**MBAR 661**

# Investigation of the success of the telehealth business model in the private and public sectors of the health care system in British Columbia post- and pre-pandemic

**Academic Research Project**

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## Introduction

Digital technologies have transformed healthcare delivery worldwide, with telemedicine emerging as a powerful tool, particularly in primary care. However, its widespread adoption remained limited before COVID-19. The pandemic's urgency for remote healthcare rapidly accelerated its integration into healthcare systems, especially in regions like British Columbia, which was encouraged by policy reforms and technology improvements by changing patient expectations and resource constraints, particularly with the launch of telehealth, which has profoundly impacted the traditional healthcare landscape and service providers' employment.

The study examines the effectiveness of various healthcare practices by leveraging data from Statistics Canada to analyze how these practices utilize staff, implement business models, and deliver services. This comprehensive approach allows us to identify the strengths and weaknesses of various telehealth models. Ultimately, the goal is to highlight successful practices that can be adapted across the healthcare sector. This adaptability is crucial for keeping pace with the ever-evolving demands within healthcare, especially when considering staff training, market employability, and patient satisfaction.

The study also delves into telehealth utilization trends in British Columbia, analyzing data from Telus reports and Infoway surveys. It also highlights how national bodies face digital transitions and advancements through the Government of Canada and Statistics Canada database (Government of Canada, n.d.). It aims to assess the province's telehealth landscape, identify trends, and explore their implications for healthcare delivery.

The analysis examines the shift in telehealth use from pre-pandemic to post-pandemic periods. Statistical tests reveal significant changes in adoption patterns, highlighting the pandemic impact on healthcare delivery dynamics and expectations.

The analysis shows a substantial increase in telehealth utilization between 2019 and 2022, with statistically significant differences observed between specific periods. The pandemic catalyzed the adoption of telehealth services, increased cost-effectiveness, and reshaped healthcare delivery across the region to a patient-centered approach.

# Chapter 1

## 1.1 Historical Context

Over the past century, the Canadian healthcare system's business structure has experienced significant modifications, encouraged by policy reforms and technology improvements, and changed patient expectations and resource constraints, particularly with the launch of telemedicine, which has profoundly impacted the traditional healthcare landscape and service providers' employment. In the past, healthcare practices were primarily based on in-person consultations and treatments; patients would need to attend medical facilities that physically, while effective, had challenges in time-consuming and location-mobility issues in remote areas (Agarwal et al., 2020).

Telemedicine emerged in the 1970s as a strategy to provide a link and remote technological access to high-income countries with disbalance between large healthcare centers across rural geographical landscapes (Agarwal et al., 2020). As the prefix "tele" refers to "at a distance," "telemedicine" and "telehealth" terms are translated by House & Roberts (1977) as the "activities in which health care professionals use telecommunication tools and channels to communicate with the team and the patients, expressing the goal of improving the way the delivery of health care service." (p.117)

With the digital revolution, this model has gradually shifted to incorporate digitalization and telemedicine as technological advancements to a patient-centered approach (Bohr & Memarzadeh, 2020), gradually transitioning and incorporating Artificial Intelligence-powered tools in the landscape of clinic operations, billing management, hiring processes, and overall patient care strategies to bridge the physical gap between healthcare professionals and patients,

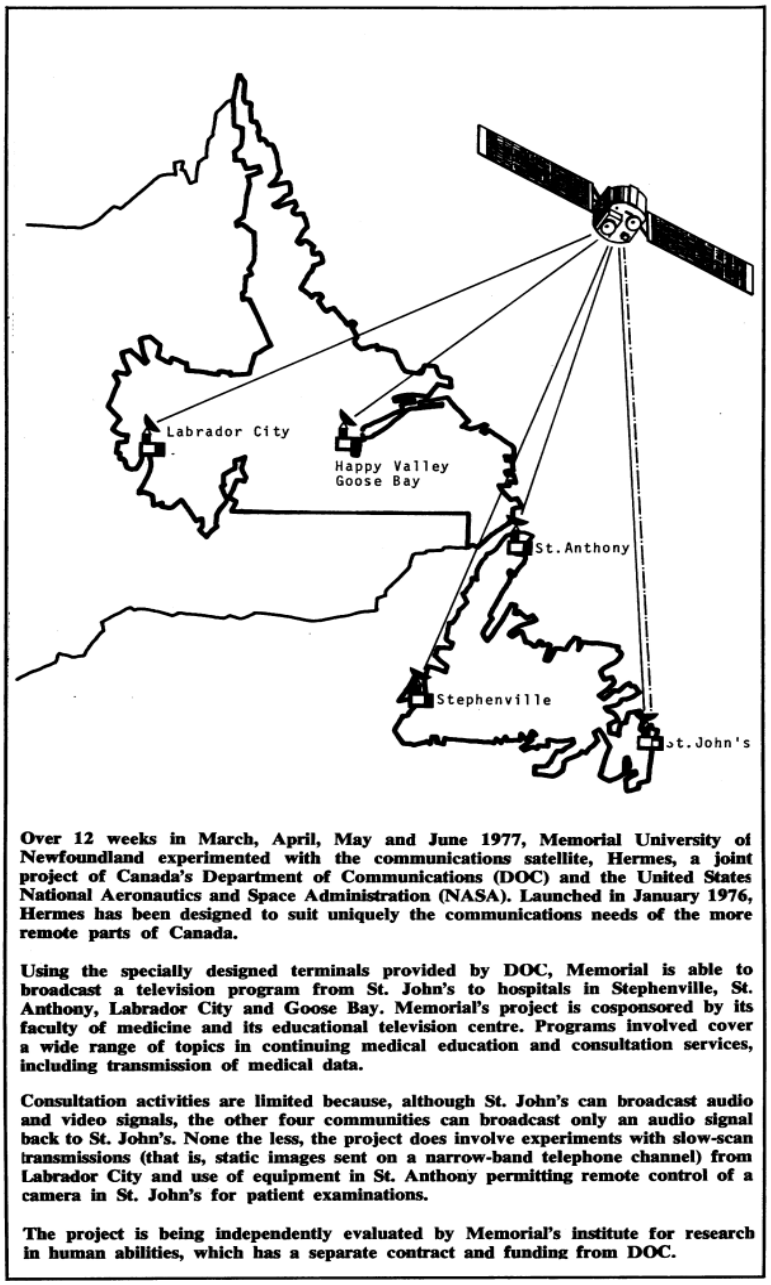
making the services more efficient and cost-effective, and enhancing but not replacing human work as such (House & Roberts, 1977).

Face-to-face interactions, synonymous with physical consultations, diagnosis, and treatments, have characterized the conventional Canadian healthcare system. However, with worldwide healthcare environment literature, especially from the United States in 1964, pointing to development and improvements, more societal needs of interaction and healthcare delivery forced Canada to experience a vigorous effort to use telephone, audio, and video systems in medical practice, starting limited telemedicine in the 1970s (House & Roberts, 1977).

The University of Wisconsin taught the Memorial University of Newfoundland courses as financial and technological changes have been profound and necessary. This allowed the link between the institutions in various operational remote transmissions (House & Roberts, 1977). In teleconferencing by the aggregating National Aeronautics and Space Administration (NASA) to Canada's Department of Communications (DOC), programs involved the delivery of continuous medical education and technical and administrative support between the United States and Canada (House & Roberts, 1977).

**Figure 1**

*Integration of healthcare operational systems between the United States and Canada in 1977*




*Note:* Continuing medical education project executed in 1977. From "Telemedicine in Canada," by A. M. House and J.M. Roberts, 1977. *Canadian Medical Association Journal. Aug 20; 117*(4): 386–388.

Management in health care is not only a professional form for organizing the sources of health corporations, institutions, and regulations, but it has become crucial in standardized practices and protocols the Canadian health care system aims to implement since the transition in the system's inception of Medicine in the 1960s, marked the jurisdictional healthcare funding from a predominantly private model to a publicly funded one (Mintzberg, 2017).

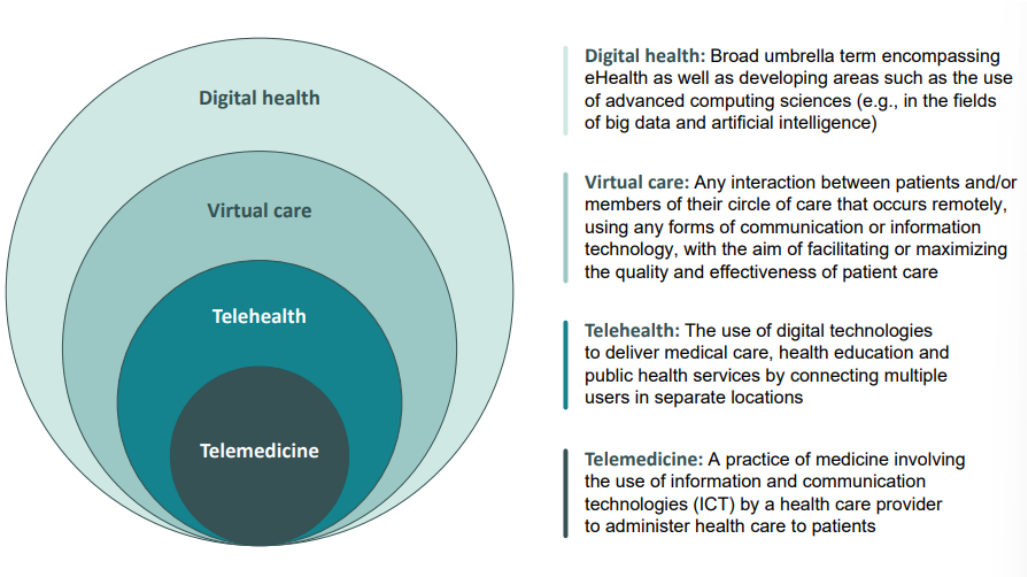
This transformation was critical in ensuring universal coverage for all Canadian citizens, laying the foundations for a healthcare system that values and prioritizes equitable access through inclusive policy reform adoption and evolving societal needs (Mintzberg, 2017). Technological business advancements have been an integral factor in a new era of revolution in the healthcare field, stimulating modifications and competitive innovations in consultation, services, and complementary exams (Research & Markets, 2015).

### 1.2 Health's Potential for Transformation

According to the Resources and Services Administration, "the terms *telemedicine* and *telehealth* are interchangeable, being used as synonyms to e-health, covering similar clinical services, and related to the use of telecommunications technology, education, and information in health care delivery." (Gajarawala & Pelkowski, 2021). On the other hand, Canadian Institute for Health Information (2022) brings a perspective of these "terms interrelation in a digital health umbrella application, aligned to devices use, algorithms analysis, and apps supporting collaborative communication and decision-making with a level of complexity and specificity" in each of them (CIHI's Virtual Care in Canada: Strengthening Data and Information, p. 7).

**Figure 2**

*Digital Health interrelation*




*Note*: Digital health organization is in the scope of practical application. From "Virtual Care in Canada: Strengthening Data and Information"by Canadian Institute for Health Information, 2022.

Telemedicine, also known as Information and Communication Technologies (ICT), has emerged as a fundamental tool for digital transformation proposed by challenges and opportunities to grow in the healthcare field in enhancing the patients' accessibility and monitoring, care pathways to develop quality, communication delivery channel, and efficiency of healthcare services, while also opening new business models and economic opportunities (AReSS Puglia, 2023). As Picot (2009) stated, telemedicine is related to "the use of information technology to emerge into the health care provision across cultural, geographical, time and social barriers." Telemedicine also delivers specialist medical care to patients who have experienced restrictive access to healthcare facilities, ensures continuity of long-term care, and maximizes the use of available medical assets (Hallem et al., 2021). Incorporating ICT into healthcare has

impacted how patients are handled in diagnostic and therapeutic models and encouraged innovation and growth in healthcare industry operations in challenges and opportunities (AReSS Puglia, 2023).

From a business outlook, the potential advantages associated with ICT extend to various stakeholders, including coordination among healthcare practitioners, increasing demand in medical organizations, patients' engagement, the health system integration across Canada, nearby communities' accessibility, and the public welfare (AReSS Puglia, 2023). The positive impacts of such technologies have been extensively documented, particularly in specialized areas such as telecardiology and home-based healthcare applications (RDMS, n.d.). These applications have proven effective in monitoring and managing chronic conditions like congestive heart failure, hypertension, diabetes, asthma, and chronic obstruction pulmonary disease (COPD), showcasing ICT's tangible benefits can bring to patient initial and follow-up care, treatment evaluation, and health outcomes (Picot, 2009).

