is for that matter, it requires a certain level of reporting and justification...and I think that when on one hand you are trying to foster innovation, that requires innovation of...even financial innovation right you take money from different piles and you put them together and you try to as efficiently as possible come up with building something new, designing something new, training new students, taking a student to do this much with their thesis and this much for the project so you are always being creative and nimble in trying to move things around and do things creatively and bring outside partners in for the right project at the right time... then when there is a sort of rigid framework for reporting, which again, I completely understand from a legal point of view if, as a tax payer, I make sure my taxes are being spent wisely, so if it goes to a research team, I want to make sure they're not flying to Hawaii twice a year.... But um it does slow you down when you have multiple layers of responsibility...There is a substantive amount of reporting and time spent on justifying and the bureaucracy does slow you down. Time that I spend in meetings with people from AGE-WELL or writing reports is time I am not spending with patients, with industry partners, or with students pushing ahead the innovations... (Case 1: AGE-WELL Project Lead).

However, Case 2 felt the flexibility in funding was seen as a facilitator, as well as, the product readiness levels (the scale that identifies the stage of development a project has obtained) are at a high enough level that it allows the projects to pivot their research along the way. In addition, AGE-WELL from the outset funded project coordinators, which was seen as an important element to help the projects run smoothly.

The emphasis on students/HQP (highly qualified personnel) was seen as a facilitator, many groups talked about their appreciation for their students working on these projects, as well as an appreciation for the attempt at varied workshops and other events offered for HQP.

However, a few projects did comment that having students could sometimes limit progress, especially Masters Students if they are only working on projects for a short amount of time. They

also commented that a lot of the webinars and/or workshops were not extremely helpful, as it was hard to directly apply the information being shared to their research/project work.

Table 5 Summary table of the themes found within each domain & coverage of themes by case

Domain	Themes Identified	Coverage of themes by case
Design User-Friendly Relevant Technology	<p>Theme 1: <i>Designing for the end-user</i></p> <p>Theme 2: <i>Complexity of designing and trialing technology in different settings/contexts</i></p> <p>Theme 3: <i>Connections and communication to build technology that is more relevant</i></p> <p>Theme 4: <i>Resources</i></p>	<p>All of the cases contributed to this theme (identified through project leads, surveys, document)</p> <p>3 of the 4 cases contributed to this theme (identified through project leads & site visits)</p> <p>2 of the 4 cases contributed to this theme (identified through project leads, site visit and researcher stakeholder)</p> <p>All of the cases contributed to this theme (identified through project leads)</p>
Establish Technology Value	<p>Theme 1: <i>Early conversations about value and knowing what data to collect</i></p> <p>Theme 2: <i>Cost-savings in the context</i></p> <p>Theme 3: <i>Considerations beyond cost</i></p>	<p>All of the cases contributed to this theme (identified through documents, surveys, project leads, industry/researcher/government stakeholders)</p> <p>All of the cases contributed to this theme (identified through project leads, industry/researcher/government stakeholders)</p> <p>All of the cases contributed to this theme (identified through project leads and researcher/government stakeholders)</p>

Create Business Model	Theme 1: <i>Resources and expertise</i>	All of the cases contributed to this theme (identified through project leads and researcher/government stakeholders)
Promote Technology	Theme 1: <i>Awareness of the types of technology</i> Theme 2: <i>Transparency of the function of the technology</i> Theme 3: <i>Marketing</i>	2 of the 4 cases contributed to this theme (identified through project leads and government stakeholder) 3 of the 4 cases contributed to this theme (identified through project leads and government/industry/researcher stakeholders) 2 of the 4 cases contributed to this theme (identified through surveys)
Form Partnerships	Theme 1: <i>Navigating relationships with health care systems and health care providers</i> Theme 2: <i>Leveraging expertise</i> Theme 3: <i>Specific setting or program to facilitate partnerships/working synergistically</i> Theme 4: <i>Different goals and motivations</i>	All of the cases contributed to this theme (identified through site visits, government/researcher/industry stakeholders, project leads) All of the cases contributed to this theme (identified through project leads and government/researcher stakeholders) All of the cases contributed to this theme (identified through project leads and researcher/government stakeholders) 3 of the 4 cases contributed to this theme (identified through project leads and researcher/industry stakeholders)

Identify Technology Champions	Theme 1: <i>Varied technology champions</i>	All of the cases contributed to this theme (identified through project leads)
Coach Users	Theme 1: <i>User education and training</i> Theme 2: <i>Impact of technology on workflow</i>	2 of the 4 cases contributed to this theme (identified through documents and project leads) 3 of the 4 cases contributed to this theme (identified through project leads, site visits, and researcher/industry stakeholders)
Older Adults	Theme 1: <i>Perceptions/Assumptions about older adults</i> Theme 2: <i>Engagement of older adults and caregivers</i> Theme 3: <i>Understanding motivations for using technology</i>	3 of the 4 cases contributed to this theme (identified through project leads and government stakeholder) All of the cases contributed to this theme (identified through project leads, documents, surveys, researcher/industry/government stakeholders) All of the cases contributed to this theme (identified through documents, surveys, project leads and researcher stakeholder)
Collaborators	Theme 1: <i>Various key stakeholders in developing and implementing technology</i> Theme 2: <i>Weighted influences of collaborators</i> Theme 3: <i>Caregiver benefits</i>	3 of the 4 cases contributed to this theme (identified through project leads, site visits and researcher/government stakeholders) All of the cases contributed to this theme (identified through project leads, surveys, site visits and industry/government/researcher stakeholders) 3 of the 4 cases contributed to this theme (identified through documents, surveys and project leads)
Context	Theme 1: <i>Fragmentation in Canada</i>	3 of the 4 cases contributed to this theme (identified through industry/government/researcher stakeholders)

	<p>Theme 2: <i>Decision making</i></p> <p>Theme 3: <i>Funding</i></p> <p>Theme 4: <i>Culture of payment in health</i></p> <p>Theme 5: <i>Differences based on the type of technology</i></p> <p>Theme 6: <i>Privacy, interoperability and standards</i></p> <p>Theme 7: <i>Aging and health- Understanding the role of technology</i></p>	<p>2 of the 4 cases contributed to this theme (identified through project leads and industry/government/researcher stakeholders)</p> <p>2 of the 4 cases contributed to this theme (identified through project leads, industry/researcher/government stakeholders)</p> <p>All of the cases contributed to this theme (identified through industry/researcher/government stakeholders)</p> <p>3 of the 4 cases contributed to this theme (identified through project leads, industry/researcher/government stakeholders)</p> <p>All of the cases contributed to this theme (identified through site visits, project leads and government/industry/researcher stakeholders)</p> <p>1 of the 4 cases contributed to this theme (identified through project leads, and researcher/industry stakeholders)</p>
AGE-WELL	<p>Theme 1: <i>Emphasis on commercialization</i></p> <p>Theme 2: <i>Promoting collaborations and transdisciplinary</i></p> <p>Theme 3: <i>NCE Structure</i></p>	<p>3 of the 4 cases contributed to this theme (identified through project leads, site visits, industry stakeholder)</p> <p>All of the contributed to this theme (identified through documents, project leads)</p> <p>All of the cases contributed to this theme (identified through project leads)</p>

5.3 Phase 2: Cross Case Analysis

A table was constructed comparing findings across the projects for each of the ADOPT categories and other descriptive information like the progression of the technology. The table is not presented as it revealed identifying information, but was used as a tool for cross-case analysis. There were both similarities and differences among the four cases:

Technology progression:

- Each case has several technology products they are working on which are at varying stages. One is at a more advanced stage of prototype testing (Case 1) while another is at an earlier stage focused on understanding the utility and acceptability of potential technologies (Case 3). Some are at intermediate stages where they have some products that are further along with prototype testing, and some products that are still undergoing usability testing (Cases 2 and 4).

AGE-WELL:

- All projects are a part of the AGE-WELL NCE, so they have the same requirements and responsibilities in terms of reporting to the network and have access to the same supports offered by the network (funding for a research coordinator/students, webinars, workshops, conferences, the online forum/intranet, etc.).
- The same timelines are laid out where the research and development stage is primarily set for the first three years of AGE-WELL with the two final years (starting in 2018) more heavily focussed on knowledge mobilization and technology transfer activities.
- All cases have been participating in knowledge mobilization activities through publications and conferences throughout the funding period.

- Some projects questioned/cautioned against the heavy focus on commercialization (Cases 3 and 4) while others have not yet started to think too seriously about commercialization (Case 2).

Design user-friendly technology:

- All projects understand the importance of designing for the end-user, and the different usability issues with individuals who may have a range of abilities.
- They all had similar comments or issues related to ethics clearance, participant recruitment, and the complexity of moving from the lab to the ‘real world’.

Establish technology value:

- All projects identified many potential purchasers and end-users, in part, because they are still early on in the process and see many potential applications for their products. However, Case 1 leans more towards health system products, Case 2 leans more towards consumer products, and Cases 3 and 4 fall somewhere in between with consumer products that may potentially have some connection with health care providers or the health system. Establishing technology value will thus vary for these projects depending on intended market/user for the technology.

Create a business model:

- Related to the prior points, all groups talked about challenges around creating business models and/or understanding who might pay for the technology. Case 1 informants, in particular, talked about this at length in terms of challenges in determining savings through prevention and determining who might pay versus who might see the benefits.

For other cases, business model exercises seemed either premature (Cases 2 and 3) or unhelpful (Case 4).

Promote technology:

- Cost of marketing was identified as a potential forward thinking obstacle by Case 1, similar to Case 4 who identified the challenge of the eventual packaging and delivery of the end product. Case 4 also identified the challenge of consumers or health providers having a lack of information to know which technologies are available. Case 2 and 3 did not comment about issues related to the promoting or marketing of their technologies.

