I.T. for P.T.:

Developing digital health core competencies for physiotherapists

by

Katie Dyck

A Thesis submitted to the Faculty of Graduate Studies of

The University of Manitoba

in partial fulfillment of the requirements of the degree of

MASTER OF SCIENCE

College of Rehabilitation Sciences, Rady Faculty of Health Sciences

University of Manitoba

Winnipeg, Manitoba

Acknowledgements

I would like to thank the following people who were instrumental in supporting me with achieving my Master's degree goal:

- Dr. Barbara Shay – For providing support and mentorship as my Advisor and providing me with the perfect balance of independence and guidance to complete my graduate degree, particularly in a relatively unexplored field of research for our profession.
- Dr. Reg Urbanowski – For providing opportunities to share my research within the Rady Faculty of Health Sciences and eHealth 2018, for assisting with building connections with digital health technology champions and for seeing ongoing potential in this work.
- Members of my Advisory/Examination Committee: Dr. Reg Urbanowski, Dr. Terry Klassen, and Dr. Amanda Condon – For agreeing to participate as part of my committee or as a subject-matter-expert and for providing me with encouragement and constructive feedback.
- University of Manitoba Faculty of Graduate Studies – For awarding me with a Travel Award to attend and present a research poster at the national eHealth Conference in 2019.
- Kim Morrison, Shared Health – For providing me with work flexibility to enable the pursuit of my graduate degree activities. Without the support of my employer, my graduate work would have been extremely challenging. Thank you also to Gillian Brennan and Liz Loewen at Shared Health for their ongoing support.
- College of Physiotherapists of Manitoba and the Manitoba Physiotherapy Association – For providing administrative support for my survey distribution and for their willingness to engage in this important work for our profession.

Dedication

- To my brothers, Tim and Simon for being amazing role models and overachievers, setting a high bar for me to strive towards personally and professionally.
- To my parents, Jim and Jennifer for always treating their three children equally despite age or gender and for never expecting me to reach any high bar but the one I set for myself.
- To my husband, Jeff for being a wonderful life partner and an incredible father. Thank you for being my rock, continuing to build our life together and raise two incredible children.
- To my son, Rylan for teaching me the value of looking before I leap. You have turned into such a caring, loyal, and smart young man and I am so proud of you. Your future is bright.
- To my daughter, Ella for teaching me the value of leaping before I look. You are beautiful inside and out. You can accomplish great things if you continue to believe in yourself and your inner strength. I'm so proud of you.
- To three of my closest friends, Katelin, Krista and Carrie. Your friendship means the world to me and I am so lucky to have such beautiful and brilliant women in my life.
- To the group of female mentors who I am proud to call friends and colleagues who have shaped my professional and personal life, thank you: Sue Thompson, Barb Shay, Mieke Vonderbank, Evelyn Lightly, Kim Shaw, Denise Dreikleft, Joanne Gross, Rickie Walkden, Brenda Martin, Megan Ferrone, Joanne Carswell, Stephanie Roberecki, Donna Watts-Hutchings, Michelle Conger, Carrie Cole, Krista Paulson, Brenda Tittlemeier, Sheila Williams, Corinne Thompson Bobrowich, Katelin McDermott, Amanda Condon, Jamie Neville, Sandra Foster, Kim Morrison, Gillian Brennan, Liz Loewen, Donna Johnson, and last but certainly not least, my sister's-in-law Samina Ali, Alla Prutkin, Amanda Cuthbert and Carla Sutherland.

Table of Contents

List of Figures

List of Tables

Abstract

As technology use increases within the physiotherapy community, development of core competencies is necessary to promote digital health literacy.

Objective: To gather information on use and attitudes about health technology in Manitoba physiotherapists.

Methods: A quantitative descriptive survey approach was undertaken to provide an environmental scan of technology use including benefits and challenges to adoption.

Results: Data analysis served as a needs assessment to target areas for education on digital health literacy. Themes identified facilitated development of a digital health core competency framework aligned with the existing physiotherapy competency profile in Canada. Results were analyzed in the context of the Clinical Adoption Framework and the Diffusion of Innovations theory to explore successful adoption approaches and clinician engagement.

Conclusion: The long-term goal of this work is to enable physiotherapists to adopt and optimize use of digital health in clinical practice to enhance patient care and support advocacy for physiotherapy services.

1 Introduction

The Canadian Physiotherapy Association (CPA) states "The heart of the physiotherapy profession is understanding how and why movement and function take place. Physiotherapists are highly skilled and autonomous health professionals who provide safe, quality client-centred physiotherapy through a commitment to service availability, accessibility and excellence." (Canadian Physiotherapy Association 2012). Members of this self-regulated profession, commonly referred to as PTs, follow principles of evidence-based practice delivering primary care services targeted to the ever-changing needs of Canadians. CPA describes the physiotherapy scope of practice as broad and dynamic focused on working towards improving quality of life by: (1) Promoting optimal mobility, physical activity and overall health and wellness; (2) Preventing disease, injury and disability; (3) Managing acute and chronic conditions, activity limitations, and participation restrictions; (4) Improving and maintaining optimal functional independence and physical performance; (5) Rehabilitating injury and the effects of disease and disability with therapeutic exercise programs and other interventions; and (6) Educating and planning maintenance and support programs to prevent re-occurrence, re-injury or functional decline (Canadian Physiotherapy Association 2012).

Several principles act as the foundation for physiotherapy practice in Canada including a commitment to patient-centred care performed ethically and within scope-of-practice. Physiotherapists demonstrate a commitment to life-long-learning and integration of current evidence into ongoing practice, continually expanding knowledge and innovating new techniques to improve the health and wellness of Canadians. They care for people of all ages, in a variety of settings including urban, rural and remote settings, publicly-funded health-care centres, community health agencies, private practices, schools and academic institutions, along with industry, government and corporate organizations. They care for a broad range of Canadians including vulnerable populations such as indigenous communities, the elderly, the homeless, those living with addictions and mental health issues, persons expressing diverse sexual orientations and gender identities, along with immigrants and people from other culturally and ethnically diverse communities. Physiotherapy scope of practice is broad and comprehensive assisting Canadians with disability and disease management, acute care and rehabilitation, through to health promotion, wellness and prevention of injuries, diseases and disorders. PTs are dynamic self-regulated health professionals with exceptional problem-solving skills and an ability to utilize resources efficiently and effectively. They have direct-access in Manitoba supported by legislation, providing patients with the ability to self-refer and obtain services to achieve optimal health and wellness. Physiotherapists are experienced team players capable of exercising leadership within interdisciplinary teams coordinating care, services and education while maintaining rigorous documentation and communicating with other roles involved in the management of care for their patients.

As health care becomes more complex, and an interdisciplinary care model becomes more prevalent, there is a vital need to develop efficient and effective methods to share information between patients, providers and our health system. Information technologies (IT) and digital health systems can play a key role in achieving this goal and supporting health-care providers to maximize care opportunities. A digitally interconnected health-care system can support providing the right information, at the right time, to the right patient and support health care delivery and health outcomes for Canadians.

Technology is advancing at a rapid rate around the world in many sectors including health care. Research by Densen (2011) notes technology is the area of medicine that is expanding and changing most rapidly and significantly. In 1950 the time required for medical knowledge to double was 50 years. In 2010, the number had decreased to three and a half years and is projected to significantly decrease further to 73 days in 2020 (Densen 2011). This technology revolution and wealth of health information provides both opportunities and challenges for health-care professionals providing them with key current-state information at their fingertips and at the point of care (O'Connor and Andrews 2015). Accordingly, this means that health-care professionals must demonstrate digital health literacy and be prepared to use technology efficiently and effectively in their clinical practice, professional development, continuous quality improvement and for research.

There is a broad range of terminologies to describe technology in health care such as eHealth, digital health and health or clinical informatics. There is some debate in the literature on one single definition for the application of digital health technology, however many organizations have developed contextual definitions to engage health professionals in its importance. For example, the American Medical Informatics Association's Nursing Special Interest Group uses the term 'clinical informatics' defined as "The science and practice which integrates [nursing] clinical practice and clinical knowledge / education, with information and communication technologies to promote the health of people, families and communities worldwide." (Canadian Association of Schools of Nursing 2013). This definition describes a direct relationship between clinical practice, clinical education and the use of health technologies, demonstrating the importance of integrating digital health competencies into health professional academic programs to maximize successful implementation.

Health information technologies, electronic communication tools, systems, and processes can be used to: (1) Deliver improved health-care services; (2) Facilitate better health;

(3) Enhance knowledge of health-care professionals; (4) Improve patient to provider and interdisciplinary communication; (5) Inform and improve health system evaluation, planning, and policy; and (6) Contribute to health research, innovation, and data-driven decision making (Haux 2010). These utilizations guide health-care professionals to potential benefits as outlined in the literature and include improvements in productivity, patient safety and care coordination which in turn can support improved patient outcomes (C. S. Kruse and Beane 2018), reduce cost within the health-care system and provide opportunities for improved access to care and services (Chaudhry et al. 2006; Lau, Price, and Keshavjee 2013).

Competency in health informatics is an emerging topic in the medical education literature which is gaining significant momentum. Collaborative work to date has demonstrated the need for national standards and national strategies to support engagement, awareness, and advocacy for this important topic. In our rapidly changing health-care system and with the innovation opportunities that technology can provide, implementation of digital health core competencies into health professional education programs is a key component to preparing learners to practice successfully in technology-enabled environments and provide a level of quality assurance to the use of digital health technology.

As technology use increases within rehabilitation science professions, consideration should be given to the development of applicable digital health core competencies. The associated programming will provide learners and practicing rehabilitation professionals with the skills and fundamental concepts necessary to support providing quality patient care, improving patient outcomes and promoting advocacy for government-funded rehabilitation services for all Canadians. Given the technology-enabled health system environments present today, knowledge and practical application of clinical informatics should be considered a foundational component of health professional education programs to support use of digital health technology and health information systems to enhance patient care.

Established in 2001 and funded by the federal government, Canada Health Infoway is an independent, not-for-profit organization focused on supporting the adoption, implementation and optimization of digital health in Canada. Infoway refers to digital health as the use of information technologies to deliver health care or facilitate improved health (Canada Health Infoway 2013). In 2011, Canada Health Infoway launched a *Clinician's-in-Training* program focused on developing digital health core competencies in collaboration with The Association of Faculties of Medicine of Canada, The Association of Faculties of Pharmacy of Canada and the Canadian Association of Schools of Nursing (Canada Health Infoway 2013). These competencies have been formally released but vary widely in their implementation status between Canadian jurisdictions, academic institutions and professions. The Canadian Medical Association Journal reports that Canadian medical schools have been slow to integrate health informatics into their curriculum (Strauss 2010) and similar sentiments have been recently released by the Canadian Association of Schools of Nursing as well as nursing associations in Germany, Austria and Switzerland (Egbert et al. 2018; Nagle 2019).

To date, digital health core competencies have not been developed for physiotherapists in Canada creating a gap in digital health literacy across the profession. This gap limits PTs from harnessing the many benefits associated with the use of digital health technology which are now well established in the literature. These benefits include improving effective patient care, reducing health system and health care delivery costs, improving efficiencies through enhanced patient-to-provider and provider-to-provider communication and supporting data driven decision-making and clinical research (Christodoulakis, Asgarian, and Easterbrook 2017; Gagnon et al. 2014; Singer et al. 2017). As electronic medical record (EMR) use increases within the physiotherapy community, development and implementation of digital health core competencies, accompanied by a national strategy and vision to support **IT for PT** is vitally important and necessary to promote digital health literacy at a grass roots level.

1.1 Information Technology (IT) in Health Care

An enormous variety of technology and tools now exist and continue to undergo a rapid rate of change and innovation providing health-care professionals with many options and a wealth of information at their fingertips. From a Canadian health care perspective, the most commonly implemented digital systems include electronic health records (EHRs), electronic patient records (EPRs), electronic medical records (EMRs), telehealth/virtual care solutions, and mobile health applications (mHealth) as described in Figure 1.

Figure 1: Types of digital health systems used in Canada

EMR **Electronic Medical Record**	• Digital provider-centric health record used in office-based clinics • Includes information limited to patient care received at that practice • Helps monitor and improve overall quality of care along with supporting business practices
EPR **Electronic Patient Record**	• Digital health record used in public practice such as hospital-based settings and community health centres • Chart includes multi-disciplinary information from all roles involved in care of the patient
EHR **Electronic Health Record**	• Digital lifetime record of a person's health history including broad range of information such as surgical history, lab results, medications, immunizations, allied health visits • Available to authorized health-care professionals or maintained privately by patient and referred to as Personal Health Record (PHR)
Telehealth **or**	• Delivery of healthcare services using information and communication technology (ICT) when the provider and patient are not in the same

Virtual Care	location • Available in a variety of formats including videoconferencing, store and forward solutions and telemonitoring systems
mHealth **Mobile health applications**	• Learning and teaching interactions that use mobile hand-held devices such as electronic notebooks, tablets, or smartphones • Enables the collection, storage and transmission of data in real-time which can be used to care for patients and for different health care purposes

1.2 Core Competencies

The concept of core competencies was first introduced in the 1990's as a business management theory. It has been defined as the "…collective learning in the organization…", which involves coordination and integration of skills that "…deliver additional value to the customer." (Prahalad and Hamel 2007). The approach was a paradigm shift in the business community and was adopted by many large corporations who attributed the core competency framework to their success. Due to the corporate successes, and the relative flexibility of the framework to be applied in multiple domains, a variety of other sectors adopted core competencies including the health-care sector.

Core competencies are now embedded in Canadian universities and have become integral components of accreditation for academic institutions. As a result, competency frameworks have become well established within health-care professional programs. A significant driver for the development of these frameworks was the *Crossing the Quality Chasm* report released in 2001 by the Institute of Medicine's (IoM) Quality of Health Care in America project (Institute of Medicine (US) Committee on Quality of Health Care in America 2001). The report emphasized critical gaps in patient care delivery and encouraged a health system re-design in support of quality patient care and improving outcomes. The report outlined five key competencies designed to be interdisciplinary and applicable across multiple health-care professions. These competencies were considered critical for system re-design to be accomplished and include: (1) Provide patient-centered care; (2) Work in interdisciplinary teams; (3) Employ evidence-based practice; (4) Apply quality improvement; and (5) Utilize informatics. It was understood and acknowledged that different health professionals would bring different skills and contributions to patient care. In support of management for these skills, *10 Rules for the 21st Century Health System* were mapped to the five core competencies. The rules were meant to be universal patient care concepts that could be implemented across all health professions. Currently, the majority of health-care educational programs and practicing clinicians in Canada today are familiar with these over-arching competencies and follow the concepts as foundational elements of clinical practice, often gaining first exposure to them as key components of undergraduate health professional education programs and entry-to-practice guidelines.

1.3 Digital Health Core Competencies

Although clinical informatics is included within the IoM's five core competencies, it has been a late edition to many health professional competency frameworks due to the timing of adoption and implementation of digital health tools and clinical systems, particularly in Canada. Electronic medical record (EMR) adoption in primary care did not gain momentum in Canada until 2009 with the commencement of the EMR Adoption Program, co-funded by the Government of Canada and Canada Health Infoway (Terry et al. 2009). The *Clinicians-in-Training* project spearheaded by Canada Health Infoway in 2011, in collaboration with the medical, nursing and pharmacy faculty associations across Canada, was instrumental in supporting entry-level clinicians with clinical informatics education opportunities (Canada Health

Infoway 2013). More information on this program can be reviewed in Section 3 - Literature Review.

1.4 Digital Health Literacy

The concepts of training and learning are often misunderstood and used interchangeably when it comes to describing the education of health professionals. Training can be defined as organized activity aimed at conveying information and/or instructions to improve the recipient's performance or to help him or her attain a required level of knowledge or skill, whereas learning is defined as measurable and relatively permanent change in behavior gleaned through experience, instruction, or study (Antonacopoulou 2001). According to the American Library Association's Information Literacy Competency Standards for Higher Education,

> Information literacy refers to the ability to determine the extent of information needed, access the needed information effectively and efficiently, evaluate the information and its sources critically, incorporate selected information into one's knowledge base, use information effectively to accomplish a specific purpose and understand the economic, legal, and social issues surrounding the use of information, and access and use information ethically and legally. (American Library Association 2000)

Thus, learning can be described as an integration and synthesis of material resulting in information literacy. An emerging concept in medical education literature is competency in health informatics focused on improving digital health literacy and preparing new graduates to practice in technology-enabled environments which have now become the norm. The concept of digital health literacy describes the foundational skills required by learners and health professionals as they search for and use online health information and clinical systems in their learning process and in their clinical practice. Health informatics literacy needs to be dynamic and evolving due to the intense pace of technology innovation and change.

1.5 Digital Health in Manitoba

In 2010, the Government of Manitoba announced the launch of a provincial EMR Adoption Program in partnership with Canada Health Infoway's pan-Canadian EMR Adoption Program funded by the federal government. The goal of the program was to accelerate the adoption and implementation of EMRs in primary care and community-based specialty clinics in Manitoba to improve quality of care, connect community practices to other providers, improve patient safety and leverage health data to improve access and patient care across the Manitoba health-care system. The reimbursement program formally closed in the spring of 2015 exceeding the goal of 70% adoption within the family physician, community-based specialist and nurse practitioner community, corresponding to a total of 1000 clinicians successfully participating across the province. EMR adoption has continued to increase in Manitoba in primary care despite the end of the Infoway program and is reaching saturation.

Despite the success of the EMR Adoption Program and a current provincial EMR adoption rate second highest in Canada within primary care practice at 89% (Leaver 2017), there is evidence demonstrating deficiencies in EMR data quality (Singer et al. 2016, Singer et al. 2017). These deficiencies reveal a lack of digital health literacy within primary care practice. This contributes to significant limitations in the utilization of rich data sources within EMRs and other health information systems to inform clinical practice, support continuous quality improvement, contribute to practice reflection and inform health-care policy.

Although digital health core competencies have been developed for medicine, nursing and pharmacy curricula, a lack of implementation has contributed to challenges with optimized use of digital health tools and deficiencies in data quality (The Association of Faculties of Medicine of Canada 2012). The family medicine and nursing experience across Canada has demonstrated a need to implement digital health core competencies at minimum in parallel with strategies that support adoption and implementation of digital health systems to maximize success (Nagle 2019; Singer et al. 2017; Terry et al. 2009). From a Manitoba perspective, integration of existing core competencies for medicine, nursing and pharmacy professional programs has yet to occur in a comprehensive way. This lack of digital health educational content within the Rady Faculty of Health Sciences at the University of Manitoba could be interpreted as a fundamental barrier to effective use of clinical systems from a current state and future state perspective.

As mentioned previously, unlike the professions noted above, no national digital health strategy or core competencies have been developed for rehabilitation science professionals in Canada. In July of 2018, as part of a provincial-wide health system transformation initiative, the Manitoba Government announced significant and broad-sweeping cuts to publicly-funded physiotherapy and occupational therapy services across the province, essentially deleting out-patient and hospital/community-based services and privatizing the majority of physiotherapy and occupational therapy services within the Winnipeg Regional Health Authority. A guiding principle behind pronouncements on Manitoba's health-system transformation have been largely driven by data-based decisions and analytics to improve efficiencies and coordinate services at a provincial level to reduce costs and improve outcomes. Although rehabilitation science workforce data does exist within provincial databases used in the evaluation, such as the Manitoba Centre for Health Policy housed at the University of Manitoba and internationally recognized as an extremely high quality and rich source of data from a broad spectrum of sources in the province, the data is largely compiled into an allied health category, with limited opportunity to filter out profession-specific data, even at the aggregate level. There is currently no source of accurate, comprehensive or reliable provincial data on utilization of digital health or patient outcomes by rehabilitation science professionals in Manitoba.

Given a large number of practicing physiotherapists work in private practice outside the publicly-funded system in comparison to occupational or respiratory therapists, PTs provided a diverse population to target with respect to the use of digital systems across work sectors, identifying this profession as a natural starting point to evaluate for this study with respect to digital health utilization and comprehension. Robust digital health literacy can inform and enhance clinical practice, enhance learning, professional development and innovative research and is a critical component to support health system planning, policy development and should be considered an innovate and effective approach to support advocacy for rehabilitation science services within Manitoba's health-care system. Given the similarities in practice, findings from this study would likely be applicable across other rehabilitation science professionals and worthy of pursuing in future research.

1.6 Purpose and Objectives

The purpose of this quantitative descriptive cross-sectional survey study is to gather information on physiotherapy knowledge, use and attitudes about digital health technology. The resulting profile will provide the groundwork to facilitate development of digital health core competencies. The research objectives for this study include: (1) To generate a baseline digital health literacy profile of registered physiotherapists in Manitoba via an online survey; (2) To identify factors that may influence digital health adoption, implementation, and optimization in Manitoba physiotherapists; and (3) To develop a digital health core competency framework, aligned with the existing national physiotherapy role-based framework, focused on better enabling physiotherapists to utilize digital health tools, systems and applications in clinical practice.

2 Theoretical Perspective

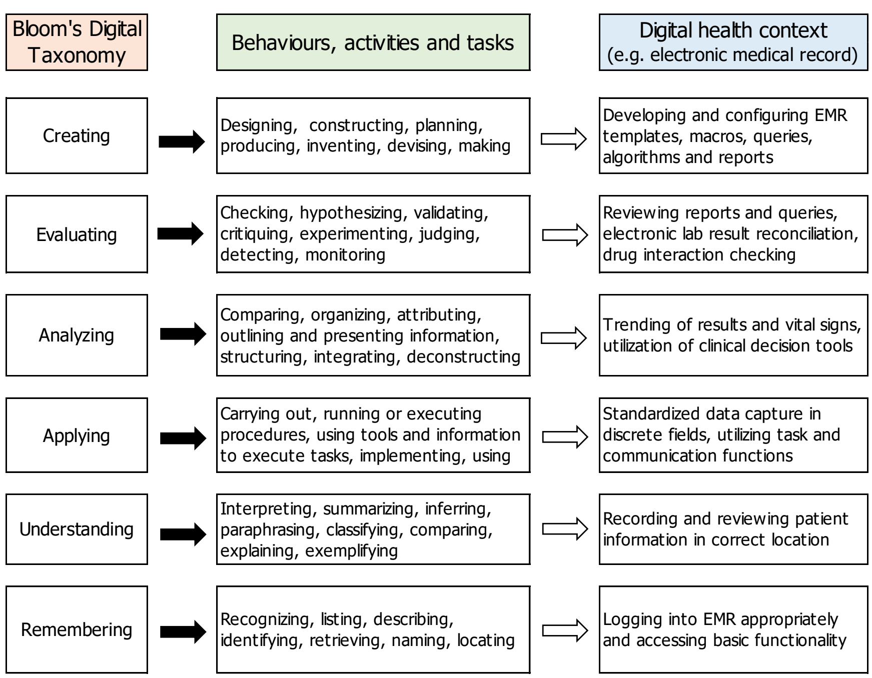
The following section describes the three theoretical frameworks identified to support different components of this research study: (1) Bloom's Taxonomy of Learning Objectives; (2) Lau's Clinical Adoption Framework; and (3) the Diffusion of Innovations Theory.

2.1 Bloom's Taxonomy of Learning Objectives

Bloom's Taxonomy of Learning Objectives is a theoretical model that aligns closely with the definition of both learning and literacy and is a framework used across a multitude of educational organizations and academic institutions to develop and evaluate learning objectives and programs. Bloom (1956) proposed three psychological domains to learning: (1) Cognitive (processing and learning); (2) Affective (attitudes and feelings); and (3) Psychomotor (physical skills). The most commonly applied domain in learning and literacy is the Cognitive domain which supports the development and evaluation of learning skills and learning objectives (Adams 2015). There are six hierarchical components in the model moving from lower-levels to higher-levels of learning: (1) Knowledge; (2) Comprehension; (3) Application; (4) Analysis; (5) Synthesis; and (6) Evaluation. In 2000, the model was revised to include action verbs to promote the model through a skills-based lens which improves the ability to apply and evaluate the levels of learning. The highest levels of learning were also adjusted demoting evaluation and adding the concept of creating content as the practical application of knowledge synthesis at the pinnacle of the hierarchy. The revised model includes: (1) Remembering; (2)

Understanding; (3) Applying; (4) Analyzing; (5) Evaluating; and (6) Creating (Krathwohl 2002). Sub-components exist in each layer of the model and are used to evaluate learning programs and assist with determining if the competency exists. A modified Bloom's Digital Taxonomy, developed by Churches in 2008, provides more specific sub-components and mapping of behaviours, actions and tasks relevant to developing and evaluating the synthesis of clinical informatics learning to optimize use of clinical systems (Churches 2008). Figure 2 provides a consolidated summary of Bloom's Digital Health Taxonomy including the behaviours, actions and tasks within each of the six taxonomic categories, along with digital context in the form of activities that could take place within an EMR, as an example. Bloom's Taxonomy and the digital modifications added by Churches (Churches 2008; Nisiforou and Eteokleous 2013) are being proposed as the theoretical framework to support competency development, evaluation of digital health competency and knowledge translation activities with respect to future components of this research study related to digital health literacy.

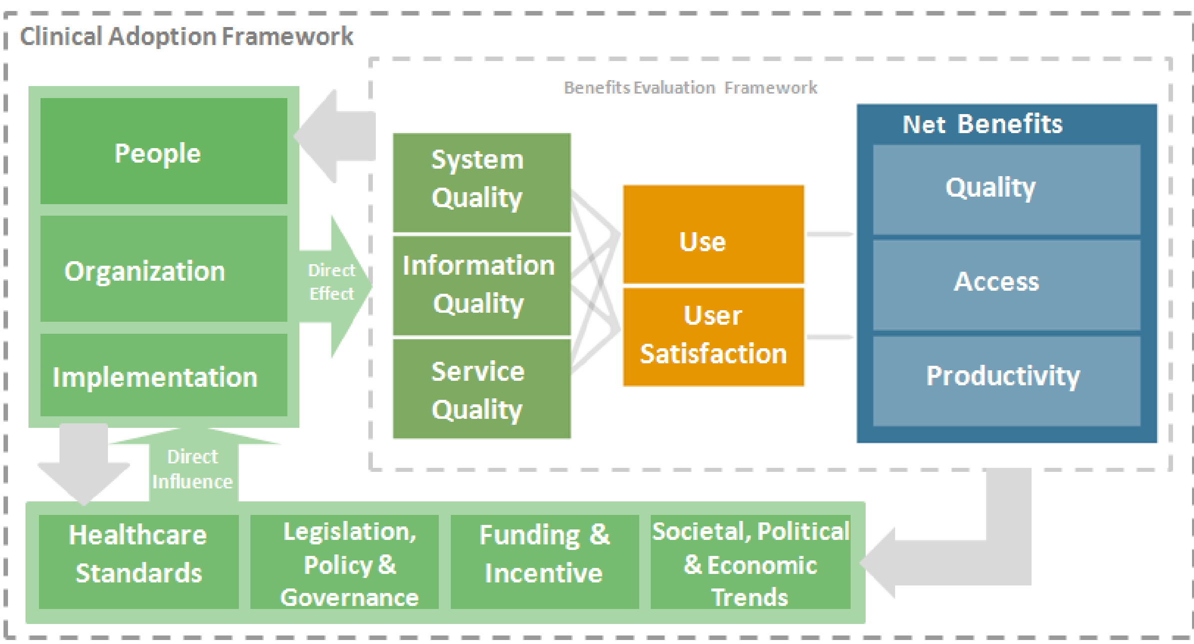
Figure 2: Consolidated summary of Bloom's Digital Taxonomy



2.2 Clinical Adoption Framework

With the absence of a national strategy or vision for the utilization of health technology by PTs, it is important to consider a theoretical perspective grounded in the constructs related to adoption and implementation when considering development of core competencies. Lau's Clinical Adoption Framework (CAF) (Lau, Hagens, and Muttitt 2007; Lau 2011) is based on the Canadian primary care experience to date. It was developed as an extension of the widely accepted Canada Health Infoway Benefits Evaluation Framework (BEF) (Lau, Hagens, and Muttitt 2007), itself developed to help understand the effects investments in digital health technologies have on individuals and the health-care system as a whole. Lau has adapted the model and demonstrated a series of factors that contribute to successful adoption of digital health technology categorized in micro, meso and macro levels (Figure 3).

Figure 3: Lau's Clinical Adoption Framework



Source: http://ehealth.uvic.ca/methodology/models/CAF.php (accessed on June 24, 2019)

The micro level consists of the BEF and contains components that directly impact the end-user such as the quality of the system and the quality of the information it contains, all of which may impact accuracy, performance, security and support. It also contains constructs related to accessing the system, the ease of use, the user interface and the knowledge and capability of the end user themselves, which is an example of required digital health competency. Net benefits such as improvements in productivity, quality of care and access to information and services are key components of the micro level. Lau has demonstrated a direct correlation between quality of the digital health system and successful adoption (Lau, Price, and Keshavjee 2013).

For successful adoption at the meso level, Lau identifies three key categories: (1) People; (2) Organization; and (3) Implementation. People refers to end-user attributes and their role and responsibilities related to the use of digital health technology. Organization considers how culture, infrastructure and other business/organizational processes contribute to success. Implementation provides awareness of planning for system use and the stages that may be involved while also considering how well the system meets the business and clinical needs of the end-user organization. This level of the CAF demonstrates the need for alignment with the system meeting both clinical need and organizational goals with minimal negative impact to clinical workflow and/or existing business processes. When these constructs successfully align with the micro level considerations, Lau postulates that optimized use of digital systems will occur, providing more return on both clinical and business investment with more user satisfaction.

Digital health system implementation requires large investments in numerous areas including, but not limited to, finances, resources, infrastructure, time, and training. This is where the macro level of the CAF must be active to provide a successful technology infrastructure and foundation to support use over time and long-term sustainability. Digital health standards and core competencies for health professionals can underpin consistent use of systems providing a level of quality assurance along with opportunities to analyze health data and inform health policy, care plans, patient outcomes and research. As shown in Manitoba and other provinces in Canada, funding incentives such as Canada Health Infoway's EMR Adoption Program have demonstrated a successful approach to support primary care physicians and nurse practitioners in the transition from paper charts to EMRs. Additional funding and incentives can play a role in increasing awareness and encouraging engagement in the use of digital health, providing some return on investment for both the end user and the funding organizations.

Licensing bodies, professional associations and governance models at the macro level can support successful adoption through policies, procedures, practice guidelines and advocacy work. There is a significant body of evidence now supporting the use of digital health systems to improve patient care, interdisciplinary teamwork, and patient-provider communication (Alkureishi et al. 2016; Chaudhry et al. 2006; Lau, Hagens, and Muttitt 2007; Zhou et al. 2010). Entry-to-practice clinicians are more commonly working in technology-based settings and need to understand the practice, professional and ethical obligations and dimensions associated with the use of digital health systems for professional purposes in comparison to their personal every-day use. Underpinning the other components of the macro level are cultural and political influences and economic barriers and drivers that add to complexity but can have an enormous impact on success, including the voice of Canadians who want access to their health information and interconnected care across health providers, health sectors and health services.

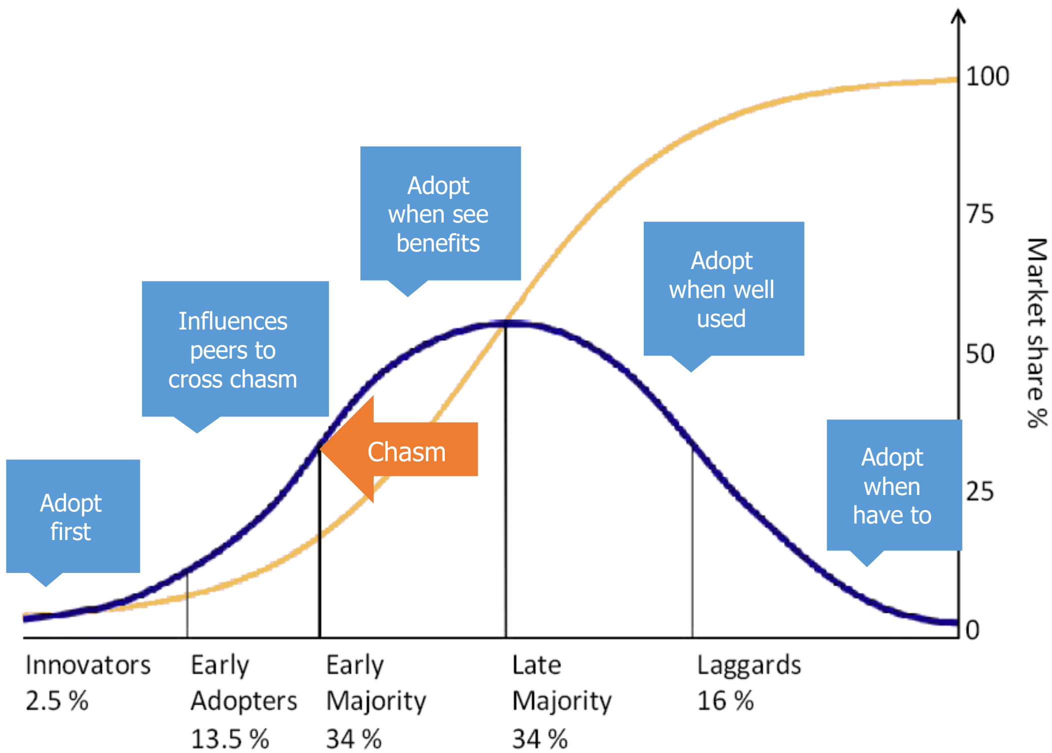
When considering development, implementation and evaluation of digital health competencies for rehabilitation science professionals, all components of the CAF will need to be considered for successful knowledge translation to occur. A coordinated approach to supporting micro and meso levels to develop accessible and clinically relevant systems and effective curricula and training will be critical, along with the macro level support from academic institutions in the form of funding, health workforce capacity building, practice guidelines, quality assurance, all contributing and facilitating the development of a digital health culture. The CAF will act as a set of guiding principles to continue the progression of this research beyond the exploratory phase.