**Figure 3**

*Telecardiology Network*


*Note*: Network flowchart in basic and specialized cardiology care using WiPaM platform (**Wi**reless **Pa**tient **M**onitoring). From "Telemedicine Network" RDSM (n.d.).

The introduction of advanced diagnostic tools, including electronic health records (EHRs) and other telemedicine platforms, has revolutionized how healthcare is accessed and delivered, enhancing efficiency in data management and diagnostic accuracy and improving patient treatment outcomes (Peachman, 2023). This technological revolution in the medical environment has been closely linked with social developments, including long life expectancy, with an aging population becoming more prevalent and aware of preventive healthcare services that have demanded more specialized professionals and services' expansion (Research & Markets, 2015).

Furthermore, the widespread expansion of internet connectivity and mobile devices has created new opportunities for healthcare providers to increase their tele-homecare methods and patient accessibility to medical devices, allowing telemedicine to emerge as a viable alternative strategy to digital innovation (AReSS Puglia, 2023).

### 1.3 Canadian Medical Practice

In Canada, general medicine has traditionally been the foundation of healthcare through Medicare, a publicly funded, universal, and single-payer healthcare system, with unrestricted access to healthcare services since 1947 (Martin et al., 2018). The Canada Health Act of 1984 provides primary attention care. It serves as a gateway to specialized services throughout the unified system through federal standards laws of portability, comprehensiveness, universality, and public administration (Martin et al., 2018). Despite these achievements, Glazier's study (2023) proposes a concern about the collapse of this system, identified by its "challenges and vulnerabilities in a lack of family doctors and other health care staff," besides crowded and long-line timed walk-in clinics, lack of infrastructure to provide primary care and little system input or accountability for the services offered.

Over the years, the role of general practitioners (GPs) has grown to include not only just diagnosis and treatment approaches but also preventive care of chronic disease management in in-person consultation (Public Health Agency of Canada, 2023). It expanded, encompassing medical preventive demand, including preventive care to multi-professional specialty practitioners, giving holistic and legitimate care to rehabilitation and therapy sessions to manage chronic illness (Public Health Agency of Canada, 2023). A recent study proposed by Glazier (2023) revealed "more than 5 million Canadians without primary care physicians;" most of these professionals are experiencing high levels of burnout, stress, and mental health impacts, relatively declining interest in GP practices, which forces that federal government to implement virtual technologies to overcome systemic barriers, stimulate virtual training and retention to help advance to areas of greatest needs (Wennersbusch, 2021) (Glazier, 2023).

**Figure 4**

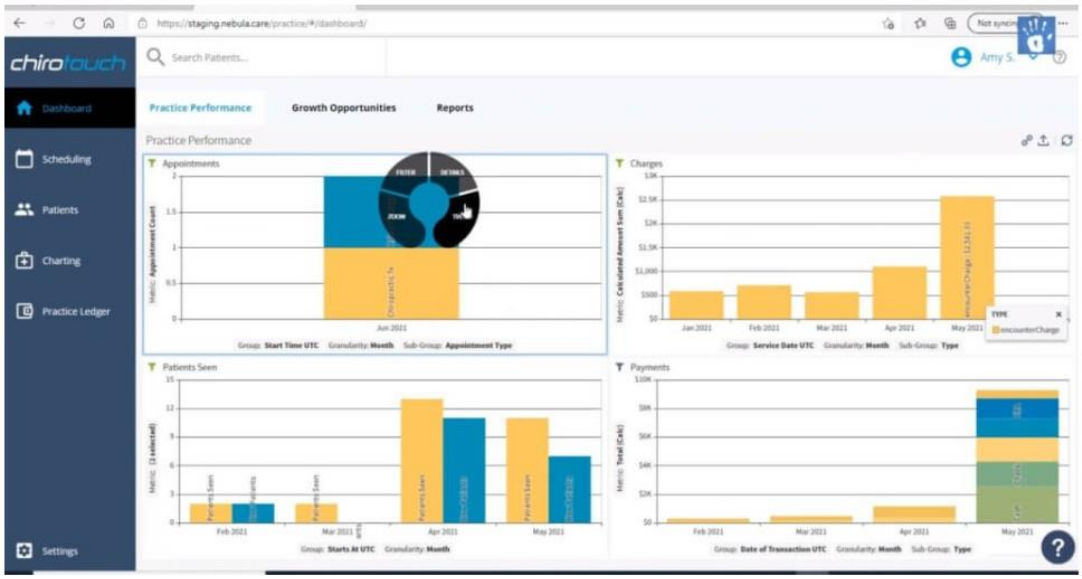
*Demonstration of Primary Care consultation with a General Practitioner*

*Note*: Telemedicine video call demonstration. From "Medical consulting with GP via video call and recommending tablets to senior patient," *BestDoctorOnline.com* (2020).

Chiropractic care, form validation, skepticism, and lack of confidence have gained education and licensing validation and are now universally acknowledged as legitimate healthcare therapy with evidence-based practitioners (Simpson, 2012). It has expanded to include a more fantastic range of manual therapies and rehabilitative exercises focusing on musculoskeletal health prevention, spinal irritation treatment (Simpson, 2012), and "neurasthenia," also called later depression to recover sleep and body health conditions (Kaptchuk & Eisenberg, 1998). Chiropractic marketing and social media are tailoring legitimacy to their practices and attracting target demographics to attract clients, warn them with exercises and postures, and engage in updated practices and treatment protocols (ChiroTouch, 2022).

**Figure 5**

*Chirotouch Platform Display showing Practice Performance metrics to analyze Chiropractic Treatment with Analytics*




*Note:* The EHR software system contributes graphical elements to predict patient behavior and improvement by technological trends in the chiropractic industry to analyze their performance. From "Improved practice and treatment protocols with Analytics," ChiroTouch (2022).

Similarly, in advance of technological innovations, physiotherapy has developed expertise to include evidence-based methods for telerehabilitation, such as patient interviews and diagnosis, follow-up consultation, maintenance activities, education, and training sessions (College of Physiotherapists of Ontario, n.d.). The role of physiotherapists has significantly increased to provide preventative treatment, sports performance, health promotion, injury prevention, pre/post-surgical, wellness, and rehabilitation programs by using telecommunication technology as a service delivery considered medium standard (College of Physiotherapists of Ontario, n.d.), including modern equipment, such as ultrasound, laser therapy, and home exercise program.

Moreover, acupuncture, a therapy based on traditional Chinese Medicine to stimulate specific body regions to modulate body physiology, has gradually integrated and is now part of contemporary Canadian healthcare practices with increasing evidence to stimulate reflexes that activate peripheral nerves (Lu et al., 2022). With a growing increasing amount of supportive research figuring its efficacy, acupuncture is commonly used for pain management and as a complementary treatment modality to longevity and well-being (Lu et al., 2022).

In addition to these medical practices, several complementary, alternative, and integrative Medicine (CAIM) modalities have been integrated into the Canadian supportive approach, with no restrictions on telehealth technology. However, they are not covered by the public healthcare system (Shah et al., 2023). These techniques, which include counseling, homeopathy, naturopathy, and ayurvedic Medicine, illustrate a comprehensive approach to health and well-being that supplements traditional Medicine with a positive health outcome (Shah et al., 2023). These CAIM practices, combined with general Medicine, physiotherapy, chiropractic treatment, and acupuncture, contribute to diversifying and broadening Canada's healthcare system,

supporting patient-centered care, and improving overall health issues to increase telehealth measures in remote and rural communities (Shah et al., 2023).

### 1.4 Business Models

The business models supporting medical practices have significantly changed, especially regarding aggregate demand and supply, investment funding, patient billing, and insurance processing (Clark et al., 2021). The publicly funded nature of Canadian healthcare ensures that most essential medical services provided by GPs, chiropractors, physiotherapists, and acupuncturists are covered under provincial health plans; however, coverage varies across provinces and practices (Public Health Agency of Canada, 2023). Patient billing practices have also evolved towards more transparent and streamlined processes facilitated by digital billing systems, requiring medical coding and billing to accurately provide the appropriate income source to medical practice for each patient encounter (Burks et al., 2022).

Integrating private insurance for services not covered by Medicare Public Health, as the CAIMs, has introduced complexity into the billing process, requiring efficient administrative systems, overall health performance and outcome, and growth in health expenditures (Lee et al., 2021). Efficiency in healthcare insurance processing has improved through electronic processing and direct billing options for private for-profit insurance and private out-of-pocket financing (Lee et al., 2021). Expanding private financing in Canada can impact regulations, reduce administrative burdens, and enhance access to and financial viability for other essential healthcare practices, such as dental care, allied health services, and pharmaceuticals (Lee et al., 2021).

### 1.5 Telemedicine in Practice

Considering differences between provinces, countries, judicial regulations, and health jurisdictions worldwide in a pre-pandemic scenario, telemedicine has particularities regarding the time- and cost-effectiveness for both parties, including patients and healthcare professionals (Dhalla & Tepper, 2018). Encouraging its analysis of strengths and weaknesses to define if its adoption is valuable and accessible to be implemented on a larger scale to improve population health and health organizations to continue doing their mission: safety, timely, effectiveness, efficiency, equitability, and patient-centered (Dhalla & Tepper, 2018).

One of the key advantages is the optimization of resources, both human and material, leading to more efficient healthcare delivery to improve patient outcomes. This optimization is achieved through streamlined processes, reduced need for physical consultations, and enhanced capacity for healthcare providers to manage a more extensive patient base without compromising the quality of care (AReSS Puglia, 2023).

The use of telemedicine opens new perspectives for the optimization of the health care system, enables better communication among health professionals in the same domain or interdisciplinary approach, regulates the allocation of resources, and reduces costs of mobility and travel while improving client satisfaction, allowing virtual first medical contact, second opinion for their pathology or exam analysis, diagnostic options, since they may have remote access and availability to medical resources that would otherwise be prohibitively enormous costs and time (Hallem et al, 2021).

The adoption of ICT in healthcare settings through telemedicine has shown significant improvement in the accessibility, quality, timeliness, and continuity of patient care, which is

almost similar to in-person care (Hallem et al., 2021). Furthermore, ICT reduces professional and educational isolation, particularly in remote or underserved areas. This connectivity enables healthcare professionals, such as telehealth nursing, remote psychiatry, and physical rehabilitation, to access continuous learning opportunities, share knowledge with peers, and consult specialists, enhancing their skills and competencies (Abraham et al., 2021) (Hallem et al., 2021).

The impact of ICT extends beyond the immediate sphere of healthcare delivery to address challenges related to healthcare professional recruitment and retention in remote areas, increasing emergency performance and service quality through video application software, distant consultation, continuous networking, report management, data storage, and leveraging skills (Hallem et al., 2021). By diminishing the sense of isolation and offering connectivity to a supportive network of coworkers and practitioner specialists, ICT makes these locations more appealing to healthcare professionals. Additionally, providing local health services, supported virtually, enhances health capacity-building and ensures that isolated communities like Indigenous, vulnerable, and rural populations receive high-quality healthcare services (Government of Canada, 2021).

Beyond the health benefits, ICT also plays a crucial role in stimulating economic development. The growth of the ICT healthcare department has resulted in the establishment of new companies, new businesses, and job opportunities, particularly in previously unexplored markets, such as prospects (Stoumpos et al., 2023). The ripple effect of this growth contributes to the overall economic vitality of communities, particularly those in rural or isolated regions, by providing employment opportunities and ensuring the development of an innovative culture and entrepreneurship mindset (Stoumpos et al., 2023).

The successful integration of ICT in healthcare also catalyzes community empowerment. By making healthcare more accessible and efficient, communities become active participants in their health management. This empowerment is essential for handling public health challenges and establishing a health awareness culture and preventive education (Haldane et al., 2019).

ICT has considerable pioneering potential in healthcare, with benefits including improving patient care and healthcare delivery efficiency to boosting technological innovation, economic growth, community empowerment, and staff recruitment optimization (Haldane et al., 2019). As the healthcare perspective develops, innovative applications of ICT will be fundamental in creating the future of healthcare services, making them more accessible, efficient, and patient-centered (Milella et al., 2021).