Form Partnerships:

- Some projects had more extensive and well-developed partnerships at the beginning, both between the co-leads and community partners (Case 1 and 4). For others some initial partnerships (e.g. industry or community partners) did not turn out as hoped (Cases 2 and 3), while for others, partners emerged with more specific interests as time progressed (Case 1 and 4).
- Case 1 and Case 4 have partnerships with rehabilitation/hospital settings, where they are able to access clinical expertise and trial technologies.
- The partnerships between the co-leads were different between the projects. For example, Case 1 and 4 talked more about their synergistic partnership with their co-project lead, where they rely on each other's knowledge being from different disciplines (clinical vs technical background) and commented how transdisciplinary working was important to them and their students. This type of partnership seemed to work very well in terms of coming up with clinically and technologically relevant solutions, as well as with moving

the work along. Case 1 and Case 4 also commented that they started to see their thinking crossover, where they would try to think about problems from the other co-leads perspective/discipline.

- The other two AGE-WELL projects (Case 2 and 3) have co-leads that come from similar backgrounds/disciplines, and it was evident that they tended to work more separately (less frequent meetings, working independently on projects etc.).
- An engaged partnership and marrying clinical and technical expertise, appeared to be helpful, for example, clinical expertise was seen as helpful for understanding the real-world applicability of technologies, and could also aid in the recruitment of older adults. One of the project leads from Case 2 commented that the network could have done a better job of matching or connecting people on both ends of the spectrum (clinical side and technology side) or matching people that are working with end-users with someone who is developing a certain type of technology.

Identify Technology Champions:

- All projects identified different technology champions for their technology. Case 1 primarily identified health care providers such as community care nurses, whereas Case 2 identified family caregivers, grandchildren or volunteers. Case 3 acknowledged a wide range of people, including anyone who has a stake in health, individuals trying to stay healthy and caregivers and clinicians. Case 4 identified long-term care homes, or other assisted living facilities and caregivers as important technology champions.

Coach Users:

- All projects talked about potential resistance or skepticism to the technology, by either health care providers or older adults.

Context:

- All projects recognize the complex context in Canada, including challenges related to reimbursement and procurement, but are generally not yet at the stage where those issues are addressed. However, Case 1 and 4 appeared to have a better understanding of health system challenges as both have co-leads who have clinical expertise.

Older Adults:

- All projects recognize challenges in developing technologies for, and engaging with, older adults.
- Despite this, they all have involved, or plan to involve, older adults in their projects through the research, development, testing or commercialization of their technology.

Collaborators:

- They all discussed the importance of getting buy-in from clinical leaders, healthcare providers/staff, caregivers or other key stakeholders/collaborators in the development and implementation of technologies.

Chapter 6 Discussion

6.1 Overview

This project identified many barriers and facilitators along the innovation pathway from development to implementation that AGE-WELL projects and key stakeholders have experienced or may encounter in the future. The ADOPT model was found to be a helpful framework that identified and categorized key factors and strategies that facilitate technology adoption that technology developers can take, including: *Design User-Friendly Relevant Technology, Establish Technology Value, Create Business Model, Promote Technology, Form Partnerships, Identify Technology Champions and Coach Users*. It also highlights key determinants related to *Older Adults, Collaborators* and their *Context* that impact the capability for, and likelihood of, technology adoption and diffusion. The ADOPT model was a helpful way to organize the findings and to answer the research questions as it allowed a capture of many facilitating and constraining factors from the initial design process through to business modeling and to coaching users, as well as a consideration for contextual issues. This study has also yielded a greater understanding of the ADOPT model (developed based on a literature review), as it has provided many specific and concrete contextual real-world examples for each of the domains, as well as examples from a Canadian context. Thus an important contribution of this thesis is providing empirical data to support the ADOPT model. Concepts or ideas that were identified in the ADOPT model but not touched on in this study include lack of access and resource issues related to technology, including broadband access for older, less educated, minority and/or lower income individuals. Additionally, there are several results found in this study that are not covered in great detail or specifically talked about in the ADOPT model. For example, transdisciplinary working and forming innovation hubs or ecosystems was a consistent

facilitator identified throughout all the cases. Further, challenging the assumptions that individuals might have about older adults and their ability to use technology emerged as an important theme from both some of the project leads, and also from stakeholders interviewed. There is an increasingly wide range of simple and easy to use technologies, as well as aging cohorts of potentially more technologically savvy individuals (e.g. Statistics Canada (2014) suggests rates of internet usage will continue to increase among Canadian seniors). Thus, it is important to not overlook older adults and assume they want to be disengaged from new and innovative approaches that may help to manage their health and wellness. Further, being critical about the ‘hype’ or need for technology to solve issues related to an aging population was a caution by a stakeholder participant. This stakeholder noted that technology is just one supportive piece of many layers of complexity in supporting an aging population. Understanding regulation and other contextual issues such as cost-containment in health, funding issues and healthcare system fragmentation in the Canadian context also emerged beyond the ADOPT model. Finally, the categories/domains in the ADOPT framework are somewhat broad and encompass a variety of concepts. For example, family caregivers are lumped with technology developers, organizations, medical providers among others, in the *Collaborators* domain, however through the results of this study, family caregivers (as one might expect) emerged as important stakeholders throughout many of the domains to help facilitate the use and access to technologies. Thus, a consideration for the model may be to make family caregivers its own domain within the centre of the model along side the *Older Adults* domain given their importance.

6.2 Study Implications

There are clear congruencies between the results of this study and previous literature around the complexities of developing and implementing technology, especially technology with a health focus targeted to an older population. Barriers related to human and financial resource and capacity issues were identified both in the literature (Snowdon, 2011; Sebastianski, 2015) and in this study where all cases felt they could benefit from different expertise to help engage in innovation activities such as business expertise/commercialization offices, user-engagement expertise, third-party payer expertise, ethics clearance expertise and clinical expertise. Further, being aware of the challenges of user-centred design with older-adults (Newell, 2007) and the potential cognitive and or physiological differences that may influence the use of a technology were identified in both the literature and results of this study. Other barriers related to system level hurdles such as Canada's multiple jurisdictions and procurement policies that are risk averse and focus on cost-containment instead of value generation were identified by both stakeholders in this study and the broader literature (Ontario Health Innovation Council, 2015; Prada, 2011; Sebastianski, 2015). Other implementation issues were identified including building business cases, interoperability issues and a lack of robust evidence on cost and outcomes for aging-related technologies (Peek et al, 2016) Many facilitators or opportunities were confirmed such as early communication and collaboration with end-users to ensure technology is relevant, ensuring funding is provided at all stages of the innovation cycle, and promoting transdisciplinary working (Lehoux, 2008, Ontario Health Innovation Council, 2015; Sixsmith, 2013).

This study has highlighted the wide-ranging complexities involved in developing and implementing technology and the varied expertise that is required from a motivated chain of

people. The development of the AGE-WELL NCE illustrates the importance of creating diverse networks of qualified people and enabling funding for interdisciplinary and transdisciplinary work. However, this study has specifically highlighted the importance of having realistic expectations about what AGE-WELL can achieve in its time. Culture change and building strong collaborations can take time. As one participant pointed out, looking for hard outcomes too fast on commercialization could mean that we only chase the low-hanging fruit. Padfield (2017) reinforces this point by indicating the need to look beyond traditional outcome measures to consider outcomes such as capacity building, and innovation culture. The strong emphasis on commercialization in AGE-WELL was generally problematized by the participants, as well as the rigid framework for reporting. However, it is understandable that for NCEs there must be a balance of both fostering creativity/innovation by minimizing rigidity but also ensuring accountability for public dollars. Promoting commercialization from the beginning has likely had both facilitating and constraining effects. On one hand, it may have forced project leads out of their comfort zone to start thinking earlier about the potential of their technology solution. On the other hand, commercialization can be a difficult thing to think about early in the research process and may not be a helpful exercise if researchers are just ‘making it up’. Similarly, when asking the project representatives questions about regulation, reimbursement, and interoperability, etc., many are early on in their process and may not have thought about these issues for their specific technology, and may perceive these processes as too far away from what they are currently working on. Despite this, they were able to identify some of the general opportunities and constraints moving forward in these areas.

Another key point to consider is managing expectations about technology, and critically questioning what it can realistically solve in terms of assisting an older population with their

health and wellness. System level transformations may be needed in order for technology to be more integrated and relevant in health care and health service delivery. Technology has the potential to transform health systems' productivity and performance and improve patient outcomes. Barker and Donnelly (2017), talk about several technologies that offer solutions to health system challenges if adopted and scaled across systems, for example, solutions that help with the management of chronic diseases that provide individual practitioners with anticipatory information about when interventions should occur. Technology data that are fed back to health systems or health providers helps those that plan care, as well as with making good decisions about the quality and cost of the services provided. The challenge then is moving from simply selling products to creating solutions that meet health system needs and achieve better patient outcomes (Piron, 2017; Padfield, 2017). One of the difficulties in achieving this, and which was a common barrier found in both the 'Establish Technology Value' and 'Context' domains is the immense difficulty in gathering the economic and business pieces in terms of understanding who pays for the technology and of determining its value. This is especially difficult when the culture of payment in health is focused on cost-containment and has a general aversion to risk. Further, it is difficult to know what the top priorities are for health systems and what innovations should be developed in the first place. The features and functions of technologies/solutions will be of little interest to decision-makers without clear understanding of how the technology will improve outcomes and lower costs (Barker & Donnelly, 2017). Innovators thus need to think about these things early in the innovation process and start early conversations with those who will be making decisions on technology adoption.

To address challenges associated with implementation of technologies, Snowdon (2017) summarizes many key points in a recent issue of Healthcare Papers called *A Blueprint for*

Innovation to Achieve Health System Transformation. Of particular relevance to this study, solutions were identified related to mobilizing leadership across governments, organizations and health systems to help define new business models and reimbursement models to incentivize innovation, redesigning clinical processes and creating pathways to implement and scale innovations across systems (Snowdon, 2017). Further, engagement between industry, entrepreneurs, health systems, and policy makers can support the co-creation of solutions, and help leaders reach beyond their traditional organizational mandates to work collaboratively across systems to support adoption of technologies (Snowdon, 2017).