2.3 Diffusion of Innovations Theory

The final theoretical framework in this research study was selected to assist with interpretation of the study results. The Diffusion of Innovations (DoI) theory was developed in 1962 by Everett Rogers, an American sociologist, professor and researcher to better understand the mechanics of technology adoption and how best to support broad implementation and proliferation (Ayanlade, Oyebisi, and Kolawole 2019; Rogers 2003).

Dr. Rogers coined the familiar term ‘early adopter’ and expounded that individuals can be classified into one of five groups based on timing of adoption, with each group following a predictable normal distribution pattern which can be used to better plan and coordinate adoption strategies, change management activities and knowledge translation related to technology adoption. The groups are outlined in Figure 4 and include: (1) Innovators; (2) Early adopters; (3) Early majority; (4) Late majority; and (5) Laggards.

Figure 4: Diffusion of Innovations theoretical framework



Modified from source: https://en.wikipedia.org/wiki/Diffusion_of_innovations *(accessed on July 25, 2019)*

The theory states that to promote widespread adoption of technology, it is vital to market to each group distinctly with unique communication channels and messages to maximize success and reach a critical mass leading to 100% market share saturation (as displayed on the vertical axis of Figure 4). *Innovators* make up 2.5% of the population and are the first to learn and adopt new technology. They tend to be more risk taking, adventurous, and thrive on being on the cutting-edge. This group is largely responsible for introducing innovation to others as they typically share experiences within their community, championing digital health amongst their peer group. *Early adopters* comprise 13.5% of the population. This group is forward thinking and is often highly respected by their peer group and others as opinion leaders. Consequently, their endorsement plays a key role in bridging the distance between trend-setters and the next several groups (the majority). Bridging this gap has been termed 'crossing the chasm' and was leveraged in the IoM's *Crossing the Quality Chasm* report, as referenced in Section 1.2 – Core Competencies. Following the normal distribution curve, 34% of the population fall into the *Early majority* category. This group takes more time and chooses to observe the experiences of peers prior to making any technology decisions. Once the technology has become status quo, and they have been convinced of real benefits, those in the *Early majority* category will take steps to implement but not before. The *Late majority* (34% of the population) are in contrast quite resistant to change, however can be responsive to peer pressure. This group will bide their time and observe what is happening but prefer things well tested and well used before even attempting to utilize a new technology. Those in the *Late majority* population tend to require cajoling by peers with multiple phases of discussions and exposure slowly over time. Rounding out the distribution is the final group, *Laggards* which comprise 16% of the population. This is an extremely challenging group to convince as they are highly resistant to change and difficult to engage through campaigns and communications as they tend to be generally disconnected from all different forms of media and IT. This group will wait extended periods of time well after the technology has become mainstream and often then will still choose to decline from implementing digital health systems. This study has explored several areas related to timing of adoption and length of time using digital health technology and the Diffusion of innovations theory has been used to assist with interpretation of results.

3 Literature Review

The long-term goal of this research study involves the development of digital health core competencies for physiotherapists. A literature search strategy was developed using the Population/Intervention/Comparator/Outcome (PICO) approach to identify main concepts for a quantitative study (Table 1).

Table 1: Literature search using PICO approach

Population	**Intervention**	**Comparator**	**Outcome**
Registered physiotherapists in Manitoba	Digital health core competencies	Not true comparator but will look at existing nursing and medical literature as no specific PT literature exists	Improved digital health literacy

Primary search terms			
Core competencies	Digital Health	Digital health literacy	Filters/Limiters
Competenc* "Core competency" "Core competencies"	ehealth e-health informatic* "digital health"	Literacy	Medical, Nursing or Pharmacy students
Secondary search terms			
Education Curricul* Clinical competenc* Competency-based education	Medical informatics Nursing informatics Electronic health records "electronic medical records"	Computer literacy Information literacy	Last 10 years English language

The search strategy was executed online searching the biomedical databases, Embase and MEDLINE along with the Cumulative Index to Nursing and Allied Health (CINAHL) database to assist with identifying research material more specific to physiotherapy or other relevant rehabilitation science professions. As digital health competencies are not yet developed for rehabilitation science professionals, medical and nursing key words were used to identify relevant studies. Search terms included 'education', 'clinical competence', 'undergraduate or competency-based education models' and 'education/curriculum'. Additional search terms were added to filter to 'core competency' and 'core competencies'. To locate literature specific to digital health, the keywords 'ehealth' or 'e-health' were included along with 'digital health', 'medical and/or nursing informatics' along with 'electronic medical records' and 'electronic health records'. The results were further refined by adding the terms 'health literacy' and 'digital health literacy' however on exploration these terms did not return the relevant literature. As a replacement, the terms 'literacy', 'computer literacy', and 'information literacy' were investigated and returned applicable research. In addition, search terms to locate literature specific to 'students – premedical', 'students – nursing', 'students – health occupations' and 'students – pharmacy' were included given competencies for some of these groups have been developed with associated available literature. As a final step, filters were added to limit the results to English research published within the last ten years to maintain currency and facilitate an effective review process.

A specific search strategy on frameworks or models for the development of core competencies and digital health content was not conducted as many options were embedded within results returned from the initial search strategy noted above. The most relevant models were extrapolated from the body of results and investigated on an individual basis by name in Embase, MEDLINE, CINAHL and Google Scholar and will be leveraged for future components of this research.

In addition to the core competency literature search, a basic search was completed in the identical databases to identify current information regarding online survey methodology and the evaluation of reliability and validity of online survey approaches given this was a key component used to gather information for the digital health profile. Content from this component of the literature search was applied to the research study to ensure a robust survey methodology was executed.

As a final source of current evidence to support this research, Shachak's (2017) *Health Professionals' Education in the Age of Clinical Information Systems, Mobile Computing and Social Networks* textbook was reviewed in detail. This book is a rich compendium of current evidence and anecdotes "…focusing on how technology is changing health professions education." (Shachak, Borycki, and Reis 2017). The book is categorized into three key areas: (1) Describing the challenges that digital health has placed on health education programming; (2) Sharing information from academic institutions on how they are preparing students to practice in technology-enabled environments and what they have learned to date; and (3) Providing strategies and advice on how digital health education programs can be developed and evaluated. As a compendium, content within the book was contributed by clinicians and health technology experts from Canada (including Manitoba), the United States, Australia and Europe providing both local and global representation and perspective across health professional disciplines and geographic locations.

3.1 Digital Health Core Competencies

As mentioned in the introduction, Canada Health Infoway supported a *Clinician's-in-Training* project to develop digital health core competencies for physicians, nurses and pharmacist learners and practicing professionals. A summary of the three programs are provided in this section as groundwork to demonstrate progress in digital health competencies amongst other health-care providers.

Physicians-in-Training

Infoway partnered with The Association of Faculties of Medicine of Canada in a two-phased project to develop digital health competencies and supporting resources. Phase one focused on the preparation of medical students. Educators from medical schools, informatics experts, learners and clinicians with subject-matter-expertise were involved in a collaborative effort to develop core competencies aligned with the existing role-based medical education framework, CanMEDS 2005, developed by the Royal College of Physicians and Surgeons of Canada (RCPSC) and widely adopted across Canadian medical education institutions (Frank JR, Snell L, and Sherbino J 2015).

The group completed an *Environmental Scan of eHealth in Canadian Undergraduate Medical Curriculum* (The Association of Faculties of Medicine of Canada 2012) to help inform the process and better understand gaps and needs. The scan involved a literature review of digital health competencies and education programs across the world, a survey of medical schools across Canada and a synthesis of all the material resulting in a discussion of trends, barriers, drivers, tools and resources that could be leveraged with respect to competency development. The outcome of the collaboration was the *eHealth Competencies for Undergraduate Medical Education* (The Association of Faculties of Medicine of Canada 2014) developed by a smaller working group and released in 2014. Each of the seven main CanMEDS roles have associated digital health competencies, which have been sub-divided into preclinical and clerkship milestones to support seamless integration of the competencies into undergraduate medical education programs.

Phase two of the initiative focused on preparing to integrate and implement the competencies into medical school curricula. The *AFMC-Infoway eHealth Workshop Toolkit Collection* was developed to support the education and training of medical school educators to better prepare faculty in understanding eHealth principles, concepts, terminologies and implications to clinical practice. This was supported through an eHealth podcast/vodcast series developed by existing eHealth faculty experts across Canada in the spring of 2015 which is now publicly available on The Association of Faculties of Medicine of Canada's YouTube® channel (The Association of Faculties of Medicine of Canada 2018).

Nurses-in-Training

The nursing profession in Canada has an established process of developing and utilizing core competencies across multiple areas of practice. These competencies are securely embedded in many Canadian nursing programs and evaluated as part of university accreditation evaluations. Nursing programs recognized the relevance and impact of digital health on their practice before many other health professions establishing the Canadian Nursing Informatics Association in 2002 to support nurses in understanding and utilizing eHealth concepts to inform their clinical practice, prepare nursing students to care for patients and support research and health policy development.

A task force and working group contributed to the digital health competency development. The process involved an extensive literature review from across the world and a granular review of existing provincial and national regulatory guidelines. From this process, 30 draft competencies were developed and shared at a National Stakeholder Symposium including over 50 Canadian nurses with clinical informatics expertise. The symposium workshop resulted in a second draft including 20 competencies which were then shared with Deans and Directors of nursing programs across the country as well as the Education Committee of the Canadian Association of Schools of Nursing. Consensus was reached on the 20 competencies and a final step was undertaken by the task force to ensure the competencies aligned with the existing national competency framework for entry level nursing practice. The outcome of this process in 2012 was the release of *Nursing Informatics: Entry-to-Practice Competencies for Registered Nurses*.

It is interesting to note the different approaches used for nursing and medicine. While the medicine approach focused on attaching competencies to the existing CanMEDS framework, the nursing guidelines begin with an overarching new competency for digital health to be used to support the synthesis of clinical information according to regulatory standards. Following this are three other new core competencies: (1) Information and knowledge management; (2) Professional and regulatory accountability; and (3) Use of information/communication technologies. Each domain has associated indicators that are considered representative of the critical knowledge components required to develop the competency itself. The main goal of the competencies and indicators are to inform curriculum development using an integrated approach with pre-existing practice competencies. In addition to the competency document, the task force also generated a *Nursing Informatics Teaching Toolkit* to support educators, and a *Nursing Informatics Inventory* of existing teaching and learning resources for educators, learners and academic institutions to utilize within their programs (Canadian Association of Schools of Nursing 2013).

Pharmacists-in-Training

The Association of Faculties of Pharmacy of Canada followed a similar approach to medicine with a few unique processes. They completed an extensive literature review and then performed interviews with key informants from academic institutions and industry. The resulting information was synthesized by a small working group and produced several deliverables including an information technology glossary/dictionary, an information technology competency framework with competency assessment tools, and an inventory/assessment of established best practices in information technology in clinical practice.

As pharmacists have been using pharmacy information systems in Canada since the early 1990's, and the practice today is largely computerized, practical tools such as clinical decision support tools, guidelines on optimizing use and targeted material on privacy/safety/effectiveness and efficiency of information technology were the focus. Content on continuing professional development was also included in addition to preparing pharmacy students for practice. Outcomes of the project included *Pharmacy Informatics: Entry-to-Practice Competencies for Pharmacists* and the *Informatics for Pharmacy eResource* (The Association of Faculties of Pharmacy of Canada 2013) outlining the tools mentioned above.

3.2 Barriers to Successful Adoption

On review of the literature on digital health competencies, a variety of barriers to development and implementation can be identified and are described in this section.

- Rapid rate of knowledge and technology change. Medicine and health care are currently undergoing an extremely rapid rate of change, with technology being one of the most rapidly growing and changing components (Densen 2011).

- Teaching does not ensure learning. Teaching competencies does not ensure learning and integration have taken place. Opportunities to synthesize principles and concepts are necessary to support adequate knowledge translation takes place (Scott, Baur, and Barrett 2017).
- Saturated curricula. Medical school curriculums are currently saturated with little room for new content. Senior administrators including Deans of health professional academic institutions need to be supportive and engaged.
- Lack of skilled faculty. Skilled faculty are not in place to provide digital health education in medical programs and there is a lack of motivation by some educators who may not feel the information is critical, and who may not be comfortable using technology themselves (Prensky 2001b).
- EMRs have a negative impact on the patient experience. There is a common misconception that use of clinical systems during patient care interferes with the patient-provider relationship (Alkureishi et al. 2016; Crampton, Reis, and Shachak 2016; Greatbatch, Murphy, and Dingwall 2001).
- You must be 'tech savvy' to engage in digital health. There is a common misconception that one needs to be technologically savvy to champion digital health concepts and principles and that the younger generation use technology in more literate ways (C. Kruse et al. 2016; Moore 2010; Prensky 2001a, 2001b; Wittie et al. 2016).
- Misinterpretation that computer and smartphone literacy equate to users having strong digital health literacy. The ability to use e-learning tools and deliver teaching and education via other digital solutions to support learning does not equate to the skills necessary to

maximize use of digital health technologies that support clinical practice and patient care activities (Nagle 2019).

3.3 Strategies to Maximize Success

The following section will describe strategies and approaches found in the literature that can maximize success with respect to implementing digital health core competencies in Canada.

- It is important that any new competencies align with current Problem-Based-Learning techniques. Digital health competencies can be seamlessly integrated into Problem-Based-Learning frameworks which generally currently exist across health professional programs (Watling and Lingard 2012).
- Another consideration is integration versus stand-alone programming. Integration of digital health competencies into existing components of health professional education is critical to success. This will best support clinical application and knowledge translation to embed the concepts into practice (Police RL; Foster T; Wong 2010).
- Academic institutions should be encouraged to utilize and/or leverage the quality digital health core competencies that already exist. Developed and peer reviewed/approved core competencies have been developed; academic institutions should use them and support the development of subject-matter-experts (Nagle 2019; Strudwick et al. 2019).
- In tandem with faculty development, institutions should work to have digital health concepts connected to departmental research. Developing integrated programs that link health informatics research with teaching programs can help departments develop grass roots research in clinical informatics and/or embed technology concepts into existing research goals (Nagle 2019).

- In order for the items listed above to be successful, the engagement and support of senior leadership including Deans and Department Heads is critical. This will enable faculty to embed health informatics concepts into the curricula and develop and nurture a health informatics culture.
- Digital health literacy should be embedded as an integrated common learning theme across health professional education courses and curricula with an interdisciplinary lens. Academic institutions should work to develop a health informatics culture within their educational programs supported with a link to departmental research goals. Activities should be planned to advocate and provide awareness of digital health concepts to engage faculty and learners in the content.
- As digital health literacy is an expanding area in the literature, academic institutions can expect accreditation bodies to take interest in the concepts and include principles within their accreditation programs. Institutions who have been preparing early by working on embedding informatics into curricula and building a strong faculty knowledge base will be best prepared for successful accreditation evaluations.

3.4 Survey Approaches

According to Creswell (2018), survey research enables measurement of areas that may appear more challenging to evaluate quantitatively, such as behaviours, attitudes and opinions. In tandem, the literature confirms the use of surveys as an excellent method to identify relationships between variables through statistical analysis techniques within a sample from a population. This aligns well with the purpose of this study as respondent data was used to generate a digital health literacy profile of Manitoba PTs facilitating gap analysis and needs assessment on physiotherapists use, knowledge and attitudes towards digital health in the province.

The online survey gathered information about demographics and clinical practice elements along with digital health use. Several techniques have been applied to support a quality psychometric approach. Litwin (1995) describes psychometrics as a process to help evaluate more qualitative concepts in a quantitative fashion which can assist in determining the quality of the survey itself. One key component to consider in survey methodology is reducing survey error. Two commonly occurring errors include random error and measurement error (Litwin 1995a). Random error can be best controlled and managed with a large sample size which tends to be more representative of the population under study. To better understand the impact of random error, an *a priori* sample size calculation was performed using a free tool available through the online survey platform Survey Monkey®. Calculating sample size heuristically when comparing a sample to a population has been proven an effective approach when using Chi Square analysis (Dattalo 2018), one of the statistical testing methods utilized in this study. There is consensus in the literature that basic sample size calculations utilize a 95% confidence interval with a 5% error margin rate. This returns a sufficient sample size level to accurately confirm a sample size as representative of the target population. A more formal statistical power analysis was calculated to inform logistic regression testing to better understand the relationship between sample size and variances related to associations between predictor and outcome variables linked to the use of digital health systems (Dattalo 2018). More details can be found in Section 4.1 - Methodology.

Measurement error demonstrates the degree of accuracy in how the survey instrument measures what it is intended to measure (Litwin 1995a). When a new survey instrument is developed, it is critical that the content and design of the survey be based on justifiable data that is reflective and representative of the population under study. When developing a new survey instrument, the literature recommends modeling questions and survey content from pre-existing surveys that have been previously validated and undergone reliability testing using statistical methods (Grimmer and Bialocerkowski 2005).

Research additionally suggests that validity must be documented when evaluating new survey instruments, or when applying established survey instruments to new populations, as it reflects accuracy of the survey instrument in measuring what is was developed to measure (Litwin 1995b). The ability to quantitatively score a survey instrument is necessary to support identifying relationships between parameters and thus also evaluate validity of the content (Creswell, 2018).

Reliability can be defined as a statistical measure of how reproducible the data is. With respect to survey data it is recommended to start with a reliability evaluation of the survey tool itself. One of the most important forms of reliability in multi-section survey instruments is internal consistency (Creswell, 2018), which can be measured quantitatively using Cronbach's alpha. Internal consistency is a measure of how different items in the survey that propose to measure similar constructs, produce similar reliability scores.

A study on improving response rates among surveys sent to the nursing profession concluded that surveys distributed and/or endorsed from professional organizations may improve participation (VanGeest and Johnson 2011). Kaplowitz et al., (2004) demonstrated the use of follow-up emails in improving response rates among physicians. In addition, there is good evidence to support the use of pre-notification communications prior to sending out the survey to engage respondents and increase response rates (Kaplowitz, Hadlock, and Levine 2004).

4 Study Design

As very limited information is known about the use of digital health technology by Manitoba physiotherapists, this quantitative descriptive research study utilized an online survey to gather information to construct a digital health utilization profile. Information collected by the survey was additionally used to answer a series of questions and validate certain assumptions related to the use of digital health systems across the province of Manitoba. This profile was used as a gap analysis and needs assessment tool to identify factors that may influence digital health adoption.

4.1 Methodology

An online survey was selected as a cost effective and convenient method to reach Manitoba physiotherapists, considering a large geographical location and survey frame of 872 individuals. This survey design included using a closed-end question methodology with the use of Likert scale questions as a robust tool to quantifiably measure the degree in which a respondent agrees or disagrees with a statement (Sullivan and Artino 2013). A multi-stage non-stratified convenience sampling procedure was implemented leveraging the College of Physiotherapists of Manitoba (CPM) database and the Manitoba Physiotherapy Association (MPA) database, providing secondary access to all licensed physiotherapists in Manitoba. A longitudinal approach may be considered for future iterations of the survey which will be explored in additional research. The survey aimed to answer three questions: (1) What percentage of physiotherapists are using digital health technologies? (2) What variables contribute to the adoption or lack of adoption of digital health technologies? and (3) Which of these variables might predict relationships between adoption and lack of adoption of digital health technologies?

To ensure an accurate profile was extrapolated from the data, the inclusion criteria included all physiotherapists in Manitoba registered in the following categories of licensure with CPM: (1) Active Practice, (2) Exam Candidate; and (3) Student (enrolled at the University of Manitoba). Physiotherapists excluded from recruitment and participation were those in the CPM registration categories of: (1) Inactive Member, (2) Temporary; and (3) Student (not enrolled at the University of Manitoba). CPM and MPA agreed to support this research study by contacting all licensed members that met the inclusion criteria via their automated email systems.

4.2 Sampling and Sample Size

Currently there is a lack of strong research specific to response rates among physiotherapists. There are instances in the literature that state high quality, publishable survey research may require response rates of 60% or more (Fincham 2008). Due to this lack of specific response rate data, a convenience sample was utilized versus a randomization process on the licensee database. As this is the first iteration of the survey, the choice to utilize a convenience sample (or nonprobability sample) focused on the opportunity to allow for a broader representation in responses given the absence of any other source of reliable data on digital health use amongst Manitoba physiotherapists.

Sample respondent survey data was compared to national statistics reported in the Physiotherapist Database at the Canadian Institute for Health Information (CIHI) to determine whether the survey data was representative of the population data reported. As demographic and practice elements (excluding the digital health survey questions as no national data exists for comparison) were compared, a sample size calculation was performed using the online tool available within the Survey Monkey® Canada platform. The calculation requires three variables; population size, confidence interval level and the margin of error. The population size of 729 was used based on the Manitoba workforce data reported in the 2016 Physiotherapist Database, the most recently published data available from CIHI. A confidence level of 95% was used based on the industry standard and the resulting ability to have a high level of confidence that the sample data was in fact representative of the population. A margin of error of 8% was calculated using a separate Survey Monkey® online tool including the population size noted above, the confidence level of 95% and the sample size value of 119, reflective of the number of physiotherapists that responded to the online survey and met the inclusion criteria. This resulted in a recommended sample size of 125.

As logistic regression statistical analysis was completed to determine whether association(s) existed between a number of predictor variables and the outcome variable of use of one of five digital health systems, an *a priori* power analysis was computed for this component of the research using the free online software G*Power (Dattalo 2018; Faul et al. 2007). The following determinants were used in the calculation; an alpha (α) level of 0.05 and a power error probability or beta (β) level of 0.80, extrapolated using a commonly implemented 4:1 ratio of β to α such that power = 1 - α4 (1 – 0.05(4) = 0.8) (Dattalo 2008). Power calculations were completed using the degrees of freedom applicable for each of the six predictor categorical variables given they were independently tested via logistic regression. Table 2 displays sample size results based on the power analysis calculations corresponding to each of the six variables.

Table 2: Statistical power calculations related to logistic regression testing

Predictor variables (categorical)	Number of categories	Sample size via power analysis
Age range	6	143
Gender distribution	2	88
Primary place of employment	12	187
Primary focus of practice	6	143
Primary work sector	3	108
Primary work geographical location	5	133

Sample size values vary based on differences in the number of categories for each variable which affects the degrees of freedom in the calculations. Using customized sample size calculations based on the variable being evaluated can assist with improving the external validity of the resulting data thus minimizing the effects of non-response bias (Dattalo 2008).

To support robust response rates, a modified three-phase Dillman approach (Thorpe et al. 2009) was leveraged for survey distribution which suggests: (1) A pre-survey advertisement to engage respondents; (2) Distribution of the consent and survey link one week later; and (3) One reminder email to complete the survey one week after the survey link distribution. The pre-survey advertisement was emailed out to the sampling frame by the College of Physiotherapists of Manitoba on October 11, 2018 and the Manitoba Physiotherapy Association via an email blast on October 10, 2018 both with the goal of encouraging engagement in the study. The survey link followed on October 22, 2018 via email to the same group of potential respondents followed by an email reminder on October 29, 2018 from CPM and November 5, 2018 from MPA. Incentives were not included in the survey methodology as literature is conflicting with respect to the effectiveness of incentives to improve response rates, particularly amongst health-care providers (Baruch and Holtom 2008; VanGeest and Johnson 2011) and has not been well studied in the physiotherapy population specifically.

4.3 Survey Instrument

The *Digital Health Survey for Manitoba Physiotherapists* (Appendix A) was a newly developed survey instrument for this research study consisting of a series of closed-end questions, five of which contain built-in logic based on "Yes" or "No" responses leading to context-specific sub-questions. The survey targets the following constructs: demographics, physiotherapy education, current employment status, practice setting, practice focus, use of electronic systems/computer software in the five technology systems commonly used in physiotherapy practice in Manitoba, along with the benefits and challenges encountered with adoption and implementation. Several questions are designed in the survey in a matrix table format to allow for a variety of similar questions to be answered efficiently and then compared. A series of questions employ a 0-5-point, labeled Likert scale as the literature identifies this type of question as a robust tool to quantifiably measure how much a respondent agrees or disagrees to a question or statement (Sullivan and Artino 2013).

To minimize measurement error, questions in this survey have been modeled after two sources: (1) A sub-set of standardized demographic and health workforce data elements collected through the CPM registration process for submission to the Physiotherapist Database (Canadian Institute of Health Information, 2012); and (2) The electronic medical records (EMR) and information technology section of the 2014 National Physician Survey (Canadian Medical Association 2017). CIHI Physiotherapist Database data elements are being utilized as a pre-established source of timely, quality information captured in a standardized approach nationally and used for statistical reporting and research purposes. A sub-set of 15 data elements (from the complete set of 68) was used for this survey based on applicability. Format and structure of the data elements was maintained in the survey as per the *Physiotherapist Database Manual, Version 2.0* and accompanying *Data Dictionary* published by CIHI (Canadian Institute for Health Information 2012).

The National Physician Survey 2014 was leveraged as a pre-existing standardized set of questions on electronic medical records and information technology established in 2012 to enable potential comparability to publicly available primary care aggregated data results on physician EMR adoption and use. The questions have been modified to align with physiotherapy practice as well as existing knowledge and use of digital health technologies within the profession in Manitoba. Using pre-existing and standardized data sets as a model for this newly developed survey is expected to minimize risk of measurement error (Grimmer and Bialocerkowski 2005). Although more recent versions of the National Physician Survey exist, the 2014 version is the most comprehensive with respect to inclusion of relevant content on digital health technology applicable for comparison in this study.

The survey application utilized was the REDCap Surveys Server housed at the George & Fay Yee Centre for Healthcare Innovation at the University of Manitoba. With respect to this study, the implementation of the survey has been considered a pilot-phase for a new instrument. Respondents were asked to complete the survey only once however, for potential future iterations of the survey as part of a longitudinal approach, the survey will be subject to revisions based on more rigorous reliability and validity analysis.

4.4 Validity and Reliability

Given the survey instrument was a newly developed tool, statistical tests were completed to evaluate validity and reliability constructs. Three types of validity testing have been applied in this methodology; content validity, face validity and predictive validity, a sub-component of criterion validity. Content validity is used to determine if the items that make up the instrument adequately reflect the variable(s) being measured. It is not quantified using statistics, but rather is a subjective measure of how appropriate the items seem to a set of subject-matter-experts. Despite the subjective nature of content validity, it can contribute to a comprehensive assessment of a survey instrument's overall validity (Creswell 2018). Resources at CPM including the Executive Director and Continuing Competence Lead reviewed the survey and agreed it contains a high level of content validity in comparison to data submitted to CIHI. The survey was also pre-pilot tested by four licensed physiotherapists in Winnipeg to ensure the terminology was well understood, the survey flowed well, and to confirm the timing to complete the survey did not exceed ten minutes (VanGeest and Johnson 2011). In addition, the survey was reviewed by two non-physiotherapists who agreed the survey appeared to measure what it was intended to measure. This provides some level of face validity (Lavrakas 2008) to the pilot-phase of this survey.

Criterion validity can provide more quantitative evidence of accuracy. Predictive validity is a sub-type of criterion validity most relevant in this study as it reflects the "capability of a survey instrument to forecast future events, behaviors, attitudes, or outcomes." (Litwin 1995b, p40). Predictive validity is typically calculated as a correlation coefficient demonstrating if certain results predict an outcome measure and/or analyzing if results correlate with other results. Correlation coefficients were calculated on the series of Likert-style questions embedded in the survey which targeted reporting of changes in quality of care and changes in productivity with the adoption of each of the five digital health systems included in the survey. Kendall's tau-b (Laerd Research 2018) will be used as the statistical measure of correlation as it is appropriate for ordinal variables including Likert scales and is not dependent on a normal distribution (as per Pearson correlation) or the pre-testing of a presence of a monotonic relationship between the variables being compared (as per Spearman correlation). Correlation coefficients of .70 or more have been used as a measure of convincing evaluation of criterion validity (Litwin 1995b).

One other validity element considered was construct validity. In relation to surveys, construct validity refers to the practical development of questions and survey content based on a theoretical framework and the degree in which the survey responses in fact reflect the theory and are in alignment with the theoretical model. As the future vision for this survey is for it to be applied in longitudinal analysis of the adoption of digital health tools and systems in the province, over time the goal will be to attain a high level of construct validity which is now the gold standard objective in survey validation, but requires repetitive and long-term use of the survey tool (Lavrakas 2008). The DoI theory has been applied in several areas of the survey results which reflect timelines on use of digital health systems. Alignment can be found between the DoI theory and the survey respondent timelines providing some degree of early construct validity, shared in Section 5.4 – Digital Health Technology Profile. Perspectives on construct validity for future iterations of the survey can be found in Section 6 – Discussion.

Reliability testing was performed on the survey instrument via a quantitative assessment of internal consistency. There are repeated sections in the digital health component of the survey instrument that include questions about the use of five types of digital health systems across key areas related to physiotherapy practice. The five digital health systems can be classified as: (1) eBilling; (2) eScheduling; (3) eDocumentation; (4) eExercise Prescription; and (5) ePatient Reported Outcome Measures. The repeated series of questions and options for responses have been written in an identical format, apart from referencing the five different digital systems. These repetitive questions, with close to identical wording, were evaluated for internal consistency to determine a reliability score using Cronbach's alpha, one of the most commonly used statistical analyses for reliability of a survey instrument (Okada 2015). A coefficient less than .60 is considered an unacceptable level of reliability with .70 to .80 considered the measurement goal for basic research. This would reflect an accepted level for reliability and serve as confirmation of how well the multiple items in the survey complement each other in measurement of different aspects of a similar variable (Litwin 1995a; Peterson 1994; Okada 2015). The statistical analysis findings for validity and reliability testing of the survey instrument are shared in Section 5.1 – Survey Validity and Reliability Evaluation.

4.5 Privacy/Ethics

No identifying information has been captured as part of the main study for two reasons. The first is related to the College of Physiotherapists of Manitoba's guidelines. CPM license numbers are generated exclusively for the purpose of registration. To date, Manitoba physiotherapists have not formally agreed as a group to utilize these numbers for research purposes. The second reason is related to the use of the REDCap Surveys Server which does not permit the capture of identifying information. Although the use of identifying information would be valuable for comparative purposes for future iterations of the survey and longitudinal analysis, particularly pre and post evaluation of digital health core competencies, this did not align with CPM or REDCap guidelines. As a secondary approach to longitudinal analysis opportunities, CPM did agree to inclusion of a final question on the survey providing respondents with the ability to consent to participate in a longitudinal study cohort via use of their email address. As REDCap does not consider email addresses as personal identifiers, this was the final approach with 73 study participants consenting to participate in the cohort (61.3%). This email address would be used to contact respondents for future iterations of the survey and has not been connected or linked to respondent data to maintain privacy and confidentiality of participants.

Participants formally consented to the collection of their information for this study purpose by clicking on the survey link outlined in the introductory emails distributed to physiotherapists both in the text of the email and in an attached consent disclosure document which can be found in Appendix B and Appendix C. All respondent survey data has been securely retained and stored in the HIPPA and PHIA compliant REDCap Survey Server for the duration of the study. Basic statistical analysis was completed within the application however the dataset was exported and imported into other statistical software for deeper analysis. Any applications housing the data required independent authorized usernames and passwords of the principal investigator and supervisor. As no identifiers were captured, there is minimal risk to privacy and confidentiality. Analysis results have only been reported and shared in aggregate form.