The continuous documentation of beneficial effects, especially in fields like telecardiology and home-based monitoring, emphasizes the importance of ICT in addressing current healthcare concerns and perspectives and leading the way for future innovations (Milella et al., 2021).

### 1.6 ICT Adoption and Integration in the Canadian Healthcare System

ICT integration, implementation, and broad dissemination in the Canadian healthcare system significantly progressed, advancing from pilot projects to more substantial applications in various domains, including Northern isolated communities. However, fully integrating these updated technologies into the existing healthcare delivery system remains an ambitious aim that offers significant challenges (Milella et al., 2021).

This barrier results from the complex and broad architecture of Canada's healthcare system, an extensive geographical area with complicated and dispersed governance (Government

of Canada, 2021). The Canada Health Act regulates Canada's healthcare system, integrating concepts that involve accessibility, universality, comprehensiveness, portability, and public administration (Government of Canada, 2021). They operate under national and provincial regulations, with these principles advocating for a cohesive, nationwide healthcare approach. However, delivering healthcare services is the responsibility of fourteen distinct jurisdictions, including ten provinces, three territories, and the federal government (Government of Canada, 2021). This decentralized structure further complicates the implementation and consistent integration of ICT solutions. Each of these jurisdictions, in turn, encompasses multiple health regions, each with its unique approach to ICT, thereby adding layers of complexity to the nationwide integration efforts. Moreover, the Canadian telehealth research community faces additional hurdles as it navigates through the myriads of jurisdictional boundaries to share collaborative ICT infrastructure (Government of Canada, 2021).

The Canadian geography and climate are ideal for introducing communications technology for long-distance medical treatment, education, and telemedicine applications (Government of Canada, 2021). Canada has a long history of using telemedicine technology, and in the last few decades, the quantity and diversity of telehealth services and activities in Canada have grown considerably. The trends observed have been boosted by establishing provincial and national infrastructure for the health information highway, improvements in health care delivery, greater technological capacity and speed, and government intervention and guidance (Government of Canada, 2021). Based on the number of projects and the number of companies interested in and financially supporting telehealth services and goods, its rate of expansion has exponentially risen, especially when public organizations adopted telehealth technologies for a

wider variety of applications and undertook an increasing amount of research to incentivize the government intervention in fostering developments (Gajarawala & Pelkowski, 2021).

# Chapter 2

## 2.1 Key Technologies in Telemedicine

Technology has become integral to telemedicine delivery as it facilitates providing healthcare services to remote patients. Including diverse digital tools ensures the smooth and efficient setup of telemedicine services. This literature review aims to provide an overview of key aspects and technologies involved in telemedicine that were progressing before the pandemic.

### 2.1.1 Video Conferencing

Video conferencing has become an imperative element of telehealth, facilitating remote clinical care by exchanging vital information for accurate diagnosis, treatment, and ongoing care (Bradbury et al., 2016). Telehealth health service is either synchronous or asynchronous; synchronous service involves real-time video or telephone communication among healthcare providers, providing immediate interaction, while asynchronous communication consists of storing and sharing the information over time using platforms like apps, emails, or web-based systems (Hawe et al., 2023).

Remove two-way real-time video conferencing (RVC), which is increasingly utilized for delivering medical, behavioral, and educational services (Bradbury et al., 2016). Significant evidence supports the advantage of remote care, including RVC, across various domains such as education, physiotherapy, and managing cardiac and respiratory diseases (Bradbury et al., 2016). Numerous studies have demonstrated the viability and acceptance of RVC in providing healthcare services, especially in underserved areas like dermatology, pediatrics, obstetrics,

endocrinology, psychiatry, and neurology, with no difference in patient satisfaction between RVC services and in-person services (Abraham et al., 2021) (Bradbury et al., 2016).

### 2.1.2 Mobile Health (mHealth) Apps

Mobile phone applications have changed healthcare by giving patients easy access to digital tools that improve interaction with healthcare providers. These mobile apps are compatible with smartphones and tablets and have great potential to enhance patient involvement and overall healthcare outcomes. Additionally, mHealth has over 300,000 health apps available in popular stores, proving to be a game changer in healthcare delivery (Kim & Kim, 2023).

mHealth contributions, from variable fitness trackers to text-based health advice, served diverse demographic groups and addressed various complex healthcare needs (Pereira-Azevedo & Venderbos, 2018). In British Columbia, the government revised the physician billing code in 2012 to allow telemedicine services to be billed under public insurance (Canadian Medical Association, 2019). This modification has aided public healthcare provision through telemedicine to all residents of British Columbia and opened the opportunity for third-party vendors (Pereira-Azevedo & Venderbos, 2018).

Private sector companies like Maple, Babylon, EQ Care, and Tai Health recruit doctors to offer virtual consultations to the patients covered under the Medical Service Plan (MSP). These providers provide direct-to-customer (DTC) telemedicine services. Additionally, other private providers like Lumino Health or Dialogue offer virtual care through employee benefits that are not publicly available. Alternatively, physicians can independently connect with patients using approved devices or online platforms such as Zoom, Skype, or mobile devices (Provincial Health Services Authority, 2021).

### 2.1.3 IoT-Based Healthcare Monitoring Systems on Remote Patient Care

The Internet of Things (IoT) links everyday items, like gadgets and sensors, to the Internet, allowing them to share data and interact with their surroundings. Wearable technologies, such as smartwatches and fitness trackers, are a part of this IoT network, providing users with continuous monitoring of their activities and health metrics. By combining wearable with IoT, known as the Internet of Wearable Things (IOWT), these devices gain enhanced functionality through connectivity and data processing capabilities. This integration has led to the development of the Internet of Medical Things (I0MT) within healthcare, where wearable devices play a pivotal role in remotely monitoring patients' health and transmitting real-time data to healthcare providers (Qureshi & Krishnan., 2018).

For instance, biomedical wearables utilize photoplethysmography (PPG) technology, which measures changes in the blood volume under the skin, to monitor vital signs like heart rate and blood oxygen levels. PPG sensors emit light into the skin and detect the reflected light, providing valuable insight into the wearer's physiological state. This noninvasive approach eliminates the need for invasive electrodes and offers a comfortable and convenient solution for continuous health monitoring. Moreover, integrating IoT technology enables seamless data collection and transmission, facilitating remote monitoring and communication between patients and health professionals (Valsalan et al., 2020).

### 2.1.4 Artificial Intelligence (AI) and Machine Learning (ML)

Integrating artificial intelligence (AI) and machine learning (ML) into a computer-aided clinical decision support system (CDSS) is crucial for advancing digital health (Lundin & Dumont, 2017). These technologies aim to complement healthcare professionals by providing support in making better judgments. The complexity of healthcare data, sourced from various

systems such as electronic health records (EHRs), electronic medical records (EMRs), and wearable and monitoring equipment, poses challenges for integration and analysis (Isson, 2018). This diversity of formats, including text, numeric, paper-based, and digital, complicates data processing, mainly when the information about the same event is scattered across different systems and formats (Isson, 2018).

AI and ML promise to enable large-scale processing and analysis of healthcare data, thereby enhancing the effectiveness of healthcare delivery (Lundin & Dumont, 2017). These technologies facilitate better decision-making and predictive analytics by harnessing gathered and chattered data in a medical setting. For instance, predictive analytics powered by ML algorithms can access risk and outcomes, such as predicting the risk of pre-eclampsia using data from mobile diagnostics of preemptive care. Furthermore, open clinical decision support systems leverage ML to provide real-time guidance and insights to medical personnel, aiding in diagnosing and deleting (Lundin & Dumont, 2017).

AI has modernized drug development and therapeutic efficacy in cardiovascular medicine, enhancing precision medicine techniques (Mathur et al., 2020). Through pharmacogenomics and precision medicine, AI enables designed dosing of drugs like warfarin, improving therapeutic outcomes and patient safety. Additionally, AI-driven approaches, such as photomapping, categorize patients with heart failure into discrete phenotypes, facilitating customized treatment plans and guiding clinical trials for targeted medication management.

Moreover, AI-based algorithms outperform conventional risk assessment tools in diagnosing coronary artery disease, highlighting the potential of big data analytics and precision medicine to enable more effective and individualized cardiovascular treatment. As AI continues to evolve, its application in cardiovascular medicine, including disease management, medication

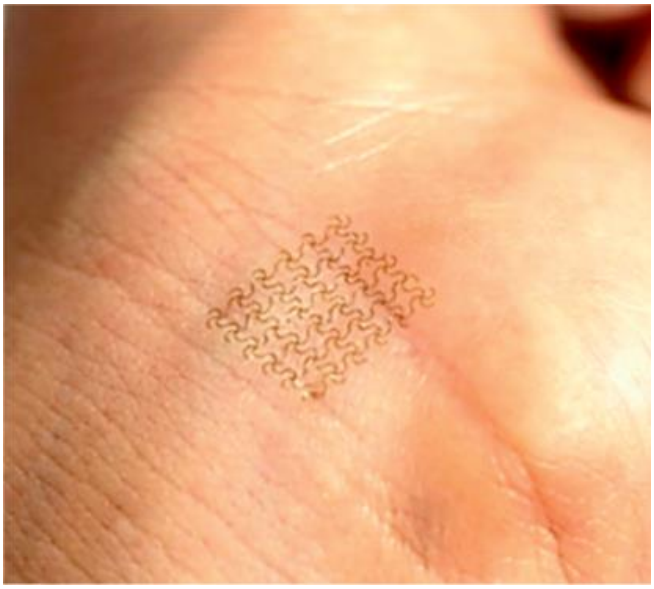
therapy optimization, and diagnostic management, will further advance healthcare outcomes (Mathur et al., 2020).

### 2.1.5 Nanotechnology

Nanotechnology stands on the cusp of transforming telemedicine and pushing healthcare to new heights, as outlined in Martha Vockley's Comprehensive Analysis of Game-Changing Technologies: 10 Promising Innovations of Healthcare" (Vockley, 2017). Nanodevices are developing as a crucial element driving substantial change in the medical landscape in 2017, and they have the potential to reform patient care and boost healthcare techniques. Intelligent skin patches represent a prime example of nanotechnology integration, combining indigenous features with a compact design to merge monitoring and medical functionality seamlessly. This innovation underscored the transformative role of nanotechnology in telemedicine and its creative application, making it pivotal for shaping the evolution of healthcare technologies (Vockley, 2017).

**Figure 6**

*Flexible and stretchable patch photograph with a single strand of crystalline nanomaterials*



*Note:* Retrieved from Vockley (2017). Game-changing technologies include ten promising innovations for healthcare. *Biochemical instrumentation of technology, 51*(2), 96-108.

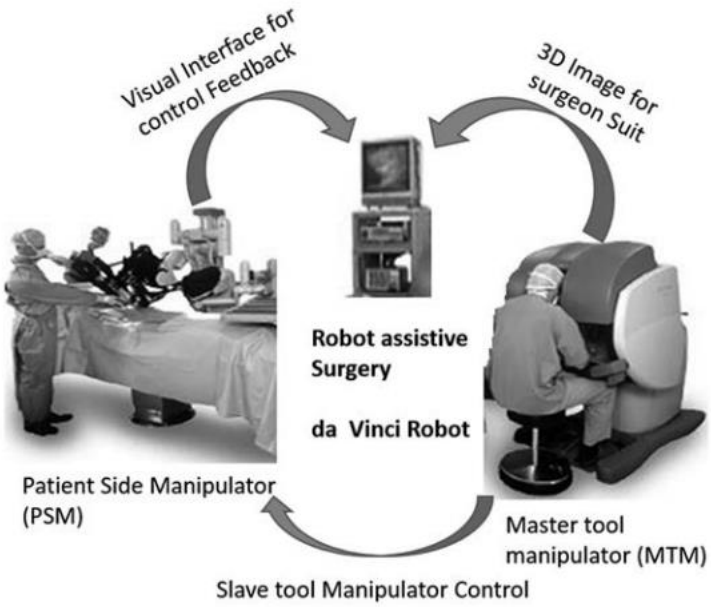
One notable application of nanotechnology is merging biochemical sensors with microneedles within intelligent skin patches (Kulbatski, 2016). These sensors monitor thrombin enzyme levels in individuals prone to thrombosis or blood clots, enabling the patch to administer precise doses of blood-thinner heparin accordingly (Kulbatski, 2016). Moreover, in patients with advanced type 2 and type 1 diabetes, the patch responds to fluctuation in blood glucose levels by administering insulin microinjections at optimal times, ensuring precise medication delivery. With the flexibility to adjust drug dosages daily or as needed, these patches tailor treatment to individual patient requirements, showcasing nanotechnology's versatility and potential impact on healthcare (Kulbatski, 2016).