Although further attention is needed to understand how technologies can better integrate within health systems to support the care of patients, including older adults and caregivers, this does not negate the importance of consumer products and understanding what well-informed consumers will purchase. Some technologies may not have a health system connection but still improve the lives of individuals. Regardless of which avenue innovators choose, the results of this study highlight the importance of early communication with end-users and potential purchasers to make sure innovations are relevant and fulfil a particular need.

6.3 Future Directions

Although there may be no simple solutions to address the barriers and challenges identified in this research and in other studies, many opportunities and current initiatives have been identified as promising ways forward. Many hospitals, programs and organizations are providing leadership for health innovation (e.g., Glenrose Rehabilitation Hospital, TEC Edmonton, MaRs, Ontario Health Innovation Council, AGE-WELL) however there still seems to be a lack of coordination across initiatives (Padfield 2017). Padfield (2017) argues for shifting the focus away from developing and designing new innovations to instead thinking about how to

scale up and implement promising pilots and ways to transform health services, otherwise Canada will continue to be referred to as a country of perpetual pilot projects (Begin et al, 2009). Similarly, funding is a significant force that influences innovation. For example in Ontario, well-established programs supported by the Ontario Centres of Excellence and FedDev Ontario have provided impressive investment in creating technologies, devices and innovative products (Padfield, 2017). These programs have supported innovators and start-ups involved in designing new technologies and products for health systems by providing important seed funding. What has not been addressed by these funding programs is an investment in health system leadership capacity to support access to health-sector markets and adoption of innovative products (Padfield, 2017). Thus, a way forward is investment in understanding the funding models that best support innovation implementation in health systems, (Padfield, 2017), including home and community care.

Further, regional health innovation ecosystems or innovation hubs that bring different types of people together (industry, academics, government, end-users etc.) to better support entrepreneurship and the development and commercialization of technology are recognized as a major potential opportunity (Bramwell, Hepburn, Wolfe, 2012; Etzkowitz, 2011). In recognition of the need to engage with diverse groups of stakeholders on a regional basis, future knowledge mobilization efforts for AGE-WELL include regional workshops in various parts of the country in which stakeholders can collaborate to identify potential solutions to the barriers and challenges identified in these case studies and related research.

Finally, results of this thesis support future use of the ADOPT model as a helpful resource or starting point for technology developers or other collaborators interested in promoting the adoption and diffusion of technologies for older adults.

6.4 Study Limitations

Participants in this study talked about a wide range of health technologies, from health and wellness type devices to medical devices. Thus, there is difficulty in generalizing the findings to all aging-related health technologies, given the great variability in the types of technologies being developed, and their potential applications. Additionally, because the stakeholders who were interviewed beyond the AGE-WELL NCE were not specifically linked to the projects, their commentary, although helpful to answer the research questions, remained more general to the development and implementation of health technologies, than to the four specific projects. The case studies were undertaken at a relatively early stage, thus additional research focused at the later stages of technology implementation would be valuable. As mentioned earlier, this study is limited to cases undertaken, as part of the AGE-WELL NCE, thus the results may not be generalizable to innovation processes in other contexts. This may to some extent be mitigated by the use of the ADOPT conceptual framework which has broader application. Related to the AGE-WELL NCE, the study may have been limited in its focus on informants linked to the specific projects—informants from the AGE-WELL leadership may have added other perspectives.

6.5 Conclusion

Technologies have the potential to help older adults maintain their independence, health and quality of life. Understanding the factors that facilitate or constrain the development and implementation of aging-related technologies can help efforts to promote their diffusion and adoption. Continued research, particularly with a focus on implementation, is needed to ensure that older adults and family caregivers can receive the benefits of these technologies.

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APPENDIX A: INFORMATION LETTER INTERVIEWS

Study Name: Policy and Regulatory Issues in Enabling Technical Innovation

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Introduction:

You are being invited to participate in a research study called “Policy and Regulatory Issues in Enabling Technical Innovation (PRI-TECH) conducted by Dr. Paul Stolee, Maggie MacNeil and Melissa Koch at University of Waterloo. This study is being conducted as part of the Aging Gracefully across Environments using Technology to Support Wellness, Engagement and Long Life Network Centre of Excellence (AGE-WELL NCE). AGE-WELL is a national research network in technology and aging whose aim is to help older Canadians to maintain their independence, health and quality of life through accessible technologies that increase their safety and security, support their independent living, and enhance their social participation. This phase of the study is being conducted as part of M. Koch’s Master’s thesis.

Your participation in this study is entirely voluntary, so it is up to you to decide whether or not to take part in this study. Before you decide, it is important for you to understand what the research study involves. This letter will provide you with information about the study. It will

explain the purpose of the research, your role in the research and potential benefits, risks and discomforts.

Please take the time to read the following information carefully.

Who is conducting the study?

This study is being conducted by: Dr. Paul Stolee, Maggie MacNeil and Melissa Koch from the School of Public Health and Health Systems at the University of Waterloo.

What is the purpose of the study?

This project will examine current policy and regulatory frameworks and processes that are relevant to the licensing, approval, regulation, reimbursement and evaluation of new technologies and innovations resulting from AGE-WELL and others involved in developing health technologies. Recommendations will be made for how innovation in health technologies for seniors can be accommodated and stimulated within existing policy and regulatory frameworks, as well as how these frameworks might be modified to support safe and timely adoption of promising and effective technologies. This understanding will be valuable in supporting the successful innovation and commercialization activities of AGE-WELL to the study aims to uncover the steps required for AGE-WELL and other technologies to be approved for licensing and marketing in different Canadian provinces.

What will happen?

You are being invited to participate in an interview to learn from your knowledge/expertise in policy and regulatory issues related to new technologies and innovations. The interview is estimated to take approximately 45-60 minutes. The types of questions that you will be asked include: your role within the federal/provincial/territorial ministry or department, your knowledge of regulatory/policy frameworks that guide the implementation of new technologies, specific existing technologies (e.g. a smart home platform, a mechanical based sensor to track movement in older adults etc.) to understand the policy and regulatory processes associated with bringing these innovations to market and any associated challenges. The conversation will take place either over the phone or in person, at a time that is convenient for you. With your permission, the interviews will be audio-recorded.

Where will the study take place?

The study will take place over the phone or in-person at a convenient location.

Will the study help you or others?

We hope to understand the regulatory and policy frameworks/processes that guide the implementation of new technologies. The knowledge gained through this study will directly help the commercialization and dissemination activities of AGE-WELL technologies that are being developed for older adults, and others involved in technology innovation. We hope to make recommendations for how innovation in health technologies for seniors can best be

accommodated and stimulated within existing policy and regulatory frameworks which will help those within and beyond the network.

Will the study harm you?

There are no known risks to participating in this study.

What do you get for being in the study?

We are not providing any remuneration.

Is your participation voluntary?

Your participation in the study is completely voluntary and you may choose to withdraw from participating at any time. You can decline to participate in the study without penalty. If you agree to participate, you will be able to talk about whatever you are comfortable. If there is a question you do not want to answer, you may say, "I don't want to answer that question."

Can you change your mind or decide not to answer a question?

You can change your mind and stop being part of the study at any time. If you decide to leave the study, all of the data collected from you will be immediately destroyed.

What will happen to your information?

All information you give during the conversation will be held in confidence. Your information will be kept in a locked filing cabinet at the University of Waterloo, School of Public Health and Health Systems, and will be accessed only by members of the research team. *Your name will not* appear on any of the data. Only the project team will have access to entire interviews. With your permission, anonymous quotations may be used in the following way(s):

- in teaching and demonstration materials
- in scholarly papers, articles and other publications, and
- in presentations at academic, health care conferences

Electronic files containing study data will be password-protected, and will be destroyed after 7 years. Audiotapes, transcriptions, and data files will remain confidential, and no names will be associated with the data. Each participant will be assigned an identification number, which will be used to organize the data. There are no conditions under which the confidentiality of data cannot be guaranteed.

Who can I contact if I have any questions?

If you have questions about the research or about your role in the study, please feel free to contact Dr. Paul Stolee by phone at (519) 888 4567 x 35879 or by e-mail (stolee@uwaterloo.ca) or Melissa Koch by email m4koch@uwaterloo.ca. This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 21006). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca."

What will happen after the study is over?

The researchers will ask if you would like to be contacted in the future to go over the findings and give your opinions on the results. If you do not want to be contacted in the future, you may indicate this preference.

Conclusion

We are excited about this study and are looking forward to listening to your experiences and insights regarding policy and regulatory frameworks that impact the medical device and health technology industry. We sincerely hope that you will consider participating.

APPENDIX B: CONSENT FORM

Consent Form

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Dr. Paul Stolee, Dr. Chiranjeev Sanyal Melissa Koch and Maggie MacNeil from the School of Public Health and Health Systems at the University of Waterloo, and Dr. Don Juzwishin of Alberta Health Services/University of Alberta. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 21006). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

YES NO

I agree to have my interview audio recorded.

YES NO

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.

YES NO

Participant Name: _____ (Please print)

Participant Signature: _____

Witness Name (1): _____ (Please print)

Witness Signature (1): _____ Date: _____

Only for consents obtained verbally:

Participant Name: _____ (Please print)

Witness Name (1): _____ (Please print)

Witness Signature (1): _____ Date: _____

Witness Name (2): _____ (Please print)

Witness Signature (2): _____ Date: _____

When this study is completed, we will write a summary of the results. Would you be interested in receiving a copy?

YES, please e-mail me a summary of the results. My e-mail address is:

YES, please mail me a summary of the results. My mailing address is:

NO, I do not wish to receive a summary of results

APPENDIX C: INTERVIEW GUIDE POLICY OFFICIALS

Interview guide for F/P/T officials involved in policy and regulation of health technologies and medical devices.

Date:

Start time of interview:

Number of participants:

Could you please describe your current role (in the federal/provincial/territorial ministry or department)?

What technologies do you look at and how do you decide which ones to consider?