At the close of the study, the cohort names and email address (provided by the consenting longitudinal cohort) will be exported from REDCap and saved on an encrypted data storage device with its own unique password known only to the principal investigator and supervisor who will also remain responsible for the data. A second version of the dataset will be saved to a separate encrypted data storage device to be stored at the College of Rehabilitation Sciences in a locked filing cabinet as a backup. The principal investigator's supervisor manages the key. The dataset storage device may be accessed external to the university on a personal computer used only by the principal investigator with a unique log-in and secure password and will be retained indefinitely as it will be used for future comparison should the survey be repeated. Final ethics approval for this research study was received from the University of Manitoba's Health Research Ethics Board on June 7, 2018 (Ethics #HS21877 (H2018:233)).

4.6 Data Analysis

The statistical software application used for the research study data analysis was IBM® SPSS® Statistics, Version 25, 64-bit edition and Microsoft Office 365® ProPlus Excel, Version 1902. The resulting survey data set was analyzed using a variety of descriptive statistical methods including frequency distributions, tables and a population pyramid for a subset of demographic and practice element variables. These variables were selected based on their inclusion in the CIHI Physiotherapist Database 2016 (CIHI-MB) which is populated on an annual basis through the CPM registration or licensing renewal process.

Using the Chi-squared goodness-of-fit test, which tests the 'fit' of the proportions in the obtained sample with proportions of the population, a comparison of the survey data to CIHI provincial statistics was completed to establish whether the survey respondent data was representative of the population under study when considering the categorical variables of age group, gender, practice area, work sector (public or private setting) and geographic location (urban versus rural). The null hypothesis in all cases denotes no difference between the groups or variables outlined. The variables were chosen for comparison based on the assumption they could be contributing factors to variances in use of digital systems across the province.

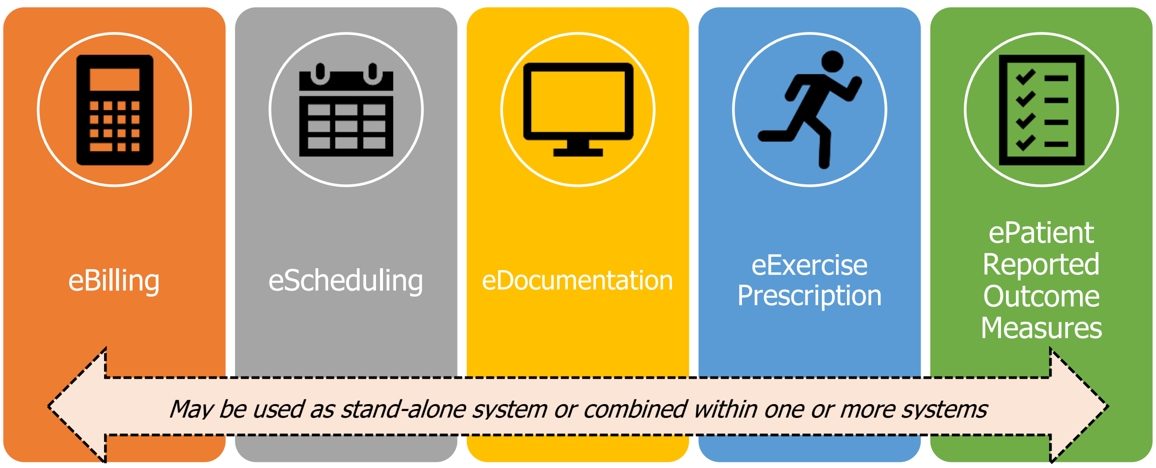
As this study involves exploratory work, several hypotheses were developed and taken into consideration when planning the analysis phase. These hypotheses are outlined in Table 3 and can be considered educated guesses based on assumptions and knowledge of the practice of physiotherapy in Manitoba..

Table 3: Research study hypotheses

H1	A higher proportion of physiotherapists working in urban versus rural locations will be using digital health systems
H2	A higher proportion of physiotherapists working in the private versus public work sector will be using digital health systems
H3	Physiotherapists over the age of 55 will have lower adoption rates than physiotherapists under 55
H4	A higher proportion of physiotherapists working in the area of orthopedics and musculoskeletal conditions will be using digital health systems
H5	Of those physiotherapists using digital health systems, the majority will be using 2-3 different types of systems
H6	The highest proportion of digital health users will be in the eScheduling category
H7	The lowest proportion of digital health users will be in the ePatient Reported Outcomes Measures category
H8	The most common benefit of using digital health systems will be increased efficiency
H9	The most common barrier to using digital health systems will be cost
H10	As the time physiotherapists are using digital systems increases, they will report increased productivity and increased quality of care

To investigate associations between variables that may influence adoption of digital health systems, elements from the demographic and practice setting components were analyzed as predictor variables and compared using statistical analysis against outcome variables to examine whether any relationships exist related to use of one of five common digital health systems used by Manitoba physiotherapists (Figure 5).

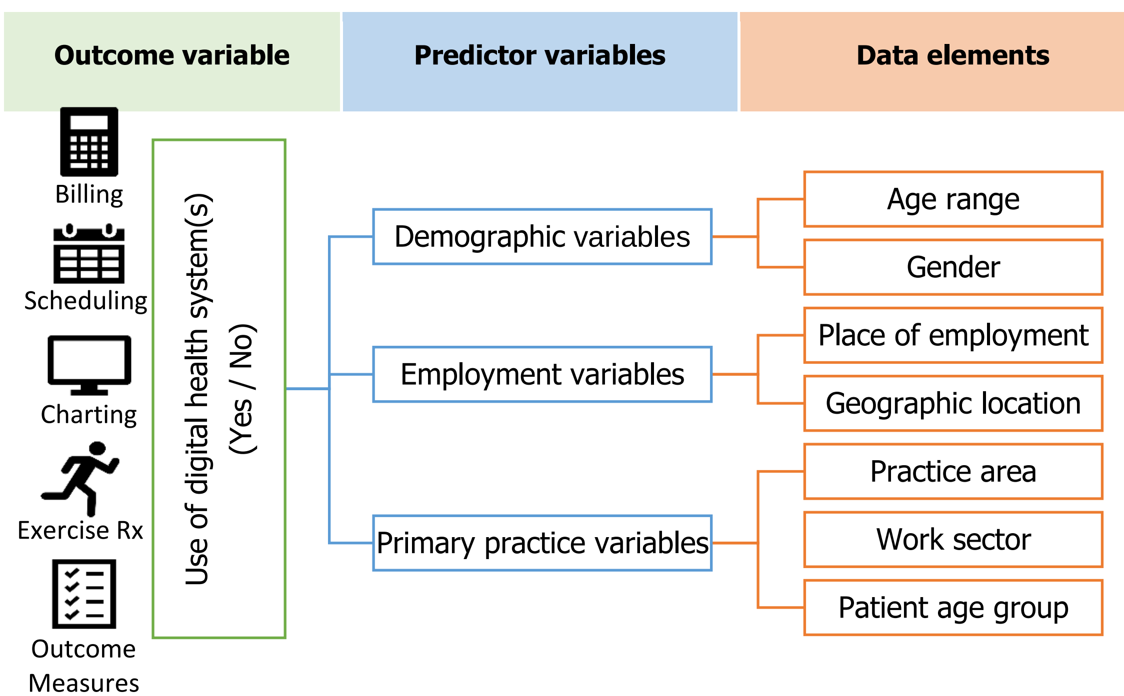
Figure 5: Types of digital health systems used by Manitoba physiotherapists



In addition, statistical tests were run to determine if associations existed between two distinct physiotherapy populations in Manitoba, those working in private practice compared to those working in public practice settings. The five outcome variables include whether the physiotherapist utilizes or does not utilize an electronic billing system (eBill), scheduling system (eSched), clinical documentation system (eDoc), exercise prescription system (eExRx) and/or patient-reported outcome measurement system (eOM). These will be compared against six predictor variables including: (1) Place of employment; (2) Practice area; (3) Practice focus; (4) Patient age group; (5) Work sector; and (6) Geographical region. Given the five outcome variables can individually be considered dichotomous as when observed or measured only one of two possible values can exist ("Yes" or "No" to use of the digital system), binary logistic regression (BLR) was the statistical method selected. BLR models a binary dependent (outcome) variable as a function of multiple independent (predictor) variables. Results are depicted as odds ratios denoting prediction of which of the two groups (Yes or No) cases end up falling into. A value over one indicates a positive association (higher odds) and a value under one implies a negative relationship (lower odds).

Modeling using BLR was performed for each of the five outcome variables against each of the predictor variables to determine association. BLR modeling was then mirrored in a second wave on the same variables on two subsets of respondent data, the work sectors of public practice and private practice. This was to quantitatively evaluate whether any unique observations could be identified within each of the cohorts. Figure 6 displays the five types of digital systems being investigated as binary outcome variables ("Yes" or "No" response).

Figure 6: Outcome variables related to predictor variables and data elements



In addition, Figure 6 displays associated predictor variables organized into three main categories, demographic, employment and primary practice variables. The associated individual data elements are included to demonstrate the potential relationships these parameters may have as predictors of the use of each of the five digital health systems.

Chi-square tests for independence can be used to identify evidence of a relationship between two categorical variables with the understanding that the null hypothesis denotes no association exists between variables. The National Physician Survey (NPS) results have demonstrated a correlation between both the time using digital health systems and the number of digital health functionalities used, compared to the improvement in productivity and quality of care reported by the end user clinician (Canada Health Infoway 2014). Using 0-5-point Likert scales, the NPS ascertained that both productivity and quality of care improvement occurs gradually over time, continuing to increase even after six years or more of use. The NPS data also demonstrated that the use of more digital health functionalities contributed to reports of increased quality of care and better productivity. Several questions in the study survey were modeled after the NPS questionnaire providing a 0-5 point-Likert scale related to quality of care improvement and increased productivity in the context of physiotherapy use of digital health systems in Manitoba. Chi-square testing was used for statistical analysis of correlation between the use of one of the five digital systems and the length of time using the system across a series of timeline brackets in years (categorical variable). A second phase of Chi-square tests for independence was completed to evaluate whether there was any association between the level of productivity or quality of care improvement in relation to how many digital systems were being used across the three clinical-based systems of clinical documentation, exercise prescription and patient-reported outcome measures. The Chi-square analysis on both the time using systems and the number of systems used in relation to quality of care and productivity change were mirrored on subsets of data to evaluate effects between public and private practice settings to inform evaluation of study hypotheses as outlined in Figure 7.

Figure 7: Survey questions involved in Chi-Square testing related to time using and changes in quality of care and productivity per use of digital health system

<table>
<tr><th colspan="5">Digital health system</th><th rowspan="2">Respondent data analysis</th></tr>
<tr><th>Billing</th><th>Scheduling</th><th>Clinical documentation</th><th>Exercise Prescription</th><th>Outcome Measures</th></tr>
<tr><td colspan="5" rowspan="3">How long (in total) have you been using an electronic system/computer software to manage <1 of 5 digital health systems>?
Options: Less than a year | 1-3 years | 4-6 years | 10-15 years | Over 15 years</td><td>All</td></tr>
<tr><td>Public cohort</td></tr>
<tr><td>Private cohort</td></tr>
<tr><td colspan="2" rowspan="6"></td><td colspan="3" rowspan="3">How has the QUALITY of the patient care you provide changed since you started using electronic <1 of 3 digital health systems>?
Options: Much better | Better | No change | Worse | Much worse | Not sure</td><td>All</td></tr>
<tr><td>Public cohort</td></tr>
<tr><td>Private cohort</td></tr>
<tr><td colspan="3" rowspan="3">Since you started using electronic <1 of 3 digital health systems>, the PRODUCTIVITY at your practice has:
Options: Greatly increased | Increased | Did not change | Decreased | Greatly decreased | Not sure</td><td>All</td></tr>
<tr><td>Public cohort</td></tr>
<tr><td>Private cohort</td></tr>
</table>

Where applicable throughout the statistical analysis, an *a priori* alpha level of .05 was used to determine statistical significance which is a commonly used and acceptable level in many forms of research. In relevant cases, effect size for correlation between variables was additionally evaluated to quantitatively interpret clinical significance. Kendall's tau-b (which can vary from -1.0 to 1.0) was chosen as the correlation coefficient as a non-parametric measure of the strength and direction of an association between two categorical variables of the ordinal type. With respect to Kendall's tau-b interpretation for correlation, values between positive or negative .10 and .29 will be considered weak, between .30 and .49 will be considered moderate and over .50 will be considered strong (or very strong if between .80 and .90). Kendall's tau-b can additionally be used as a non-parametric measure of effect size such that a value between positive or negative .20 to .29 will be considered a moderate effect size relationship. This is a commonly used reference point given the lack of an agreed upon reference guideline in the literature when used beyond the purpose of evaluation of simple correlation (Botsch 2014).

With respect to binary logistic regression testing, Cox and Snell R square and Nagelkerk R square (generated by SPSS) were used to determine the percent of variance in the dependent variable explained by each model. As a final confidence test in the modeling generated, the percent accuracy classifications were reviewed to determine the percentage of time that predictions from the model determine the correct outcome. These measures are being used to determine broad overall predictive ability of the model and provide some degree of confidence in quality of the model fit in relation to the resulting association between the predictor variables and outcome variables.

5 Study Results

5.1 Survey Validity and Reliability Evaluation

Two measures for validity (content and face validity) were completed prior to the distribution of the survey and were described in Section 4.3 – Survey Instrument. To evaluate a third type (criterion validity) correlation testing was completed on six questions with 0-5-point Likert scales assessing changes in quality of care and productivity related to the use of three separate digital health systems (eDoc, eExRx and eOM). Table 4 outlines the correlation between the change in quality of care and change in productivity comparisons for each system resulting in three sets of separate Kendall's tau-b findings, along with their p-values to denote statistical significance. With respect to eDoc systems (Table 4a), there was a moderate positive correlation between changes in quality of care and productivity, which was statistically significant (τb = .773, p = .000*). For eExRx systems (Table 4b), a moderate positive association was also present and statistically significant (τb = .798, p = .000*). The results shown in Table 4c for the eOM system (τb = .996, p = .000*) denote a very strong positive relationship indicative of near perfect correlation. All three results are over the .70 threshold denoted at the start of the study and therefore can be considered confirmation of strong criterion validity within the survey instrument.

Table 4: Validity testing results via Kendall's tau-b correlation coefficients

Table 4a: Correlations – eDocumentation systems

			Change in quality of care	Change in productivity
Kendall's tau_b	Change in quality of care	Correlation Coefficient	1.000	.773**
		p-value		.000
		N	119	119
	Change in productivity	Correlation Coefficient	.773**	1.000
		p-value	.000	
		N	119	119

Table 4b: Correlations – eExercise Prescription systems

			Change in quality of care	Change in productivity
Kendall's tau_b	Change in quality of care	Correlation Coefficient	1.000	.798**
		p-value	.	.000
		N	119	119
	Change in productivity	Correlation Coefficient	.798**	1.000
		P-value	.000	.

		N	119	119

Table 4c: Correlations – ePatient Reported Outcome Measures systems

			Change in quality of care	Change in productivity
Kendall's tau_b	eOM - change in quality of care	Correlation Coefficient	1.000	.996**
		p-value	.	.000
		N	119	119
	eOM - change in productivity	Correlation Coefficient	.996**	1.000
		p-value	.000	.
		N	119	119

** Correlation is significant at the 0.01 level.

Cronbach's alpha was the chosen index to measure the reliability construct of internal consistency for the survey instrument. Six questions with 0-5-point Likert scales assessing changes in quality of care and productivity related to the use of three separate digital health systems (eDoc, eExRx and eOM) were the chosen items for testing given their similarity. The resulting coefficient of .637 (Table 5) indicates an acceptable level of reliability but does not meet the recognized gold standard of .70. Further evaluation of the reliability analyses did not identify improvements in the coefficient value with the removal of any of the questions from the testing process, demonstrating the highest value with inclusion of all six items.

Table 5: Reliability testing of survey instrument via Cronbach's alpha

Reliability Statistics

Cronbach's Alpha	N of Items
.637	6

5.2 Sample Versus Population Comparison

Chi-square goodness-of-fit calculations were completed to confirm whether the sample data was representative of the Manitoba physiotherapy population as outlined in the 2016 CIHI-MB data, using an alpha level of .05 and a null hypothesis denoting no difference between sample and population data. Results of the non-parametric cross tabulation testing are shown in Table 6 and commence with an age-comparison, re-grouping some of the age categories to meet the assumptions of the Chi-square calculation such that the expected frequency in each level of the variable was at least five. This resulted in a p-value > .05 and an acceptance of the null hypothesis equating to no difference noted between the survey and population data in the age category (χ^2 (2, n = 119) = .997, p = .593).

Table 6: Survey sample versus CIHI population data comparison using Chi-square

AgeGroup	n = 119
Chi-Square	.997
df	2
Asymp. Sig.	.593
Gender	**n = 119**
Chi-Square	44.782
df	1
Asymp. Sig.	.000*
Practice area/focus	**n = 119**
Chi-Square	7.337
df	5
Asymp. Sig.	.197
WorkSector	**n = 119**
Chi-Square	1.663
df	1
Asymp. Sig.	.197
Geographic location	**n = 119**
Chi-Square	25.420

df	1
Asymp. Sig.	.000*

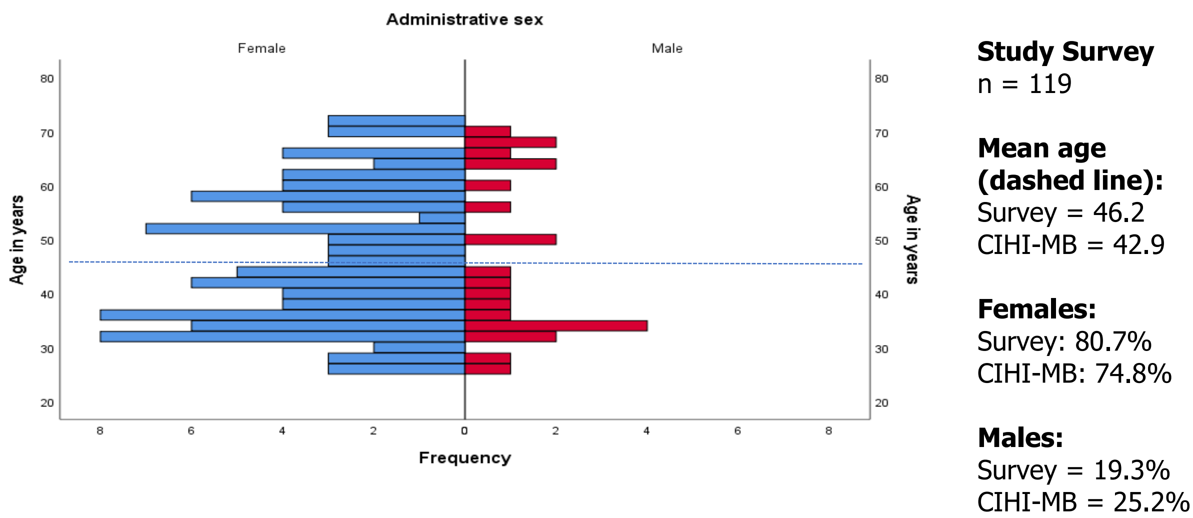
* = statistically significant at p < .05

In addition to age groupings, practice area (χ^2 (5, n = 119) = 7.337, $p = .197$) and work sector (χ^2 (1, n = 119) = 1.663, $p = .197$) showed similar results with a retention of the null hypothesis equating to no difference between the sample and CIHI data. With respect to gender, a larger proportion of females and a lower proportion of males responded to the survey, while a larger proportion of rural physiotherapists participated in the survey compared to the reported proportion by CIHI. The resulting calculations for gender (χ^2 (1, n = 119) = 44.782, $p = .000$*) and geographic location (χ^2 (1, n = 119) = 25.420, $p = .000$*), denote significant p-values (< .05) leading to rejection of the null hypothesis for these particular variables, reinforcing the finding that gender and geographic location survey data was likely not representative of the population data.

5.3 Descriptive Statistics

Out of the 872 physiotherapists in Manitoba contacted to complete the survey, 124 responded. Five records were incomplete and were therefore excluded leaving a final count of 119 successful respondents equating to a 13.6% response rate. Figure 8 displays the age distribution (y-axis) of survey respondents by administrative sex (x-axis) using a population pyramid with comparisons provided to the CIHI-MB data. The mean age of respondents was 46.2 years as displayed via the dashed line on the population pyramid. This is in comparison to the mean age denoted in the Manitoba section of the CIHI Physiotherapist Database of 42.9 years.

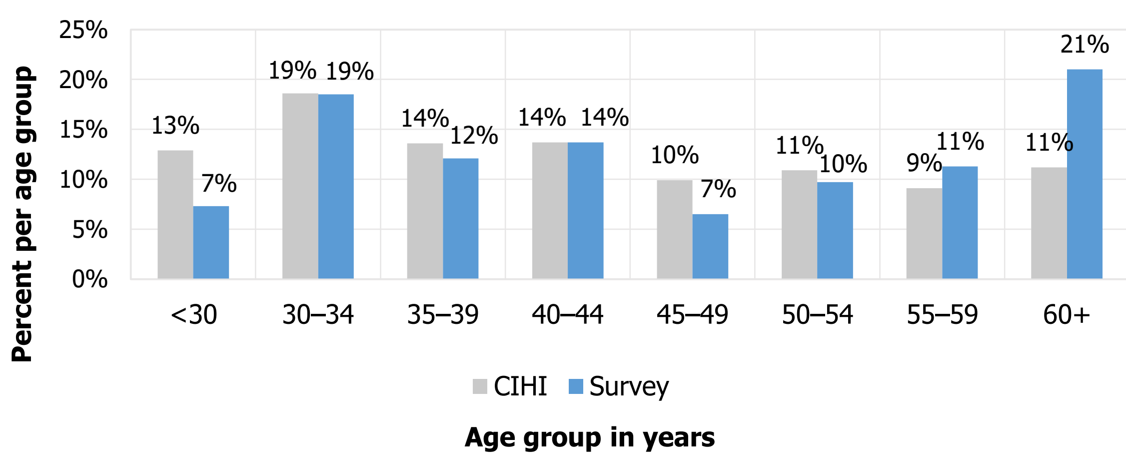
Figure 8: Population pyramid of survey respondents by age and administrative sex



As mentioned previously, a higher proportion of females was reported in the survey (80.7% versus 74.8%) and a lower proportion of males was reported (19.3% versus 25.2%) compared to the CIHI-MB data.

Figure 9 displays a comparison by age group with the most notable variations found in the under thirty population and over sixty age groups. CIHI-MB reports close to twice the frequency compared to the survey data (13% versus 7%) in the under 30 age group.

Figure 9: Comparison between CIHI data and survey data by age group



The opposite is found in the over 60 age group where the survey data reflects almost twice the frequency compared to the CIHI-MB data (21% versus 11%).

Tables 7 through 12 provide information on frequencies and distributions in a series of demographic and practice elements gathered in the survey data. Comparison to the CIHI-MB results have been provided for a selection of the variables as captured in the online survey. In some instances, CIHI combined and grouped data for reporting purposes which has been outlined in the tables accordingly.

Table 7 displays the survey data results for registration status at the College of Physiotherapists of Manitoba. Although University of Manitoba physiotherapy students were contained within the inclusion criteria, no students responded to the survey with 96.6% of the respondents in the active licensure category and 3.4% in the exam candidate category.

Table 7: Survey results by College of Physiotherapist of Manitoba registration status

CPM registration status		
	Freq	%
Active	115	96.6
Exam Candidate	4	3.4
Total	119	100.0

Physiotherapists work in many different places of employment as outlined in Table 8. 28.5% of survey respondents' primary place of employment is hospital or health facility based, compared to CIHI-MB at 41.9%. The data reports this was most commonly in a general hospital (17.6%), followed as expected by rehabilitation facilities (7.6%), and by smaller numbers working in mental health (0.8%) and residential care facilities (2.5%).

Table 8: Survey results by primary place of employment with CIHI comparison

Primary place of employment	Survey data		*CIHI-MB 2016*	
	Freq	%	*Freq*	*%*
General Hospital	21	17.6		
Rehabilitation Hospital/Facility	9	7.6		
Mental Health Hospital/Facility	1	0.8		
Residential Care Facility	3	2.5		
Total	34	28.5	*291*	*41.9*
Community Health Centre/Program	8	6.7		
Private Practice (solo)	13	10.9		
Private Practice (2 or more therapists)	48	40.3		
Post-secondary Educational Institution	6	5.0		
School or School Board	4	3.4		
Total	79	66.3	*340*	*49.0*
Government or para-government	2	1.7		
Industry	0	0		
Other	4	3.4		
Total	6	5.1	*63*	*9.1*
Grand Total	119	100.0	*694*	*100*

Beyond traditional health facilities, PTs have a large presence in community practice in Manitoba with CIHI-MB reporting a grouped proportion of 49% while the survey data, when grouped accordingly, reported a higher rate of 66.3%. When analysing the survey data for this grouping by individual parameters, private practices account for the primary place of employment for 51.2% of the survey respondents (solo or multiple physiotherapists). Other employment locations include community health centres/programs (6.7%), followed by post-secondary institutions (5%), and within schools or school boards (3.4%). A small proportion of Manitoba PTs are working in government or other employment settings not previously noted (5.1% compared to CIHI-MB at 9.1%). None of the survey respondents reported working in an industry setting.

Physiotherapists have a broad scope of practice with clinical focus areas that cover most of the human body and multiple body systems as outlined in the parameters of Table 9.

Table 9: Survey results by primary area of practice with CIHI comparison

Primary area of practice	Survey data		*CIHI-MB 2016*	
	Freq	%	*Freq*	*%*
General practice	34	28.6		
Total – General practice	34	28.6	*230*	*31.7*
Sports Medicine	4	3.4		
Burns and Wound Management	0	0.0		
Plastics	0	0.0		
Orthopedics	31	26.1		
Rheumatology	0	0.0		
Hand Therapy and Custom Splinting	1	0.8		
Women's Health/Perineal	3	2.5		
Total – Orthopedics	39	32.8	*276*	*38.0*
Pediatrics	15	12.6		
Total - Pediatrics	15	12.6	*56*	*7.7*
Neurology	9	7.6		
Vestibular Rehabilitation	2	1.7		
Total – Neurology	11	9.3	*41*	*5.6*
Amputations	1	0.8		
Oncology	0	0.0		
Palliative Care	0	0.0		
Total – Multi-systems	1	0.8	*4*	*0.6*
Critical Care	1	0.8		
Cardiology	1	0.8		
Respirology	0	0.0	*17*	*2.3*
Total – Critical care	2	1.6		
Health Promotion and Wellness	0	0.0		
Return to Work Rehabilitation	1	0.8		
Ergonomics	0	0.0		
Total – Health and wellness	1	0.8	*10*	*1.4*
Administration	7	5.9		
Teaching	2	1.7		
Research	2	1.7		

Total – Non-clinical focus	11	9.3	*54*	*7.4*
Other	5	4.2		
Total - Other	5	4.2	*38*	*5.2*
Grand Total	119	100.0	726	100.0

Almost one third of PTs in Manitoba consider themselves working in the area of general practice (28.6% in the survey compared to 31.7% from CIHI-MB). The next largest proportion of physiotherapists report working in the area of orthopedics with the survey data denoting 32.8% and the CIHI data reporting a higher rate of 38%. The next highest proportion noted in the survey are those physiotherapists working in the area of pediatrics. Manitoba's survey rate at 12.6% is notably higher than CIHI-MBs reported rate of 7.7%. In the areas of neurology, multi-system care such as amputation and oncology, and in the area of non-clinical focus such as teaching and administration, the survey reports a slightly higher rate at 9.3%, 0.8% and 9.3% respectively compared to 5.6%, 0.6% and 7.4% by CIHI-MB. The remaining areas of cardio-respiratory/critical care along with health promotion and ergonomics display slightly lower results in the survey at 1.6% and 0.8% compared to CIHI-MB at 2.3% and 1.4% respectively.

Throughout their scope of practice, physiotherapists treat a variety of patient age groups. The survey data reports that the majority of care is being provided to an adult population (40.3%), however 33.6% of survey respondents noted they cared for all ages during their practice as displayed in Table 10. While 13.4% reported treating a pediatric population, 7.6% focused on our growing senior population and 5% are working in non-clinical areas and consequently did not define a primary patient age group. This variable is not released publicly as part of the CIHI-MB data and therefore is not available for comparison.

Table 10: Survey results by primary patient age group

Primary employment client/patient age	Freq	%
Pediatrics (0-17)	16	13.4
Adults	48	40.3
Seniors (65+)	9	7.6
All ages	40	33.6
Not applicable	6	5.0
Total	119	100.0

Several assumptions for this research study are based on two defined sub-populations of practicing physiotherapists in Manitoba, those working in public practice and those working in private practice. Although similar information was captured in the primary place of employment noted in Table 8 above, the data was grouped with other areas of practice. The primary work sector variable in Table 11 was used to determine if a representative sample was evident from the survey as compared to the population CIHI data with respect to these two sub-populations. The results report inverted findings between the survey data and CIHI-MB data with 46.2% working in public practice (compared to 54.6% from CIHI-MB) and 51.3% working in private practice (compared to 45.4% from CIHI-MB).

Table 11: Survey results by primary work sector with CIHI comparison

Primary work sector	Survey data		*CIHI-MB 2016*	
	Freq	%	*Freq*	*%*
Public practice	55	46.2	*372*	*54.6*
Private practice	61	51.3	*309*	*45.4*
Other	3	2.5	--	--
Total	119	100.0	*681*	*100.0*

Manitoba is divided into five regional health authorities which have been used to denote primary work main geographical location as shown in Table 12.

Table 12: Survey results by primary work main geographic location with CIHI comparison

Primary work main geographical location

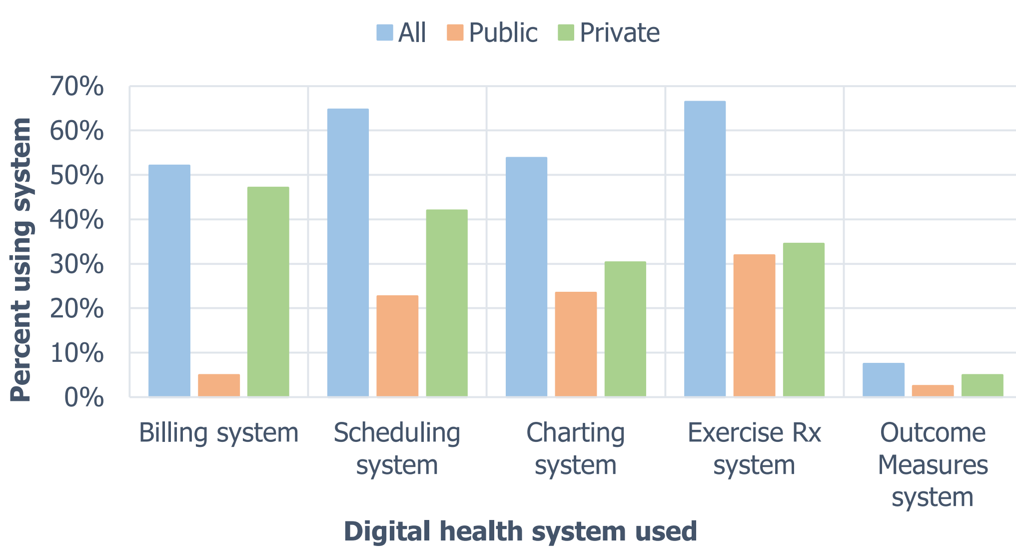
	Survey data		*CIHI-MB 2016*	
	Freq	%	*Freq*	*%*
Winnipeg	87	73.1	*622*	*87.2*
Interlake-Eastern	7	5.9		
Prairie Mountain	16	13.4	*91*	*12.8*
Southern Health-Santé Sud	5	4.2		
Northern	4	3.4		
Total	119	100.0	*100*	*100.0*

Much of Manitoba's population lives close to the largest urban centre, the capital city of Winnipeg. In alignment, almost three quarters of PTs report working in the urban Winnipeg environment (73.1% via survey and 87.2% in the CIHI-MB data). The survey data outlines that the remaining quarter are spread throughout the province working more rurally with the largest proportion at 13.4% working west of Winnipeg in the Prairie Mountain Health region which houses Brandon, Manitoba's second largest city. To continue on from a rural perspective, results demonstrate 5.9% are working in the Interlake-Eastern region which contains a large number of First Nation communities, and 4.2% are working in Southern Health-Santé Sud region which contains the city of Steinbach housing Manitoba's third largest population. The smallest proportion of physiotherapists are working in the Northern region which often has challenges recruiting and maintaining health-care professionals across a variety of disciplines. When comparing the data, a larger percentage of rural physiotherapists (26.9%) responded to the survey in comparison to the rural population represented in the CIHI data (12.8%).