### 2.1.6 Robotics

In surgical practice, robotics plays a crucial role across numerous stages of the procedure, including pre-operative planning, interoperative navigation, operative evaluation, and simulation training (Verma et al., 2018). Robotic-assisted surgery (RAS) enhances surgical precision by allowing perfect micro-movement without tremors, minimizing surgical trauma, and preventing healthy tissues. Consequently, this merger improves surgical outcomes and facilitates swifter patient recovery (Verma et al., 2018).

**Figure 7**

*Robot Assistive Surgery*




*Note:* Robot Assistive Surgery (Modified from Okamura et al., 2010. *IEEE Robotics & Automation Magazine, 17*(3): p. 26–37. [83]) Retrieved from Hassanien et al., 2019. Medical Big Data and Internet of Medical Things: Advances, Challenges and Applications (aitskadapa.ac.in)

Computer-aided surgery (CAS) primarily utilizes computer interfaces to assist surgeons, while robotically assisted surgery (RAS) employs motorized devices for intervention control. CAS application encompasses Various functionalities such as motion planning, cancer cell identification, and tool detection. Standard components of the RAS system include the master tool manipulator (MTM) and the patient side manipulation (PSM), with the MTM providing surgeons with enhanced accuracy and manipulability during surgery on the PSM through telemetry or autonomous control (Verma et al.,2018).

Surgical robots must exhibit high accuracy, strength, and limited skill to qualify for orthopedic procedures and treat delicate organs like the heart, brain, and eyes (Verma et al.,

2018). Additionally, robots in soft tissues and minimally invasive surgeries require a high degree of expertness, efficiency, and responsiveness to execute intricate movements efficiently. This persistent search for improvement in surgical instruments and techniques has led to developing sophisticated systems like AESOP, ZEUS, and the do Vinci surgical system, offering patients less invasive alternatives that may lead to reduced hospital stays and accelerated recovery (Stefano, 2017).

### 2.1.7 Cloud Computing

Cloud computing has emerged as a powerful solution for addressing the challenges faced by healthcare IT systems, offering significant ability for their development. Adapting things in healthcare can lead to substantial cost reduction, which is particularly beneficial during economic strain. Moreover, cloud computing plays a crucial role in evaluating the standard of care and pushing improved collaboration among hospital physicians and patients by accelerating effective communication and coordination across the healthcare ecosystem. The cloud-based system boosts patients' overall treatment experience and improves healthcare outcomes (Bamiah et al., 2012).

One key benefit of integrating cloud computing into healthcare information systems is its ability to address various challenges, including cost reduction, system integration, storage, and resource optimization. The healthcare system can overcome the high-cost inflexibility and complexity associated with traditional hardware and software components by adopting low-cost cloud technologies. Cloud computing enables easy access to patient data from any location with an internet connection, empowering doctors to make informed decisions about patient diagnosis and treatment. This accessibility and flexibility contribute to the modernization and efficiency of healthcare delivery (Bamiah et al., 2012).

Cloud computing is the backbone for numerous healthcare applications, including telemedicine, electronic medical records (EMR), clinical research, and medical imaging. Cloud storage facilitates the secure storage and sharing of patient data, supporting daily consultations, follow-ups, and educational initiatives. Additionally, cloud-based solutions enable quick prehospital diagnosis and centralize ECG databases, revolutionizing telecardiology. Cloud-based collaboration tools enhance team-based care and mobile health delivery, improving patient care outcomes by fostering collaboration and communication among healthcare practitioners. Overall, cloud computing in healthcare offers scalability, accessibility, and efficiency, leading to innovative advancements and improved patient care delivery (Daman et al., 2016).

### 2.1.8 Cybersecurity

Remote patient monitoring (RPM) has emerged as a crucial telemedicine component, offering enhanced patient care while reducing healthcare delivery costs. RPM leverages technology to remotely monitor patients from their homes, progressing access to high-quality healthcare services. However, as RPM technology progresses, cybersecurity becomes increasingly crucial concerning the confidentiality and integrity of patient data transmitted by these monitoring devices. The significance of cybersecurity in RPM systems highlights the FDA's definition, which involves protection against unauthorized access or exploitation of medical device data (Ondiege et al., 2017).

Despite the evident benefit of RPM, the healthcare sector faces increasing cybersecurity challenges, particularly with the rising incidence of cyberattacks targeting medical equipment integral to the RPM system. Recent studies have revealed that an astonishing 94% of health organizations are experiencing cyber-attacks, underscoring the vulnerability of RPM devices to remote exploration. These attacks risk patient privacy and raise critical concerns regarding

patient safety, especially when cyber criminals infiltrate essential medical devices like dialysis machines. Consequently, there is an urgent need for robust cybersecurity measures to protect the RPM system and ensure the safety and privacy of patient data (Ondiege et al., 2017).

### 2.1.9 Blockchain

Telemedicine has emerged as a significant tool in modern healthcare technology, aiding real-time data exchange from various on-body sensors and remote access to medical records like electronic medical records (EMR)or electronic health records(HER). However, the extensive sharing of sensitive medical data has brought significant challenges regarding privacy, security, scalability, and interoperability. The chief concerns are Protecting patients' necessary medical data from unauthorized access and ensuring seamless integration between different healthcare systems, which must be addressed for telemedicine to accomplish its full potential (Rifi et al., 2017).

Blockchain technology is promising to address the challenges and enhance healthcare data management security. Its decentralized structure and cryptographic algorithm offer high security, making it challenging for malicious attackers to alter or corrupt the data without detection. By creating an immutable chain of blocks containing encrypted data, blockchain ensures the integrity and privacy of healthcare data, minimizing the risk of unauthorized access or manipulation. Additionally, blockchain transparency enabled real-time data monitoring and verification, permitting healthcare institutions to track data transfer and swiftly detect illegal access or manipulation challenges. Moreover, automating security protocols and enforcing laws and regulations through blockchain-based intelligent contracts further enhance data security and compliance measures (Telo, 2017).

## 2.2 Technology Application into Specialties

### 2.2.1 Telemedicine in General Practitioners

Telehealth is a more beneficial technology in primary health care (PHC) due to reasons previously mentioned, as seamless access to health services for people in remote places to self-management promotion, preventive treatment, patient empowerment, cost reduction of unnecessary referrals, long-term assistance, while lowering the need for commuting to seek medical care and treatment (Milella et al., 2021).

Physicians can communicate information via telehealth channels to share better clinical education with patients; when a patient is interested in a doctor's advice about a non-emergency medical problem, it does not substitute a face-to-face consultation but complements it for faster diagnosis, disease prevention and quicker therapeutic interventions. For example, telephone-based care and telemonitoring of vital signs in people with heart disease decreased the risk of mortality and hospitalization and increased quality of life (Beheshti et al., 2022).

Telehealth services also provide a new communication approach between healthcare professionals, patients, relatives, and caregivers, facilitating the sharing of vital critical knowledge, clinical stories, and personal experiences. This technology can also encourage physicians to hire, recruit, and stay in remote and rural areas by allowing them to contact with and retain in remote and rural areas. This enables them to communicate virtually with coworkers or classmates and pursue long-distance education. The general health field can also deal with the issue of limited resources and insecurity and save time and money on travel (Beheshti et al., 2022).

This technology allows people to take blood pressure medicine, refill medications, and recall appointments. In addition, patients can describe their symptoms to doctors by email, take a series of self-tests, and enroll in step-by-step training services tailored to their specific condition. For all these circumstances, electronic health technology simplifies chronic illness management by placing care monitoring applications and smartphones in the hands of patients (Hallem, 2021).

### 2.2.2 Telehealth in Physiotherapy

The healthcare industry, particularly physical therapy, has seen significant evolution due to technological advancements and historical events of the last decades with accelerated adoption of telehealth services, allowing telerehabilitation to emerge as a critical area of focus (Cottrell & Russel, 2020). It offers a variety of advantages, such as affordability and cost reduction. It reduces inconvenience associated with clinic travel, thereby making care more accessible, especially to underprivileged communities and those in low- to middle-resourced countries (Cottrell & Russel, 2020). However, they faced risks and uncertainties, like extensive restrictions due to regulatory practical barriers, lack of technological resources in clinics, and general unfamiliarity with the technology with the professionals (Cottrell & Russel, 2020).

The convenience of care from home and full-time access to exercise and educational materials increases patient engagement (Roytman et al., 2021). Moreover, telerehabilitation enhances interactivity through on-demand communication and artificial intelligence (AI) to provide feedback during exercises and treatments (Roytman et al., 2021). However, solid clinical evidence is needed for telerehabilitation to gain wider acceptability. Studies have shown that physical therapy assessments conducted via telerehabilitation can be reliable and valid for

various conditions, though challenges remain in assessing certain areas with high accuracy (Saaei & Kappla, 2021).

Despite these advantages, telerehabilitation faces challenges, including the lack of physical contact, which is crucial for specific assessments and therapeutic interactions; the limitations include that some clinics have begun to dabble with the use of telehealth, primarily as a supplementary tool to traditional in-person treatment, but with time they improved telerehabilitation techniques, involving the use of primary video conferencing platforms, allowing physiotherapists to consult with patients remotely by training to use the telehealth platforms effectively (Roytman et al., 2021).

Additionally, virtual sessions may miss context-related factors in in-person therapy, such as the therapy environment and direct physical interaction. To overcome these challenges, a hybrid model incorporating in-person and virtual care is suggested, along with the development of online platforms offering commodity, security, and satisfactory treatment results (Cottrell & Russel, 2020).

### 2.2.3 Telehealth in Chiropractic

Integrating chiropractic care and telerehabilitation before the pandemic had significant impacts on healthcare accessibility since the chiropractic profession had already begun embracing innovative approaches to healthcare delivery among innovations in telerehabilitation and musculoskeletal telehealth services before the global upheaval caused by the pandemic (Roytman et al., 2021).

This adaptation period it marked a significant transition between more accessible and flexible healthcare solutions, particularly musculoskeletal and mobility issues, among the most common reasons for medical consultations (Simpson, 2012).

Chiropractic practice has traditionally been in-person and hands-on, emphasizing diagnosing, treating, and preventing mechanical abnormalities of the musculoskeletal system, particularly the spine (Simpson, 2012). This interest originated from the need to contact patients who could not attend in-person appointments due to geographical, physical, or temporal restrictions (Roytman et al., 2021).

Cottrell & Russell (2020) affirm that the creation of musculoskeletal telemedicine services “established a new era in chiropractic therapy.” These services include consultation, exam solicitation, risk assessments, individual guidance, and rehabilitation activities appropriate for the patient's unique treatment needs. This system also uses video conferencing to create a real-time virtual environment where patients can engage with their healthcare practitioners (Cottrell & Russell, 2020).

The benefits of telehealth in chiropractic care by Cottrell & Russell (2020) include “patients' quick involvement and recognition of the advantages of the virtual appointments, reporting the telehealth visits and accessibility being helpful thoroughly addressing their concerns.” The possibility to consult with a chiropractor from the safety and comfort of their home was a much-needed strategy when in-person visits posed potential health risks and locomotion abnormalities (LaFebvre et al., 2012). Furthermore, this approach proved to be an efficient way to sustain treatment, ensuring that patients stay actively involved in their recovery process (LaFebvre et al., 2012).

Operationalizing the telehealth process demands team conduction to create teamwork and collaborate to remain engaged in their rehabilitation processes (Galiny, 2019). The effective incorporation of telemedicine services into chiropractic care was primarily due to the successful integration of telehealth services, mainly due to regular interprofessional collaboration and strong relationships between clinic owners and clients' corporations (Cottrell & Russell, 2020). This collaborative approach helped to operationalize telehealth services, making them a viable choice in an integrated healthcare system. Healthcare experts expedited the process by collaborating closely on everything from appointment scheduling to virtual visits and follow-ups (ChiroTouch, 2022).