What is your involvement in policy-making, planning or decision-making related to regulations and reimbursement of medical devices and other health technology?

Can you walk us through the process, from submission to approval, and do you have any guidelines or frameworks that guide this?

Do you have any policy or regulatory frameworks for technologies related to aging? How does the reimbursement process for aging-related technologies differ from other health technologies?

What is currently working well in terms of regulatory processes in the medical device or health technology industry? (Facilitators)

What could be improved? (Barriers)

Are you working on identifying potential policy or research priorities related to regulations and reimbursement in the medical devices and other health technologies?

Are there any documents or summarized reports that you would be able to share with us?

Have you heard of _____ (AGE-WELL Technology)? What factors would influence the feasibility of this technology getting regulatory approval and adopted for reimbursement by the province?

End time of interview:

APPENDIX D: INTERVIEW GUIDE INDUSTRY AND OTHER STAKEHOLDERS

Date:

Start time of interview:

Number of participants:

Could you please describe the role of your organization in the health technology and medical device industry? What is your role within this organization?

What technologies do you look at and how do you decide which ones to consider?

How do you hear or become informed of them?

Have you ever been consulted or given advice to aid in policy-making, planning or decision-making related to regulations and reimbursement of medical devices and other health technology? Was this formal or informal consultation- is it reoccurring?

What is currently working well in terms of regulatory processes in the medical device industry?

What could be improved?

Is your organization working on identifying potential policy or research priorities related to regulations and reimbursement for medical devices and other health technologies?

How do you go about identifying the priorities? Is it working?

Are there any documents or summarized reports that you would be able to share with us?

Have you heard of _____ (AGE-WELL Technology)? What factors would influence the feasibility of this technology getting regulatory approval and adopted for reimbursement by the province?

End time of interview:

APPENDIX E: INTERVIEW GUIDE AGE-WELL MEMBERS

Date:

Start time of interview:

Number of participants:

Which AGE-WELL work package are you affiliated with?

Could you briefly describe your team (e.g. roles, expertise, industry partners etc?)

Are you familiar with any policy or regulatory frameworks with regards to reimbursement that are pertinent to the medical device and health technology industry?

Are you familiar with any policy or regulatory frameworks for technologies related to aging?
How do you think the reimbursement process for aging-related technologies differ from other health technologies?

What are the facilitators to implementing new technologies in Canada?

What are the barriers to implementing new technologies in Canada?

What do you think are the facilitators and barriers to implementing technologies related to aging?
Do you think the facilitators and barriers are similar to other technologies? If different, how so?

Do you have any specific example of these (facilitators and barriers), relating to you work package?

What resources would help your work package's commercialization and dissemination activities?

End time of interview:

APPENDIX F: SECOND INTERVIEW GUIDE AGE-WELL MEMBERS

Date:

Start time of interview:

Number of participants:

For the following questions (Reference their survey/previous interview/Site Visit where appropriate to see what has changed)

What product(s) is your group currently working on/developing? How has the product(s) evolved/progressed (if at all) since the start of the AGE-WELL NCE?

Where do you see this/these technologies being used/implemented?

What factors do you think have facilitated the development of this product/these products?

What factors do you think have constrained the development of this product/these products?

What factors will facilitate the development and eventual implementation of this product/these products moving forward?

What factors will constrain the development and eventual implementation of this product/these products moving forward?

How has working within an NCE influenced the work you are doing? Do you have any examples of when it facilitated or constrained your project?

Examples of Probing Questions more directly related to the ADOPT Framework:

How is designing technologies for older adults different from other user groups? What things do you need to consider? What specific issues do you think affect an older adult's ability to use the technology?

How will you establish/demonstrate your technology's value (to the health care system? Consumer? Improve quality of care? Lower costs?)

Has your team created a business model or intend to create one? What might this look like?

How do you plan to market/promote your technology to its intended end user?

What partnerships does your team have currently have? What partnerships may you need in the future for successful technology diffusion/implementation?

Who might need to be the technology champions for this technology? (E.g. if it is to be used in a health care setting who might need to champion it or likewise if it is to be used at home?)

In conjunction with the question before, who might be involved in coaching the user of the technology? (E.g. older adult, caregiver, or employees of an aging service organization)

Do you anticipate running into challenges related to policy, reimbursement, interoperability, and/or privacy considerations?

End time of interview:

APPENDIX G: INFORMATION LETTER OBSERVATIONS OF LAB SPACES

Study Name: Policy and Regulatory Issues in Enabling Technical Innovation

Researchers:

Paul Stolee, PhD

Associate Professor

University of Waterloo

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Maggie MacNeil, PhD candidate

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Melissa Koch, MSc candidate

University of Waterloo

200 University Ave West, Waterloo, ON N2L 3G1

Email: m4koch@uwaterloo.ca

Introduction:

You are being invited to participate in a research study called “Policy and Regulatory Issues in Enabling Technical Innovation (PRI-TECH) conducted by Dr. Paul Stolee, Maggie MacNeil and Melissa Koch at University of Waterloo. This study is being conducted as part of the Aging Gracefully across Environments using Technology to Support Wellness, Engagement and Long Life Network Centre of Excellence (AGE-WELL NCE). This phase of the study is being conducted as part of M. Koch’s Master’s thesis.

Your participation in this study is entirely voluntary, so it is up to you to decide whether or not to take part in this phase of the study. This phase of the study is using an opt-out consent process (see below for more details).

Please take the time to read the following information carefully.

Who is conducting this phase of the study?

This phase of the study is being conducted by Melissa Koch from the School of Public Health and Health Systems at the University of Waterloo.

What is the purpose of this phase of the study?

The thesis project involves case studies of AGE-WELL technology projects, to explore what factors facilitate or constrain their innovation journey (from development to implementation/adoption), including any policy, regulatory and/or health system issues that may be relevant. In order to understand the technologies your work package is developing, we would like to come visit your team's lab space to observe the types of technologies you are working on, and to talk to project leads/students informally about their work on developing technologies within AGE-WELL.

What will happen?

Observations would last between 30-45 minutes. We are interested in observing the physical technologies that your team is working on/developing and the physical spaces where you work on, and test these technologies. During this observation, conversations with students/project leads would be informal; the types of conversations would focus on what your AGE-WELL work consists of, the physical lab space, your experience of developing these technologies and working within the AGE-WELL NCE. The researcher would take jot notes on an 'observation guide' to capture some of the physical features of the lab space and technology that is being developed, as well as, some of the main ideas expressed through informal conversations. Conversations **will not** be audio recorded and names of project leads/students **will not** be recorded with the jot notes.

Where will the observations take place?

The observations will take place in person at your University in your lab space.

Will the observations help you or others?

We hope to understand the processes that facilitate or constrain the development and implementation of technologies of older adults. The knowledge gained through this study will directly help the commercialization and dissemination activities of AGE-WELL technologies that are being developed for older adults, and others involved in technology innovation. We hope to make recommendations for how innovation in health technologies for seniors can best be accommodated and stimulated within existing policy and regulatory frameworks which will help those within and beyond the network.

Will this phase of the study harm you?

There are no known risks to participating in the observations for this phase of the study.

What do you get for participating in this observation process?

We are not providing any remuneration.

Is your participation voluntary?

Your participation in the observation/informal conversation process is completely voluntary and you may choose to withdraw from participating at any time. This phase of the study is using an opt-out consent process. You can decline to participate without penalty; if you do not want to be included in the observation/informal conversation process please let the researcher know by emailing m4koch@uwaterloo.ca. If you wish to opt-out, the researcher will not inform your project lead that you do not want the observation/discussion process with you to be used as data. If you agree to participate, you will be able to talk about whatever you are comfortable. If there is a question/inquiry you do not want to answer, you may say, "I don't want to answer that question."

What will happen to your information?

All information you give during the conversation will be held in confidence. The researcher is not collecting any names or identifying information, however the observation guides/jot notes will be kept in a locked filing cabinet at the University of Waterloo, School of Public Health and Health Systems, and will be accessed only by members of the research team. *Your name will not* appear on any of the data. Only the project team will have access to the observation guides. Information recorded on the observation guide may be used in the researcher's thesis and other publications that come of this research; the information that will be reported in the thesis will focus on information related to the technologies being developed, characteristics of the physical lab space and any ideas around the barriers/facilitators to developing/implementing technologies for older adults.

Electronic files containing study data will be password-protected, and will be destroyed after 7 years. Observation guides will remain confidential, and no names will be associated with the data.

Who can I contact if I have any questions?

If you have questions about the research or about your role in the study, please feel free to contact Dr. Paul Stolee by phone at (519) 888 4567 x 35879 or by e-mail (stolee@uwaterloo.ca) or Melissa Koch by email m4koch@uwaterloo.ca. This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 21006). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

What will happen after the study is over?

The researchers will ask if you would like to be contacted in the future to go over the findings and give your opinions on the results. If you do not want to be contacted in the future, you may indicate this preference.

APPENDIX H: RECRUITMENT LETTER FOR OBSERVATIONS

Observation Recruitment Script (verbal or email) for AGE-WELL Project Leads

Date:

Study Name: Policy and Regulatory Issues in Enabling Technical Innovation

Hello, my name is Melissa Koch. I am contacting you from the University of Waterloo, I am a Master's student working on a study within the AGE-WELL NCE in work package 7: "Policy and Regulatory Issues in Enabling Technical Innovation (PRI-TECH)".

This project examines current policy and regulatory frameworks and processes that are relevant to the licensing, approval, regulation, reimbursement and evaluation of new technologies and innovations resulting from AGE-WELL and others involved in developing health technologies.

My thesis project is an extension of this project and involves case studies of AGE-WELL technology projects, to explore what factors facilitate or constrain their innovation journey (from development to implementation/adoption), including any policy, regulatory and/or health system issues that may be relevant. In order to understand the technologies your work package is developing, I would like to come visit your lab space to observe the types of technologies you are working on, and talk to your students informally about their work on developing technologies within AGE-WELL.