5.4 Digital Health Technology Profile

Figure 10 outlines the adoption rate of physiotherapists using any of the five digital health systems identified in the survey with additional comparison by the work sectors of public practice and private practice. When looking at the complete dataset, the most commonly used digital systems are exercise prescription (eExRx) at 66.4% followed closely by scheduling applications (eSched) at 64.7%. Over half of physiotherapists in Manitoba (52.1%) are using billing systems (eBill) and 53.8% are using electronic documentation systems (eDoc) demonstrating moderate adoption rates throughout the province. The least used digital health system was in the patient reported outcome measures (eOM) category with only a 7.5% adoption rate.

Figure 10: Percentage of PTs using digital health systems with work sector comparison



As expected when comparing the results by work sector, only a small proportion of PTs in the public sector are using eBill systems (5% compared to 47.1%) given funding for these services would be provided by Manitoba Health and remuneration processes would not be handled directly by PTs. Almost double the proportion of private sector therapists are using eSched systems (42% compared to 22.7%) while a closer distribution between the private and public sector cohort was found in the eDoc category (30.3% private versus 23.5% public) and the eExRx category (34.5% private versus 31.9% public). With respect to the eOM category, 50% less public sector PTs are using these systems in comparison to private practice with the lowest overall distribution across the systems (2.5% public versus 5% private).

Survey data was analyzed with respect to age groups and the utilization of digital health systems. Table 13 displays adoption rates across the different age groups and the five digital health systems in the study including a total percent adoption rate.

Table 13: Percent adoption rate of digital health systems by age group

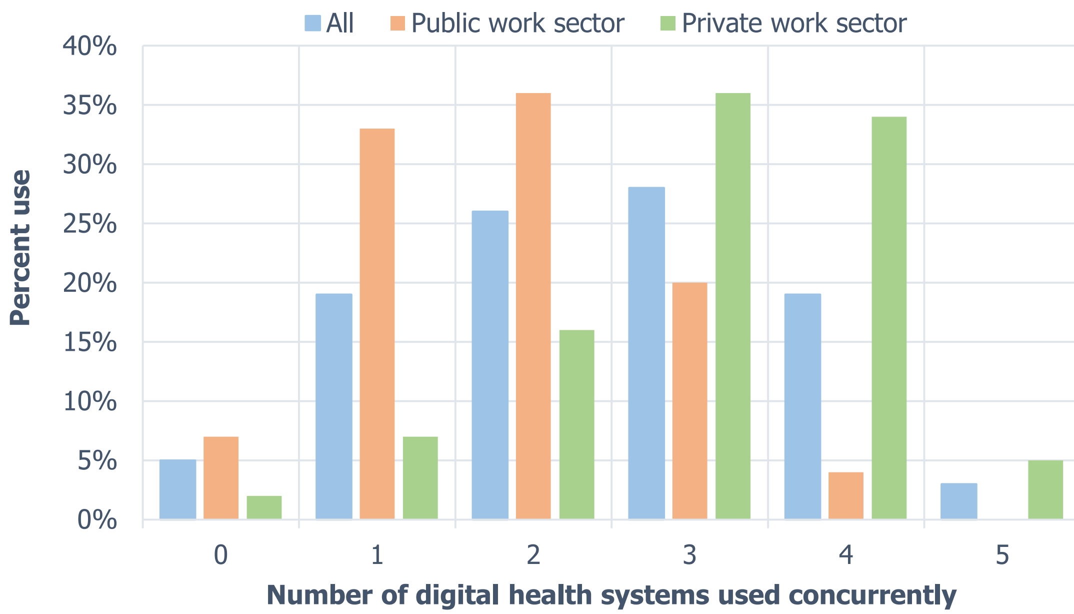
Age group in years	Digital health system					
	eBilling	eSched	eDoc	eExRx	eOM	Total
<30	4.2%	5.0%	3.4%	5.9%	0.0%	18.5%
30-34	10.9%	14.3%	10.9%	11.8%	1.7%	49.6%
35-39	8.4%	9.2%	7.6%	8.4%	0.0%	33.6%
40-44	8.4%	10.9%	7.6%	12.6%	2.5%	42.0%
45-49	1.7%	1.7%	2.5%	2.5%	0.0%	8.4%
50-54	3.4%	5.9%	6.7%	6.7%	0.0%	22.7%
55-59	2.5%	6.7%	5.0%	5.9%	0.0%	20.1%
60+	12.6%	10.9%	10.1%	12.6%	3.4%	49.6%
Total	52.1%	64.6%	53.8%	66.4%	7.6%	

The age groups of 30-34 and 60+ had the highest total adoption rate at 49.6% with a similar distribution of utilization across the five digital systems excluding differences in the eSched category (14.3% in the younger group and 10.9% in the higher age bracket) and the eOM category where the older cohort reported twice the adoption rate (3.4% versus 1.7%). The age group of 45-49 showed the lowest total adoption rate at 8.4% with a relatively equal distribution across four of the five digital health systems, followed by the under 30 age group at 18.5% and the 55-59 age group at 20.1%. As noted previously, the eOM category demonstrated notably low adoption rates and was isolated to the three age groupings of 30-34 (1.7%), 40-44 (2.5%) and 60+ (3.4%).

From an individual system level perspective, the eSched category demonstrated the highest adoption rate at 14.3% in the 30-34 age bracket. The next highest adoption rate was shared by the eBill and eExRx categories, both at 12.6% in the 60+ age bracket, followed closely by eBill and eDoc in the 30-34 age bracket and eSched in the 60+ age bracket, all at 10.9%. Lowest adoption rates per digital health system were found consistently in the 45-49 age bracket (eBilling/eSched at 1.7%, eDoc/eExRx at 2.5% and eOM at 0%).

An electronic medical record (EMR) system would commonly offer billing, scheduling and charting features and functions within one application. Based on this knowledge, additional analysis was performed on the data to identify how many systems were being used concurrently (either within one application or multiple applications). Figure 11 displays this distribution demonstrating that the majority of physiotherapists are using two to three systems (26% and 28% respectively) while equal proportions of therapists are using one or four systems concurrently (19%). A limited number (3%) are using the full functionality of five systems while 5% report not using any digital systems in practice.

Figure 11: Percentage of digital health systems used concurrently by work sector



This construct was also evaluated from a work sector perspective comparing physiotherapists working in the public versus private sector. For the public practice cohort, the majority of this group report using one to two systems (33% and 36% respectively) with only 4% reporting the use of four systems and zero physiotherapists using all five systems.

The private practice group demonstrated a third pattern with the majority using three to four systems (36% and 34% respectively) and with 5% reporting using all five systems. The private practice group also demonstrated the lowest percentage of physiotherapists using no systems (2%) or only one system (7%).

To further understand the concurrent system use, analysis was completed to determine the variety of combinations of concomitant use amongst the five digital systems. Each used system reported in the survey is identified in the table as a letter representative of the system. If the system was not being utilized, a hyphen symbol (-) has been used to represent the gap.

Therefore, use of all five systems would be represented as 'BSDEO' while use of only the first three systems would be represented as 'BSD--'. 21 unique combinations were identified across all survey respondents, 14 alternate patterns were identified by public practice while the private practice cohorts identified 14 of their own unique combinations. The top five for each category are displayed in Table 14 which in all cases represents over 50% of the respondents (56.3% for all respondents, 69.1% for the public practice group and 80.3% of the private practice group).

Table 14: Combinations of digital health systems used by work sector

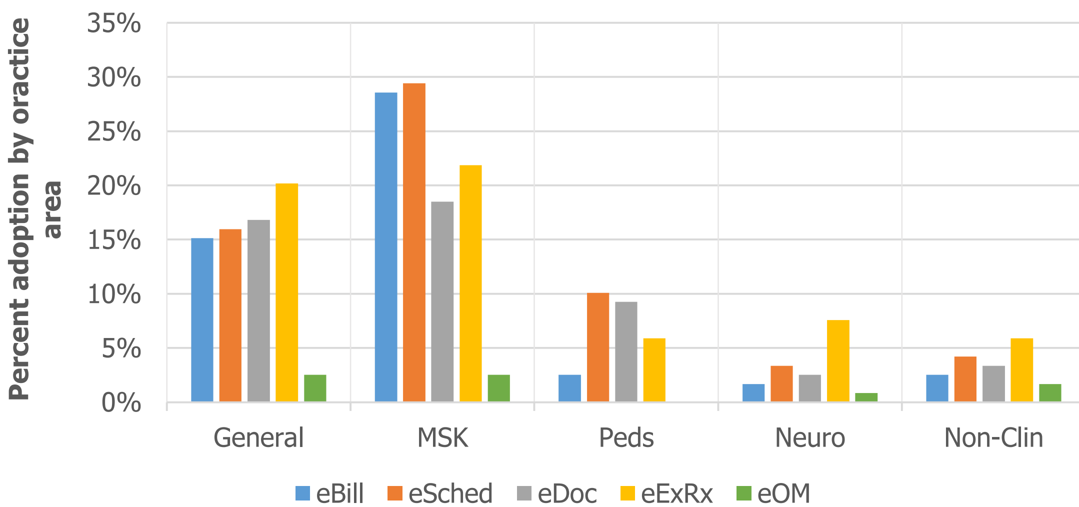
	All		Public work sector		Private work sector	
Ranking	Combinations	% use	Combinations	% use	Combinations	% use
1	BSDE-	16.8%	---E-	23.6%	BSDE-	31.1%
2	BSD--	11.8%	--DE-	14.5%	BS-E-	18.0%
3	---E-	10.9%	-S-E-	12.7%	BSD--	16.4%
4	BS-E-	10.1%	-SDE-	10.9%	B--E-	9.8%
5	--DE-	6.7%	BSD--	7.3%	BSDEP	4.9%
All five	BSDEP	2.5%	BSDEP	0.0%	BSDEP	4.9%
None	-----	5.0%	-----	7.3%	-----	1.6%

Legend: - = not using system | B = eBilling | S = eScheduling | D = eDocumentation | E = eExercise Prescription | P = ePatient Reported Outcome Measures

The combined use of eBill, eSched, eDoc and eExRx (BSDE-) was the most commonly utilized for all physiotherapists (16.8%) as well as the private practice cohort who reported almost twice the rate of use at 31.1%. The most common combination in the public practice cohort was the single use of eExRx at 23.6%. The remainder of the combinations varied across all three groups. When comparing the public versus private respondent data, only the private practice cohort demonstrated use of all five digital systems at 4.9%. Although frequencies are low, public practice PTs have the highest percentage of zero use of digital systems at 7.3% compared to the private practice cohort at 1.6%.

Practice area is another consideration when analyzing the digital system data. As Figure 12 displays, PTs working in the practice area category of musculoskeletal (MSK) practice are most commonly using digital health systems. This includes those working in sports medicine, burns and wound management, plastics, orthopedics, rheumatology, hand therapy/custom splinting and women's health. Following this category are those working in general practice who have close to the same adoption rate of eExRx as the MSK group with only a 1.6% difference (20.2% versus 21.8%). The areas of pediatrics and neurology have less than half the adoption rates of those in MSK practice however pediatrics does have a stronger proportional adoption rate of eSched and eDoc than the remainder of all the practice areas.

Figure 12: Digital system adoption by practice area



The non-clinical area includes those working in administrative roles, teaching and research and does demonstrate adoption of all five digital systems (eBill 2.5%, eSched 4.2%, eDoc 3.4%, eExRx 5.9% and eOM 1.7%), with the same adoption rate of eExRx as those working in pediatrics (5.9%) and a higher adoption of eSched than the neurology practice area (4.2% versus 3.4%). Excluded from the figure are very low adoption rates (0-1.7%) in the areas of cardiorespiratory, multisystem practice (including amputations, oncology and palliative care) and prevention/wellness (including return to work rehabilitation, ergonomics and health promotion/wellness).

Table 15 outlines digital health use across the province by geographical location. Physiotherapists working in the Winnipeg region demonstrate higher adoption rates across all five digital health systems with the largest difference identified in the eDoc category with more than five times the rate of adoption in Winnipeg (44.5% versus 8.4%), followed by just under three times the rate of adoption in eSched (47.9% versus 16.8%) and eBilling systems (37.8% compared to 14.3%).

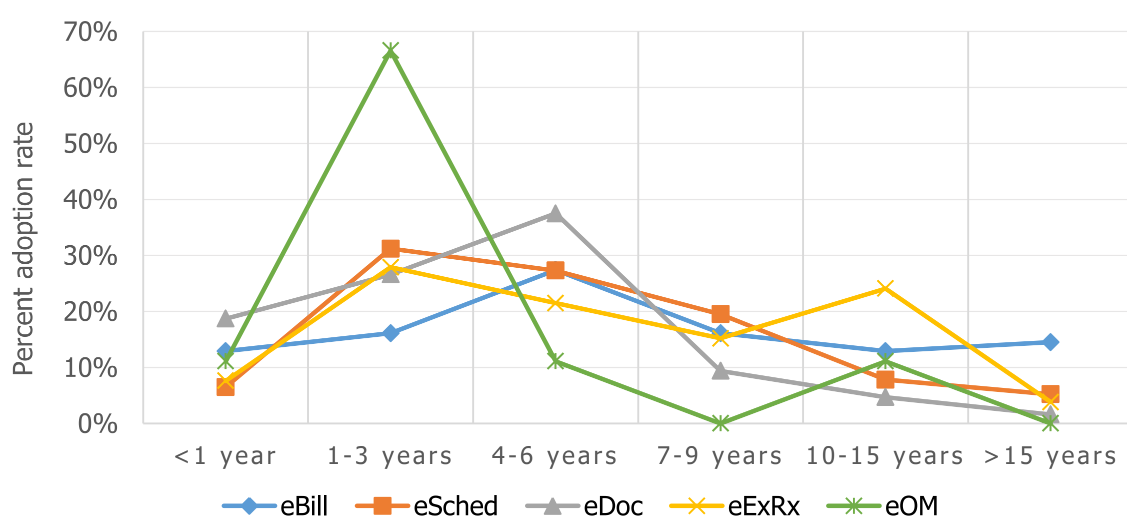
Table 15: Digital health system adoption by geographical location

Geographical location	Digital health system				
	eBilling	eSched	eDoc	eExRx	eOM
Urban					
Winnipeg	37.8%	47.9%	44.5%	43.7%	5.0%
Total	37.8%	47.9%	44.5%	43.7%	5.0%
Rural					
Interlake-Eastern	4.2%	4.2%	3.4%	4.2%	0.8%
Prairie Mountain	7.6%	10.1%	5.0%	11.8%	0.8%
Southern Health-Santé-Sud	1.7%	1.7%	0.0%	4.2%	0.8%
Northern Regional Health	0.8%	0.8%	0.8%	2.5%	0.0%
Total	14.3%	16.8%	8.4%	22.7%	2.4%
Grand Total	52.1%	64.7%	53.8%	66.4%	7.6%

With respect to eExRx and eOM, rural therapists are using these systems at approximately half the rate of Winnipeg-based colleagues (22.7% versus 43.7% and 2.4% versus 5.0% respectively). In rural Manitoba, the Prairie Mountain Health region in the west of the province shows the highest rural adoption rates between 10% and 12% for eExRx and eSched systems. The Interlake-Eastern region has a low rate of adoption across the systems but maintains a relatively equal distribution (3.4% – 4.2%) across all systems excluding the eOM category. Southern Health-Santé Sud's highest adoption rate is 4.2% for the category of eExRx, the same proportion as the Interlake-Eastern region, but has no reported adoption of eDoc. The Northern region has low adoption rates also with the highest proportion (2.5%) using eExRx software. No physiotherapists in the north are using eOM.

Survey results in Figure 13 demonstrate trending lines that reflect the percent adoption rate for each of the five digital health systems per length of time physiotherapists have been utilizing each system in their practice.

Figure 13: Trending lines displaying percent adoption by number of years using each digital health system



The largest growth is found in the eOM system with over three quarters (77.7%) of adoption occurring in the last one to three years. A proportion of physiotherapists in Manitoba are long-term users across all five systems with 27.4% of PTs using eBill, 13.0% using eSched, 6.3% using eDoc, 11.1% using eOM and over one in four (27.9%) using eExRx systems for ten years or more. When reviewing the data from a new user perspective, close to one in five physiotherapists (18.7%) have been using eDoc for less than one year, just over one in four (26.6%) have been using eDoc for one to three years and 37.5% have been using for four to six years. A similar adoption pattern can be noted for eBill with 12.9% using less than one year, 16.1% using for one to three years and 27.4% using for four to six years. Use of an eExRx system has the most evenly distributed proportion across the utilization years with an interesting mix of both new users (35.5% within the last three years) and long-term users (27.9% using for more than ten years).

When analyzing the same data by work sector, Figure 14 displays trending lines for each of the digital health systems per number of years of utilization to distinguish patterns or differences in use between the two cohorts. The results demonstrate that experienced users using systems for more than 15 years are primarily from private practice (21.0% versus 4.1%). When analyzing the data for the ten to fifteen-year category, both work sectors have the identical adoption rate of 31% however public practice physiotherapists have been using eExRx at three times the rate (16.5% versus 5.1%) as compared to those in private practice. As expected, the private practice sub-group has a higher proportion using eBill (11.3% compared to 1.6% respectively). 11.1% of the public practice group adopted eOM more than ten years ago compared to private practice and in fact, private practice has only adopted this system within the last six years. 4.7% of private practice physiotherapists have been using eDoc systems for more than ten years as early adopters while no public practice PTs have been using longer than seven to nine years.

Figure 14: Digital system adoption by time using and work sector

In the last six years the increase in adoption of eExRx and eOM software has been largely in the private sector with moderate rates occurring in the last one to three years with private practice adopting at twice the rate as those in the public practice sector. eDoc systems have shown steady increase in adoption in recent years in both the public and private sectors with the largest gains four to six years ago.

As a progression, more granular analysis was conducted on the time using digital health system data in the context of the Diffusions of Innovations theory. The timeline categories comprised above were applied based on groupings included in the National Physician Survey and can be readily mapped to the DoI framework. For the purpose of the analysis for this study, innovators will be classified as PTs using digital health systems for more than 15 years, early adopters would be those using for 10-15 years, early majority would be those using four to nine years and the late majority and laggards would be using one to three years and less than one year respectively. Using this mapping to the DoI framework, Figures 15 through 18 display the adoption rates per digital health system in columns using the modified utilization timelines. A trending line has been added in each chart to depict the percent adoption rates as quantified in the DoI theory itself in order to allow for visual comparison against the survey results. For each digital health system, sub-charts have been included to reflect additional work sector analysis to see if any differences exist within the two cohorts. The purpose of this analysis was to show trending patterns and general alignment with the framework.

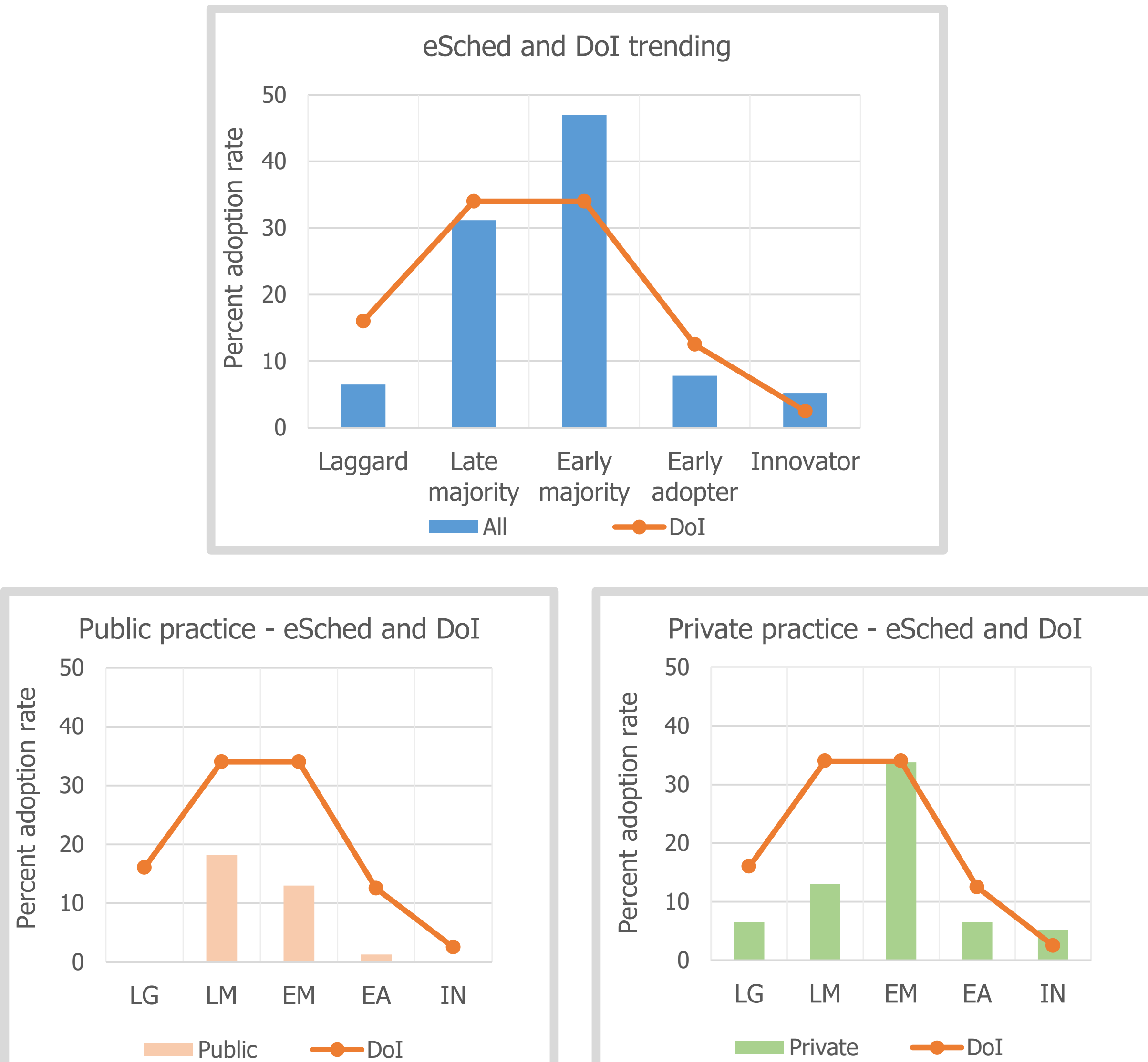
From an eBill perspective (Figure 15), there has been quite successful adoption according to the DoI theory with larger proportions of innovators and early majority, and smaller than expected proportions of late majority and laggards. A very similar pattern is shown in the private practice cohort however significantly skewed lower results are found in the public practice cohort where the respondent data failed to align even remotely to the DoI framework pointing to unsuccessful adoption of this system within this sub-grouping.

Figure 15: Percent adoption of eBill system with work sector analysis and comparison to the Diffusion of Innovations framework

Legend: LG = Laggard | LM = Late majority | EM = Early majority | EA = Early adopter | IN = Innovator

Figure 16 displays analysis for the use of eSched which aligns well with the framework when considering all respondents demonstrating less than half of the expected laggards and a higher proportion of early majority and slightly higher proportion of innovators.

Figure 16: Percent adoption of eSched system with work sector analysis and comparison to the Diffusion of Innovations framework

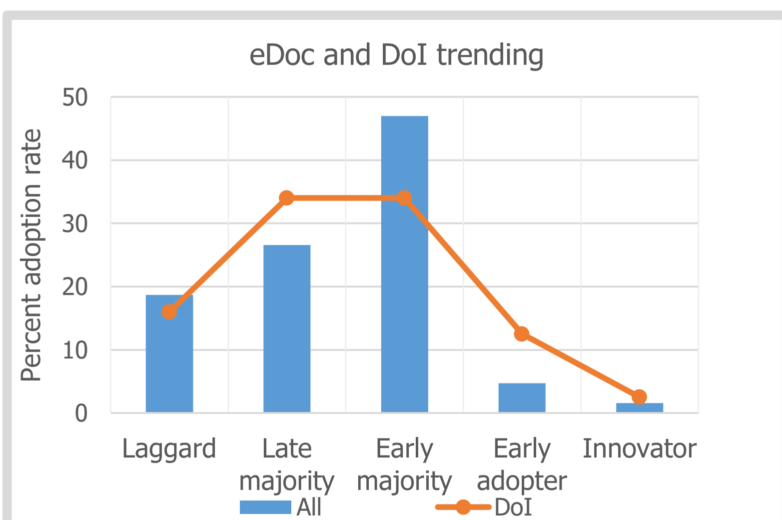


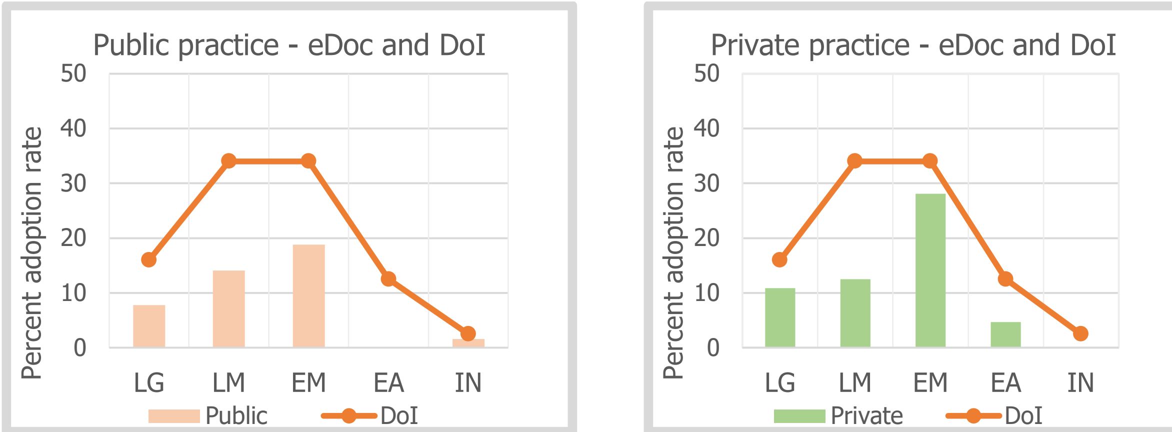
Legend: LG = Laggard | LM = Late majority | EM = Early majority | EA = Early adopter | IN = Innovator

As per the eBill public practice cohort, there is very poor alignment with the DoI framework with respect to eSched and a similar pattern in the private practice cohort with a lower number of laggards and late majority demonstrating fairly successful adoption.

Figure 17 outlines the analysis for eDoc users which shows a different pattern in the overall results with a higher proportion of laggards and early majority and less than half of the expected early adopters. Both the public and private practice cohorts follow very similar patterns however fail to meet any of the expected adoption rates although they do align to the trending distribution overall. Of note is a complete absence of early adopters in the public practice sector and an absence of innovators in the private work sector. The private sector also demonstrates a low proportion of early adopters and only a third of the expected late majority users.

Figure 17: Percent adoption of eDoc system with work sector analysis and comparison to the Diffusion of Innovations framework

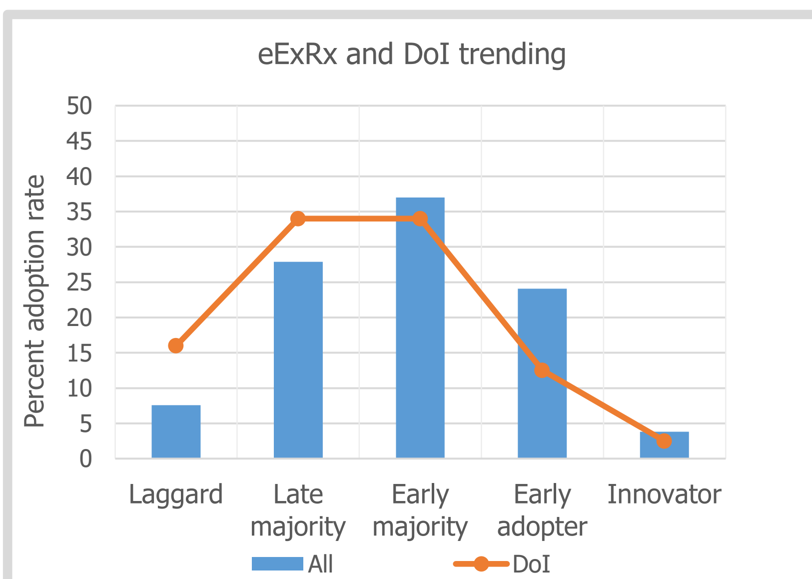


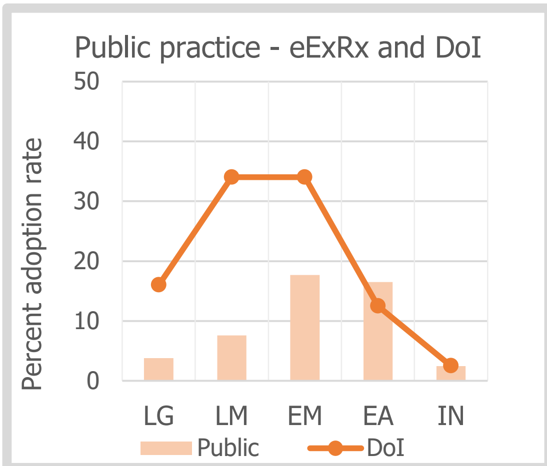


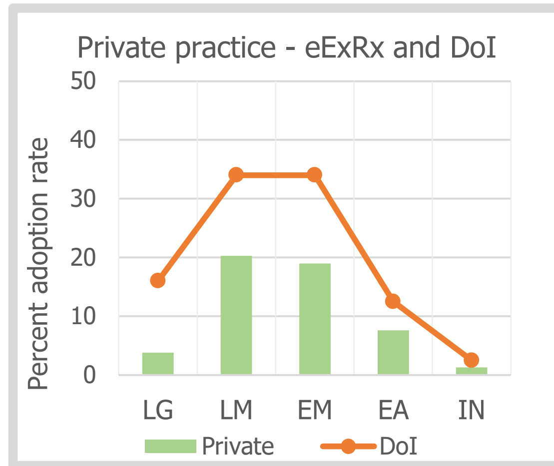
Legend: LG = Laggard | LM = Late majority | EM = Early majority | EA = Early adopter | IN = Innovator

The final system evaluated against the DoI framework is eExRx with results displayed in Figure 18 showing good overall alignment with the theory.

Figure 18: Percent adoption of eExRx system with work sector analysis and comparison to the Diffusion of Innovations framework







Legend: LG = Laggard | LM = Late majority | EM = Early majority | EA = Early adopter | IN = Innovator

In the full dataset there are less than half the expected laggards and almost double the amount of expected early adopters. The public practice cohort shows a shift towards more early adopters and innovators while the private practice cohort demonstrates an opposite shift with less early adopters and a higher proportion of users in the late majority category. Additional context and explanation of these results is discussed in Section 6.3 – Alignment with the Diffusion of Innovations Theory.

Survey respondents who reported they were not utilizing any of the five digital systems were asked if they were considering using that specific digital health system in the next two years. Table 16 displays the results of the survey respondent data for this question with additional work sector level analysis.

Table 16: Potential adoption rates of digital health systems in the next two years

Plan to adopt in the next two years	eBill		eSched		eDoc		eExRx		eOM	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No

All	6%	94%	17%	83%	34%	66%	22%	78%	13%	87%
Public work sector	4%	87%	12%	61%	19%	34%	14%	32%	3%	46%
Private work sector	2%	7%	5%	22%	15%	32%	8%	46%	10%	41%

For those not already using eBill or eSched systems in public practice, results show a strong disinclination to adopt them in the next two years (87% and 61%). A total of 34% of physiotherapists not already using eDoc plan to adopt in the next two years with a slightly higher representation from public practice (19% versus 15%). 78% do not plan to adopt eExRx systems and 87% do not plan to adopt an eOM system with relatively equal distributions across both public and private sector PTs.

There are a variety of reasons why physiotherapists may choose not to adopt a digital health system. Table 17 outlines the respondent data for those physiotherapists who have not adopted technology with further analysis at the work sector level.