The pre-pandemic use of telehealth in chiropractic care proved its potential to transform healthcare delivery (ChiroTouch, 2022). The lessons learned during this era will likely affect future procedures (Canadian Institute for Health Information, 2022). Telehealth services have increased the reach of chiropractic treatment and emphasized the value of adaptation and innovation in healthcare (Canadian Institute for Health Information, 2022). The success of these services underscores the need for continued collaboration among healthcare practitioners, technology specialists, and administrative agencies in improving the quality and accessibility of treatment for people worldwide (Canadian Institute for Health Information, 2022).

Simultaneously, telerehabilitation and musculoskeletal telehealth services established a new norm for chiropractic therapy before the pandemic. It looked forward to a future where healthcare is accessible, patient-centered, and adaptable to society's changing (Cottrel & Russel, 2020).

### 2.2.4 Tele Mental Health in Psychology and Counselling Approaches

Telehealth, when applied to mental health specifications, must include video and phone connections to facilitate the relationship between the provider and client/patient (Barnett & Huskamp, 2020). Mental health services providers may refer to this type of delivery as elemental health, counseling approaches, telepsychiatry, teletherapy, or telepsychology (Barnett & Huskamp, 2020). In addition to the implementation of new steps due to technological innovation, telehealth adoption has been gradual for the public, with most efforts beginning in the decades of the 1960s and 1970s (Shore et al., 2020).

Early testers and adopters were required to pay for expensive equipment without a transparent consistency of use (Waldeck et al., 2020). Additionally, some government-funded initiatives were urged to expand telehealth access to encourage the program expansion. However, that care delivery model dissipated when funding was unavailable (Shore et al., 2020). Barnett and Huskamp (2020) stated that “early telehealth services were provided primarily in small provinces, rural states, underserved counties, and publicly owned clinic facilities.” Due to certain precariousness limitations, telehealth had a slow increase over time, including the use among substance use disorder treatment providers, especially in long-distance and rural areas (Barnett & Huskamp, 2020).

Telemedicine in psychology, often called telepsychology, has been a developing field for several decades before the global pandemic (Shore et al., 2020). This mode of service delivery uses technology to provide mental health services from a distance, increasing accessibility for patients who may not have been able to attend traditional in-person sessions (Shore et al., 2020).

Telepsychology and counseling modalities gradually gained acceptance in various societal spheres as they eliminated geographical and logistical barriers (Wennersbusch, 2021). Primarily due to its potential to reach underserved or remote populations, individuals with transportation constraints, and elderly individuals with mobility issues. Secondly, before the public health crisis (Barnett & Huskamp, 2020).

This flexibility in a variety of therapeutic interactions, crisis intervention or in aura symptoms, avoiding starting a new crisis, and group or individual therapy sessions allows telepsychology uses various technology software to be implemented, including video conferencing, practical classes, phone calls, chat platforms, and even text messaging to communicate with clients (Shore et al., 2020).

One of the initial challenges for telepsychology was the technology's cost of implementation, which required a substantial investment in quality hardware and software, which was a financial and knowledge barrier for many practitioners and students adapting to the new market trends. However, with the advancement of technology and the democratization of services, most costs have drastically decreased to a more accessible margin for clinicians and patients (Shore et al., 2020).

Despite these advantages, mental health applied to telepsychology and virtual counseling before the pandemic was not absent of its challenges and difficulties. Issues like patient privacy regulations, video and information confidentiality, maintaining treatment efficacy in a virtual setting, and dealing with technology-related issues were all concerns for practitioners and experts in this expansion field (Shore et al., 2020).

Moreover, there were also legal provinces jurisdictions and ethical considerations to address, such as ensuring secure data transmission and session recording, if necessary, obtaining informed consent for each treatment or change during the virtual modality adaptation, and navigating jurisdictional issues related to approvals, licensure by providing services into and across state or provinces (Shore et al., 2020).

Nonetheless, telepsychology's potential to access mental health services, reduce healthcare disparities and timeline to reach the services and finally provide flexible care options formally recognized to patients who prefer or can not go to a personal consultation (Shore et al., 2020).

One example of successful implementation is a program called PHEIC, which allows mental health providers to revisit their models of previous emergency and disaster response. It included steps: an immediate call to action between administrators and support clinicians' professional development, some types of consultations such as individual, family, and group assessments/diagnosis, and therapy for socially isolated clients (Shore et al., 2020). The initial challenge for providers or administrators was determining organizational and individual spheres plans to improve or change and assessing capacity to diversify their structures for delivering care at a distance (Waldeck et al., 2020).

### 2.2.5 Telemedicine in Surgery Consultation

Telemedicine technologies have been used in surgical care, enhancing pre- and postoperative consultations (Asiri et al., 2018), monitoring, teleconferencing, and teaching across provincial and national borders (Aziz & Ziccardi, 2009). In 1998, Robie et al. acknowledged that telemedicine offered an "appropriate diagnosis for newborn surgical consultations." This saved

patients' time and resources and satisfied them with the preoperative process. Bullard et al. (2013) discovered that "mobile-phone images of CT scans were sufficient for neurosurgeons to make patient decisions, reducing the need to transfer patients from referring institutions by 30-50%." It is crucial to develop the diagnosis and treatment in an online platform based on an informed consent agreement in mutual part and confidentiality privacy policies.

When telehealth is used to give perioperative care in surgery, it saves time and avoids direct interaction between healthcare workers and patients. The growing popularity of telehealth raises ethical and legal concerns for doctors and patients. Demartines et al. (2000) discussed the "accuracy of assessing organ structure and function before digestive or endocrine surgery as a method of accessing preoperative diagnosis via telemedicine," exhibiting similar accuracy as in-person clinics.

Then, as exposed by the previous articles, the various benefits of using telemedicine in pre-and post-operative consultations, including follow-up, show evidence of reduced travel time and distance and broadened access to specialized services (Demartines et al., 2000). Moreover, the safety and effective routine can allow more restful postoperative recovery than a clinical appointment, for example, when patients need to save their voices, especially in laryngectomy, thyroidectomy, and parathyroidectomy (Demartines et al., 2000). As telehealth is gaining visibility worldwide, the evolving ethical, moral, and medico-legal challenges are progressively increasing from this alternative mode of doctor-patient interaction that can not be underestimated (Demartines et al., 2000). Likewise, by creating regulatory medical-legal bodies, clinics, and hospitals can offer a safer environment for the parts involved, and telehealth service providers practice their job familiarized with an ethical guideline named the Ethical Guidelines on Practice of Telemedicine, executed by the Medical Council of Hong Kong (Demartines et al., 2000).

# Chapter 3

## 3.1 Navigating the Telemedicine During the COVID-19 Pandemic

The COVID-19 pandemic has revolutionized how healthcare services are provided to patients. Although telemedicine services were in use before the pandemic, the spread of the virus has further surged the demand for telemedicine services. Telemedicine has emerged as the most essential element to maintaining the continuity of healthcare and lowering the risk of virus transmission. This change has allowed businesses to research, innovate, and gain customers by offering healthcare services. Worldwide adoption of telemedicine to address the rising demand for distant healthcare services has motivated firms to research, innovate, and develop platforms supporting telemedicine infrastructure (Hincapié et al., 2020).

Furthermore, the telemedicine market is expected to grow even after the pandemic as there was considerable acceptance and favor and preferable comments provided by the patients and healthcare practitioners supporting this idea. Thus, businesses now have an exceptional opportunity to invest in healthcare technology, creating promising solutions to meet the specific demand for telemedicine. By taking advantage of this momentum, businesses can prepare for long-term goals, success, and growth in virtual healthcare services (Hincapié et al., 2020).

## 3.2 Advancing Digital Health Amidst COVID-19 in Canada

The urge to provide immediate solutions to the prevailing public health care issue has forced Canada to shift towards digital health transformation during the pandemic. The Canadian Institutes of Health Research (CIHR), the federal health research funder, has made this shift happen by working with multiple partners to introduce COVID-19-focused research funding opportunities quickly (McMahon et al., 2020). CIHR has given $169.2 million in fast research

funding, sponsoring multiple initiatives that utilize digital health technology to crack the pandemic's complications (McMahon et al., 2020).

The ongoing research programs cover various areas, such as creating digital health interventions pitched explicitly toward harm caused to the body and mental health, telemedicine platforms, and mobile health apps. In addition, the COVID-19 main concern for health services and policy research has been established by CIHR's Institute of Health Services and Policy Research (IHSPR) (McMahon et al., 2020). This draws attention to the fact that digital health solutions are crucial in reshaping the nation's healthcare system during the pandemic.

Canada is more inclined to provide advanced digital solutions to its citizens, as evidenced by its initiatives and investments to leverage technology to protect the health of its people and strengthen its health system. By collaborating with CIHR and IHSPR, Canada aims to create the groundwork for a more responsive and integrated healthcare system (McMahon et al., 2020). Canada has set itself to combat the COVID-19 pandemic with an enhanced capacity to handle approaching healthcare issues and improve its overall healthcare services by incorporating digital health research and innovation (McMahon et al., 2020).

### 3.2.1 Video Conferencing

Video conferencing is the most significant development to offer telemedicine service during covid 19. This emerged as a solution to the pressing need for social distancing during the pandemic to protect patients and healthcare providers from getting exposed to the virus. The worldwide healthcare system was unprepared to fight against the widespread virus, thus creating the pressure to rush for personal protective equipment (PPE) and procedures guaranteeing protection to health workers and patients (Uberoi & Hausegger, 2021).

Additionally, the pandemic has drawn our attention toward novel approaches to healthcare that do not demand in-person interaction between medical practitioners and patients; this was made possible with video conferencing and telemedicine (Barbieri et al., 2021). Telehealth platforms became invaluable during the pandemic, allowing medical practitioners to engage with patients and provide essential healthcare services without risking their well-being (Barbieri et al., 2021).

Video conferencing was immensely used in Alberta, Canada, during the COVID-19 epidemic to maintain the scale of care to meet public health constraints; this brought attention to a significant move towards digital healthcare. The role of Zoom and other video conferencing technology as an integration for the Connect Care platform exhibits how telehealth has reduced the gap between patients and medical professionals (Baumgart, 2020).

This change catalyzed the entire range of virtual services besides real-time virtual care, such as on-call consultations and follow-up. Telehealth platforms incorporate all features relevant to clinic operations, including clinical information systems, electronic visits, referrals, priorities, and consultations (Sinha et al., 2020). The assortment of digital health solutions, from video conferencing for direct patient care to mobile applications for public health management, were saviors during the COVID-19 pandemic for healthcare delivery across Canada (Baumgart, 2020).

### 3.2.2 Mobile Health (mHealth) Apps

The COVID-19 pandemic was a wake-up call to notice that Canada needs technological solutions like mobile health applications to improve information sharing, contact tracing, and symptom evaluation (Kondylakis et al., 2020). As the disease was proliferating and required

social distancing, the usability, accessibility, and capacity to support these physical distancing initiatives made mobile healthcare applications prevalent (Kondylakis et al., 2020).

Mobile health apps provide various services, such as monitoring symptoms, self-assessment tools for virtual care, and medical practitioners' consultations (Kondylakis et al., 2020). These mHealth apps were developed after thoroughly examining the medical records database, application stores, and online platforms. Although the mHealth app tends to provide a wide range of services during the COVID-19 pandemic, issues were associated with its inclusion, efficacy, and interaction with the real-time healthcare system (Kondylakis et al., 2020). This draws our attention to the necessity of continual innovation in this area to maximize the efficiency of mHealth apps in combating covid 19 and other health emergencies in Canada (Kondylakis et al., 2020).

The government of British Columbia has also released an mHeath app, namely Covid-19 support, available for download on the Government website, Apple store, and Google Play. The app includes a self-assessment feature that allows residents to observe symptoms and register for coronavirus tests if needed (CTV News Vancouver Island, 2020). Referrals-only COVID-19 screening facility, available in the self-assessment tool, improved the region's testing capacity and support, as 3,300 to 3,600 tests are performed daily in British Columbia based on their recommendations (CTV News Vancouver Island, 2020).