Observations would last between 30-45 minutes. Involvement in these observations would be entirely voluntary and there are no known or anticipated risks to participation in this study. The types of things I am interested in observing are the physical technologies you are working on/developing and the physical spaces where you work/test these technologies. Additionally, conversations with students would be informal; the types of conversations would center on their experiences of developing these technologies and working within the AGE-WELL NCE.

You can decline to answer any of my informal questions and terminate the observation at any time. All information you provide will be considered confidential. This study has received ethics clearance through a University of Waterloo Research Ethics Committee.

With your permission, I would like to email/mail/fax you an information letter which has all of these details along with contact names and numbers on it to help assist you in making a decision about your participation in these observations. Please let us know at your earliest convenience if you would like to participate.

If you have any questions or concerns please do not hesitate to contact me by email or at my research office number 519-888-4567 ext. xxxx

APPENDIX I: OBSERVATION GUIDE

Context/Lab Space (#of students? # of technologies tested/looked at)

Types of expertise on the team

Comments about NCE/Comments about AGE-WELL

Processes (technology processes/team processes/development processes/structural processes etc)

Barriers within their work

Facilitators within their work

APPENDIX J: RECRUITMENT LETTER INTERVIEWS

Date:

Study Name: Policy and Regulatory Issues in Enabling Technical Innovation

Hello, my name is _____. I am contacting you from _____ about a study that we would like to invite you to participate in called “Policy and Regulatory Issues in Enabling Technical Innovation (PRI-TECH)”. This study is being conducted as part of AGE-WELL, which is a national research network whose aim is to help older Canadians maintain their independence, health and quality of life through accessible technologies that increase their safety and security, independent living, and social participation.

This project will examine current policy and regulatory frameworks and processes that are relevant to the licensing, approval, regulation, reimbursement and evaluation of new technologies and innovations resulting from AGE-WELL and others involved in developing health technologies.

Interviews would be over the phone or in-person (at a time that is convenient to you), and would last between 45 to 60 minutes. Involvement in this interview would be entirely voluntary and there are no known or anticipated risks to participation in this study. The types of questions that you would be asked include your role within the federal/provincial/territorial ministry or department and your knowledge of regulatory/policy frameworks, to help us understand the policy and regulatory processes involved with bringing these innovations to market.

You may decline to answer any of the questions and may terminate the interview at any time. With your permission, the interview will be tape-recorded to facilitate collection of information, and later transcribed for analysis. All information you provide will be considered confidential. This study has received ethics clearance through a University of Waterloo Research Ethics Committee.

With your permission, I would like to email/mail/fax you an information letter which has all of these details along with contact names and numbers on it to help assist you in making a decision about your participation in this study. Please let us know at your earliest convenience if you would like to participate.

If you have any questions or concerns please do not hesitate to contact me by email or at my research office number 519-888-4567 ext. xxxx

APPENDIX K: FEEDBACK LETTER

Department Letterhead

University of Waterloo

Date

Re:

Dear (*Insert Name of Participant*),

I would like to thank you for your participation in this study. As a reminder, the purpose of this study is to gather information about current policy and regulatory frameworks and developments that are relevant to the licensing, approval, regulation, reimbursement and evaluation of new technologies and innovations resulting from AGE-WELL.

The data collected during interviews will contribute to a better understanding of how innovation in health technologies for seniors can be accommodated and stimulated within existing policy and regulatory frameworks.

Please remember that any data pertaining to yourself as an individual participant will be kept confidential. Once all the data are collected and analyzed for this project, I plan on sharing this information with the members of the AGE-WELL NCE as well as with the research community through seminars, conferences, presentations, and journal articles. If you are interested in receiving more information regarding the results of this study, or if you have any questions or concerns, please contact me at the email address listed at the bottom of the page. If you would like a summary of the results, please let me know now by providing me with your email address. When the study is completed, I will send it to you. The study is expected to be completed by *[insert date]*.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 21006). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca

Paul Stolee, PhD stolee@uwaterloo.ca

Department of Health Studies and Gerontology

APPENDIX L: SURVEY

AGE-WELL Technologies Policy and Regulatory Process Survey

Dear Workpackage Leader,

This survey is being sent to you by workpackage 7.1 Policy and Regulatory Issues in Enabling Technological Innovation (PRI-TECH). The goal of PRI-TECH is to help AGE-WELL better comprehend the policy, regulatory and other processes that affect health technology innovation and adoption. The aim of this survey is to help PRI-TECH better understand your plans for technological innovation and the intended pathways for commercialization and adoption of your health technology.

We are sending one survey for each workpackage project. Completion of the survey is expected to take about 20-25 minutes. You may omit any question you prefer not to answer. There are no known or anticipated risks to participation in this survey. Participation in this survey is voluntary, and all information you provide will be kept confidential. The data collected through this study will be kept for a period of 7 years in a secure location and then destroyed. Electronic files containing survey data will be password-protected, and will also be destroyed after 7 years.

If interested, please email the completed survey to Dr. Paul Stolee. By returning the completed survey you are implying your consent to participate in the study. By providing your consent, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

If you have any questions, or would like additional information to assist you in reaching a decision about participation, please feel free to contact Dr. Stolee at 519-888-4567 ext. 35879

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE# 21006). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca

Yours sincerely,

Paul Stolee

Section One: About Your Work Package:

In this section, you will be asked to identify your work package and inform PRI-TECH about the technology that your work package is developing.

****Note:** for the purpose of this survey, “technology” refers to: web portals or online tools, mobile applications, communication technologies, robots or intelligent control or communication technologies, digital technologies (games, etc.), hardware-software systems and sensor technologies.**

1. You are the project leader for:

--

2. The following passage is a summary of our knowledge of WP#'s work related to the development of a technology.

Insert WP specific description.

Having read the summary above, please provide any additional details that might help PRI-TECH understand the health technology that your work package is currently developing, the progress that you have made, and the general scope of the project:

--

3. The intended use of your health technology is to: *Please check all boxes that apply.*

- To diagnose a disease, disorder, abnormal physical state or symptom
- To treat a disease, disorder, abnormal physical state or symptom
- To mitigate a disease, disorder, abnormal physical state or symptom
- To prevent a disease, disorder, abnormal physical state or symptom
- To restore, modify or correct a body structure
- To restore, modify or correct functioning of any part of the body

- To screen or assess
- To promote healthy behaviour
- None of the above. What is the intended use?

4. Does your health technology use software? If yes, please indicate if your software is involved in: *Please check all boxes that apply.*

- Data collection
- Data monitoring
- Data analysis
- Data editing
- Image generation and/or identification of a region of interest in an image
- Determination of measurements
- Identification (through an alarm/alert) if results from a monitor that are outside of an established range
- None of the above. What is the intended use?

5. The intended end-user of your health technology is: *Please check all boxes that apply.*

- Informal or family caregiver
- Older adults (65 years or older)
- Community care/home-care workers
- Long-term care staff
- Healthcare provider
- Other

If you selected "Healthcare provider", please specify:

6. The intended purchaser of your health technology is: *Please check all boxes that apply.*

- Provincial ministry
- Health region / health authority / Local Health Integration Network

- Hospital
- Long-term care
- Home /community care agency
- Older adults (65 years or older)
- Informal or family caregivers
- Consumers
- Other

--

Section Two: Policy and Regulatory Processes: In this section, you will be asked questions that are relevant to the policy and regulatory processes in enabling health technology in older adults. New health technologies undergo a process of innovation involving several steps. These steps, or phases, may not necessarily occur in succession. Each phase is described in the table below. Please answer these questions to the best of your ability or knowledge.

Phase	Definition
Research and development	Developing new products; applied research which may facilitate future product development
Regulatory Process	The process of obtaining regulatory approval from Health Canada or other government bodies for the health technology.
Health Technology Assessment	The systematic evaluation of properties, effects, and/or impacts of health technology. It is a multidisciplinary process to evaluate the social, economic, organizational and ethical issues of a health intervention or health technology. The main purpose of conducting an assessment is to inform policy decision making.
Commercialization	The process of introducing a new product into commerce-making it available on the market
Marketing	Promoting and selling products or services, including market research and advertising.
Adoption and Procurement	The dissemination or implementation portion of the innovation process
Reimbursement	Managed care payment by hospitals, group purchasing organizations, regional health authorities, third party payers and patients to a company/innovator/service provider

7. Which phase is your health technology currently at?

- Research and Development

- Regulatory Process
- Health Technology Assessment
- Commercialization
- Marketing
- Adoption and Procurement
- Reimbursement
- Other

8. To what extent do you (and your team) feel prepared to navigate each of the following phases?

	Not at all prepared	Somewhat prepared	Moderately prepared	Very well prepared
Research and Development	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Regulatory Process	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Health Technology Assessment	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Commercialization	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Marketing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Procurement/Adoption	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Reimbursement	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

9. This question will ask about obstacles in the innovation process. If the question is not applicable to your workpackage or technology, please write "N/A".

- a) What obstacles do you anticipate facing with regards to the **research and development** phase for your product?

If you have already developed a technology, what obstacles did you face with regards to the research and development phase of your product?

If you have already developed a technology, what did you find helpful? Or what were the enablers in developing your technology?

b) What obstacles do you anticipate facing with regards to obtaining **regulatory approval (i.e. Health Canada, FDA) for your product?**

If you have already developed a technology, what obstacles did you face with regards to obtaining regulatory approval for your product?

If you have already developed a technology, what did you find helpful for obtaining regulatory approval? Or what were the enablers in obtaining regulatory approval your technology?

c) What obstacles do you anticipate facing with regards to **Health Technology Assessment for your product?**

If you have already developed a technology, what obstacles did you face with regards to Health Technology Assessment for your product?

If you have already developed a technology, what did you find helpful with regards to Health Technology Assessment? Or what were the enablers in regards to Health Technology Assessment?

d) What obstacles do you anticipate facing with regards to **commercialization** of your product?

If you have already developed a technology, what obstacles did you face with regards to commercialization of your product?

If you have already developed a technology, what did you find helpful with regards to commercialization? Or what were the enablers in regards to commercialization?

e) What obstacles do you anticipate facing with regards to **marketing** for your product?