Table 17: Reasons provided for not adopting digital health systems by work sector

Reasons for not using	**eBilling**		**eSched**		**eDoc**		**eExRx**		**eOM**	
	Pub	Priv	Pub	Priv	Pub	Priv	Pub	Priv	Pub	Priv
Unable to find product suitable	3%	2%	7%	--	5%	10%	3%	8%	22%	31%
Too costly	2%	3%	3%	7%	3%	20%	5%	15%	7%	11%
Too time consuming	--	2%	3%	5%	--	11%	9%	5%	5%	31%
Privacy concerns	--	--	--	7%	--	13%	--	--	2%	8%

Lack of training	--	--	--	--	2%	19%	--	2%	10%	11%
Not comfortable with technology	--	--	--	--	--	3%	2%	--	3%	5%
Limited keyboarding/typing skills	--	--	--	--	--	2%	3%	2%	5%	2%
Retiring soon	2%	2%	2%	7%	--	10%	3%	2%	10%	8%

Legend: -- = 0%

Respondents were provided with a list of choices modified from the National Physician Survey and could select multiple items based on their personal applicability. The most common reason reported in public practice across all systems was being unable to find a suitable product. This was most evident in the eOM category (22%). The next most common reason reported across the systems was in the eDoc category where twice as many PTs in private practice compared to public practice (10% and 5% respectively) reported the barrier to adoption was related to systems being too costly. This subset additionally reported that privacy concerns affected their decision to adopt eDoc systems (13%) which was not reported as a barrier from the public practice subset. Physiotherapists in the private sector conveyed that cost was an issue when considering adoption of eExRx (15%) at three times the rate as the public practice group (5%). In general, cost-related issues were less reported in the public practice subset.

Those that adopt digital health systems report a series of benefits. Table 18 displays the benefits reported by survey respondents per digital health system and by work sector.

Table 18: Reported benefits of adopting digital health systems by work sector

Benefits of using	eBilling		eSched		eDoc		eExRx		eOM	
	Pub	Priv	Pub	Priv	Pub	Priv	Pub	Priv	Pub	Priv
Increased efficiency	10%	85%	40%	74%	43%	48%	50%	51%	2%	5%
Increased productivity	5%	43%	14%	43%	21%	36%	22%	28%	2%	5%
Improved patient management/care	7%	38%	24%	57%	31%	43%	45%	52%	2%	8%
Improved communication	9%	46%	33%	57%	47%	43%	48%	57%	--	7%
Positive financial impact	2%	34%	2%	21%	--	8%	2%	3%	--	3%
Supports clinical decision-making	5%	15%	3%	16%	17%	23%	12%	30%	2%	5%
Supports business decision-making	--	38%	5%	25%	2%	11%	--	2%	2%	2%
Requires less human resources	52%	23%	5%	25%	14%	20%	14%	3%	2%	--

Legend: -- = 0%

As per the challenges section, respondents were able to choose from a list of provided benefits selecting multiple options based on their individual circumstances. The most commonly reported benefit across all systems was increased efficiency. This was reported at a higher percentage in all five system categories for those working in the private sector, with the highest reported rates in the eBill (85%), followed by eSched (74%), eExRx (51%) and eDoc (48%) categories. The second most common benefit noted across all five systems was improved communication. This benefit is more evenly distributed across the public and private work sectors for eExRx use (48% versus 57%) and eDoc (47% versus 43%). 57% of private practice PTs using eExRx reported this as a benefit compared to 48% in public practice. For eDoc system use, 47% of public practice therapists reported the benefit of improved communication in comparison to 43% in private practice. Following closely as a third benefit across all systems is improved patient management/patient care which was reported by a higher proportion of private practice PTs notably in the eSched category (57% versus 24%) followed by the eExRx category (52% compared to 45%) and the eDoc category (43% and 31%).

Another area more commonly reported as a benefit from the private practice cohort was increased productivity with the use of eBill (43%), eSched systems (43%) and eDoc (36%) listed as the top three systems providing the benefit. Public practice physiotherapists reported increased productivity with use of the same digital systems but at a lower rate (5%, 14% and 21% respectively). Support for clinical decision-making was another benefit more commonly reported by the private practice sector. This was most notable in the eExRx category (30% compared to 12%), eBill category (15% compared to 5%) and eSched category (16% compared to 3%). This benefit was additionally reported with use of eDoc but with less difference between private and public sector physiotherapists (23% compared to 17%). The least reported benefits across all systems were in the categories of positive financial impact and supporting business decision-making with the largest proportion for this benefit coming from the private sector with respect to use of eBill (34% and 38% respectively) and eSched systems (21% and 25% respectively).

Physiotherapists who have adopted digital health systems report experiencing challenges along their journey as shown in Table 19.

Table 19: Reported challenges related to digital health system adoption

Challenges of using	**eBilling**	**eSched**	**eDoc**	**eExRx**	**eOM**

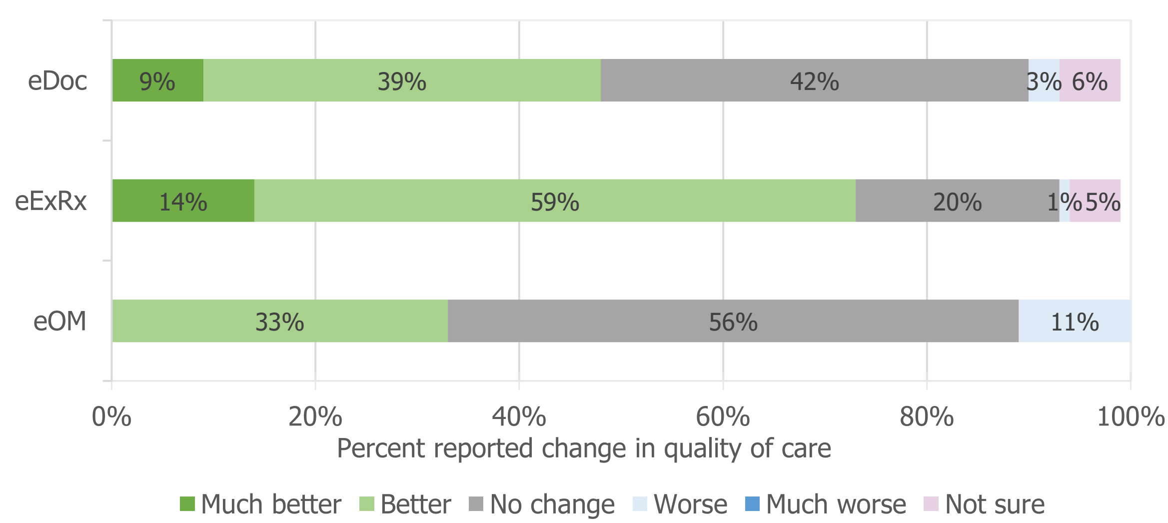
	Pub	Priv	Pub	Priv	Pub	Priv	Pub	Priv	Pub	Priv
Compatibility with other systems	--	33%	5%	18%	14%	11%	16%	11%	3%	3%
Privacy issues	--	5%	3%	5%	7%	2%	--	5%	--	--
Hardware availability	--	10%	10%	13%	17%	13%	31%	15%	3%	2%
Technical glitches	--	54%	14%	48%	24%	46%	28%	36%	3%	7%
Lack of training	--	18%	3%	18%	7%	13%	9%	11%	--	2%
Firewall/security issues	--	5%	3%	3%	3%	2%	3%	2%	--	--
Not aligned with clinical workflow	2%	15%	12%	15%	12%	15%	19%	15%	3%	5%
None	9%	33%	26%	25%	12%	15%	17%	16%	--	2%

Legend: -- = 0%

The most commonly reported challenge chosen by respondents from a list of options across all five systems are technical glitches with higher percentages displayed by the private practice cohort in all categories most notably in the eBill (54%), eSched (48%) and eDoc categories (46%). Interestingly, the second highest reported challenge was the category 'None' with fairly even distribution across the two work sectors with the exclusion of the eBill category (33% private sector and 9% public sector). Compatibility with other systems, issues with hardware availability and concerns with the systems not aligning with clinical workflow were reported at 11% across all five systems and was the challenge with the highest percentage in the eOM category. The public practice work sector reported more compatibility issues for eExRx (16% compared to 11%) and eDoc systems (14% compared to 11%), and more issues with hardware availability when using the same systems with twice the rate of private practice in the eExRx category (15% versus 31%). The challenge of lack of training was more commonly reported by those working in the private sector with the highest percentage shown in the eSched and eBill categories (18%) followed by eDoc (13%) and eExRx (11%) categories. The challenge that was least reported across all five systems was firewall/security issues with relatively even distribution across both work sectors.

In addition to the benefits categories asked in the survey, two separate specific questions were asked to users of three of the five digital health systems with respect to how they would rate improved quality of patient care and improved productivity. A 0-5-point Likert scale was provided for each question and respondents were asked to reply in the context of their use of eDoc, eExRx and eOM systems given their direct relationship to patient care activities. Figure 19 outlines the results from the survey from all respondents related to changes in quality of care displayed as a stacked horizontal bar depicting the Likert scale results.

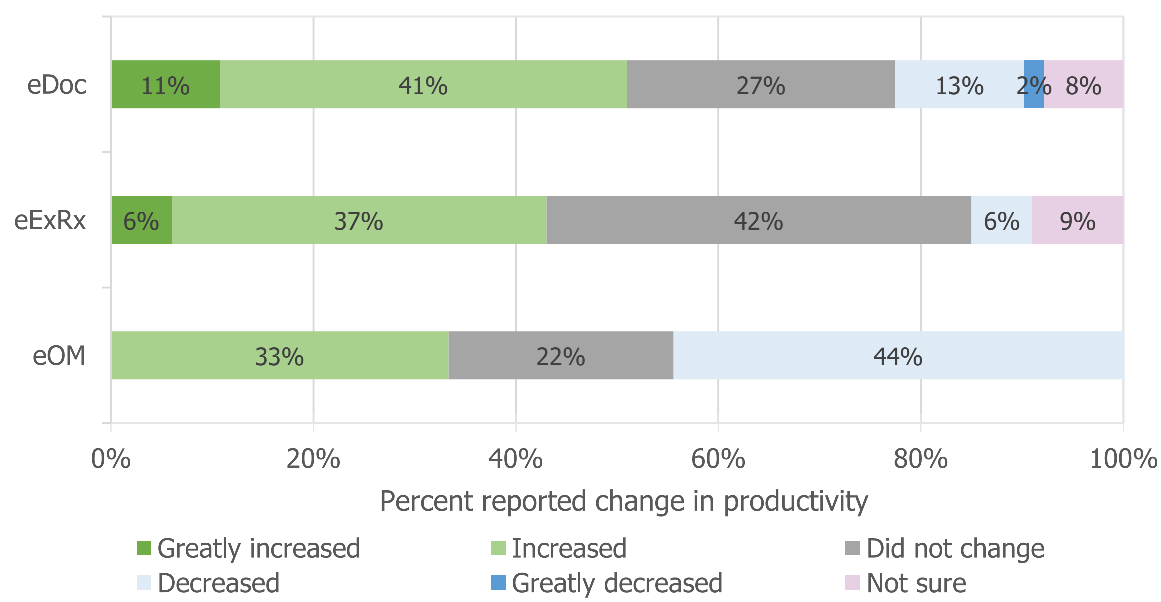
Figure 19: Quality of care change related to digital health use



The highest proportions noted for reported change in quality of care with use of eDoc and eOM systems was no change (42% and 56%). For both systems the second most common reply was better at 39% and 33% respectively. In comparison, over half of users of eExRx (59%) noted better quality of care and only 20% noted no change. 9% of eDoc users and 14% of eExRx users note quality of care was much better after adoption. In the case of all three systems, no physiotherapists reported quality of care was much worse however a small percentage did note quality of care was worse (3% of eDoc users, 1% of eExRx users and 11% of eOM users).

Figure 20 displays the responses to the survey questions related to changes in productivity. 44% of eOM system users report a decrease in productivity compared to only 13% of eDoc users and 6% of eExRx users.

Figure 20: Productivity change related to digital health use

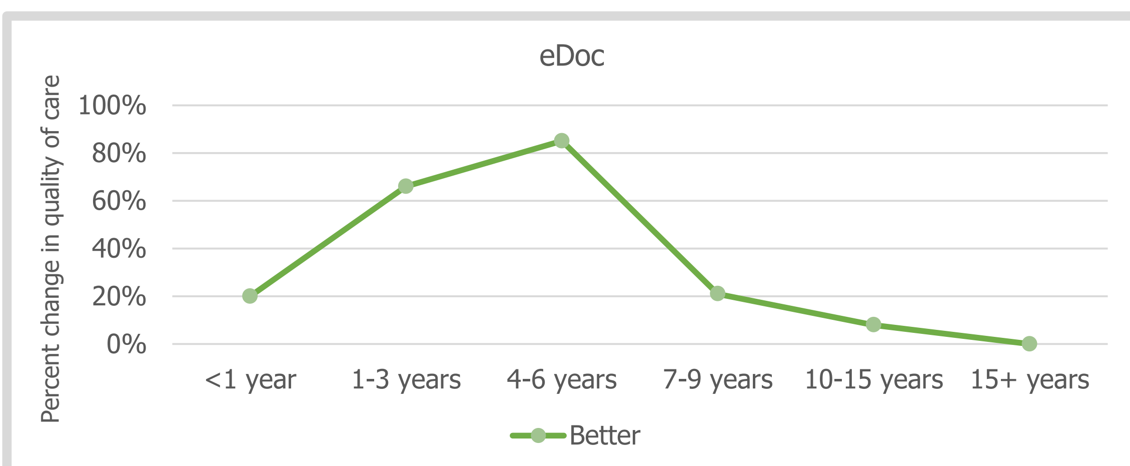


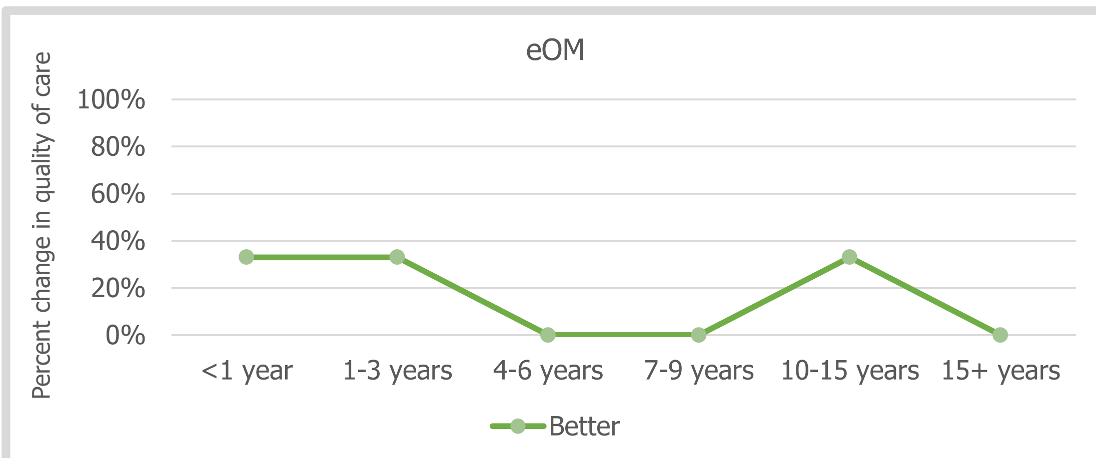
A small percentage of physiotherapists (2%) using eDoc reported productivity was greatly decreased. In comparison, 33% of PTs using eOM, 43% of those using eExRx and just over half of physiotherapists using eDoc systems (52%) report productivity was greatly increased or increased. Of note is that close to one in ten users of eDoc (8%) and eExRx (9%) are not able to ascertain whether productivity changed with use.

Analysis at the work sector level was not completed for this variable however additional investigation regarding improved quality of care and increased productivity based on time using each of the three clinically-related digital health systems and by the number of systems used concurrently was completed. This was to enable reflection against the results of the National Physician Survey for 2014 which can be found in the discussion section of this thesis.

As displayed in Figure 21 using a line graph to demonstrate trends over time using each system, the survey showed that 66% of both eDoc and eExRx users reported quality of care was better (combined results of “Better” and “Much better” from the Likert scale) after using the system for one to three years. There were also gains within the first year of use with one in five physiotherapists reporting improvement.

Figure 21: Reported improvement in quality of care over time per digital system

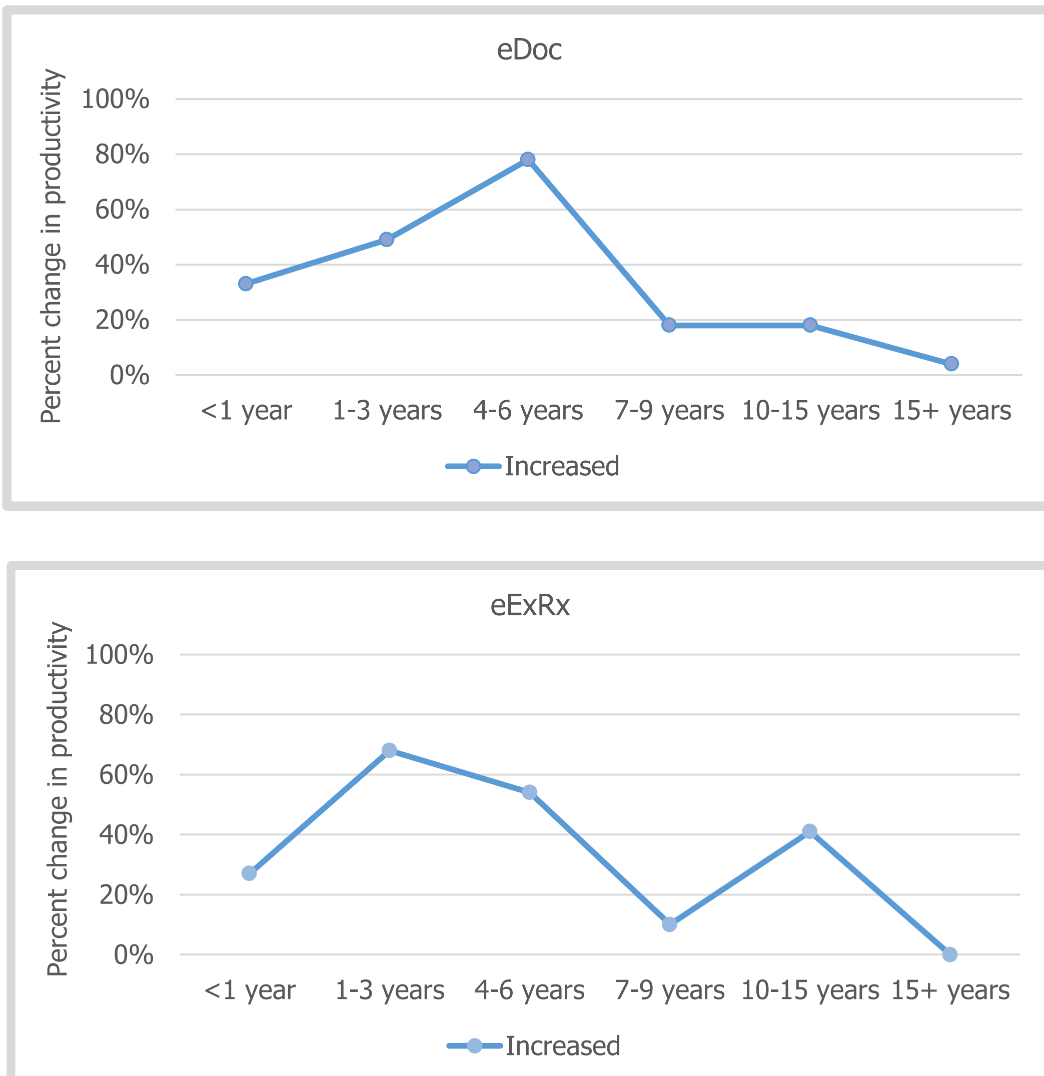


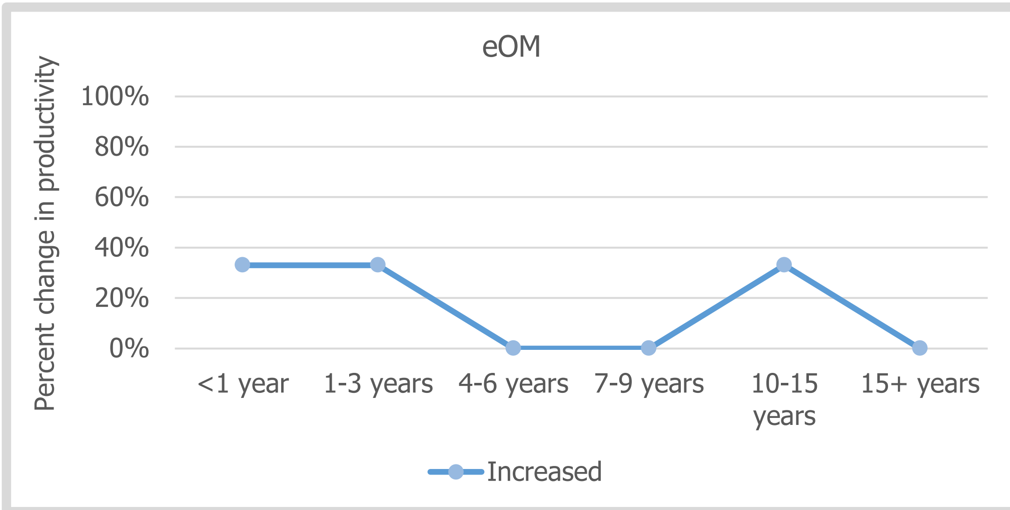


eDoc users continue to report increases in quality with ongoing use into the four to six-year time bracket where the highest gains were achieved at 85%. Over half of therapists using eExRx longer than three years report gains in quality of care until using more than seven years where the gains decrease from 55% to 19%. Physiotherapists using eDoc and eExRx systems continue to see gains in quality of care, but at significantly lower rates once using longer than ten to fifteen years. In the eOM category, the results for quality of care improvement show less variation due to the low adoption rates. One third of users report better quality of care in the first three years of adoption which carries over into the early adopters using more than ten years.

A very similar pattern of results is displayed in Figure 22 illustrating reported productivity improvement of increased (combined results of "Increased" and "Greatly increased" from the Likert scale) based on use of three digital health systems.

Figure 22: Reported improvement in productivity over time per digital system

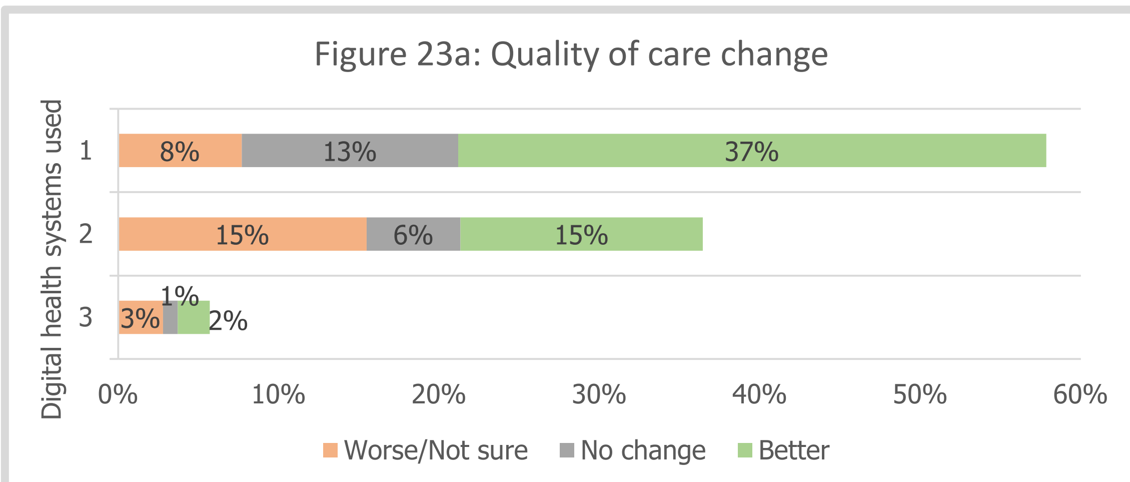


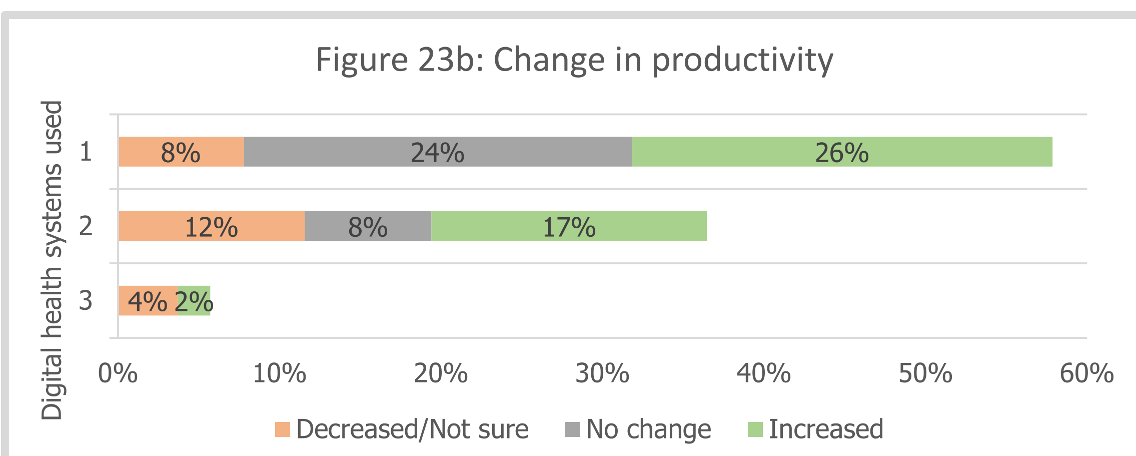


The greatest productivity gains are seen in the four to six-year mark using eDoc (78%) and the one to three-year mark with eExRx (68%). New users in the first year of use are reporting productivity gains higher than the quality of care gains noted above with one third of eDoc users and 27% of eExRx users reporting improvement within that first year. Close to one in five physiotherapists using eDoc for seven to fifteen years continue to report improvement in productivity at a combined percentage of 36%, while just over half of eExRx users (51%) in the same time bracket continue to report gains with the majority of those gains reported in the over ten-year users (41%). For the eOM category, one third of PTs considered early adopters within the first three years of use are reporting increased productivity, continuing through to ten to fifteen years of use.

Investigation of responses from the National Physician Survey in 2014 demonstrated that improvements in quality of care and productivity can be positively correlated to the number of functionalities used within digital health systems. To assist with considering this in the survey responses, analysis was completed to review quality of care and productivity changes in relation to whether physiotherapists were using eDoc and/or eExRx and/or eOM systems (one, two or three systems). Figure 23 outlines the results for both constructs (quality of care and productivity change) in a stacked horizontal bar chart identifying the Likert scale responses compared across the number of systems used concurrently. In preparation to meet frequency assumptions of the Chi-square test, the Likert scale was grouped into three response categories to avoid violating the test assumptions.

Figure 23: Analysis of quality of care and productivity change based on number of digital health systems used





From a quality of care perspective (Figure 23a), 37% of physiotherapists report an improvement in this parameter with the use of one of the three systems however this decreased to 15% with the addition of a second system and decreased further to 2% with the addition of a third system. 13% reported no change with the use of one system which also decreased to 6% and then 1% with the addition of a second and third system which demonstrates they may be experiencing some value from the additional systems. Of some concern is the increase in reporting of worsening quality of care (or PTs who are unsure if any change occurred) with the addition of a second system which increased from 8% to 15%. Changes in productivity follow very similar patterns (Figure 23b). Of note with this variable is that almost one in four PTs report no change in productivity with the adoption of either an eDoc, eExRx or eOM system however a very similar amount (26%) report increased productivity.

To evaluate whether a meaningful relationship existed between the number of digital health systems used and changes in quality of care or productivity at a more quantitative level, Chi-square cross-tabulations were calculated between these constructs to determine whether the findings could be validated via statistical testing of significance (p-value) and evaluation of effect size (Kendall's tau-b). Statistical analysis was completed on all survey respondents who were using eDoc and/or eExRx and/or eOM (n=104). Despite the response category adjustments, some assumptions of the Chi-square testing remained violated related to expected observation frequencies per Likert scale category. For this reason, the Chi-Square Likelihood Ratio result replaces the Pearson Chi-square value as the accepted statistical response to ascertain whether associations exist between two ordinal variables. Results of the statistical testing are presented in Table 20.

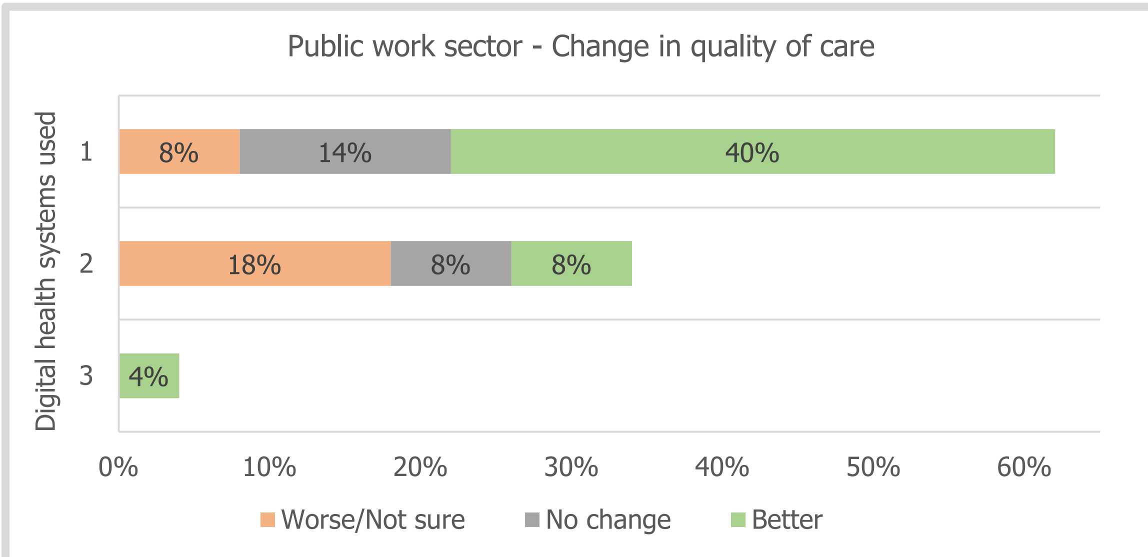
Table 20: Association between number of systems used and changes in quality of care and productivity via Chi-Square test

All respondents using eDoc and/or eExRx and/or eOM (n=104)			
No. of systems x quality of care			
	Value	Significance (2-sided)	Kendall's tau-b
Pearson Chi-square	12.639	.013	
Likelihood Ratio	*15.433*	*.004**	*.084*
No. of systems x productivity			
Pearson Chi-Square	8.898	.064	
Likelihood Ratio	*8.684*	*.069*	--

When comparing to the *a priori* alpha level of .05, a statistically significant finding was identified for the cross-tabulation comparing the number of systems used and quality of care change (χ^2 (4, n = 104) = 15.3, $p = .004$*). The associated Kendall's tau-b of .084 denotes a very weak positive association and signifies that only a very small amount of variation in quality of care change is explainable by the number of digital health systems used.

In addition to the full data set evaluation, mirrored analysis was completed on the two cohorts of PTs working in public practice (n=50) and private practice (n=54). Visual representation of the quality of care change results per number of digital health systems used for both cohorts are shown in Figure 24 while Figure 25 displays the productivity change results for both cohorts. Results are again shown in horizontal stacked bar charts to enable some visual comparison between the two cohorts along with comparison to the full data set analysis. These figures are then followed by Chi-square test results to determine if any of the associations were statistically significant and with what effect size. In general, the public and practice work sector analyses are very similar in findings to the overall analysis in Figure 23.