### 3.2.3 IoT

**Figure 8**

*Commercially accessible wearable pulse oximeters*


*Note:* Adapted from Wearable sensing and telehealth technology with potential applications in the coronavirus pandemic (Ding et al., 2020). *IEEE reviews in biomedical engineering, 14, 48-70. Retrieved on 2/26/2024.*

During the COVID-19 epidemic, IOT devices were vastly used as a vital remote patient monitoring tool, particularly for patients who were under isolation or quarantine. Most critical readings, such as heart rate, breathing rate, and activity level, were continually monitored with the help of wearable technology such as smartwatches or fitness trackers with sensors (Ding et al., 2020).

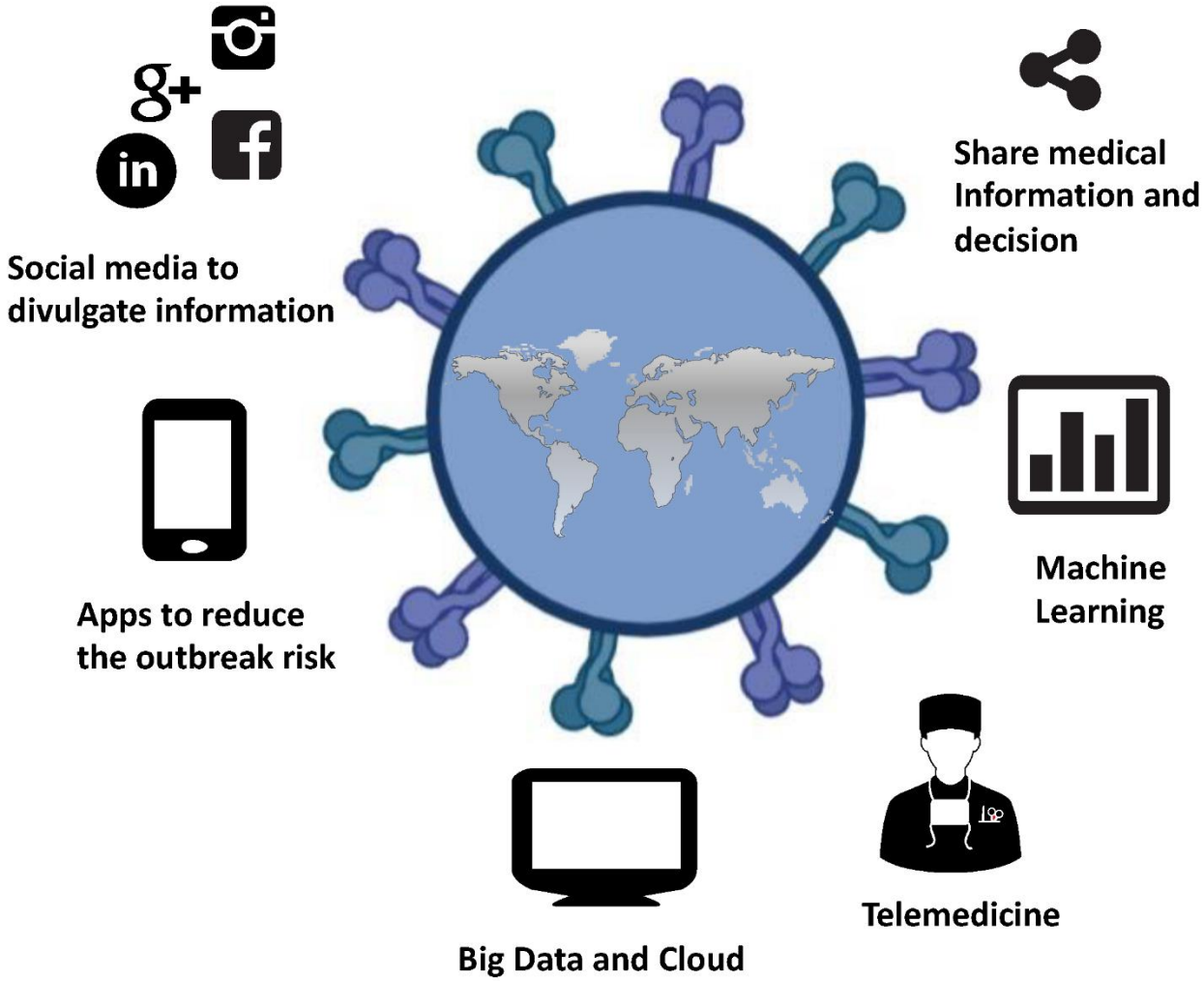
A very prominent IOT device that was exceedingly beneficial was a pulse oximeter that tracks oxygen saturation levels, which is essential to understanding the respiratory health condition of the patient during the epidemic (Ding et al., 2020). These gadgets use Bluetooth technology to connect with mobile applications and transfer real-time data to dashboards, facilitating healthcare providers to examine and act accordingly (Ding et al., 2020).

These technologies have played a vital role in minimizing physical contact and lowering the danger of virus transmission, enabling medical practitioners to continually monitor remotely located patient's health conditions and promptly respond to critical situations.

### 3.2.4 Artificial Intelligence (AI) and Machine Learning (ML)

**Figure 9**

*Artificial intelligence and new technologies versus the COVID-19 pandemic*




*Note:* Artificial intelligence and new technologies versus the COVID-19 pandemic. Adapted from "How Artificial Intelligence and New Technologies Can Help the Management of the COVID-19 Pandemic" by Barbieri et al., 2021. *International Journal of Environmental Research and Public Health, 18*(14), 7648.

Al and ML technology have become an integral part of the healthcare system in Canada because of their innovative approach to contact tracing, customized treatment, and remote patient monitoring (Chen et al., 2021). Prediction models created by AI-driven algorithms helped identify people at high risk by employing intelligent resource allocation and targeting

interventions to understand the spread of viruses better and control their spread(Chen et al., 2021).

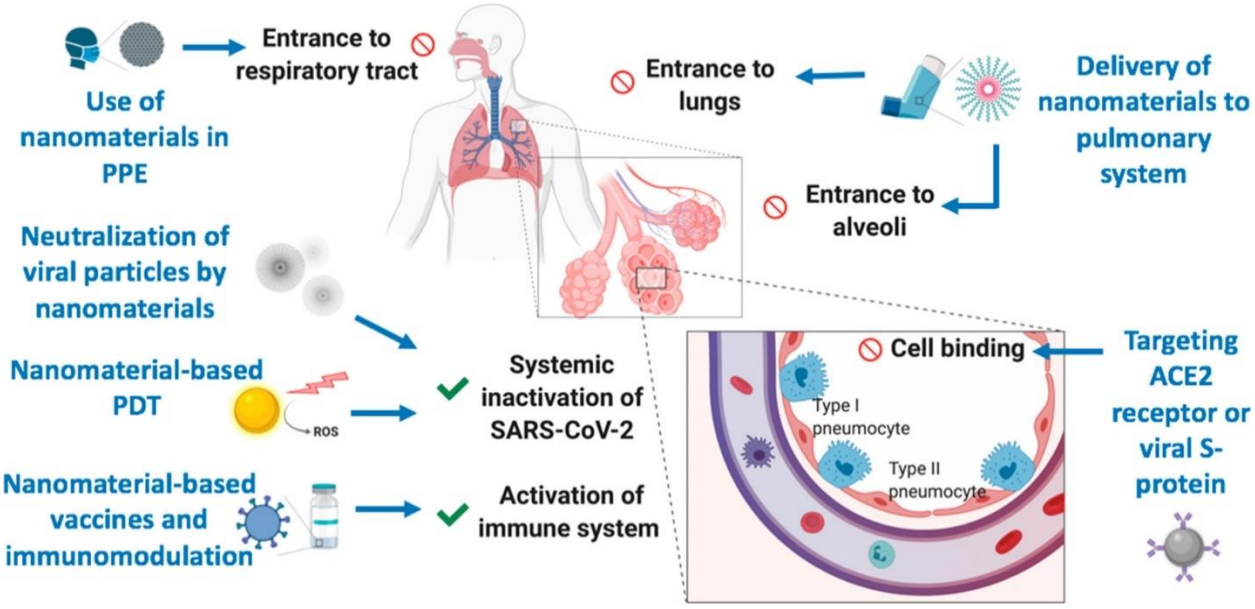
Additionally, rapid advancement in AI and ML technology has opened doors to make it possible to automate the diverse functions in healthcare operations, lessening the load on healthcare providers and contributing to overall patient care (Chen et al., 2021). These transformations have changed the Canadian healthcare response to COVID-19, providing the international medical practitioner community with crucial information on combating the virus and response guidelines.

### 3.2.5 Nanotechnology

In Canada’s fight against COVID-19, nanotechnology has proven promising by providing creative solutions for different stages of the virus' life cycle. Nanoparticles (NPs) can potentially transform conventional disinfection procedures in medical settings by utilizing their inherent antipathogenic qualities (Weiss et al., 2020). They can effectively inactivate viruses such as SARS-CoV-2 through processes like photothermal action or photocatalysis-induced formation of reactive oxygen species (ROS) (Weiss et al., 2020). This ability creates opportunities for developing innovative disinfection techniques that can be safer, more sustainable, and highly successful.

**Figure 10**

*Nanomaterials for prevention and therapy of COVID-19*




*Note:* Integrating nanomaterials into personal protective equipment (PPE) can prevent the entrance of SARS-CoV-2 into the respiratory system. Retrieved from "Toward Nanotechnology-Enabled Approaches against the COVID-19 Pandemic" by Weiss et al., 2020. *ACS Nano, 14*(6), 6383–6406.

Moreover, nanotechnology can also be used to improve treatment approaches against COVID-19. Targeted drug interactions between the virus protein spike and angiotensin-converting enzyme 2 (ACE2) receptors can be done by engineering nanomaterials delivered directly to the pulmonary system (Weiss et al., 2020). This strategy may reduce viral replication in infected individuals, improving respiratory symptoms. Furthermore, as defined by Weiss et al. (2020) "nanoimmunity by design allows efficient immune response modulation.” Nanomaterials could activate or repress immune responses as needed in vaccine development efforts, which could be helpful in the fight against COVID-19 while providing insightful information for Canada's future pandemic preparedness plans.

### 3.2.6 Robotics

The COVID-19 pandemic has highlighted the significance of robotics in the healthcare industry, especially in preventing the transmission of infections and safeguarding the frontline staff. Medical facilities increasingly use robots to maintain a physical barrier between themselves and their patients to reduce the spread of pathogens while providing essential services (Zemmar et al., 2020). These robots limit contact by acting as a barrier and reduce the need for extensive personal protective equipment (PPE).

Furthermore, artificial intelligence (AI)-enabled robots can be incorporated into different stages of patient care, such as pre-operative evaluations, intra-operative procedures, and post-operative recuperation (Zemmar et al., 2020). This can help reduce the possible transmission of infectious diseases and assist in patient management during demand spikes for medical services.

### 3.2.7 Cloud Computing

The COVID-19 epidemic has accelerated the transformation of Canada's telehealth services, expediting the adoption of cloud computing (Khabeer, 2022). To address the rising demand for remote healthcare services, healthcare providers have turned to cloud-based telehealth technologies by combining cloud infrastructure with Internet of Things (IoT) capabilities and Artificial Intelligence (AI) techniques like Machine Learning (ML) and Deep Learning (DL) (Khabeer, 2022). This method, known as "cloud telehealth," allows patients and healthcare providers easy access to medical consultations and data management.

Due to the versatility and scalability of cloud platforms, telehealth services have advanced to unprecedented levels, enabling remote patient monitoring, diagnosis, and treatment while lowering the danger of virus transmissions. The implementation and growth of cloud telehealth solutions throughout Canada have been aided by top cloud service providers, including

Google Cloud, Microsoft Azure, and Amazon Web Services (AWS) (Khabeer, 2022). The persistence of ongoing difficulties, notably those in data security, privacy, and regulatory compliance, necessitate ongoing research and innovations to maximize the effectiveness and reliability of cloud-based telehealth services during the pandemic and beyond (Khabeer, 2022).