If you have already developed a technology, what obstacles did you face with regards to marketing for your product?

If you have already developed a technology, what did you find helpful with regards to marketing? Or what were the enablers in regards to marketing?

f) What obstacles do you anticipate facing with regards to **procurement/adoption** for your product?

If you have already developed a technology, what obstacles did you face with regards to procurement/adoption for your product?

If you have already developed a technology, what did you find helpful with regards to procurement/adoption? Or what were the enablers in regards to procurement/adoption?

g) What obstacles do you anticipate facing with regards to **reimbursement** for your product?

If you have already developed a technology, what obstacles did you face with regards to reimbursement for your product?

If you have already developed a technology, what did you find helpful with regards to reimbursement? Or what were the enablers in regards to reimbursement?

10. What resources, if any, (individuals, institutes, documents, etc.) do you have to help you through the different phases?

11. Who will be involved in the research, development, testing or commercialization of your health technology? Please check all boxes that apply.

- Older adults (65 years or older)
- Patients
- Informal and family caregivers
- Healthcare providers
- Manufacturers
- Vendors
- None of the above

Other

If you selected "Patients", please specify:

If you selected "Healthcare providers", please specify:

Please explain how each group you indicated above is/or will be involved (e.g. How did you recruit them? How many people participated? How often did they participate?).

12. What additional information would you like to know about the different phases in enabling health technology for older adults?

APPENDIX M: CODEBOOK

Codebook developed by pulling key concepts from *The ADOPT model: Accelerating diffusion of proven technologies for older adults* (Wang et al., 2011). This helped inform what concepts should go under each of the ADOPT domains.

Context:

- Policy (including reimbursement, interoperability and privacy considerations).
- Resources/access issues relating to technology/ economic/logistical barriers/broader cultural or societal factors.
- Regulatory issues such as licensing can affect health technology diffusion particularly for technologies that overlap with the clinical setting.

Older Adults:

- Difference between age groups, (Laggards are more likely to be advanced in age),
- Issues to consider include: cognitive and physical limitations, health status and disease conditions, multiple medical providers, technology literacy and familiarity and motivation to use technology for health and other purposes.
- Identify the older adult's location on spectrum of tech familiarity, acceptance and ability.
- Perceived usefulness is another key factor in technology adoption.
- Older adults have demonstrated instances of successful use of technology for health (e.g. older adults exhibit high rates of using the internet for health information).

Collaborators:

- Collaborators include but are not limited to (formal/informal caregivers, family members, aging services providers, technology developers, medical providers, and health plans.
- Collaborators are important for older adults due to unique considerations that affect their use of tech: A lower level of familiarity/awareness of technology, cognitive or physical limitations that make it difficult to use technology and resource and other limitations that make accessing tech difficult.
- Importance of social contact and connectedness in diffusion.
- Certain individuals/opinion leaders can influence the overall diffusion process.

Seven “diffusion strategies” in the ADOPT model, which describe actions that older adults’ collaborators can take to facilitate technology adoption and diffusion

Design User-Friendly, Relevant Technology:

- Design solutions to existing needs of the user (Identifying a need is the first step);
- Older adults tend to use tech to reach a goal or realize a benefit.
- Perceived usefulness and ease of use are important.

- Ease of Use/lack of complexity: Older adults have lower overall levels of familiarity with technology compared to other age groups and may also face physical or cognitive barriers
- Obtaining direct feedback from older adults during the development process may be helpful in designing suitable technology applications.
- Work to refine existing products to increase their relevance and ease of use.

Establish Technology Value:

- Reimbursement for health technology from payers is limited- this could be changed by developing more robust evidence base for the outcomes their technologies can create (through RCTs, ROI calculations and other outcomes...tech developers can make a stronger case for why their technologies should be reimbursed).
- If tech developers develop more robust evidence base for their techs ability to improve quality of care while lowering costs, payers and government mandates would be more likely to promote policies and reimbursement that support the spread of tech.

Create Business Model:

- Tech companies can fail despite having a superb product if a sustainable business model is not in place, tech diffusion can take a significant amount of time so developing a strong business model as early as possible is necessary.
- Finding the proper mechanisms to support the company (through payments, grants, partnerships, reimbursement, or other sources).
- Making technology affordable for its customers.
- Financial concerns are among the largest barriers...many health systems, hospitals, aging services organizations, and individual end-users have budget constraints. The technology must be able to deliver financial or other benefits for whoever is paying for the technology.
- Establishing and delivering the product's value proposition.

Promote Technology:

- Lack of awareness and other knowledge barriers
- Health providers, patients, payers and technology leaders unaware of connected health solutions or examples.
- Technology developers to market their technology effectively.
- Developing methods and materials to communicate the benefits of a technology, promoting through the appropriate channels, and creating a clear and compelling story for its use to the target audience.

Form Partnerships:

- Spreading its impact through the right partnerships that will allow for scale in the diffusion process.
- Partners for spreading technology may include large health care systems, a network of aging services organizations, or a community-based organization.

- Forming the right partnerships...explore as early as possible in the process to enable successful diffusion.

Identify Technology Champions:

- Once a technology has been launched within an organization, community, or individual end-user, in many cases it is necessary to find someone to champion the technology
- The technology champion(s) may be an employee in an aging services organization, a community member, or an older adult's caregiver or family member, among other examples.
- It is necessary to have a champion who believes in the technology, is committed to its implementation, and has the resources to help overcome inevitable barriers and failures in the adoption process.

Coach Users:

- The user includes both the older adult and others who have to overcome workflow challenges to work with the older adult or use technology on his or her behalf (e.g., caregivers or employees of an aging services organization).
- Workflow challenges --coaching users on how to make technology fit into the flow of their work or life.
- The older adult, or the individual who acts on behalf of the older adult, must receive the proper coaching to learn how to use the technology and what benefits it provides.
- Coaching should be an interactive process focused on empowering and activating the older adult.
- Helping older adults develop the skills for sustained self-management and technology use.
- User coaching can be very simple for some technologies or very complex for others.
- The optimal coach could be the older adult's health provider, family member, informal/formal caregiver, or an organization's technology champion (or a combination of these).

Facilitators and Barriers

Facilitators: Factors that aide in, or help promote innovation processes/activities (from development to implementation)

Barriers: Obstacles or factors that impede various innovation processes/activities (from development to implementation)

APPENDIX N: SURVEY ANSWERS

Survey Questions	Case 1
Q3: The intended use of your health technology is to:	<input checked="" type="checkbox"/> To diagnose a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To treat a disease, disorder, abnormal physical state or symptom <input checked="" type="checkbox"/> To mitigate a disease, disorder, abnormal physical state or symptom <input checked="" type="checkbox"/> To prevent a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To restore, modify or correct a body structure <input type="checkbox"/> To restore, modify or correct functioning of any part of the body <input checked="" type="checkbox"/> To screen or assess <input type="checkbox"/> To promote healthy behaviour <input type="checkbox"/> None of the above. What is the intended use? <input style="width: 150px;" type="text"/>
Q4: Does your health technology use software? If yes, please indicate if your software is involved in:	<input checked="" type="checkbox"/> Data collection <input checked="" type="checkbox"/> Data monitoring <input checked="" type="checkbox"/> Data analysis <input checked="" type="checkbox"/> Data editing <input checked="" type="checkbox"/> Image generation and/or identification of a region of interest in an image <input checked="" type="checkbox"/> Determination of measurements <input checked="" type="checkbox"/> Identification (through an alarm/alert) if results from a monitor that are outside of an established range <input type="checkbox"/> None of the above. What is the intended use? <input style="width: 150px;" type="text"/>
Q5: The intended end-user of your health technology is:	<input checked="" type="checkbox"/> Informal or family caregiver <input checked="" type="checkbox"/> Older adults (65 years or older) <input checked="" type="checkbox"/> Community care/home-care workers <input checked="" type="checkbox"/> Long-term care staff <input checked="" type="checkbox"/> Healthcare provider <input type="checkbox"/> Other <input style="width: 150px;" type="text"/> If you selected "Healthcare provider", please specify: <input style="width: 200px;" type="text" value="Home care nurses, physicians"/>
Q6: The intended purchaser of your health technology is:	<input type="checkbox"/> Provincial ministry <input checked="" type="checkbox"/> Health region / health authority / Local Health Integration Network <input checked="" type="checkbox"/> Hospital <input checked="" type="checkbox"/> Long-term care <input checked="" type="checkbox"/> Home /community care agency <input type="checkbox"/> Older adults (65 years or older) <input type="checkbox"/> Informal or family caregivers <input checked="" type="checkbox"/> Consumers <input type="checkbox"/> Other <input style="width: 200px;" type="text"/>

Q7: Which phase is your health technology at?

- Research and Development
- Regulatory Process
- Health Technology Assessment
- Commercialization
- Marketing
- Adoption and Procurement
- Reimbursement
- Other

Q8: To what extent do you (and your team) feel prepared to navigate each of the following phases:

	Not at all prepared	Somewhat prepared	Moderately prepared	Very well prepared
Research and Development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
Regulatory Process	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Health Technology Assessment	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
Commercialization	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Marketing	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Procurement/Adoption	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reimbursement	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q11: Who will be involved in the research, development, testing or commercialization of your health technology?

- Older adults (65 years or older)
- Patients
- Informal and family caregivers
- Healthcare providers
- Manufacturers
- Vendors
- None of the above
- Other

If you selected "Patients", please specify:

If you selected "Healthcare providers", please specify:

Please explain how each group you indicated above is/or will be involved (e.g. How did you recruit them? How many people participated? How often did they participate?).