Figure 24: Work sector analysis of quality of care change based on number of digital health systems used



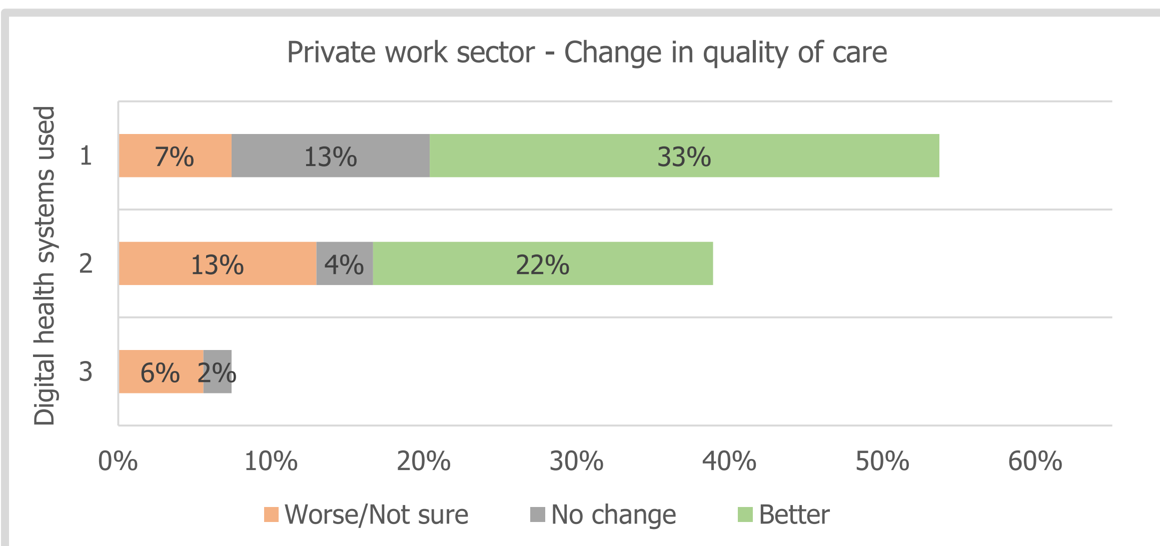
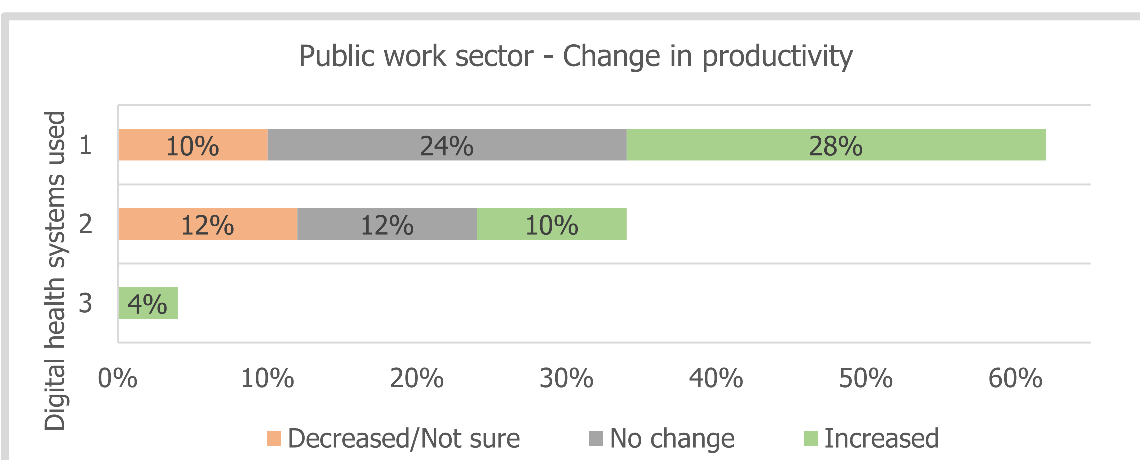
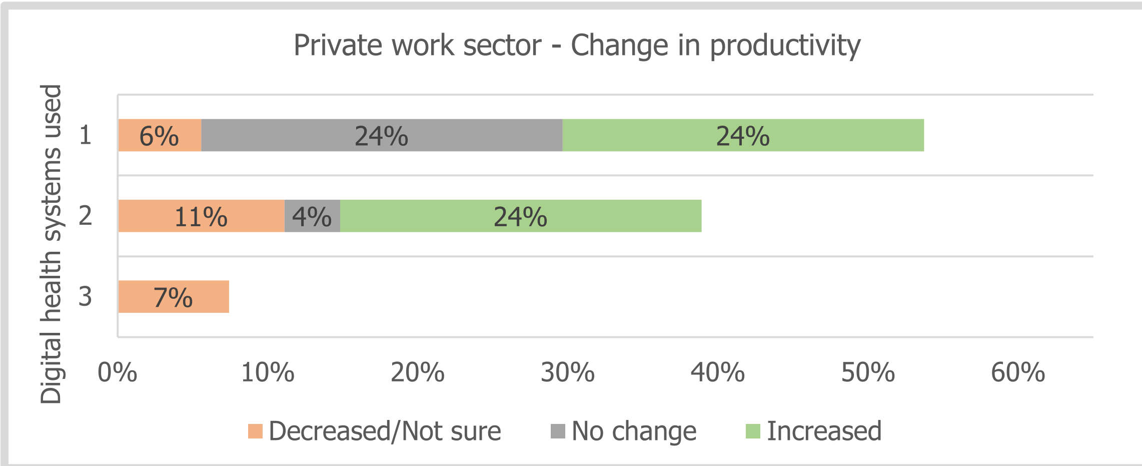


Figure 24 notes a higher proportion of public sector PTs (40% versus 33%) report better quality of care with the use of one system however this decreases with the adoption of two or three systems. The decrease is more pronounced in the public practice work sector with a drop to 8% (versus 22%) with the use of a second system. This drops in half to 4% for the public sector with the addition of the third system while the private sector reports zero improvements in quality of care when moving to the third system. In tandem with the full data set analysis, 14% in the public sector and 13% in the private sector reported no change with the use of one system which decreased to 8% and 4% respectively with the addition of a second system. Continuing with the analysis, 2% of the private practice cohort noted no change in quality of care with the addition of a third system while the public practice group only noted a 4% improvement in quality of care. Mirrored again from the full data set analysis, there is twice the rate of reporting of worsening quality of care (or reports of PTs being unsure if any change occurred) with the addition of a second system (8% to 18% in public sector and 7% to 13% in the private sector). The private practice group reported a worsened (or unsure) quality of care change of 6% with the addition of a third system while the public practice group did not report any decrease.

To complete the comparisons, Figure 25 outlines changes in productivity for both work sectors.

Figure 25: Work sector analysis of productivity change based on number of digital health systems used





The results again follow very similar patterns to the full data set analysis. Both the public sector and private sectors report increased productivity with the use of one system (28% and 24% respectively). With the addition of a second system, the productivity gains are much less pronounced in the public work sector (10%) while the private sector continues to report a 24% productivity gain. The public sector continues to report gains with the addition of a third system at 4% while the private practice group reports no increase. Similar to the full data set analysis, reports of no productivity change in the public sector decrease by more than half with the addition of a second system. This reduction is more pronounced in the private sector cohort where reports of no change decrease significantly from 24% to 4% with the addition of the second system and is not reported at all with the addition of a third system.

The reports of decreased productivity (or unsure) again mirror the full data set analysis with more PTs reporting decreased productivity with the addition of a second system. The private sector reports twice the rate of decreased productivity with the move to using a second system (6% to 11% versus 10% to 12%). The public sector does not report any productivity decrease with the addition of a third system whereas the private practice group reports a 7% decrease, close to twice the rate reported in the full data set analysis.

Chi-square results are displayed in Table 21 for determining the association between changes in quality of care and productivity and the number of digital health systems used by work sector breakdown.

Table 21: Association between number of systems used and changes in quality of care and productivity per work sector via Chi-Square test

Public work sector using eDoc and/or eExRx and/or eOM (n=50)			
No. of systems x quality of care			
	Value	Significance (2-sided)	Kendall's tau-b
Pearson Chi-Square	11.216	.024	
Likelihood Ratio	*12.648*	*.013**	*.167*
No. of systems x productivity			
Pearson Chi-Square	4.395	.355	
Likelihood Ratio	*4.690*	*.321*	--

Private work sector using eDoc and/or eExRx and/or eOM (n=54)			
No. of systems x quality of care			
	Value	Significance (2-sided)	Kendall's tau-b
Pearson Chi-Square	7.266	.122	
Likelihood Ratio	*8.534*	*.074*	--
No. of systems x productivity			
Pearson Chi-Square	12.935	.012	
Likelihood Ratio	*10.658*	*.031**	*-.253*

Two statistically significant results (when comparing to the *a priori* alpha level of .05) were found across the set of four Chi-square tests in the following categories: (1) Public practice cohort cross-tabulation between number of systems used and quality of care change (χ^2 (4, n = 50) = 11.2, $p = 0.013$*), and (2) Private practice cohort cross-tabulation between number of systems used and productivity change (χ^2 (4, n = 54) = 10.7, $p = 0.031$*). The first significant result was associated with a Kendall's tau-b of .167 denoting a weak positive association between the two variables. This signifies that only a small amount of variation in quality of care change is explainable by the number of digital health systems used by PTs in the public practice cohort. The final significant result for the private practice group is accompanied by a Kendall's tau-b of -.253. This would conventionally be considered a moderate association such that a moderate amount of quality of care change was impacted by the number of digital health systems used by private practice PTs.

The remaining two Chi-square results are considered not statistically significant with p-values greater than .05 leading to retention of the null hypothesis of the Chi-square test concluding no association exists between the number of digital health systems used and reported changes in quality of care or productivity in those categories. Effect size calculations are irrelevant and have not been shown for these non-statistically significant findings.

One of the research objectives of this study was to identify factors that may influence digital health adoption in Manitoba PTs. Statistical analysis using binary logistic regression was performed against each of the predictor variables chosen to determine association per use of one of the five digital systems (outcome variable). Results were tabulated for the full respondent data set (n=119) and then mirrored on the work sector cohorts to again analyze whether any differences may be present for PTs working in the public sector (n=55) or private sector (n=64). The following series of tables display the results of the regression testing for the variables that were associated with a statistically significant result (p-value less than .05).

Results related to the use of eBill include positive associations with three predictor variables and negative associations with three separate predictor variables as noted in Table 22. The predictor variables with the highest statistical significance likely reflecting the strongest association were place of employment, patient age and work sector.

Table 22: Significant results of binary logistic regression - eBilling system

Results – eBilling system (Yes/No) / n=119				
			95% C.I.	
Independent variable:	Sig.	Odds Ratio	Lower	Upper
Place = Community	.000*	27.5	7.5	100.4
Area = Musculoskeletal	.004*	5.0	1.7	15.1
Area = Pediatrics	.040*	-77.8	6.8	94.7
Patient age = 0-17yrs	.000*	-94.2	74.8	98.7
Patient age = 18-65yrs	.008*	-72.8	29.1	89.6
Work sector = Private	.000*	57.2	18.5	176.2

Physiotherapists working in community-based places of employment (e.g. community health centres, private practices and post-secondary educational institutions) are 27.5 times more likely to be using eBilling systems compared to therapists working in hospital/facility-based settings (OR = 27.5; 95% CI = 7.5, 100.4; p = .000*). eBill systems are 57 times more likely to be utilized by PTs working in the private work sector compared to those working in the public sector (OR = 57.2; 95% CI = 18.5, 176.2; p = .000*). When considering the age of patients being clinically managed, therapists primarily treating a pediatric aged population (0-17 years of age) are 94.2% less likely to be using eBilling systems compared to a clinical caseload including all age ranges (OR = -94.2; 95% CI = 74.8, 98.7; p = .000*).

The final positively associated predictor variable to eBill is related to practice area. Physiotherapists working in the area of musculoskeletal and integumentary systems, including sports medicine, burn and wound management, amputations, orthopedics, rheumatology, hand therapy and perineal/incontinence management, are five times more likely to be using eBill systems compared to those working in general practice (OR = 5.04; 95% CI = 1.7, 15.1; p = .004*).

Two remaining predictor variables were associated with decreased odds of using eBill systems, the practice area of pediatrics and treating an adult-only patient group. PTs working in the area of pediatrics are 77.8% less likely to be using eBilling systems compared to those working in general practice (OR = -77.8; 95% CI = 6.8, 94.7; p = .040*). In addition, those treating an adult-only population (18-65 years of age) are 72.8% less likely to be using eBilling compared to therapists treating all age groups (OR = 72.8; 95% CI = 29.1, 89.6; p = .008*). Predictive classifications and variance calculations have been provided for each eBilling predictor variable model as a gauge for predictive ability and goodness of fit (Table 23).

Table 23: Predictive measures for binary logistic regression modeling - eBilling

Predictor variable	*Variance explained by predictor variable*	*Predictive ability classification*
Place of employment	37.4% - 49.8%	80.7%
Practice area	28.9% - 38.6%	73.9%
Patient age	25.6% - 34.2%	69.7%
Work sector	48.4% - 65.5%	88.2%

When considering the outcome variable of use of eSched systems, five predictor variables were identified during regression testing; three with positive associations and two with negative associations (Table 24).

Table 24: Significant results of binary logistic regression - eScheduling system

Results – eScheduling system (Yes/No) / n=119				
			95% C.I.	
Independent variable:	Sig.	Odds Ratio	Lower	Upper
Age	.028*	-3.2	.3	6.0
Place = Community	.000*	5.8	2.3	14.2
Area = Musculoskeletal	.004*	5.5	1.7	17.6

Patient age = 65+yrs	.016*	-85.5	30.1	97.0
Work sector = Private	.000*	5.2	2.3	11.8

The predictor variables of place of employment and work sector resulted in highly significant results with p-values of .000. In alignment with eBill systems, physiotherapists working in community-based places of employment are 5.8 times more likely to be using eSched systems compared to those working in hospital/facility-based places of employment (OR = 5.8; 95% CI = 2.3, 14.2; p = .000*) and those working in the private work sector are 5.2 times more likely to be using eSched compared to counterparts working in public practice (OR = 5.2; 95% CI = 2.3, 11.8; p = .000*). Another instance of alignment with eBill system use is the predictor variable of working in the musculoskeletal practice area where PTs have 5.5 increased odds of using eSched compared to therapists working in general practice (OR = 5.5; 95% CI = 1.7, 17.6; p = .004*). Further regression testing identified that PTs working with seniors are 85.5% less likely to be using eSched compared to those working with all age groups (OR = -85.5; 95% CI = 30.1, 97.0; p = .016*) and for each year increase in age of the physiotherapist, there is a 3.2% decrease in the likelihood they will be utilizing eSched (OR = -3.2; 95% CI = .940, .997; p = .028*). As per the eBilling results, predictive classifications and variance calculations have been provided for each eSched predictor variable model as a gauge for predictive ability and goodness of fit (Table 25).

Table 25: Predictive measures for binary logistic regression modeling - eScheduling

Predictor variable	*Variance explained by predictor variable*	*Predictive ability classification*
Age	4.1% - 5.6%	65.5%
Place of employment	17.3% - 23.7%	73.1%
Practice area	21.0% - 28.9%	72.3%

Patient age	7.2% - 9.9%	67.2%
Work sector	13.3% - 18.3%	68.9%

No predictor variable associations were identified through regression testing of all respondents with respect to the utilization of eDoc systems. Regression testing for the remaining eExRx and eOM systems identified only a single predictor variable for each model outlined in Table 26.

Table 26: Significant results of binary logistic regression – eExercise Prescription and eOutcome Measures systems

Results – eExercise Prescription system (Yes/No) / n=119				
			95% C.I.	
Independent variable:	Sig.	Odds Ratio	Lower	Upper
Geographical location = Prairie Mountain Health	.049*	4.7	1.0	22.0

Results – ePatient Reported Outcome Measures (Yes/No) / n=119				
			95% C.I.	
Independent variable:	Sig.	Odds Ratio	Lower	Upper
Gender = Male	.010*	6.4	1.6	26.1

Physiotherapists working in the Prairie Mountain Health region are 4.7 time more likely to be using eExRx compared to counterparts working in the Winnipeg region (OR = 4.7; 95% CI = 1.0, 22.0; p = .049*) and male physiotherapists have almost 6.4 times increased odds of utilizing eOM systems compared to female colleagues (OR = 6.4; 95% CI = 1.6, 26.1; p = .010*). As per the other results, predictive classifications and variance calculations have been provided for each predictor variable model as a gauge for predictive ability and goodness of fit (Table 27).

Table 27: Predictive measures for binary logistic regression modeling - eExercise Prescription and eOutcome Measures

Predictor variable	*Variance explained by predictor variable*	*Predictive ability classification*
Gender	5.3% - 12.7%	92.4%
Geographical location	7.9% - 10.9%	66.4%

As per other analysis in this study, further evaluation of the respondent data was completed to identify if any differences in predictor variable associations may be present within the public practice and private practice work sector cohorts. No unique differences were found within the eBill or eExRx regression testing however significant findings were present in the eSched, eDoc and eOM categories across five variables; age, gender, practice area, patient age and geographical location.

The results of the eSched regression analysis identified one significant positive association in the practice area variable for the public practice cohort and one negative association in the age variable for the private practice cohort (Table 28).

Table 28: Significant results of binary logistic regression by work sector – eScheduling

Results – eScheduling system (Yes/No) Work sector = Public practice / n=55				
			95% C.I.	
Independent variable:	Sig.	Odds Ratio	Lower	Upper
Area = Pediatrics	.022*	6.7	1.3	33.7

Results – eScheduling system (Yes/No) Work sector = Private practice / n=64			
Independent variable:	Sig.	Odds Ratio	95% C.I.

			Lower	Upper
Age	.002*	-9.4	3.7	14.8

Public work sector physiotherapists are over six times more likely to be using eSched if they work in the area of pediatrics compared to general practice (OR = 6.7; 95% CI = 1.3, 33.7; p = .022*). For every one-year increase in age of PTs working in the private sector, the likelihood of using an eSched system in their practice decreases by 9.4% (OR = 6.39; 95% CI = 1.56, 26.13; p = .010*). Predictive classifications and variance calculations have once again been provided for each eScheduling predictor variable model as a gauge for predictive ability and goodness of fit (Table 29).

Table 29: Predictive measures for binary logistic regression modeling by work sector - eScheduling systems

Predictor variable	*Variance explained by predictor variable*	*Predictive ability classification*
Area (Public)	26.4% - 35.2%	72.7%
Age (Private)	19.2% - 31.1%	78.1%

Regression testing identified three additional positive associations between predictor variables; one with respect to eDoc and two in relation to eOM displayed in Table 30. Public practice physiotherapists working with a pediatric population (0-17 years of age) are 15 times more likely to be using eDoc compared to counterparts working with all ages (OR = 15.0; 95% CI = 1.3, 169.9; p = .029*).

Table 30: Significant results of binary logistic regression by work sector – eDocumentation and eOutcome Measures systems

Results – eDocumentation system (Yes/No) Work sector = Public practice / n=55				
			95% C.I.	
Independent variable:	Sig.	Odds Ratio	Lower	Upper
Patient age = 0-17yrs	.029*	15.0	1.3	169.9

Results – eOutcome Measures system (Yes/No) Work sector = Public practice / n=55				
			95% C.I.	
Independent variable:	Sig.	Odds Ratio	Lower	Upper
Geographical location = Interlake Eastern	.035*	39.0	1.3	1179.4

Results – eOutcome Measures system (Yes/No) Work sector = Private practice / n=64				
			95% C.I.	
Independent variable:	Sig.	Odds Ratio	Lower	Upper
Gender = Male	.036*	6.9	1.1	42.1

In addition, those working in the public sector in the Interlake-Eastern region are 39 times more likely to be using eOM compared to PTs working in the Winnipeg region (OR = 39.0; 95% CI = 1.3, 1179.4; p = .035*). In continuation with the outcome variable of use of eOM, males working in the private sector have 6.9 times increased odds of using eOM systems compared to female physiotherapists in the private sector (OR = 6.9; 95% CI = 1.1, 42.1; p = .036*). Predictive classifications and variance calculations have been provided for each predictor variable model as a gauge for predictive ability and goodness of fit (Table 31).

Table 31: Predictive measures for binary logistic regression modeling by work sector – eDocumentation and eOutcome Measures systems

Predictor variable	*Variance explained by predictor variable*	*Predictive ability classification*
Patient age (Public)	21.9% - 35.2%	29.2%
Geographical location (Public)	11.4% - 33.0%	94.5%
Gender (Private)	7.1% - 15.4%	90.6%

As the second objective of this research study was exploratory in nature seeking to identify factors that may influence adoption of digital health systems, further hierarchical logistic regression modeling was not completed and may be pursued in future research.

6 Discussion

This section will focus on synthesis of the study results, reflecting on the hypotheses and objectives that were proposed and identifying some of the limitations of the research methodology. Implications and applications of the research findings will be discussed in the context of both current study results and opportunities for future research.

6.1 Hypothesis Conclusions

The following table (Table 32) describes conclusions to the hypotheses proposed at the beginning of this research study with associated explanations including sources and quantitative data analysis findings. Where applicable, findings were included for the two separately analyzed cohorts of physiotherapists working in the public work sector and private work sector to identify unique differences related to digital health technology use.

Table 32: Hypothesis conclusions

H1	A higher proportion of physiotherapists working in urban versus rural locations will be using digital health systems	
Source	Table 15 - Mean adoption rate for urban physiotherapists is 43% compared to 16% in the rural population	True
H2	A higher proportion of physiotherapists working in the private versus public work sector will be using digital health systems	
Source	Figure 10 - Mean adoption rate for private work sector is 31.8% compared to 17.1% in public practice	True
H3	Physiotherapists over the age of 55 will have lower adoption rates than physiotherapists under 55	
Source	Table 13 – Combined adoption rate over the age of 55% is 31.9% compared to 68.1% in the under the age of 55 population	True
Source	Table 13 – Mean adoption rate over the age of 55% is 29.1% compared to 34.9% in the under the age of 55 population	False
H4	A higher proportion of physiotherapists working in the area of orthopedics and musculoskeletal conditions will be using digital health systems	
Source	Figure 12 – All five digital health systems display highest adoption rates in the MSK category (eBill 28.6%, eSched 29.4%, eDoc 18.5%, eExRx 21.8% and eOM 2.5%)	True
H5	Of those physiotherapists using digital health systems, the majority will be using 2-3 different types of systems	
Source	Figure 11 - 54% of physiotherapists are using 2-3 different systems	True
Source	Figure 11 – 70% of physiotherapists working in the private work sector are using 3-4 different systems while 69% of physiotherapists working in the public work sector are using 1-2 different systems	False
H6	The highest proportion of digital health users will be in the eScheduling category	
Source	Figure 10 – The highest proportion of users was in the eExRx category at 66.4%. This was mirrored in the public work sector data analysis at 31.9%	False
Source	Figure 10 – The highest proportion of users in the private work sector was in the eBill category at 47.1%	False
H7	The lowest proportion of digital health users will be in the eOutcomes Measures category	
Source	Figure 10 – The overall adoption rate for eOM was 7.5% (2.5% in the public work sector and 5.0% in the private work sector)	True
H8	The most common benefit of using digital health systems will be increased efficiency	

Source	Table 18 – The most common benefit reported was increased efficiency (29% in the public work sector and 52.6% in the private work sector)	True
H9	The most common barrier to using digital health systems will be cost	
Source	Table 17 – The most common barrier reported was being unable to find a suitable product (8% in the public work sector and 10.2% in the private work sector)	False
H10	As the time physiotherapists are using digital systems increases, they will report increased productivity and increased quality of care	
Source	Figures 21 and 22 – Productivity and quality of care gains were limited to years 1-6 for eDoc and years 1-3 for eExRx	True

As expected, a higher proportion of physiotherapists working in the urban centre of Winnipeg are using digital systems compared to rural settings (H1). Rural settings often experience more challenges with technology infrastructure including robust Internet connectivity which contributes to this finding. In addition, physiotherapists working in the north of the province may be located in Winnipeg and travel remotely on a scheduled basis or locum basis to provide services which may also contribute to lower rates in rural settings and specifically the Northern Regional Health Authority. Another factor influencing the first hypothesis is related to H2. A larger proportion of physiotherapists work in private practice in the Winnipeg region compared to rural settings and this work sector reported a higher percentage of digital health system use overall. EMR adoption rates in the primary care sector in Manitoba are above 90% supported by a provincial strategy and funding program to support family physicians, nurse practitioners and community-based specialists with the implementation of EMRs. All five regional health authorities have also adopted digital health systems, namely electronic patient records, but often with limitations in user scope with a lack of access to the system for rehabilitation science professionals including physiotherapists. This was evident in the "True" conclusion for the second hypothesis of this study concluding that a higher proportion of private practice physiotherapists are using digital health systems in contrast to those in public practice.

To continue the review of the study hypotheses, H3 was deemed true after analysis of the survey data. Based on the study results, and reflected in the CIHI data, PTs over the age of 55 are more commonly working in public practice work settings which have lower adoption rates than those working in private practice settings. As mentioned previously, many public health-care settings have not fully adopted comprehensive electronic patient record systems and those that have often do not provide physiotherapists and other allied health professionals with broad spectrum access significantly limiting the value in digital health implementation. Embedding digital health competencies into education programming could support physiotherapists in advocating for access to digital health systems in certain practice locations and/or work sectors. Of interest, when analyzing this data from a mean adoption rate perspective, the hypothesis concludes with a false result with physiotherapists over the age of 55 demonstrating a mean adoption rate of 34.9% compared to 29.1% in the under the age of 55 population. This result is influenced by high adoption rates across the five digital health systems in the 60+ age category in fact matching the highest combined adoption rate in the age category of 30-34. This finding may be the product of bias given the comparative analysis against the CIHI population data demonstrated approximately double the response rate in the 60+ age category, likely influencing this result.

The true conclusion to H4 is interconnected to the conclusion to H3 as a higher majority of PTs working in the area of orthopedics and MSK conditions are more commonly working in private practice settings resulting in a higher rate of adoption. The highest rates are in the areas of eBill and eSched demonstrating the value digital health systems can play in supporting business practices that directly and indirectly support patient care activities. The next highest rate for this cohort is in the area of eExRx. Exercise prescription is a fundamental component of rehabilitation practice and digital health systems to support this practice significantly improve efficiency for physiotherapists and patients alike. Some of the most commonly used eExRx systems used in Manitoba have worked diligently to provide interoperability and integrate with some of the most commonly used systems for eBill, eSched and eDoc. This integration is likely one of the reasons why eExRx adoption rates are third highest behind eBill and eSched for those working with an orthopedic caseload and is the most commonly adopted digital health system in the full aggregated results.

The areas of practice of pediatrics and neurology have less than half the adoption rates of those in MSK practice likely due to most of this care being provided via public practice settings. Of interest however, is that pediatrics does have a stronger proportional adoption rate of eSched and eDoc than the remainder of all the practice areas. This is likely supported in part by central intake scheduling and the implementation of an electronic medical record by the Specialized Services for Children & Youth Network (SSCY) via the Children's Therapy Initiative with a goal to provide coordinated and regionally-based services across Manitoba. This group has adopted a system which is part of an extensive shared EMR instance across community-based primary care and public-practice facilities and clinics within the Winnipeg Regional Health Authority, the largest health authority in Manitoba. Physiotherapists within SSCY now have broader access to patient information across the shared WRHA Community EMR instance, providing access to the right information, at the right time, on the right patient to support clinical decision making and coordination of treatment care plans within an interdisciplinary team approach. Much can be learned from this approach with respect to other physiotherapy departments integrating with existing systems in support of a goal towards a single-patient record to maximize continuity of care and comprehensive care opportunities.

Another point of interest in the practice area results identified adoption rates between 2.5% and 5.9% across all five systems within the non-clinical practice area (eBill 2.5%, eSched 4.2%, eDoc 3.4%, eExRx 5.9% and eOM 1.7%) which includes those working in administrative roles, teaching and research. One explanation for this finding could be the use of digital systems for administrative purposes and staff resourcing activities (eBill and eSched), patient / wait-list management activities (eSched and eDoc), initiating and updating staff user access (eSched, eDoc, eExRx and eOM) and monitoring and managing practice or privacy auditing activities (eDoc, eExRx, and eOM). In comparison, the non-clinical practice cohort demonstrated the same adoption rate of eExRx as those working in pediatrics (5.9%) likely due to administrators providing user access to the system or managing a single enterprise level account and likely due to some use of this particular digital health system within the College of Rehabilitation Sciences at the University of Manitoba in the areas of teaching and research. The exceedingly low adoption rates (0-1.7%) in the practice areas of cardiorespiratory, multisystem practice (including amputations, oncology and palliative care) and prevention/wellness (including return to work rehabilitation, ergonomics and health promotion/wellness) are likely explained by the majority of this care being provided in public practice, particularly in hospital-based or facility-based settings which may not be using electronic patient record systems or may not be providing all-inclusive access to allied health professionals.

Prior to adoption of full EMR functionality, many primary care clinicians (including physiotherapists) have been using eBill and eSched systems concurrently to improve clinical workflow and support robust business practices. The results of this study demonstrated this was true as per H5 which was as expected. This result also demonstrated private practice physiotherapists have adopted the additional use of eDoc and eExRx with the majority of this cohort using these 3-4 systems concurrently. Those in the public work sector are more commonly using 1-2 systems concurrently, typically eExRx and eDoc. What was more unexpected was the outcome of H6 which did not support eSched as the most commonly used digital health system in either all the respondents or the two work sector cohorts. Electronic exercise prescription systems were the most commonly used systems in total (66.4%) and interestingly in the public practice cohort (31.9%). Commonly used eExRx systems exist as stand-alone applications that are not embedded functionality within EMR systems. This provides physiotherapists with the freedom to access digital exercise prescription opportunities when they may not have access to other systems in public practice work settings. This was demonstrated in the survey where 10% of all survey respondents and 23.6% of the public practice cohort are only using eExRx systems with the highest reported benefits of increased efficiency (50%), improved patient care management (45%) and increased communication opportunities (48%). The private practice cohort are most commonly using eBill systems at 47.1% followed by eSched at 42.0%. This would be expected as their practice is based on direct billing to the patient or third-party insurance providers at the individual business/clinic level compared to hospital-based billing practices coordinated through the provincial government.

The most commonly reported benefit of using digital health systems was increased efficiency leading to a conclusion of "True" for H8. This aligns with results of the 2014 National Physician Survey where 42% of physician respondents reported increased efficiency with implementation of EMRs. The NPS reported operational efficiencies such as quicker access to information, better billing/scheduling capabilities and improved legibility of records as key activities related to efficiency improvements which would be applicable to physiotherapy practice. These benefits are excellent points to support promotion of digital health system across the profession and raise awareness of their importance and value.

For those that have not adopted digital health systems, the most common barrier to implementation noted by respondents in this study was the inability to find a suitable product with 22% of the public practice sector and 31% of the private practice sector reporting this as the largest barrier. This resulted in a result of "False" for H9. The family physicians and other providers who participated in the government funding program to transition to digital health systems had the option to select from several Manitoba certified EMRs. This embedded a level of confidence in the applications with respect to meeting provincial privacy requirements and offering a core set of features and functions that best support and integrate with primary care clinical workflow. The development of digital health core competencies for physicians provided the guidance required to maximize use of these systems. This is an example of application of Lau's Clinical Adoption Framework where the micro level (certification of systems ensuring core quality information systems), meso level (a national strategy and vision from The Faculties of Medicine of Canada and the Canadian Medical Association) and the macro level (government supported incentive program to adopt digital systems) enables successful digital health adoption. Physiotherapists in Manitoba do not have the equivalent certified digital health system options to choose from. The lack of a provincial and national strategy to adopt applications that meet the needs of physiotherapists in Canada directly impacts adoption choice as reflected in these study results. The challenges related to the Canadian Physiotherapy Association's release of the national eOM application can be well explained by the components of Lau's Clinical

Adoption Framework. Although CPA did attempt to offer a national eOM system (macro level elements), a lack of integration with current clinical workflows (micro level elements), lack of training as well as an absence of digital health competency knowledge translation related to the release of the application (meso level elements), may have contributed to the lack of adoption and implementation of the national eOM system. This can be supported by the results of H7 which demonstrated very low adoption rates for eOM (7.5%). Poor software application design and lack of customizability negatively impact end users and these two variables correlate with lack of adoption in the literature and contribute to the barriers of reduced productivity and complaints of technology being too time consuming (Christodoulakis, Asgarian, and Easterbrook 2017; Lau, Price, and Keshavjee 2013). Lau's Clinical Adoption Framework focuses on the need to integrate micro, meso and macro elements to support successful adoption (Lau 2011).