### 3.2.8 Cybersecurity

Throughout the COVID-19 pandemic, cybersecurity proved essential to telemedicine in guaranteeing medical services' availability, confidentiality, and integrity. However, with the increased use of telemedicine came an increased risk of cyberattacks. Hackers frequently took advantage of the loopholes in telehealth systems, as evidenced by data breaches and illegal access to virtual meetings (Keenan, 2020). This security lapse jeopardized patient privacy, causing delays in treatment, and eroded confidence in telemedicine platforms. Consequently, to protect sensitive patient data and secure the telemedicine infrastructure, cybersecurity measures must be given a top priority (Keenan, 2020).

This includes installing intrusion detection systems, multi-factor authentication, potent encryption techniques, and frequent security assessments. Healthcare companies must also invest in personnel training and awareness initiatives to encourage healthy cybersecurity practices among employees and reduce the human element in security events (Keenan, 2020). Collaboration between healthcare providers, technology vendors, and cybersecurity specialists is essential to effectively resist cyber threats while ensuring the durability of telemedicine services beyond the pandemic (Keenan, 2020).

### 3.3 Challenges of Telemedicine Implementation

Since before the pandemic, there has been a noticeable opportunity for improvement in ICT implementation and integration into the healthcare field, encouraging the readiness and willingness of various stakeholder groups to engage with and adopt new technologies, which is evident in some gaps, including human resource planning and budgeting planning (Janett & Watanabe, 2006). An often overlooks critical elements for its successful integration, such as change management, specialized training and support for diverse user groups, attention to specific functionalities and workflow patterns, besides the necessity for technology to be easy to use and universally accessible, and strategies to address last-mile connectivity issues (Janett & Watanabe, 2006).

The challenges extend beyond the initial adoption of technology to encompass the resources required to initiate and sustain change. Strategic planning must now consider the ongoing human factors and the costs associated with ensuring connectivity to the most remote users, often called the "last mile" problem (Milella et al., 2021). These considerations are just beginning to be recognized as integral components of strategic business plans within the healthcare sector (Huebner & Flessa, 2022).

Huebner and Flessa (2022) state that addressing these challenges requires four approaches: “tactic long-term actions, strategic apex, complexity, and uncertainty about consequences.” There are three steps to implement these techniques.

Firstly, there is a need for comprehensive strategic planning that includes dedicated resources for change management, tailored training programs, interdependent alliances, and support systems for various user groups within the healthcare system (Huebner & Flessa, 2022).

This planning should also focus on enhancing the functionality and user-friendliness of ICT solutions, ensuring they are integrated into existing workflows to support healthcare professionals rather than add to their burdens. Secondly, adopting universal design principles in developing ICT solutions can facilitate easier access and use across different regions and by various user groups, thereby addressing one of the core principles of the Canada Health Act called accessibility (Huebner & Flessa, 2022). Thirdly, innovative solutions are required to overcome the last-mile connectivity challenges, ensuring that remote and underserved communities are not left behind in the digital transformation of healthcare (Huebner & Flessa, 2022).

Collaboration is essential across provincial jurisdictions and with stakeholders, including healthcare providers, patients, technology developers, and policymakers. This collaboration aims to promote the alignment of policies, procedures, and standards across the country, simplifying the integration process and ensuring that ICT solutions are implemented sensitively to each region's unique needs and user group (Huebner & Flessa, 2022).

### 3.4 How does Canada opportune this technology in British Columbia?

British Columbia has a rich tradition of utilizing teleconferencing technology to aid clinical consultations for individuals in rural and remote areas, guided by diverse clinical groups with distinct objectives (Government of Canada, 2021). One such initiative is the video teleconferencing platform by Interior Health Authority, offering help with specialist insight and expertise to residents in remote regions to access health facilities and an e-teleconferencing platform (Agarwal et al., 2020). The BC Children's Hospital offers an inclusive partnership to the program, and it is intensely involved in virtual diagnosis and treatment to support residents in remote or rural provincial areas (BC Children's Hospital, n.d.). A practical strategy for evolving

tele-intensive care unit and exam analysis is aligned with an elective approach to teleconsultations from a growing list of specialties that increases expansion to the national market. Another example is Carrier Sekani Family Services (CSFS), located in Prince George, BC, which has made considerable development in the past ten years of implementation as a virtual primary care program that allows network using telemedicine to holistic and relationship-based services to remote Indigenous communities in north-central BC (Carrier Sekani Family Services, 2024). The CSFS software provides a coordination approach through videoconferencing health services to give members of the Indigenous community access to primary care consultation (Carrier Sekani Family Services, 2024). Many community members who enrolled in this program have health complications and chronic diseases.

According to Agarwal et al. (2020), a provincial program called "Rapid Access to Consultative Expertise (RACE) to enhance primary care professionals' access and referral to specialty services was created in 2010" to recruit professionals, train them and give access to real-time telephone advice to solve the demand of more than forty-three specialty activities and manages, based on more than 800 calls per month." The program has been shown to save up to $200 in each call to the provincial healthcare system, with the RACE's satisfaction rate of the specialists and providers indicating that they will continue to share and use the service (Agarwal et al., 2020).

The COVID-19 pandemic has accelerated the global use of telemedicine and telehealth (Bhaskar et al., 2020), especially throughout mental health, primary care, and specialized medical and allied departments (Shaver, 2022). The increasing growth and dependence on digital health services have raised various privacy concerns about the use of technology in healthcare (Shaver, 2022). Security concerns regarding telemedicine and telehealth post-COVID primarily

focus on data security, patient confidentiality, and the possibility of unwanted access or breaches (Houser et al., 2023). The following are significant factors concerning these queries:

### 3.5 Policy development and technological implementation

The foundation of Canada's e-health strategy is developing and implementing robust policies that address critical, innovative areas of health care (MacNeil et al., 2019). These policies ensure that digital health solutions are accessible, secure, and effective in development, assessment, and implementation (MacNeil et al., 2019). A significant milestone in this journey has been the establishment of pan-Canadian guidelines that cover professional, organizational, and human resource aspects of e-health (Government of Canada, 2021), providing technological access to citizens integrated into telehealth systems, inoperability integration of different telehealth platforms, and address challenges regarding the internet connectivity, video conferencing quality, and platform reliability affecting service's delivery (Nair & Adetayo, 2019). These guidelines are a testament to Canada's commitment to a unified approach to healthcare, ensuring that e-health solutions are seamlessly integrated into the existing healthcare framework in provinces (Government of Canada, 2021).

Health regulatory bodies, including professional associations, credentialing and licensing bodies, and accreditation agencies, have played a crucial role in shaping e-health policies (Bourgeault et al., 2020). They have collectively identified seven areas for attention: credentialing, licensing, and registration; privacy and security; confidentiality, consent, and authorization; reimbursement; accreditation; liability, insurance, and negligence; and cross-jurisdictional services (Gershuni et al., 2023). The guiding principle behind these efforts is to align the policies and guidelines for technology-enabled care with those of traditional care, emphasizing public and patient safety and quality care (Gershuni et al., 2023).

### 3.6 Standardization and regulatory compliance

Another pillar of Canada's e-health strategy is the focus on standardization and regulatory compliance (Scott & Mars, 2013). By investing in organizations and structures that develop or approve health information standards, Canada aims to facilitate the adoption of quality and acceptable e-health solutions across the country to examine concerns related to data protection, confidentiality, and compliance with health privacy laws and regulations (Government of Canada, 2024, February 22). Besides that, some standard complexities surrounding medical licensing across other provinces or countries are designed to be compatible with existing health system policies, such as privacy and security, and to meet international ICT standards where appropriate reimbursement policies and insurance coverage can be applicable (Government of Canada, 2024, February 22).

The emphasis on standardization extends to ensuring that e-health solutions honor jurisdictional legislation and legal requirements. This approach highlights the importance of interoperability and the need for solutions that can operate within the complex regulatory landscape of Canada's healthcare system, preventing inappropriate medication administration, managing electronic devices to avoid measurable mistakes, and checking patient’s information stored (da Fonseca et al., 2021).

### 3.7 Addressing gaps and fostering education to a new transition model

Despite significant progress in this field, some areas require further focus due to initial knowledge or resource limitations. It is crucial to inform stakeholders about the advancements in e-health in the scope of care and treatment; likewise, delivering constraints can occur, including in procedures that require physical examination, rehabilitation, and in-person follow-up (Scott & Mars, 2013). Identifying and addressing gaps in traditional methods remains necessary to

facilitate health professionals' access to up-to-date technologies and extract the best of both scenarios, real and virtual, to fulfill the population's demand for health and ensure diagnostic accuracy based on the availability of services (da Fonseca et al., 2021).

Moreover, it is essential to adapt these advancements to different provincial and cultural contexts (Nair & Adetayo, 2019). Understanding the distinction between health and industry policies and standards is essential for progress in this sector. Addressing these areas involves a concerted effort to fill knowledge gaps and ensure all stakeholders know the current and future status of e-health policies and standards (Nair & Adetayo, 2019).

### 3.8 Partnerships for success and equitable delivery

Canadians value their healthcare benefit more than any other social program. Partnerships are at the heart of Canada's e-health initiatives because they aggregate societal alliance, collective sense of equity, and network (Government of Canada, 2023). Based on the wide range of stakeholders, including medical students, health professional associations, healthcare professionals, public sector entities, communities, and the private sector, these efforts perform to establish a collaborative environment appropriate to the successful implementation of e-health solutions for universality and equity services' access (Government of Canada, 2023). However, several areas require attention to ensure the success of these partnerships and that technological access can be equitable deliverable, including strategies related to defining cross-jurisdictional relations, sharing infrastructure platforms interprovince, and establishing effective partnerships with other public government sectors and private insurance companies (Nair & Adetayo, 2019).

Successful collaboration requires a clear point of view of expressing shared goals, respect for unique objectives, and a comprehensive understanding of different stakeholders' medical and

general terminology to facilitate clear communication and accessibility, including people with disabilities (Gershuni et al., 2023). Moreover, skills related to revenue models, contracts, policy scalability, and intellectual property issues are essential for fostering productive partnerships (Nair & Adetayo, 2019).

### 3.9 Challenges of Mitigating System During COVID-19

Since March 2020, when it was published by World Health Organization the term "pandemic" to describe the worldwide coronavirus crisis (World Health Organization, 2020), many healthcare providers have begun using telemedicine's functionalities to educate patients, consult them, and protect frontline healthcare workers about the increasing progressive effect the virus (Glazier, 2023). Continuously, telemedicine's quick rise during this period served as a dramatic illustration of how necessity can drive innovation and training adaptation, transforming a problematic scenario into a potential positive change in the face of human creativity, skills development, and adaptability to fight with a global disease's infection and the urge of technology innovation to aggregate knowledge and integrate the systems worldwide (Sarasohn-Kahn, 2020).

The pre-pandemic scenario, which was constrained dramatically by tight regulations, limited insurance reimbursements, and a lack of necessary technology in many areas, was changed to an increasingly facilitated telehealth insertion globally, becoming an indispensable resource for improving patients' surveillance, interrupting disease spread, and facilitating timely diagnosis and care management of ill people, and their potential comorbidities (Sarasohn-Kahn, 2020). Dr. Brett Belchetz, CEO of Maple, a private telemedicine company based in Toronto, which has anticipated medical consultation since 2016, proposes that "the tremendous fear of telemedicine evolution in Canada is because that has never been done nationally previously"

(Owens, 2018) and Dr. Sabrina Wong, head of the Centre for Health Service Administration and Policy Research at the University of British Columbia, acknowledge “the incredible innovation to the public system, completing gaps to address public demands.” (Owens, 2018).

The evolution of telehealth serves as an indication of hope, a dedication of a professional to learn new technological applications and train new job modalities. This patient education allows the development of new healthcare possibilities, and a reminder of what people can achieve and overcome when they collaborate to reimagine and rebuild the systems that keep them healthy (Sarasohn-Kahn, 2020).