Survey Questions	Case 2
<p>Q3: The intended use of your health technology is to:</p>	<ul style="list-style-type: none"> <input type="checkbox"/> To diagnose a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To treat a disease, disorder, abnormal physical state or symptom <input checked="" type="checkbox"/> To mitigate a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To prevent a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To restore, modify or correct a body structure <input type="checkbox"/> To restore, modify or correct functioning of any part of the body <input type="checkbox"/> To screen or assess <input checked="" type="checkbox"/> To promote healthy behaviour <input type="checkbox"/> None of the above. What is the intended use? <input style="width: 150px;" type="text"/>
<p>Q4: Does your health technology use software? If yes, please indicate if your software is involved in:</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Data collection <input checked="" type="checkbox"/> Data monitoring <input checked="" type="checkbox"/> Data analysis <input type="checkbox"/> Data editing <input checked="" type="checkbox"/> Image generation and/or identification of a region of interest in an image <input type="checkbox"/> Determination of measurements <input checked="" type="checkbox"/> Identification (through an alarm/alert) if results from a monitor that are outside of an established range <input type="checkbox"/> None of the above. What is the intended use? <input style="width: 150px;" type="text"/>
<p>Q5: The intended end-user of your health technology is:</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Informal or family caregiver <input checked="" type="checkbox"/> Older adults (65 years or older) <input type="checkbox"/> Community care/home-care workers <input type="checkbox"/> Long-term care staff <input type="checkbox"/> Healthcare provider <input type="checkbox"/> Other <input style="width: 200px;" type="text"/> <p>If you selected "Healthcare provider", please specify: <input style="width: 300px;" type="text"/></p>

<p>Q6: The intended purchaser of your health technology is:</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Provincial ministry <input type="checkbox"/> Health region / health authority / Local Health Integration Network <input type="checkbox"/> Hospital <input checked="" type="checkbox"/> Long-term care <input checked="" type="checkbox"/> Home /community care agency <input checked="" type="checkbox"/> Older adults (65 years or older) <input checked="" type="checkbox"/> Informal or family caregivers <input checked="" type="checkbox"/> Consumers <input type="checkbox"/> Other <input style="width: 200px;" type="text"/> 																																								
<p>Q7: Which phase is your health technology at?</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Research and Development <input type="checkbox"/> Regulatory Process <input type="checkbox"/> Health Technology Assessment <input type="checkbox"/> Commercialization <input type="checkbox"/> Marketing <input type="checkbox"/> Adoption and Procurement <input type="checkbox"/> Reimbursement <input type="checkbox"/> Other <input style="width: 200px;" type="text"/> 																																								
<p>Q8: To what extent do you (and your team) feel prepared to navigate each of the following phases:</p>	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 40%;"></th> <th style="width: 15%;">Not at all prepared</th> <th style="width: 15%;">Somewhat prepared</th> <th style="width: 15%;">Moderately prepared</th> <th style="width: 15%;">Very well prepared</th> </tr> </thead> <tbody> <tr> <td>Research and Development</td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input checked="" type="radio"/></td> </tr> <tr> <td>Regulatory Process</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td>Health Technology Assessment</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td>Commercialization</td> <td><input type="radio"/></td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td>Marketing</td> <td><input type="radio"/></td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td>Procurement/Adoption</td> <td><input type="radio"/></td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td>Reimbursement</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </tbody> </table>		Not at all prepared	Somewhat prepared	Moderately prepared	Very well prepared	Research and Development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	Regulatory Process	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Health Technology Assessment	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Commercialization	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	Marketing	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	Procurement/Adoption	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	Reimbursement	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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Reimbursement	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>																																					

<p>Q11: Who will be involved in the research, development, testing or commercialization of your health technology?</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Older adults (65 years or older) <input checked="" type="checkbox"/> Patients <input checked="" type="checkbox"/> Informal and family caregivers <input type="checkbox"/> Healthcare providers <input type="checkbox"/> Manufacturers <input type="checkbox"/> Vendors <input type="checkbox"/> None of the above <input type="checkbox"/> Other <input style="width: 200px;" type="text"/> <p>If you selected "Patients", please specify:</p> <p><input style="width: 200px;" type="text"/> Dementia Mild Cognitive Impairment</p> <p>If you selected "Healthcare providers", please specify:</p> <p><input style="width: 200px;" type="text"/></p> <p>Please explain how each group you indicated above is/ or will be involved (e.g. How did you recruit them? How many people participated? How often did they participate?).</p> <p>We are currently recruiting older adults with dementia through (x organization). We have 12 older adults and 12 informal caregivers who have signed up for an initial interviewing phase.</p>
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Survey Questions	Case 3
<p>Q3: The intended use of your health technology is to:</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> To diagnose a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To treat a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To mitigate a disease, disorder, abnormal physical state or symptom <input checked="" type="checkbox"/> To prevent a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To restore, modify or correct a body structure <input type="checkbox"/> To restore, modify or correct functioning of any part of the body <input checked="" type="checkbox"/> To screen or assess <input type="checkbox"/> To promote healthy behaviour <input type="checkbox"/> None of the above. What is the intended use? <input style="width: 150px;" type="text"/>
<p>Q4: Does your health technology use software? If yes, please indicate if your software is involved in:</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Data collection <input checked="" type="checkbox"/> Data monitoring <input checked="" type="checkbox"/> Data analysis <input checked="" type="checkbox"/> Data editing <input type="checkbox"/> Image generation and/or identification of a region of interest in an image <input type="checkbox"/> Determination of measurements <input type="checkbox"/> Identification (through an alarm/alert) if results from a monitor that are outside of an established range <input type="checkbox"/> None of the above. What is the intended use? <input style="width: 150px;" type="text"/>

<p>Q5: The intended end-user of your health technology is:</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Informal or family caregiver <input checked="" type="checkbox"/> Older adults (65 years or older) <input checked="" type="checkbox"/> Community care/home-care workers <input type="checkbox"/> Long-term care staff <input checked="" type="checkbox"/> Healthcare provider <input type="checkbox"/> Other <input style="width: 200px;" type="text"/> <p>If you selected "Healthcare provider", please specify:</p> <input style="width: 200px;" type="text" value="Potentially primary care physicians"/>
<p>Q6: The intended purchaser of your health technology is:</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Provincial ministry <input checked="" type="checkbox"/> Health region / health authority / Local Health Integration Network <input type="checkbox"/> Hospital <input checked="" type="checkbox"/> Long-term care <input checked="" type="checkbox"/> Home /community care agency <input checked="" type="checkbox"/> Older adults (65 years or older) <input type="checkbox"/> Informal or family caregivers <input type="checkbox"/> Consumers <input type="checkbox"/> Other <input style="width: 200px;" type="text"/>
<p>Q7: Which phase is your health technology at?</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Research and Development <input type="checkbox"/> Regulatory Process <input type="checkbox"/> Health Technology Assessment <input type="checkbox"/> Commercialization <input type="checkbox"/> Marketing <input type="checkbox"/> Adoption and Procurement <input type="checkbox"/> Reimbursement <input type="checkbox"/> Other <input style="width: 200px;" type="text"/>

<p>Q8: To what extent do you (and your team) feel prepared to navigate each of the following phases:</p>		Not at all prepared	Somewhat prepared	Moderately prepared	Very well prepared
	Research and Development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
	Regulatory Process	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Health Technology Assessment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
	Commercialization	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Marketing	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
	Procurement/Adoption	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>
	Reimbursement	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q11: Who will be involved in the research, development, testing or commercialization of your health technology?

- Older adults (65 years or older)
- Patients
- Informal and family caregivers
- Healthcare providers
- Manufacturers
- Vendors
- None of the above
- Other

If you selected "Patients", please specify:

If you selected "Healthcare providers", please specify:
 Potentially primary care physicians or related specialists

Please explain how each group you indicated above is/or will be involved (e.g. How did you recruit them? How many people participated? How often did they participate?).
 Current studies will be collecting data from a total of 65 older adults

Survey Questions	Case 4
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<p>Q3: The intended use of your health technology is to:</p>	<ul style="list-style-type: none"> <input type="checkbox"/> To diagnose a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To treat a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To mitigate a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To prevent a disease, disorder, abnormal physical state or symptom <input type="checkbox"/> To restore, modify or correct a body structure <input type="checkbox"/> To restore, modify or correct functioning of any part of the body <input checked="" type="checkbox"/> To screen or assess <input checked="" type="checkbox"/> To promote healthy behaviour <input type="checkbox"/> None of the above. What is the intended use? <input style="width: 150px;" type="text"/>
<p>Q4: Does your health technology use software? If yes, please indicate if your software is involved in:</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Data collection <input checked="" type="checkbox"/> Data monitoring <input type="checkbox"/> Data analysis <input type="checkbox"/> Data editing <input type="checkbox"/> Image generation and/or identification of a region of interest in an image <input type="checkbox"/> Determination of measurements <input type="checkbox"/> Identification (through an alarm/alert) if results from a monitor that are outside of an established range <input type="checkbox"/> None of the above. What is the intended use? <input style="width: 150px;" type="text"/>
<p>Q5: The intended end-user of your health technology is:</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Informal or family caregiver <input checked="" type="checkbox"/> Older adults (65 years or older) <input type="checkbox"/> Community care/home-care workers <input checked="" type="checkbox"/> Long-term care staff <input checked="" type="checkbox"/> Healthcare provider <input checked="" type="checkbox"/> Other <input style="width: 150px;" type="text" value="Housing providers and administrators"/> <p>If you selected “Healthcare provider”, please specify: Physiotherapists, occupational therapists, exercise therapist, nurses, physicians</p>
<p>Q6: The intended purchaser of your health technology is:</p>	<ul style="list-style-type: none"> <input type="checkbox"/> Provincial ministry <input checked="" type="checkbox"/> Health region / health authority / Local Health Integration Network <input type="checkbox"/> Hospital <input checked="" type="checkbox"/> Long-term care <input type="checkbox"/> Home /community care agency <input checked="" type="checkbox"/> Older adults (65 years or older) <input checked="" type="checkbox"/> Informal or family caregivers <input type="checkbox"/> Consumers <input type="checkbox"/> Other <input style="width: 200px;" type="text"/>