The second most commonly reported barrier was financial cost which was highest in the categories of eDoc, where one in five physiotherapists in the private sector reported the challenge, and in eExRx where 15% of private sector clinicians reported a cost burden. This aligns with literature from the last ten years related to hospital-based electronic patient record systems where cost displays strong correlation as a major adoption barrier (Christodoulakis, Asgarian, and Easterbrook 2017; Simon et al. 2007). This barrier was much less reported in the public practice sector which would be expected given this cohort would not incur personal impact by the cost of a given system. The public practice cohort reported less barriers overall compared to the private sector who would likely experience more challenges given their more direct involvement in decision-making related to product choice, economic considerations and technology infrastructure. One common barrier reported by both cohorts was the lack of training. A national strategy and core competencies may support physiotherapists in becoming educated on digital health concepts and assist them in becoming more adept at use. Organizations such as the Canadian Physiotherapy Association and the National Physiotherapy Advisory Group are well positioned to support PTs in Canada in this endeavor, in keeping with their mandates to support physiotherapists in achieving excellence, using evidence-based practice, providing high quality patient-centred care and utilizing innovative learning and clinical practice approaches.

For those that have adopted, the most commonly reported challenge were technical glitches which is a common complaint with any technology implementation. Interestingly, the second highest reported challenge was the category "None" with fairly even distribution across the two work sectors. For these therapists who have not identified any challenges, would a national strategy or funding program be the successful catalyst to encourage adoption? Experience from the family medicine perspective in Canada demonstrates the answer to this question could be yes.

The most common challenge reported in the NPS 2014 survey related to digital health system implementation was the concern of utilization being too time consuming. Of interest from the study results is the private practice cohort who noted that the use of eOM was too time consuming, reinforcing the outcome from the CPA system that a lack of integration into clinical workflow (micro level element) and the need to utilize stand-alone systems without a single sign-on opportunity (meso level element) potentially leads to high risk of lack of adoption.

Hypothesis 10 was also proposed based on NPS 2014 results which demonstrated that physicians reported increased productivity and improvements in quality of care as their time using the EMR increased. Although the rates of productivity and quality of care improvements at adoption in the study findings mostly align with NPS findings of improvements reported within the first three years of use, these gains appear to decrease over time. This decrease becomes more noticeable as physiotherapists adopt an increased number of digital health systems concurrently, which conflicts with NPS data that demonstrates these constructs increase with increased functionalities used in digital systems (Leaver 2017). Some of the challenges PTs face related to the use of multiple systems is the lack of interoperability and a lack of alignment with clinical workflows. PTs working in private practice generally reported less decrease in quality of care with the use of additional systems likely because they have more opportunity to work on clinical applications which integrate eDoc and eExRx functionality compared to counterparts working in public practice. They did however report more productivity loss with the move to multiple systems. This could be interpreted as a lack of digital health competency resulting in limitations with maximizing value and return on investment for implementing digital health systems. PTs in public practice often face challenges with limited interoperability from enterprise level IT infrastructure leading to utilization of siloed and stand-alone systems which directly impacts the ability to generate meaningful use of technology and thus support improved quality of patient care. This was reflected in the study results as a moderate proportion of PTs using eDoc and eOM reported no change in quality of care. Those that did report improvement noted these improvements significantly decreased when using the system longer than six years, particularly when more than one to two systems were being used. A lack of core competencies and education regarding optimal use of technology appears to directly impact physiotherapists such that they are not able to garner the benefits technology can provide such as improving quality of care and productivity.

6.2 Integrating the Clinical Adoption Framework

Lau's framework demonstrates a direct correlation between quality of the digital health system and successful adoption. The lack of certified applications or funding programs at the provincial and national level leaves physiotherapists to determine product quality independently and limits the opportunity for successful adoption across the profession. Although PTs can be proud of their digital health adoption progress to date, the overall adoption rate collected from the study survey of 48.9% demonstrates there is much room for improvement across the province.

The micro level, and to a lesser extent the meso and macro levels, of Lau's Clinical Adoption Theory are represented in the survey instrument through questions that relate to benefits and barriers to implementation as well as impact to quality of care and productivity. More specific questions relating to the meso and macro levels will need to be incorporated to secure high construct validity. Constructs within the survey relating to technology support, the workplace technology culture and associated technology policies and procedures could better reflect the meso level of the CAF. The macro level could be represented with questions that relate to data standards, national and/or provincial technology strategies, and practice guidelines related to the use of digital health systems and health technology. The addition of evaluation of this content would better reflect components of the CAF and the underlying alignment to this theoretical framework in the survey instrument itself. This could then be used to evaluate construct validity as well as contribute to evaluation of quality assurance across the professions in terms of alignment with the use of technology standards. Gathering this information from PTs could be extremely beneficial to our national licensing bodies, associations and academic institution organizations to better understand the needs of the profession and tailor a national strategy that aligns with activities and processes that maximize success.

6.3 Alignment with the Diffusion of Innovations Theory

There are several areas in the study results where the Diffusion of Innovations (DoI) theory has been applied. Figure 10 outlines the percentage of digital health systems used concurrently by all respondents of the survey compared with the public practice and private practice cohorts. The full data set can be aligned well with the five categories of the theory if you consider the use of five digital health systems as an innovator (DoI 2.5%; survey 3%), using four systems as an early adopter (DoI 12.5%; survey 19%), use of three systems as an early majority (DoI 34%; survey 28%), use of two systems as late majority (DoI 34%; survey 26%) and use of zero to one system as laggards (DoI 16%; survey 24%). The public and private practice cohorts do not align as closely to the framework. The public sector demonstrates less early adopters and early majority likely as this group has less choice and timing of implementation given the decision would be at the facility level. In contrast, the private sector demonstrates more innovators and early adopters and less late majority and laggards given they would be more directly in control of decision-making and tend to gravitate towards solutions that support robust business practices as well as clinical practice improvements. When considering strategies to improve overall adoption, the private practice early adopters may be an influential group who can engage the public practice early and late majority to encourage adoption and more importantly provide peer support as digital health champions.

Practical use of the DoI theory was additionally applied in Figures 14 through 17 displaying the number of years physiotherapists reported using each unique digital health system in aggregate and by work sector cohort with the inclusion of comparison using a trending line to denote the DoI framework. It is interesting to note that the digital health system with the highest overall adoption rate (eExRx), most closely aligns with the DoI theory for successful adoption and demonstrates the most congruity between the two cohorts with the public practice group skewing slightly higher in the early adopter category. As this group would have less need for adoption of eBill and eSched, and less control over adoption of eDoc, the data shows they may have championed early for eExRx systems to improve efficiency in their day-to-day practice. These systems are easily used as stand-alone systems as they directly interact with clinical workflow but often have the ability to integrate with common eDoc systems used by physiotherapists in private practice further improving efficiency and productivity.

Application of the theory to the public practice cohorts for eBill and eSched displays unsuccessful adoption however when taken into perspective in the work sector context, this cohort would not have the decision-making ability to adopt billing systems or eSched as this would occur at the enterprise/organizational level. Although a similar explanation could be made for the use of eDoc with this cohort, there is more direct link to patient care and working within an interdisciplinary team which therefore is more likely to garner engagement in adoption of these systems and relatively close alignment with the private practice cohort. The private practice group does demonstrate higher adoption rates of eDoc than the public sector but by less than 10%. When applying the DoI framework it is clear to see that both groups have similar numbers of laggards and late majority and are lacking innovators and early adopters who can act as champions. This will be a strong consideration when developing communication and engagement strategies for both cohorts with respect to successful adoption of eDoc systems.

Although the eOM results were not included in the DoI comparison due to a low number of respondents using the system, the data did demonstrate 66.6% of the population mapped to the late majority category (using within the last one to three years). One explanation for this large cohort is the transition from a Bachelor to a Master of Physical Therapy degree program at the University of Manitoba in 2012 which celebrated the first graduating class in 2014. The degree change was accompanied by curricular changes, one of which included a focus on evidence-based practice approaches backed up with proven evaluation and confirmation of robust reliability and validity including outcome measures. As these new graduates entered the workforce, it is possible this group focused more heavily on outcome measures as a strong, reliable, valid tool within the early years of their practice. The program change could also explain the increase in the last six years in the adoption of eExRx and eOM in the private sector and eDoc across both sectors.

6.4 Digital Health Strategies and Policies

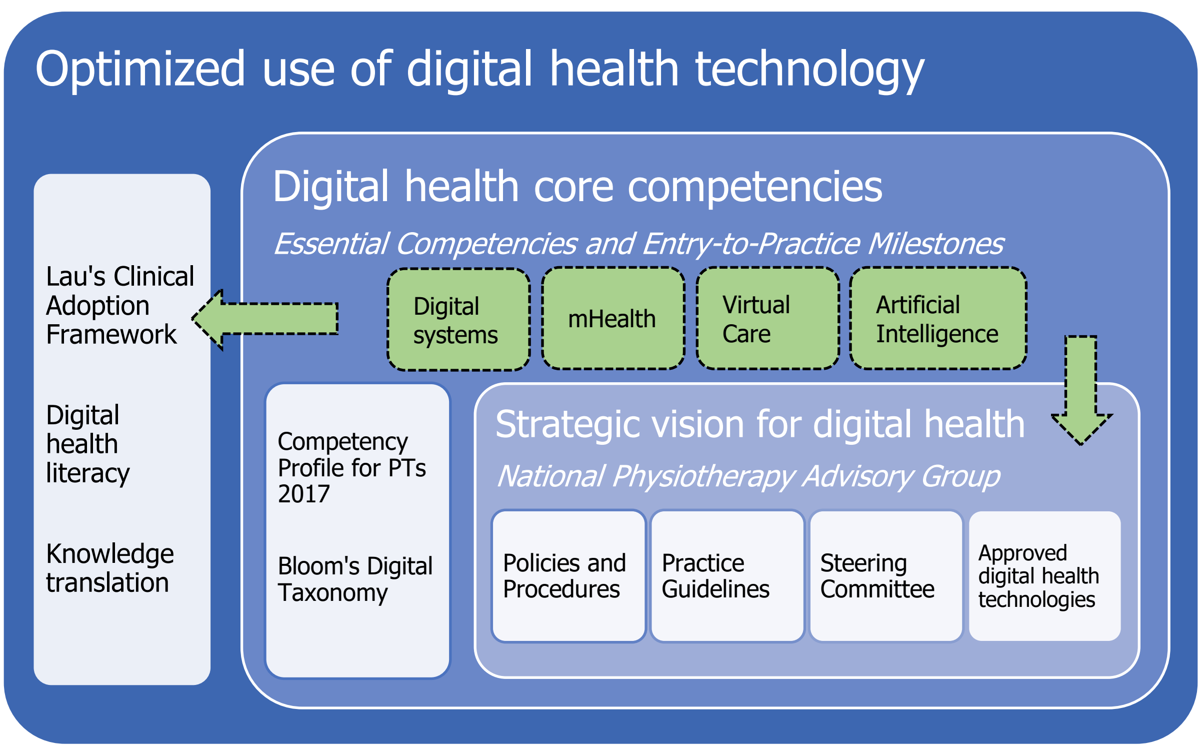
Manitoba has implemented several primary care strategies and policies to support EMR adoption including the EMR Adoption Program, the Home Clinic initiative, and tariffs for chronic disease management linked to patient care data in EMRs and the submission of primary care quality indicator data from both public and fee-for-service family physicians. The *Patient's Medical Home* from The College of Family Physicians of Canada is the model that supports Manitoba's Home Clinic initiative which requires the use of an EMR and the use of associated primary care data from the EMR to support improved patient care, improved access and continuous quality improvement for patients who are enrolled to the Home Clinic and consider the clinic their main primary care provider. Physicians are then able to submit tariffs for enrolled patients to Manitoba Health and receive payment for preventive care, screening and management of certain chronic conditions, all supported by submission of primary care EMR data. The success of the EMR Adoption Program in Manitoba clearly demonstrates how financial support can have significant positive impact on adoption rates. As PTs, and many other rehabilitation science professionals provide primary care services via direct-access, it is unfortunate that Canada Health Infoway's funding did not extend to these health-care professionals, many of which are working directly and indirectly with the family physicians, nurse practitioners and community-based specialists who received funding.

The other benefit that could extend from Infoway involvement would be support for a national and/or provincial strategy for technology adoption for physiotherapists, in collaboration with the National Physiotherapy Advisory Group that represents the national association, provincial associations, universities and academic institution accreditors. The provincial experience in Manitoba with adoption rates close to 90% in family medicine have been directly influenced by a national strategy to improve technology use and provides the driver for colleges, licensing bodies and associations to develop supportive policies and practice guidelines that support technology users in maximizing appropriate use that aligns with the needs of clinicians and scope of practice. The lack of success of the Canadian Physiotherapy Association's eOM launch is reflective of the critical need for a physiotherapy working group or technology committee that can provide provincial representation to consult on the development of a strategic vision, digital health core competencies and faculty development to support physiotherapists in adoption and maximizing the clinical and business value of digital health systems.

6.5 Digital Health Core Competency Framework

The final objective of this research study was the development of a digital health core competency framework (Figure 26). The foundation of this framework is focused on the importance of a strategic vision for digital health technology use by Canadian physiotherapists through collaboration across associations, regulators and academic institutions across the country to build policies, procedures and practice guidelines to support a national digital health vision.

Figure 26: Digital health core competency framework



A Steering Committee should be in place to provide governance and oversight, and work to develop a preferred list of approved digital health technologies to assist physiotherapists with decision-making and support integration of systems that support clinical practice and provide access to health information in support of both in-person and virtual patient care. Once the vision and strategic direction has been defined, development of the digital health core competencies can occur. Alignment with the existing Competency Profile for Physiotherapists 2017 provides an existing framework to model specific Essential Competencies and Entry-to-Practice Milestones for digital health technology. Competency development could be led by the Steering Committee and/or a Working Group coordinated through the National Physiotherapy Advisory Group, similar to the development of the current Competency Profile, and should take into consideration the six hierarchical levels of Bloom's Digital Taxonomic framework. A foundational strategic vision, list of approved technologies, developed digital health core competencies and the implementation of such competencies into academic institutions leveraging Bloom's Taxonomic framework, provides an opportunity for successful adoption and implementation of digital health technology ensuring the micro, meso and macro levels of the Clinical Adoption Framework are incorporated. Adoption will continue to build and refine digital health literacy of physiotherapists providing the opportunity for digital health champions, provincial associations and academic institutions to support knowledge translation activities targeting optimized use and ensuring continuing competence.

Aligning to national strategies, core competencies and practice guidelines for the use of digital health technology could be incorporated into continuing competency programs at both the provincial and national levels providing a strong framework for physiotherapists to reflect on their practice and perform continuous quality improvement activities. Provincial and national associations could leverage the information submitted during the continuing competency process to inform ongoing policy development and provide a consistent and longitudinal quality assurance approach to determine compliance.

Another consideration for this framework is the burgeoning field of Artificial Intelligence (AI) which has enormous potential to improve patient safety by providing personalized clinical decision support and customized health care. As traditional evidence-based medicine becomes enhanced and replaced by intelligence-based medicine, physiotherapists must have a comprehensive understanding and robust literacy in health technology in order to engage with patients in predictive analytics and consider personalized preventive and therapeutic options.

6.6 Study Limitations

This section will describe limitations of this research study both in methodology and those recognized related to the developed survey instrument.

The survey recruitment process was one of convenience and not a random sample which may increase response bias and contribute to errors in the statistical findings of the study. The use of a convenience sample may in fact have encouraged a degree of bias by enabling physiotherapists with more or less interest in technology to respond to the survey based on their preferences. For example, survey data showed nearly twice the rate of physiotherapists who report working in the area of pediatrics compared to CIHI-MB. There are several pediatric groups in public practice who have recently successfully implemented the community electronic medical record within the WRHA which may have led to a large cohort of pediatric therapists with bias to respond to a digital health survey. No students participated in the study which may also have contributed to some amount of bias.

The response rate itself did not meet the *a priori* sample size calculation of 125 for the CIHI data comparison and only met the power calculation sample size for the regression testing in relation to two variables, gender and work sector. This may have reduced the statistical significance findings in the results for this study and reduce the generalizability of some of the results. Future iterations of the survey would benefit from a random sampling process. This being said, some statistical research does note that if significant results are found during analysis this can reflect an appropriate sample size was collected.

Another factor that may have reduced the response rate was the modified Dillman approach. This 3-phase approach has specific timelines associated with the methodology which were not adhered to exactly as written with a seven to ten-day delay between phases. The distribution of the survey emails was reliant on the College of Physiotherapists of Manitoba and the Manitoba Physiotherapy Association resources which contributed to the delay. For future iterations of the survey, it may be beneficial for the survey coordinator to have access to email distribution lists to better align to the methodology which has evidence to support successful recruitment and robust response rates. Incentives may also play a role in increasing response rates in future iterations of the survey.

Test-retest reliability is generally one of the most common forms of reliability used in survey research. Inter-observer reliability testing was not practical in this study, particularly as the survey instrument was newly developed and in pilot-phase. There was the potential opportunity to evaluate intra-observer reliability by contacting the cohort of respondents who agreed to be contacted for longitudinal purposes via email. A random sample could have been contacted by email three months post closure of the survey and be requested to repeat the survey. Initial and follow-up responses could then have been compared using correlation coefficients to determine a reliability score. For the reliability testing that was completed, the survey instrument did not meet the study threshold and therefore is not considered a reliable tool in its current state.

Although validity testing did exceed the .70 *a priori* threshold, the chosen methodology allowed for a gap in validity testing. Construct validity is considered the gold standard for validity testing of survey instruments and had limited evaluation in this study. The future approach for this construct was discussed previously in Section 6.2 with respect to the Clinical Adoption Framework. As the survey was newly developed it was also challenging to determine validity by comparing to established scores from past use of the instrument.

There were several challenges and limitations associated with the comparison to the CIHI Physiotherapists database. Due to delays in publishing content, the most recent data available for comparison was from 2016, while study survey data was collected in 2018. This could impact sample versus population comparisons. As part of the design, the survey instrument included a sub-set of data elements from the CIHI database and the National Physician Survey for comparison. It is recognized that limitations exist when utilizing sub-sets of data and making assumptions about pre-existing reliability and validity of the data used. Comparisons to the CIHI data was made on aggregated data publicly available on their website and not on raw data sets. It is possible that more granular access to the raw CIHI data may have enabled more robust statistical analysis. It is also possible that making comparisons to the NPS results was not reflective of physiotherapy processes and led to skewed findings.

With respect to the digital health system use data, the low adoption rates for eOM may have influenced statistical findings in this area particularly if a higher rate of adoption had been included in the statistical analysis. It is challenging to understand the true state of this outcome variable and its associated predictor variables. Small frequencies in some variable categories also contributed to challenges with Chi-square testing leading to violation of some of the statistical test assumptions which could therefore challenge the interpretation and generalization of the results.

Binary logistic regression was the chosen statistical approach to identify variables that may influence digital health system adoption. BLR can evaluate associations between variables but does not measure effect size, explain why an association may be present or evaluate cause and effect. Variation measurements (R squared) were generally on the lower end of the spectrum leading to consideration of a lack of correlation. In contrast, predictive ability classifications were generally over 65% showing some good predictive ability. Future iterations of the survey would benefit from a more advanced statistical approach that could better identify influencers related to digital health adoption as many predictor variables did not result in statistically significant findings leading one to believe other variables may be present that were not accounted for in the study.

Bloom's Taxonomy had limited applicability to this phase of the research and is generally more applicable for future extensions of this work related to the development of the core competencies themselves. As it is a component of the proposed digital health core competency framework, it was included for context. Other components of the proposed framework including mHealth, Virtual Care and Artificial Intelligence, had only contextual inclusion in this research, but have the potential to play a large role in necessary competency discussions and have enormous potential to impact physiotherapy practice. These areas require more in-depth research and consideration given the breadth of literature becoming available.

The final limitation discussed involves the study approach itself. A quantitative methodology was chosen based on the exploratory nature of the topic. This research would greatly benefit from a qualitative component to discover trends in thoughts and opinions and gather information on attitudes and behaviours directly from physiotherapists in Manitoba. Methods such as focus groups, interviews and participant observation would assist with gaining more insight on technology use, potential predictor variables or relationships between variables studied or un-studied and contribute immensely to the future development of digital health literacy and core competencies.

6.7 Conclusion

As the influx of technology in health care continues to grow, clinicians are under more pressure to retain a high level of digital information literacy. The ability to seek, find, comprehend and critically appraise health information gathered via digital health systems and tools is generally not included in health education or continuing professional development programs. Understanding how digital tools interact with workflows or impact clinical practice while technology is being learned and implemented is an important factor in acceptance and success (Gagnon et al. 2012). Competency in health informatics is an emerging topic in the health professional education literature with many studies recommending the inclusion of digital health core competencies into academic institutions (Shachak, Borycki, and Reis 2017). For rehabilitation science professionals to be successful in the use of digital health, strong consideration should be given to the development and implementation of digital health competencies to support clinical practice in the technology-enabled environments of today. Digital health systems have enormous potential to support rehabilitation professionals with the goal of improving quality of life for patients and supporting health-care professionals in achieving and maintaining personal health and wellness.

Notwithstanding some of the limitations of this study, and the known challenges and barriers identified as part of the survey, physiotherapists in Manitoba should take pride in the progress shown to date evident in an overall digital health system adoption rate approaching 50% (48.9%). Many in our profession are harnessing their power and directly and indirectly experiencing the value that digital health system utilization can provide. Given a legacy of evidence-based practice and the burgeoning field of technology opportunities, physiotherapists are well positioned to make the transition to digital health systems. Organizations such as the National Physiotherapy Advisory Group are uniquely positioned to play a leadership role providing guidance, governance and advocacy via an integrated approach across provincial and national associations, regulatory bodies and academic institutions.

The objectives of this study were threefold: (1) To generate a baseline digital health literacy profile of registered physiotherapists in Manitoba via an online survey; (2) To identify factors that may influence digital health adoption, implementation, and optimization in Manitoba physiotherapists; and (3) To develop a digital health core competency framework, aligned with the existing national physiotherapy role-based framework, focused on better enabling physiotherapists to utilize digital health tools, systems and applications in clinical practice. These objectives were met however more work needs to be done to better understand influencers, barriers, challenges and benefits and support physiotherapists in improving digital health literacy.

This investigative research study lays a foundation and builds the clinical, business and academic case for the importance of digital health literacy within the physiotherapy profession facilitated by digital health core competencies. Next phases of the research may include a qualitative research approach to further evaluate themes identified within the survey results. Once themes and the competency framework are well established, research plans include development of digital health Essential Competencies and Entry-to-Practice Milestones across the seven Domains of Physiotherapy included in the Competency Profile for Physiotherapists in Canada (National Physiotherapy Advisory Group 2017). Following this will be development of a knowledge translation strategy to implement the developed core competencies into the Master of Physical Therapy program at the University of Manitoba and possibly in other physiotherapy programs across the country. The long-term goal of this work is to better enable physiotherapists in Manitoba to adopt, implement and optimize use of digital health tools, systems and applications in clinical practice to enhance patient care and support advocacy for physiotherapy services in the province.

Beyond the obvious patient care improvements, digital health utilization facilitates the opportunity to clinically use, collect and analyze health data which has enormous potential to inform improvements and growth within the profession of physiotherapy itself while generating data that could inform policy development, support innovative research and guide education programming to support physiotherapists in continuing to provide quality patient-centred care. The key to success will not be teaching physiotherapists how digital health systems work, but to teach them how to configure and utilize the systems to facilitate the important work they do. There are already physiotherapists using digital systems in innovative ways including mobile applications that manage exercise prescription, video gaming programs for balance and fitness for neurological conditions, virtual reality devices for pain control during complex wound management, simulated clinical procedures to promote learning and artificial intelligence embedded in applications and devices that adapt and learn as patients make improvements in their rehabilitation or as disease progresses. These early adopters and digital health champions can play a critical role in engaging others and sharing their lived experience including successes and challenges they faced. This group of champions are currently laying a digital health foundation for the physiotherapy profession to follow. A national strategy and digital health competencies can support physiotherapists on a journey to reach a destination of successful digital health system utilization and comprehensive digital health literacy to support the growth and expansion of the profession and promote the health and wellness of Canadians.

References

Adams, Nancy. 2015. "Bloom's Taxonomy of Cognitive Learning Objectives." *Journal of the Medical Library Association* 103 (3): 152–53. https://doi.org/10.3163/1536-5050.103.3.010.

Alkureishi, Maria, Wei Lee, Maureen Lyons, Valerie Press, Sara Imam, Akua Nkansah-Amankra, Deb Werner, and Vineet Arora. 2016. "Impact of Electronic Medical Record Use on the Patient–Doctor Relationship and Communication: A Systematic Review." *Journal of General Internal Medicine* 31 (5): 548–60. https://doi.org/10.1007/s11606-015-3582-1.

American Library Association. 2000. "Information Literacy Competency Standards for Higher Education." 2000. http://www.ala.org/Template.cfm?Section=Home&template=/ContentManagement/ContentDisplay.cfm&ContentID=33553.

Antonacopoulou, Elena P. 2001. "The Paradoxical Nature of the Relationship between Training and Learning." *Journal of Management Studies* 38 (3): 327–50. https://doi.org/10.1111/1467-6486.00239.

Ayanlade, O S, T O Oyebisi, and B A Kolawole. 2019. "Health Information Technology Acceptance Framework for Diabetes Management." *Heliyon* 5 (5): e01735. https://doi.org/10.1016/j.heliyon.2019.e01735.

Baruch, Yehuda, and Brooks C. Holtom. 2008. "Survey Response Rate Levels and Trends in Organizational Research." *Human Relations* 61 (8): 1139–60. https://doi.org/10.1177/0018726708094863.

Bloom, BS. 1956. *Taxonomy of Educational Objectives : The Classification of Educational Goals.*

Handbook 1: Cognitive Domain. New York: New York : David McKay.

Botsch, Bob. 2014. "Significance and Measures of Association." APLS 301 Scopes and Methods of Political Science. 2014. http://polisci.usca.edu/apls301/Text/.

Canada Health Infoway. 2013. "Clinicians-in-Training 'Get the Facts.'" *Clinicians-in-Training*. https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/clinical-adoption/1260-clinicians-in-training-get-the-facts.

———. 2014. "Advanced Use of Digital Health Functionalities in Canadian Primary Care Settings." Toronto. 2014. https://infoway-inforoute.ca/en/component/edocman/2609-advanced-use-of-digital-health-functionalities-in-canadian-primary-care-settings-results-from-the-2014-national-physician-survey/view-document?Itemid=0.

Canadian Association of Schools of Nursing. 2013. "Nursing Informatics Teaching Toolkit: Supporting the Integration of the CASN Nursing Informatics Competencies into Nursing Curricula." https://casn.ca/wp-content/uploads/2014/12/infowaytoolkit.jpg.

Canadian Institute for Health Information. 2012. "Physiotherapist Database Manual, Version 2.0." https://www.cihi.ca/sites/default/files/document/physio_db_man_en.pdf.

Canadian Medical Association. 2017. "CMA Workforce Survey 2017." *Canadian Medical Assocation*. https://www.cma.ca/En/Pages/physician-workforce-surveys.aspx.

Canadian Physiotherapy Association. 2012. "Description of Physiotherapy in Canada 2012." www.physiotherapy.ca.

Chaudhry, Basit, Jerome Wang, Shinyi Wu, Margaret Maglione, Walter Mojica, Elizabeth Roth, Sally C Morton, and Paul G Shekelle. 2006. "Systematic Review: Impact of Health

Information Technology on Quality, Efficiency, and Costs of Medical Care." *Annals of Internal Medicine* 144 (10): 742–52. https://doi.org/10.7326/0003-4819-144-10-200605160-00125.

Christodoulakis, Christina, Azin Asgarian, and Steve Easterbrook. 2017. "Barriers to Adoption of Information Technology in Healthcare." In *Proceedings of ACM CASCON Conference*. Vol. November. Toronto, Canada: CASCON'17. https://doi.org/10.475/123_4.

Churches, Andrew. 2008. "Bloom's Digital Taxonomy." Australian School Library Association NSW Incorporated. http://burtonslifelearning.pbworks.com/f/BloomDigitalTaxonomy2001.pdf.

Crampton, Noah H., Shmuel Reis, and Aviv Shachak. 2016. "Computers in the Clinical Encounter: A Scoping Review and Thematic Analysis." *Journal of the American Medical Informatics Association* 23 (3): 654–65. https://doi.org/10.1093/jamia/ocv178.

Creswell, J. 2018. *Research Design : Qualitative, Quantitative, and Mixed Methods Approaches / John W. Creswell, Department of Family Medicine, University of Michigan, J. David Creswell, Department of Psychology, Carnegie Mellon University.* Edited by J David Creswell. Fifth edit. Thousand Oaks, California : SAGE Publications, Inc.

Dattalo, Patrick. 2008. *Determining Sample Size: Balancing Power, Precision, and Practicality*. New York, New York: Oxford University Press. Google e-Books.

———. 2018. "Determining Sample Size Using Fast and Slow Thinking." *Journal of Social Service Research* 44 (2): 180–90. https://doi.org/10.1080/01488376.2018.1436632.

Densen, Peter. 2011. "Challenges and Opportunities Facing Medical Education." *Transactions of the American Clinical and Climatological Association* 122: 48–58.

https://doi.org/10.4172/2155-9619.S6-009.

Egbert, Nicole, Johannes Thye, Werner O Hackl, Maria Müller-Staub, Elske Ammenwerth, and Ursula Hübner. 2018. "Competencies for Nursing in a Digital World. Methodology, Results, and Use of the DACH-Recommendations for Nursing Informatics Core Competency Areas in Austria, Germany, and Switzerland." *Informatics for Health and Social Care*, 1–25. https://doi.org/10.1080/17538157.2018.1497635.

Faul, Franz, Edgar Erdfelder, Albert-Georg Lang, and Axel Buchner. 2007. "G*Power 3: A Flexible Statistical Power Analysis Program for the Social, Behavioral, and Biomedical Sciences." *Behavior Research Methods* 39 (2): 175–91. https://doi.org/10.3758/BF03193146.

Fincham, Jack E. 2008. "Response Rates and Responsiveness for Surveys, Standards, and the Journal." *American Journal of Pharmaceutical Education* 15 (72): 43. https://doi.org/10.5688/aj720243.

Francis Lau, Morgan Price and Karim Keshavjee. 2011. "From Benefits Evaluation to Clinical Adoption: Making Sense of Health Information System Success in Canada." *Healthcare Quarterly* 14 (1): 39–45. https://www.longwoods.com/product/22157.

Frank JR, Snell L, and Sherbino J. 2015. "CanMEDs 2015 Physician Competency Framework." *Royal College of Physician and Surgeons of Canada*. Ottawa, Ontario. file:///C:/Users/kdyck10/Downloads/canmeds-full-framework-e.pdf.

Gagnon, Marie-Pierre, Marie Desmartis, Michel Labrecque, Josip Car, Claudia Pagliari, Pierre Pluye, Pierre Frémont, Johanne Gagnon, Nadine Tremblay, and France Légaré. 2012. "Systematic Review of Factors Influencing the Adoption of Information and Communication

Technologies by Healthcare Professionals." *Journal of Medical Systems* 36 (1): 241–77. https://doi.org/10.1007/s10916-010-9473-4.

Gagnon, Marie-Pierre, El Kebir Ghandour, Pascaline Kengne Talla, David Simonyan, Gaston Godin, Michel Labrecque, Mathieu Ouimet, and Michel Rousseau. 2014. "Electronic Health Record Acceptance by Physicians: Testing an Integrated Theoretical Model." *Journal of Biomedical Informatics* 48 (April): 17–27. https://doi.org/10.1016/J.JBI.2013.10.010.

Greatbatch, David, Elizabeth Murphy, and Robert Dingwall. 2001. "Evaluating Medical Information Systems: Ethnomethodological and Interactionist Approaches." *Health Services Management Research* 14 (3): 181–91. https://doi.org/10.1177/095148480101400305.

Grimmer, Karen, and Andrea Bialocerkowski. 2005. "Surveys." *Australian Journal of Physiotherapy* 51 (3): 185–87. https://doi.org/10.1016/S0004-9514(05)70026-X.

Haux, Reinhold. 2010. "Medical Informatics: Past, Present, Future." *International Journal of Medical Informatics* 79 (9): 599–610. https://doi.org/https://doi.org/10.1016/j.ijmedinf.2010.06.003.

Institute of Medicine (US) Committee on Quality of Health Care in America. 2001. "Crossing the Quality Chasm: A New Health System for the 21st Century." http://www.nationalacademies.org/hmd/~/media/Files/Report Files/2001/Crossing-the-Quality-Chasm/Quality Chasm 2001 report brief.pdf.

Kaplowitz, Michael D., Timothy D. Hadlock, and Ralph Levine. 2004. "A Comparison of Web and Mail Survey Response Rates." *Public Opinion Quarterly* 68 (1): 94–101. https://doi.org/10.1093/poq/nfh006.

Krathwohl, David R. 2002. "A Revision of Bloom's Taxonomy: An Overview." *Theory Into*

Practice 41 (4): 212–18. https://doi.org/10.1207/s15430421tip4104_2.

Kruse, Clemens, Caitlin Kristof, Beau Jones, Erica Mitchell, and Angelica Martinez. 2016. "Barriers to Electronic Health Record Adoption: A Systematic Literature Review." *Journal of Medical Systems* 40 (12): 1–7. https://doi.org/10.1007/s10916-016-0628-9.

Kruse, Clemens Scott, and Amanda Beane. 2018. "Health Information Technology Continues to Show Positive Effect on Medical Outcomes: Systematic Review." *Journal of Medical Internet Research* 20 (2): e41. https://doi.org/10.2196/jmir.8793.

Laerd Research. 2018. "Kendall's Tau-b Using SPSS Statistics - A How-To Statistical Guide by Laerd Statistics." Laerd Statistics. 2018. https://statistics.laerd.com/spss-tutorials/kendalls-tau-b-using-spss-statistics.php.

Lau, Francis, Simon Hagens, and Sarah Muttitt. 2007. "A Proposed Benefits Evaluation Framework for Health Information Systems in Canada." Edited by Francis Lau. *Healthcare Quarterly (Toronto, Ont.)* 10 (1): 112–18.

Lau, Francis, Morgan Price, and Karim Keshavjee. 2013. "From Benefits Evaluation to Clinical Adoption: Making Sense of Health Information System Success in Canada." *Healthcare Quarterly*. https://doi.org/10.12927/hcq.2011.22157.

Lavrakas, Paul J, ed. 2008. *Encyclopedia of Survey Research Methods*. *Encyclopedia of Survey Research Methods*. Los Angeles, California: SAGE Publications, Inc.

Leaver, Chad. 2017. "Use of Electronic Medical Records among Canadian Physicians - 2017." 2017. https://infoway-inforoute.ca/en/component/edocman/3362-2017-cma-workforce-survey-digital-health-results/view-document?Itemid=0.

Litwin, Mark S. 1995a. "Reliability." In *How to Measure Survey Reliability and Validity*. Thousand Oaks, California: SAGE Publications, Inc.

———. 1995b. "Validity." In *How to Measure Survey Reliability and Validity*. Thousand Oaks, California: SAGE Publications, Inc.

Moore, Christopher. 2010. "Teaching Digital Natives: Partnering for Real Learning." *International Journal for Educational Integrity* 6 (2): 74–76. https://doi.org/10.1099/mic.0.28030-0.

Nagle, Lynn. 2019. "Study of Digital Health in Canadian Schools of Nursing: Curricular Content and Nurse Educator Capacity." *Canadian Association of Schools of Nursing*. https://www.casn.ca/wp-content/uploads/2019/06/SoN-Final-Report-EN.pdf.

National Physiotherapy Advisory Group. 2017. "Competency Profile for Physiotherapists in Canada (2017)." https://www.alliancept.org/wp-content/uploads/2018/02/Competency-Profile-Final2018_EN.pdf.

Nisiforou, Efi, and Nikleia Eteokleous. 2013. "Defining Evaluation Criteria in Blogging and Non Blogging: A Case Study from a Pedagogical Perspective." In *7th International Technology, Education and Development Conference (INTED)*. Valencia, Spain.

O'Connor, Siobhan, and Tom Andrews. 2015. "Mobile Technology and Its Use in Clinical Nursing Education: A Literature Review." *Journal of Nursing Education* 54 (3): 137–44. https://doi.org/10.3928/01484834-20150218-01.

Okada, Kensuke. 2015. "Bayesian Meta-analysis of Cronbach's Coefficient Alpha to Evaluate Informative Hypotheses." *Research Synthesis Methods* 6 (4): 333–46. https://doi.org/10.1002/jrsm.1155.

Peterson, Robert A. 1994. "A Meta-Analysis of Cronbach's Coefficient Alpha. (Measure of Scale Reliability)." *Journal of Consumer Research* 21 (2): 381. https://doi.org/10.1086/209405.

Police RL; Foster T; Wong. 2010. "Adoption and Use of Health Information Technology in Physician Practice Organisations: Systematic Review." *Informatics In Primary Care* 18 (4): 245–58.

Prahalad, C.K., and G. Hamel. 2007. "The Core Competence of the Corporation." *Harvard Business Review*, 2007. https://web.archive.org/web/20140714112311/http://km.camt.cmu.ac.th/mskm/952743/Extra materials/corecompetence.pdf.

Prensky, Marc. 2001a. "Digital Natives, Digital Immigrants Part 1." *On the Horizon* 9 (5): 1–6. https://doi.org/10.1108/10748120110424816.

———. 2001b. "Digital Natives, Digital Immigrants Part 2: Do They Really Think Differently?" *On the Horizon* 9 (6): 1–6. https://doi.org/10.1108/10748120110424843.

Rogers, Everett M. 2003. *Diffusion of Innovations* . 5th ed. New York: Free Press.

Scott, Karen M., Louise Baur, and Jenny Barrett. 2017. "Evidence-Based Principles for Using Technology-Enhanced Learning in the Continuing Professional Development of Health Professionals." *Journal of Continuing Education in the Health Professions* 37 (1): 61–66. https://doi.org/10.1097/CEH.0000000000000146.

Shachak, Aviv, Elizabeth Borycki, and Shmuel P Reis. 2017. *Health Professionals' Education in the Age of Clinical Information Systems, Mobile Computing and Social Networks / Edited by Aviv Shachak, Elizabeth M. Borycki, Shmuel P. Reis.* London : Academic Press.

Simon, Steven R., Rainu Kaushal, Paul D. Cleary, Chelsea A. Jenter, Lynn A. Volk, Eric G. Poon, E. John Orav, Helen G. Lo, Deborah H. Williams, and David W. Bates. 2007. "Correlates of Electronic Health Record Adoption in Office Practices: A Statewide Survey." *Journal of the American Medical Informatics Association* 14 (1): 110–17. https://doi.org/10.1197/jamia.M2187.

Singer, Alexander, Andrea L Kroeker, Sari Yakubovich, Roberto Duarte, Brenden Dufault, and Alan Katz. 2017. "Data Quality in Electronic Medical Records in Manitoba: Do Problem Lists Reflect Chronic Disease as Defined by Prescriptions?" *Canadian Family Physician Medecin de Famille Canadien* 63 (5): 382.

Singer, Alexander, Sari Yakubovich, Andrea L Kroeker, Brenden Dufault, Roberto Duarte, and Alan Katz. 2016. "Data Quality of Electronic Medical Records in Manitoba: Do Problem Lists Accurately Reflect Chronic Disease Billing Diagnoses?" *Journal of the American Medical Informatics Association* 23 (6): 1107–12. https://doi.org/10.1093/jamia/ocw013.

Strauss, Stephen. 2010. "Canadian Medical Schools Slow to Integrate Health Informatics into Curriculum." *Canadian Medical Association Journal = Journal de l'Association Medicale Canadienne* 182 (12): e551. https://doi.org/10.1503/cmaj.109-3302.

Strudwick, Gillian, Lynn Nagle, Iman Kassam, Meera Pahwa, and Lydia Sequeira. 2019. "Informatics Competencies for Nurse Leaders: A Scoping Review." *Journal of Nursing Administration* 49 (6). https://doi.org/10.1097/NNA.0000000000000760.

Sullivan, Gail M., and Anthony R. Artino. 2013. "Analyzing and Interpreting Data From Likert-Type Scales." *Journal of Graduate Medical Education* 54 (4): 541–42. https://doi.org/10.4300/JGME-5-4-18.

Terry, Amanda L., Gavin Giles, Judith Belle Brown, Amardeep Thind, and Moira Stewart. 2009. "Adoption of Electronic Medical Records in Family Practice: The Providers' Perspective." *Family Medicine* 41 (7): 508–12.

The Association of Faculties of Medicine of Canada. 2012. "Environmental Scan of E-Health in Canadian Undergraduate Medical Curriculum." https://ehealthresources.ca/en/articles/19.

———. 2014. "EHealth Competencies for Undergraduate Medical Education." http://bit.ly/1xh5NRn.

———. 2018. "EHealth Workshop Toolkit Collection - YouTube." YouTube. https://www.youtube.com/playlist?list=PLj7rb7PzF6gYZTm04G3iirHUCcJTk7jT9.

The Association of Faculties of Pharmacy of Canada. 2013. "Pharmacy Informatics: Entry-to-Practice Competencies for Pharmacists." Pharmacy Informatics: Entry-to-Practice Competencies for Pharmacists. 2013. http://www.afpc.info/system/files/public/AFPC ICT Informatics Brochure In house1%5B1%5D.pdf.

Thorpe, C., B. Ryan, S. L. McLean, A. Burt, M. Stewart, J. B. Brown, G. J. Reid, and S. Harris. 2009. "How to Obtain Excellent Response Rates When Surveying Physicians." *Family Practice* 26 (1): 65–68. https://doi.org/10.1093/fampra/cmn097.

VanGeest, Jonathan, and Timothy P. Johnson. 2011. "Surveying Nurses: Identifying Strategies to Improve Participation." *Evaluation and the Health Professions* 34 (4): 487–511. https://doi.org/10.1177/0163278711399572.

Watling, Christopher J., and Lorelei Lingard. 2012. "Grounded Theory in Medical Education Research: AMEE Guide No. 70." *Medical Teacher* 34 (10): 850–61. https://doi.org/10.3109/0142159X.2012.704439.

Wittie, Michael, Quyen Ngo-Metzger, Lydie Lebrun-Harris, Leiyu Shi, and Suma Nair. 2016. "Enabling Quality: Electronic Health Record Adoption and Meaningful Use Readiness in Federally Funded Health Centers." *Journal for Healthcare Quality : Official Publication of the National Association for Healthcare Quality* 38 (1): 42. https://doi.org/10.1111/jhq.12067.

Zhou, Yi Yvonne, Michael H. Kanter, Jian J. Wang, and Terhilda Garrido. 2010. "Improved Quality at Kaiser Permanente through E-Mail between Physicians and Patients." *Health Affairs* 29 (7): 1370–75. https://doi.org/10.1377/hlthaff.2010.0048.

Appendix A – Digital Health Survey for Manitoba Physiotherapists

<table>
<tr><th>Part 1</th><th colspan="2">The following questions will capture demographic and practice-related information.</th></tr>
<tr><td>1.0</td><td colspan="2">Your year of birth is: [select year from pick list]</td></tr>
<tr><td>2.0</td><td colspan="2">Your gender is:
• Female
• Male</td></tr>
<tr><td>3.0</td><td colspan="2">The College of Physiotherapists of Manitoba (CPM) registration status that most represents you currently is:
• Active
• Exam Candidate
• Student</td></tr>
<tr><td rowspan="3">4.0</td><td colspan="2">Have you ever been licensed to practice physiotherapy outside of Manitoba?
• Yes
• No</td></tr>
<tr><td>If Yes</td><td>If No</td></tr>
<tr><td>4.1 Please list location(s): [free text]</td><td>Skip to 5.0</td></tr>
<tr><td>5.0</td><td colspan="2">Please identify your current level of physiotherapy or health-related education by selecting the date of graduation for each applicable item below: [select year from pick list]
• Diploma
• Baccalaureate/Bachelor's
• Master's
• Doctorate</td></tr>
<tr><td>6.0</td><td colspan="2">In what university or college did you obtain your education for each applicable item below:
• Diploma - [free text]
• Baccalaureate/Bachelor's - [free text]
• Master's - [free text]
• Doctorate - [free text]</td></tr>
<tr><td>7.0</td><td colspan="2">Your current employment status is (includes employees and those who are self-employed):
• Employed in physiotherapy
• Employed in physiotherapy but on leave
• Employed in other than physiotherapy and seeking physiotherapy</td></tr>
</table>

	employment • Employed in other than physiotherapy and not seeking employment in physiotherapy • Unemployed and seeking employment in physiotherapy • Unemployed and not seeking employment in physiotherapy
8.0	Your primary employment category is: • Permanent employee • Temporary employee • Casual employee • Self-employed • Other (specify) – [free text]
9.0	Your full-time/part-time status in your primary physiotherapy role is: • Full time (equal to or greater than 30hrs per week) • Part-time (less than 30hrs per week) • Casual (equal to or less than 15hrs per week)
10.0	Your primary place of employment or self-employment is: • General hospital • Rehabilitation Hospital/Facility • Mental Health Hospital/Facility • Residential Care Facility • Community Health Centre/Program • Private Practice (Solo) • Private Practice (2 or more therapists) • Post-secondary Educational Institution • School or School Board • Government or Para-government • Industry/Commercial • Other (specify) – [free text]
11.0	Your primary clinical/non-clinical focus of practice is: • Musculoskeletal system • Neurological system • Cardiovascular and Respiratory System • Skin and Related Structures • Clinical focus on more than one system • Non-clinical focus
12.0	Your primary area of practice (direct or non-direct service) is: • General practice • Sports Medicine

	• Burns and Wound Management • Plastics • Amputations • Orthopedics • Rheumatology • Hand Therapy and Custom Splinting • Pediatrics • Vestibular Rehabilitation • Women's Health/Perineal • Oncology • Critical Care • Cardiology • Neurology • Respirology • Health Promotion and Wellness • Palliative Care • Return to Work Rehabilitation • Ergonomics • Administration • Teaching • Research • Other (specify) – [free text]
13.0	Your primary employment client/patient age range is: • Pediatrics (0-17) • Adults • Seniors (65+) • All ages • Other (specify) – [free text]
14.0	Your primary work sector is: • Public practice • Private practice • Other (specify) – [free text]
15.0	Your primary work main geographical location/region is: • Winnipeg • Interlake-Eastern • Prairie Mountain • Southern Health-Santé Sud • Northern
Part 2	The following questions will capture information related to use of digital health tools, systems and information technologies.

<table>
<tr><td rowspan="5">16.0</td><td colspan="2">In your practice setting, are you using an electronic system/computer software to manage billing?:
• Yes
• No</td></tr>
<tr><td>If Yes</td><td>If No</td></tr>
<tr><td>16.1 Name of electronic system/computer software: [free text]</td><td>16.5 Are you planning to use an electronic system/computer software to manage billing in the next 2 years?:
• Yes
• No</td></tr>
<tr><td>16.2 How long have you been using an electronic system/computer software to manage billing?:
• Less than a year
• 1-3 years
• 4-6 years
• 7-9 years
• 10-15 years
• Over 15 years</td><td>16.6 What are your reasons for not using an electronic system/computer software for billing?:
• Unable to find product suitable for my practice
• Too costly
• Too time consuming
• Privacy concerns
• Lack of training
• Not comfortable using technology
• Limited keyboarding/typing skills
• I am planning to retire soon or end my clinical practice
• Other (specify) – [free text]</td></tr>
<tr><td>16.3 What is/are the main benefit(s) you see for implementing an electronic system/computer software for billing?:
• Increased efficiency
• Increased productivity
• Improved patient management /patient-centred care
• Improved communication
• Positive financial impact
• Supports clinical decision-making
• Supports business decision-making</td><td></td></tr>
</table>

	• Requires less human resources • Other (specify) – [free text]	
	16.4 What challenges have you encountered with implementing an electronic system/computer software for billing?: • No significant challenges • Compatibility with other systems • Privacy issues • Hardware availability (e.g. computers, servers) • Technical glitches/reliability (e.g. Internet connection, slowness) • Lack of training • Firewall/security issues • Not aligned with clinical workflow (e.g. duplicate data entry, requires logging into another separate system)	
17.0	In your practice setting, are you using an electronic system/computer software to manage scheduling?: • Yes • No	
	If Yes	If No
	17.1 Name of electronic system/computer software: [free text]	17.5 Are you planning to use an electronic system/computer software to manage scheduling in the next 2 years?: • Yes • No
	17.2 How long have you been using an electronic system/computer software to manage scheduling?: • Less than a year • 1-3 years • 4-6 years • 7-9 years • 10-15 years • Over 15 years	17.6 What are your reasons for not using an electronic system/computer software for scheduling?: • Unable to find product suitable for my practice • Too costly • Too time consuming • Privacy concerns • Lack of training

		• Not comfortable using technology • Limited keyboarding/typing skills • I am planning to retire soon or end my clinical practice • Other (specify) – [free text]
	17.3 What is/are the main benefit(s) you see for implementing an electronic system/computer software for scheduling?: • Increased efficiency • Increased productivity • Improved patient management /patient-centred care • Improved communication • Positive financial impact • Supports clinical decision-making • Supports business decision-making • Requires less human resources • Other (specify) – [free text]	
	17.4 What challenges have you encountered with implementing an electronic system/computer software for scheduling?: • No significant challenges • Compatibility with other systems • Privacy issues • Hardware availability (e.g. computers, servers) • Technical glitches/reliability (e.g. Internet connection, slowness) • Lack of training • Firewall/security issues • Not aligned with clinical workflow (e.g. duplicate data entry, requires logging into another separate system)	

<table>
<tr><td rowspan="5">18.0</td><td colspan="2">In your practice setting, are you using an electronic system/computer software to manage clinical documentation?:
• Yes
• No</td></tr>
<tr><td>If Yes</td><td>If No</td></tr>
<tr><td>18.1 Name of electronic system/computer software: [free text]</td><td>18.5 Are you planning to use an electronic system/computer software to manage clinical documentation in the next 2 years?:
• Yes
• No</td></tr>
<tr><td>18.2 How long have you been using an electronic system/computer software to manage clinical documentation?:
• Less than a year
• 1-3 years
• 4-6 years
• 7-9 years
• 10-15 years
• Over 15 years</td><td>18.6 What are your reasons for not using an electronic system/computer software for clinical documentation?:
• Unable to find product suitable for my practice
• Too costly
• Too time consuming
• Privacy concerns
• Lack of training
• Not comfortable using technology
• Limited keyboarding/typing skills
• I am planning to retire soon or end my clinical practice
• Other (specify) – [free text]</td></tr>
<tr><td>18.3 What is/are the main benefit(s) you see for implementing an electronic system/computer software for clinical documentation?:
• Increased efficiency
• Increased productivity
• Improved patient management /patient-centred care
• Improved communication
• Positive financial impact
• Supports clinical decision-making
• Supports business decision-</td><td></td></tr>
</table>

	making • Requires less human resources • Other (specify) – [free text]	
	18.4 What challenges have you encountered with implementing an electronic system/computer software for clinical documentation?: • No significant challenges • Compatibility with other systems • Privacy issues • Hardware availability (e.g. computers, servers) • Technical glitches/reliability (e.g. Internet connection, slowness) • Lack of training • Firewall/security issues • Not aligned with clinical workflow (e.g. duplicate data entry, requires logging into another separate system)	
	18.5 How has the QUALITY of the patient care you provide changed since you started using electronic clinical documentation?: • Much better • Better • No change • Worse • Much worse • Not sure	
	18.6 Since you started using electronic clinical documentation, the PRODUCTIVITY at your practice has: • Greatly increased • Increased • Did not change • Decreased • Greatly decreased • Not sure	
19.0	In your practice setting, are you using an electronic system/computer software	

	to manage exercise prescription?: • Yes • No	
	If Yes	If No
	19.1 Name of electronic system/computer software: [free text]	19.5 Are you planning to use an electronic system/computer software to manage exercise prescription in the next 2 years?: • Yes • No
	19.2 How long have you been using an electronic system/computer software to manage exercise prescription?: • Less than a year • 1-3 years • 4-6 years • 7-9 years • 10-15 years • Over 15 years	19.6 What are your reasons for not using an electronic system/computer software for exercise prescription?: • Unable to find product suitable for my practice • Too costly • Too time consuming • Privacy concerns • Lack of training • Not comfortable using technology • Limited keyboarding/typing skills • I am planning to retire soon or end my clinical practice • Other (specify) – [free text]
	19.3 What is/are the main benefit(s) you see for implementing an electronic system/computer software for exercise prescription?: • Increased efficiency • Increased productivity • Improved patient management /patient-centred care • Improved communication • Positive financial impact • Supports clinical decision-making • Supports business decision-making	

	• Requires less human resources • Other (specify) – [free text]	
	19.4 What challenges have you encountered with implementing an electronic system/computer software for exercise prescription?: • No significant challenges • Compatibility with other systems • Privacy issues • Hardware availability (e.g. computers, servers) • Technical glitches/reliability (e.g. Internet connection, slowness) • Lack of training • Firewall/security issues • Not aligned with clinical workflow (e.g. duplicate data entry, requires logging into another separate system)	
	19.5 How has the QUALITY of the patient care you provide changed since you started using electronic clinical documentation?: • Much better • Better • No change • Worse • Much worse • Not sure	
	19.6 Since you started using electronic clinical documentation, the PRODUCTIVITY at your practice has: • Greatly increased • Increased • Did not change • Decreased • Greatly decreased • Not sure	
20.0	In your practice setting, are you using an electronic system/computer software to manage patient reported outcome measures?:	

<table>
<tr><td rowspan="5"></td><td colspan="2">Yes
No</td></tr>
<tr><th>If Yes</th><th>If No</th></tr>
<tr><td>20.1 Name of electronic system/computer software: [free text]</td><td>20.5 Are you planning to use an electronic system/computer software to manage patient reported outcome measures in the next 2 years?:
Yes
No</td></tr>
<tr><td>20.2 How long have you been using an electronic system/computer software to manage patient reported outcome measures?:
Less than a year
1-3 years
4-6 years
7-9 years
10-15 years
Over 15 years</td><td>20.6 What are your reasons for not using an electronic system/computer software for patient reported outcome measures?:
Unable to find product suitable for my practice
Too costly
Too time consuming
Privacy concerns
Lack of training
Not comfortable using technology
Limited keyboarding/typing skills
I am planning to retire soon or end my clinical practice
Other (specify) – [free text]</td></tr>
<tr><td>20.3 What is/are the main benefit(s) you see for implementing an electronic system/computer software for patient reported outcome measures?:
Increased efficiency
Increased productivity
Improved patient management /patient-centred care
Improved communication
Positive financial impact
Supports clinical decision-making
Supports business decision-making</td><td></td></tr>
</table>

	• Requires less human resources • Other (specify) – [free text]	
	20.4 What challenges have you encountered with implementing an electronic system/computer software for patient reported outcome measures?: • No significant challenges • Compatibility with other systems • Privacy issues • Hardware availability (e.g. computers, servers) • Technical glitches/reliability (e.g. Internet connection, slowness) • Lack of training • Firewall/security issues • Not aligned with clinical workflow (e.g. duplicate data entry, requires logging into another separate system)	
	20.5 How has the QUALITY of the patient care you provide changed since you started using electronic clinical documentation?: • Much better • Better • No change • Worse • Much worse • Not sure	
	20.6 Since you started using electronic clinical documentation, the PRODUCTIVITY at your practice has: • Greatly increased • Increased • Did not change • Decreased • Greatly decreased • Not sure	
21.0	Please indicate if you or your patients	*Matrix table with the following*

	use the following functionality within your practice setting: • Request appointments online • Schedule appointments online • Send automated email or text appointment reminders • Send electronic invoices/receipts • Send electronic exercise prescription information • Access schedule remotely (outside clinic/practice setting) Access clinical documentation/patient chart information remotely (outside clinic/practice setting)	*columns as choices:* • *Not available* • *Available but don't use* • *Access via desktop/laptop* • *Access via tablet* • *Access via smartphone*
22.0	Do you refer your patients to any websites?: • Yes • No	
	If Yes	If No
	22.1 Please specify for what purpose: • Disease/condition/injury information • Treatment information • Patient support groups/forums • Lifestyle/prevention/wellness information • Health monitoring/tracking • Physiotherapy specific information • Other (specify) – [free text]	*Skip to 23.0*
23.0	Do you recommend any mobile applications (Apps) to your patients?: • Yes • No	
	If Yes	If No
	23.1 Please specify for what purpose: • Disease/condition/injury information • Treatment information • Patient support groups/forums • Lifestyle/prevention/wellness information	*Skip to 24.0*

	• Health monitoring/tracking • Physiotherapy specific information • Other (specify) – [free text]	
24.0	Have you ever used a website or mobile application (App) to support your practice as a physiotherapist?: • Yes • No	
	If Yes	If No
	24.1 Please list up to five favourite websites/mobile applications (Apps) you use: 1. [free text] 2. [free text] 3. [free text] 4. [free text] [free text]	*Skip to 25.0*
25.0	Have you used any telehealth or videoconferencing technologies in your practice?: • Yes • No	
	If Yes	If No
	25.1 How have you used a telehealth or videoconferencing technology in your practice?: • Initial assessment of patient • Subsequent treatment of patient • Follow up with patient • Consultation with patient • Consultation with physician • Consultation with physiotherapist • Consultation with other provider • Consultation with other person involved in care of your patient • Continuing education Other (specify) – [free text]	25.2 What reason(s) do you have for not using a telehealth or videoconferencing technology in your practice?: • Do not see value • Privacy concern • Not familiar with this technology • Not comfortable using this technology • Issues with Internet connection • Hardware/equipment challenges • Unsure of practice guidelines • Other (specify) – [free text]
26.0	Do you or your practice setting use any	*Matrix table with the following*

<table>
<tr>
<td></td>
<td>of the following technologies or social media platforms professionally to support physiotherapy and for how long have you been using?:
Website
LinkedIn
Facebook
Instagram
Twitter
Blog/Forum
Youtube/Flickr
Other (specify) – [free text]</td>
<td>columns as choices:
No
Plan to start within next 12 months
Using for less than 1 year
Using for 1-2 years
Using for 3-4 years
Using for greater than 5 years
Comments: [free text]</td>
</tr>
<tr>
<td>27.0</td>
<td colspan="2">Do you use social media and media sharing platforms (e.g. Facebook, Instragram, Twitter, Youtube) professionally to:
Receive information
Share information
Promote yourself professionally
Promote physiotherapy
Connect with existing and potential clients
Connect with colleagues
I do not use these platforms for professional purposes</td>
</tr>
<tr>
<td rowspan="3">28.0</td>
<td colspan="2">The ability to track a cohort of individuals over time provides valuable research information. Are you willing to have these responses linked to your responses on future iterations of this digital health survey using your email address? Results from this cohort data would only be reported in aggregate form, never at the individual level and will be de-identified for analysis and storage.
Yes, I am willing to be part of this survey cohort and share my email address
No thanks</td>
</tr>
<tr>
<td>If Yes</td>
<td>If No</td>
</tr>
<tr>
<td>28.1 Email address: [free text]

Thank you for participating!</td>
<td>Thank you for participating!</td>
</tr>
</table>

Appendix B – Email invitation to participate

Subject line: Digital health survey for physiotherapists – we want to hear from you!

You are being asked to participate in an online survey which will ask you a series of questions and should take about 10-15 minutes to complete. Feedback from this survey will be used to perform gap analysis and needs assessment on physiotherapists use, knowledge and attitudes towards digital health in Manitoba.

A better understanding of digital health tools and health data can support health system planning, policy development and advocacy for physiotherapy services within Manitoba's health-care system. Your feedback is important!

Study name:
I.T. for P.T.: Developing digital health core competencies for physiotherapists

Principal Investigator:
Katie Dyck BMR(PT), College of Rehabilitation Sciences, University of Manitoba
Ph. (xxx) xxx-xxxx | E: umdyc275@myumanitoba.ca

Purpose of Study:
This survey is part of a Master of Science in Rehabilitation Sciences research study being conducted to develop digital health core competencies for physiotherapists. The objectives of this study are to better enable physiotherapists to leverage digital health tools, systems and applications to:

- practice effectively in technology-based settings
- inform and enhance clinical practice and patient care
- enhance learning, professional development, and innovative research
- develop and encourage digital health literacy to support a culture of data driven patient care and continuous quality improvement activities
- facilitate interprofessional practice and communication
- support health system planning, policy development and advocacy for physiotherapy services within Manitoba's health-care system

We will not be recording IP addresses or email addresses as part of the process. We are asking participants to provide College of Physiotherapists of Manitoba (CPM) registration numbers. This is to ensure only one response to the survey is submitted per respondent after which time the data will be de-identified and coded for analysis. All survey responses will be aggregated and shared only in group format, so no identifiable individual responses will be reported. The de-identification codes will be stored securely to enable comparison of the dataset should future iterations of the survey be distributed in subsequent years. Should this be the case, the same de-identification process will be followed.

Click the survey link below to learn more about the survey process and complete the online consent process.

https://rsurvey.med.umanitoba.ca/redcap/surveys/?s=WE7EAHL8NW

Thank for your time and we hope you will consider participating.

Please contact Katie Dyck as principal investigator if you have any questions or concerns at Ph. (xxx) xxx-xxxx | E: umdyc275@myumanitoba.ca.

Appendix C – Online Survey Consent Disclosure

Study Title: **I.T. for P.T.: Developing digital health core competencies for physiotherapists**

Principal Investigator: Katie Dyck BMR(PT)
College of Rehabilitation Sciences, University of Manitoba
R106 - 771 McDermot Avenue, Winnipeg, MB R3E 0T6
Ph. (xxx) xxx-xxxx | E: umdyc275@myumanitoba.ca

Definition: For the purpose of this study, digital health (commonly referred to as e-health) will be defined using the Association of Faculties of Medicine Canada definition as follows:

> "…the appropriate and innovative use of information and communication technologies (ICTs) to enable and improve health and health care services."

Purpose of Study

This survey is part of a research study being conducted to develop digital health core competencies for physiotherapists. The objectives of this study are to better enable physiotherapists to leverage digital health tools, systems and applications to:

- practice effectively in technology-based settings
- inform and enhance clinical practice and patient care
- enhance learning, professional development, and innovative research
- develop and encourage digital health literacy to support a culture of data driven patient care and continuous quality improvement activities
- facilitate interprofessional practice and communication
- support health system planning, policy development and advocacy for physiotherapy services within Manitoba's health-care system

You are being asked to participate in an online survey which will ask you a series of questions and should take about 10-15 minutes to complete. Feedback from this survey will be used to perform gap analysis and needs assessment on physiotherapists use, knowledge and attitudes towards digital health in Manitoba.

If you agree to participate in this survey, you will be asked to complete questions involving length of time in practice, practice area, practice hours, knowledge and experience with digital health along with perceptions, assumptions, challenges and benefits of using digital health and health data. For example, you will be asked questions about electronic charting, exercise prescription software, practice websites and use of social media.

All responses are voluntary and you can exit the survey at any point without consequence. Participants may be contacted through multiple channels to complete the survey; the College of Physiotherapists of Manitoba (CPM), Manitoba Physiotherapy Association and/or the College of Rehabilitation Sciences at the University of Manitoba. **Please respond only once to the survey.**

No identifying information is being captured as part of this survey. We will not be recording IP addresses or email addresses as part of the process. All survey responses will be aggregated and shared only in group format, so no individual responses will be reported or identifiable.

This survey may be repeated in the future to track change over time. At the end of the survey you will be asked if you wish to participate in a longitudinal study cohort. If you consent to participate in the cohort, you will be asked to provide an email address for communication purposes. Longitudinal study data will be compared across iterations of future surveys using this email address. Email addresses provided for participation in the study cohort will not be attached to the initial survey data and will only be used for comparison with future survey iterations. Email addresses will be stored securely at all times within the University of Manitoba's Secure Research Environment.

There are no consequences or identified risks to you if you decide to participate or decide not to participate in the survey.

The survey does **not** need completed in one sitting. Each time you click the "Next" button, the responses to the previous questions are saved. Closing the browser window and then clicking the survey link at a later date will allow you to continue with the survey.

The survey data will be electronically stored for the duration of this study in a secure, encrypted location with limited access to authorized users only.

By clicking on the survey link, you are consenting to participate in the online survey. You are indicating that you have understood to your satisfaction the information regarding participation in the survey and agree to participate in it including understanding that information regarding your personal identity will be kept confidential, but that confidentiality is not guaranteed. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time without prejudice or consequence.

The University of Manitoba may look at your survey records to see that the research is being done in a safe and proper way. This study has been approved by the University of Manitoba Health Research Ethics Board. **For questions about your rights as a research participant, you may contact The University of Manitoba, Bannatyne Campus Research Ethics Board Office at (204) 789-3389**

Notice Regarding Collection, Use, and Disclosure of Personal Information by the University

Your personal information is being collected under the authority of *The University of Manitoba Act*. The information you provide will be used by the University for the purpose of this study, as outlined above. Your personal information will not be used or disclosed for other purposes, unless permitted by *The Freedom of Information and Protection of Privacy Act* (FIPPA). If you have any questions about the collection of your personal information, contact The University of Manitoba, Bannatyne Campus Research Ethics Board Office at (204) 789-3389.