<p>Q7: Which phase is your health technology at?</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Research and Development <input type="checkbox"/> Regulatory Process <input type="checkbox"/> Health Technology Assessment <input type="checkbox"/> Commercialization <input type="checkbox"/> Marketing <input type="checkbox"/> Adoption and Procurement <input type="checkbox"/> Reimbursement <input type="checkbox"/> Other <input style="width: 300px;" type="text"/> 																																								
<p>Q8: To what extent do you (and your team) feel prepared to navigate each of the following phases:</p>	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="width: 30%;"></th> <th style="width: 15%;">Not at all prepared</th> <th style="width: 15%;">Somewhat prepared</th> <th style="width: 15%;">Moderately prepared</th> <th style="width: 15%;">Very well prepared</th> </tr> </thead> <tbody> <tr style="background-color: #f2f2f2;"> <td>Research and Development</td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input checked="" type="radio"/></td> </tr> <tr> <td>Regulatory Process</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr style="background-color: #f2f2f2;"> <td>Health Technology Assessment</td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td>Commercialization</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr style="background-color: #f2f2f2;"> <td>Marketing</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr> <td>Procurement/Adoption</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> <tr style="background-color: #f2f2f2;"> <td>Reimbursement</td> <td><input checked="" type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> <td><input type="radio"/></td> </tr> </tbody> </table>		Not at all prepared	Somewhat prepared	Moderately prepared	Very well prepared	Research and Development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	Regulatory Process	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Health Technology Assessment	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	Commercialization	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Marketing	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Procurement/Adoption	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Reimbursement	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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<p>Q11: Who will be involved in the research, development, testing or commercialization of your health technology?</p>	<ul style="list-style-type: none"> <input checked="" type="checkbox"/> Older adults (65 years or older) <input type="checkbox"/> Patients <input checked="" type="checkbox"/> Informal and family caregivers <input checked="" type="checkbox"/> Healthcare providers <input checked="" type="checkbox"/> Manufacturers <input type="checkbox"/> Vendors <input type="checkbox"/> None of the above <input checked="" type="checkbox"/> Other <input style="width: 300px;" type="text" value="University students"/> <p>If you selected "Patients", please specify:</p> <input style="width: 300px;" type="text"/> <p>If you selected "Healthcare providers", please specify: Potentially primary care physicians or related specialists Physiotherapists, occupational therapists, exercise therapist, nurses, physicians. Some of these health care providers are also administrators</p>																																								

	<p>of facilities and organizations that provide housing and care to older adults.</p> <p>Please explain how each group you indicated above is/or will be involved (e.g. How did you recruit them? How many people participated? How often did they participate?).</p> <p>The number, extent, and type of participation by each group varies depending on the project. For example, in sub-project (x), older adults were research participants only. In others older adults are actively involved in helping to refine and improve the product. Some also assist in informing the evaluation approach and others are involved as research participants. Recruitment strategies included: delivering presentations and workshops with senior-serving organizations and to seniors in housing complexes (e.g. independent living, assisted living); using brokers (i.e. third party contacts within the research team’s existing professional network); accessing participant lists from our previous studies; leveraging support from “natural leaders” within the older adult and certain health care professional communities.</p>
--	--

APPENDIX O: ETHICS CLEARANCE

Dear Researcher:

A Request for ethics review of a modification or amendment (ORE 104) to your ORE application:

Title: Policy and Regulatory Issues in Enabling Technological Innovation ORE #: 21006

Principal/Co-Investigator: Paul Stolee

Principal/Co-Investigator: Ayse Kuspinar

Collaborator: Donald Juzwishin

Collaborator: Pascale Lehoux

Collaborator: Don Husereau

Collaborator: Michael Wilson

Collaborator: Dr. Chiranjeev Sanyal Student Investigator: Melissa Koch Student Investigator: Maggie MacNeil

together with a copy of relevant materials, was received in the Office of Research Ethics on:

March 27, 2017 - 1) Incorporate a few additional aspects of a Master's thesis (which is part of the original project) by adding new research questions to study AGE-WELL technologies being developed within the network, as case studies, to understand the barriers and facilitators to their innovation process. 2) Add interviews (two separate interview guides) and a survey of AGE-WELL members (project leads); visit their lab spaces to observe the technologies they are developing and informally chat with students working on the projects; Interview key informants beyond the AGE-WELL network that have expertise in innovation health technologies to provide additional insight beyond AGE-WELL members. 3) Master's thesis portion of the study will be done by September 2017. 4) New study locations: On campus (LHN, 2nd floor); Off campus (government organizations and the University campuses where these technologies are being developed.)

The proposed modification request has been reviewed and has received full ethics clearance.

Note 1: This project must be conducted in accordance with the description in the application and modification for which ethics clearance has been granted. All subsequent modifications to the protocol must receive prior ethics clearance through the Office of Research Ethics.

Note 2: Researchers must submit a Progress Report on Continuing Human Research Projects (ORE Form 105) annually for all ongoing research projects. In addition, researchers must submit a Form 105 at the conclusion of the project if it continues for less than a year.

Note 3: Any events related to the procedures used that adversely affect participants must be reported immediately to the ORE using ORE Form 106.

Nick Caric
Research Ethics Advisor
Office of Research Ethics
East Campus 5 (EC5), 3rd Floor
519.888.4567 ext. 30321

APPENDIX P: FIGURE PERMISSIONS

Figure 1 Permissions

Hi Melissa,

Sorry for the delayed response.

Yes, you have permission to use the diagram but you must note CAHO as the source.

I hope this helps.

Suzanne

Suzanne de Breyné Executive Assistant
Council of Academic Hospitals of Ontario (CAHO)
200 Front Street W, Suite 2301 Toronto, ON M5V 3L1
416 205 1336

From: Melissa Koch [<mailto:m4koch@uwaterloo.ca>]

Sent: July 26, 2017 10:26 AM

To: Karen Michell

Subject: Permission to use diagram

Good morning,

My name is Melissa Koch and I am a Masters student at the University of Waterloo. I am in the process of completing my thesis work, which is a multiple case study of technologies that are being developed within a Network of Centers of Excellence, Aging Gracefully across Environments using technology to support Wellness, Engagement, and Long Life (AGE-WELL).

I was wondering if I could get permission to use the Diagram: Innovation Development and Implementation Pathway: Chart 1, found in the presentation *CAHO Recommendations to OHIC*. I would like to use this diagram in the literature review of my thesis as I have identified it as a model to understand the scope of my work.

If you are not the correct source of permission, would you be able to provide me with the contact information of the correct source?

Thanks for your time,

Melissa Koch

MSc Candidate, School of Public Health and Health Systems

Geriatric Health Systems Research Group

University of Waterloo

Waterloo, ON

Figure 2 Permissions

Hi Melissa. Permission granted!

Jovan Matic

Office of the Chief Health Innovation Strategist

Phone: 416-670-7277

From: Melissa Koch [<mailto:m4koch@uwaterloo.ca>]

Sent: July 26, 2017 10:09 AM

To: OCHIS (MOHLTC)

Subject: Permission to use figure

Good morning,

My name is Melissa Koch and I am a Masters student at the University of Waterloo. I am in the process of completing my thesis work, which is a multiple case study of technologies that are being developed within a Network of Centers of Excellence, Aging Gracefully across Environments using technology to support Wellness, Engagement, and Long Life (AGE-WELL). I was wondering if I could get permission to use Figure 1: The Health Technology Innovation Cycle, from *The Catalyst towards an Ontario Health Innovation Strategy*. I would like to use Figure 1 in the literature review of my thesis as I have identified it as a model to understand the scope of my work.

I can see that the Figure is adapted from another source, so if you are not the correct source of permission, would you be able to provide me with the contact information of the correct source?

Thanks for your time,

Melissa Koch

MSc Candidate, School of Public Health and Health Systems

Geriatric Health Systems Research Group

University of Waterloo

Waterloo, ON

Figure 3 Permissions



Health Canada Santé
Canada Canada

July 26th, 2017

Ref: HC2017-0313

Ms. Melissa Koch
MSc Candidate
School of Public Health and Health Systems
Geriatric Health Systems Research Group
University of Waterloo
200 University Avenue West
Waterloo, ON
N2L 3G1

Email: m4koch@uwaterloo.ca

Unleashing Innovation: Excellent Healthcare for Canada
Report of the Advisory Panel on Healthcare Innovation

Dear Melissa,

On behalf of Health Canada (HC), I am pleased to grant you permission to reproduce Figure 9.2: Innovation Adoption Journey from Health Canada's material entitled: "**Unleashing Innovation: Excellent Healthcare for Canada – Report of the Advisory Panel on Healthcare Innovation**" for its educational and non-commercial purposes.

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Yours sincerely,

Louise Sicard

Project Officer, Commercial Licensing & Copyright
Publications/Distribution
Marketing & Creative Services Division, CPAB

Figure 4 Permissions

Hi Melissa,

I don't have an issue with using the model for your thesis if the original source is credited and not for a wider audience. However, I would also check with the publisher Springer as I'm not familiar with their policies.

Good luck!

Ange

From: Melissa Ann Koch [<mailto:m4koch@uwaterloo.ca>]

Sent: 25 July 2017

To: Dr. Ange Wang

Subject

Good morning Dr. Wang,

My name is Melissa Koch and I am a Masters student at the University of Waterloo. I am in the process of completing my thesis work, which is a multiple case study of technologies that are being developed within a Network of Centers of Excellence, Aging Gracefully across Environments using technology to support Wellness, Engagement, and Long Life (AGE-WELL). I was wondering if I could get permission to use Figure 1 a conceptual model of technology diffusion which discusses important considerations for diffusing health technologies in home and community-based settings for older adults from the article *The ADOPT Model: Accelerating Diffusion of Proven Technologies for Older Adults*, written by yourself and Lynn Redington, Valerie Steinmetz and David Lindeman.

If you are not the correct source of permission, would you be able to provide me with the contact information of the correct source?

Thanks for your time,

Melissa Koch

MSc Candidate, School of Public Health and Health Systems

Geriatric Health Systems Research Group

University of Waterloo

Waterloo, ON

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