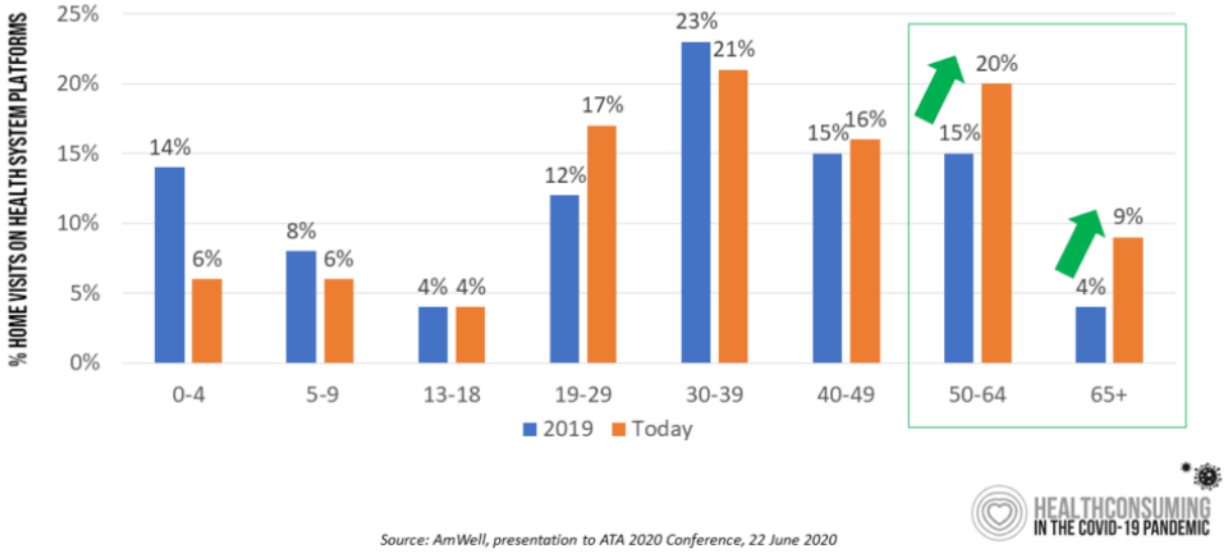
### 3.10 Challenges in Ethical Considerations

Telehealth introduces psychological and ethical considerations, including patient privacy, technological familiarity, and potential biases in treatment delivery (da Fonseca et al., 2021). Obtaining patient consent and managing the psychological impact of remote care are crucial. Ethical considerations also involve ensuring fair and universal access to telehealth services and preventing discrimination (Nair & Adetayo, 2019). In telehealth, interventions can be paired with interactions with healthcare professionals in allied treatment spheres. This allows doctors to see patients without requiring hospital or office visits. This delivery method can be helpful in mental health patients who require therapy, allowing them to participate in sessions at home at flexible times. It can also be used to monitor symptoms in cancer patients undergoing treatment. One crucial area to explore is the psychological impact of remote healthcare services on patients. This includes concerns about privacy and confidentiality (Nair & Adetayo, 2019). It is essential to consider how these factors may influence a patient's desire to use telehealth services and procedures and potential solutions to promote broader acceptance of remote healthcare (Government of Canada, 2024, March 19).

Furthermore, there are various issues related to regulations and telemonitoring, including the authorization for virtual interactions between healthcare professionals and patients needing follow-up (Nair & Adetayo, 2019). This involves ensuring that patients are fully informed and have consented to remote care and addressing potential biases in remote care delivery. The goal should be to create a telehealth system that respects the rights and needs of all patients, regardless of their location or situation (Sarasohn-Kahn, 2020).

**Figure 11**

*The Pandemic demographic expansion of Telehealth users*




*Note*: The Pandemic's advantage of virtual care platforms expansion comparing boomers and seniors between 2019 and 2020. From "How Telehealth and Health Equity Can Survive After COVID-19". Medecision, 2020. Adapted from Amwell presentation to ATA 2020 Conference, 22 June 2020.

The consensus was that older adults might find the technological requirements and demands of virtual care applications challenging to learn and manage, perhaps leading to lower adoption rates than younger, more technologically capable generations. However, in Medecision's article analysis (2020), Koloski indicates that the "pattern changed significantly

between 2019 and 2020 as the COVID-19 pandemic transformed virtual care from a simple convenience into a crucial requirement." This change highlights a greater acceptance and adaptation to technology within these age groups by the urgent desire for security and healthcare accessibility options (Koloski, 2020). The crescent growth of virtual care platforms provided an essential resource, enabling older adults to continue accessing virtual allied programs and receiving medical treatment without risking exposure to COVID-19 in clinical settings.

Furthermore, the boost in telehealth adoption by the older population has helped eliminate the myth that this age group is resentful of digital healthcare solutions. Data published by the Canadian Health Survey on Seniors - 2019/2020 acknowledge that the rapid population aging implications on health care services are nationally impacting the progress of telehealthcare services in multivariable multimorbidity predispositions to logistically visit medical specialists and receive non-emergency tests (Islam & Gilmour, 2024). This tendency also marks a significant milestone in the evolution of healthcare delivery, not only increasing reliance on telehealth services during the pandemic but also reshaping the healthcare landscape, even post-pandemic, to acute and chronic diseases by proposing accessibility, convenience, and safety (Monaghesh & Hajizadeh, 2020).

As the virus propagated and the pandemic progressed, it became evident that traditional in-person healthcare methods posed additional concerns; individual consultation and diagnosis were not enough for a globalized risky reality (Monaghesh & Hajizadeh, 2020). As a result, the urge necessity forced countries to switch to telemedicine practically immediately, making technology more accessible, ensuring quality care, and continuing to adapt to measurements and regulations to meet the needs of a changing world (Koloski, 2020). Online restrictions were relaxed, and software was created, allowing doctors to treat patients virtually across state or

province boundaries. Insurance companies boosted coverage for telehealth services, recognizing their importance in running the healthcare system. This rapid change was revolutionary, transforming telemedicine from a convenience to a lifeline (Koloski, 2020).

### 3.11 Forward Triage technology usage and Hygiene recommendation

During the COVID-19 pandemic, telemedicine has become a way of 'forward triage,' where patients are triaged before they even attend an emergency department to prevent infection propagation, side effects during treatment, and illness complications (Kishloo et al., 2020). Direct-to-consumer, or on-demand telemedicine, has become a technique by which patients can be monitored and screened despite being self-quarantined, guaranteeing hygiene techniques and sanitation adequacy recommendations (Government of Canada, 2022). This means of triage maintains patient-oriented care with protocols' steps of symptoms and potential treatment while protecting other patients and healthcare providers (Government of Canada, 2022). Telemedicine has been utilized to investigate respiratory symptoms since the initial symptoms, facilitating the detection of COVID-19 infection (Kichloo et al., 2020), besides cardiovascular and other chronic conditions, physical disabilities, mental health classes, and non-emergency surgeries (Islam & Gilmour, 2024).

# Chapter 4

## 4.1 The Pandemic Impact on Healthcare Staffing, Maintenance of Hiring and Recruitment Process for Professionals During the Pandemic and Post-Pandemic

The COVID-19 pandemic and its aftermath have significantly impacted the healthcare sector, particularly in the recruitment and retention of professionals (Hassani et al., 2021). In British Columbia, the healthcare system faced unprecedented challenges due to the increased demand for healthcare services and professionals, which recruited innovative approaches to maintain the workforce, especially with staff shortages, burnout, and the sudden increase in patient demand for online healthcare services (Vodiraju, 2022), influencing the creation of strategies during the pandemic to hire and retain healthcare professionals and maintained after that to examine how these strategies have evolved in the post-pandemic landscape.

## 4.2 Pandemic Challenges and Responses

At the pandemic's outset, B.C.'s healthcare sector grappled with a sudden spike in demand for medical professionals across various specialties, increasing costs for labor, digital engagement tools adoption, and training processes to equip staff and clinicians to use virtual health (Vodiraju, 2022). Hospitals and clinics were overwhelmed, not only with COVID-19 patients but also with individuals needing care for other conditions, amidst stringent infection control and distancing measures (Hassani et al., 2021).

The immediate challenge was recruiting additional staff and ensuring the safety and well-being of existing and prospective employees, including virtual visit orientation, digital message integration, continuing education, and remote or real-time patient monitoring (Hassani et al., 2021). In the early months of the pandemic, the B.C. Ministry of Health reported a 20% increase

in healthcare staffing requirements across the province in human resources strategy, particularly acute shortages in critical care, long-term care, surgeries, and emergency departments (B.C. Gov News, 2022, September 29).

### 4.3 Emergency Measures for Recruitment and Hiring

In response to the national labor shortage challenge, the B.C. government and healthcare institutions implemented several emergency measures (B.C. Gov News, 2022, September 29):

**Reduced Recruitment Costs:** Virtual interviews and videoconferencing eliminate the need for physical meeting space and travel expenses, significantly reducing the overall cost of the hiring process and streamlining interviews and assessments to faster decision-making (Vodiraju, 2022).

Moreover, digital advertising and social media campaigns for job openings have proven cost-effective and far-reaching, breading a rapid turnaround, which is crucial in the healthcare sector, where filling vacancies promptly can directly impact patient care quality (Hassani et al., 2021).

**Expedited Hiring Processes:** Recognizing the urgent need for healthcare workers, regulatory bodies, and healthcare institutions to streamline credential verification and licensing processes. This expedited approach enabled quicker attraction and onboarding of professionals, reducing barriers for retired practitioners, international practitioners, and healthcare career promotion, inclusive for those from other provinces (Hassani et al., 2021).

**Enhanced Incentives:** In a healthy environment to attract and retain healthcare workers, B.C. implemented enhanced benefits, including competitive salaries, hazard pay, inclusion and cultural safety, and flexible work arrangements. Additionally, mental health support and wellness

programs were bolstered to support staff facing increased workloads, burnout, and stress (B.C. Gov News, 2022, September 29).

**Training and Redeployment:** Recognizing the dynamic nature of pandemic demands, healthcare workers were offered rapid training opportunities to advance skills and qualifications. This flexibility allowed healthcare providers to meet critical needs in various care settings, including emergency departments, intensive care units, nursing and allied health, pharmacy, occupational health and safety resources, and vaccination clinics.

### 4.4 Post-Pandemic Adaptations

As BC transitioned to the post-pandemic period, the emergency response focused on sustainability and resilience in workforce planning. The lessons learned during the pandemic have informed ongoing human resources and operational strategies to maintain a robust healthcare workforce (B.C. Gov News, 2022, September 29):

**Continued Investment in Telehealth**: The pandemic underscored the value of telehealth in expanding access to care while reducing the physical and logistical burdens on healthcare professionals and services. Post-pandemic benefits for the province were the continuous investment in telehealth infrastructure, operational processes, and videoconferencing for hiring new professionals, ensuring it remains an integral part of healthcare delivery, including a flexible payment method, remote visits policies, and time-saving convenience health (Vodiraju, 2022).

**Focus on Work-Life Balance:** The pandemic empowered productivity and well-being workflows, highlighting the importance of work-life balance for healthcare staff members. Federal legislators and institutions emphasized flexible scheduling to increase performance

routine, remote appointment options for non-clinical staff, and initiatives to reduce burnout and job dissatisfaction.

**Ongoing Professional Development:** To retain hiring and retaining staff, the B.C. The government is investing in expansion and modernization based on professional development opportunities promotion and new sponsored 'Earn and Learn' Programs (B.C. Gov News, 2022, September 29), including advanced training in digital care and health technologies, provincial artificial intelligence, leadership skills to increase workforce and responsiveness, and specialized medical scopes of practice.

### 4.5 Technological Advancements bridging the gap in Healthcare Delivery

The onset of the COVID-19 pandemic catalyzed unprecedented global challenges, compelling British Columbia health sectors to innovate and adapt swiftly as frontline service providers in embracing technological advancements and patient engagement and significantly altering the landscape of healthcare delivery and professional practices.

At several steps of the patient's journey to explore this new reality of telemedicine evolution, the crucial role of digital platforms in providing psychological and mental health services and the strategic investments in telecommunication advancements illustrate the profound shift towards digital health solutions from that moment to the future (Vodiraju, 2022).

#### 4.5.1 Telemedicine: Automation and omnichannel implementation

With the imposition of social distancing measures, traditional face-to-face medical consultations became restricted, forcing B.C.'s healthcare system, in response, to vastly integrate online services and digital tools to facilitate patient convenience to remote consultations and in-

house pharmacies, flexibility to access patient-centered care, and service efficiency between healthcare professionals, customers, and stakeholders. This digital shift among digital solutions ensured uninterrupted healthcare services during lockdowns and democratized access to healthcare for remote and underserved communities in rural areas based on artificial intelligence (A.I.), big data analytics, and mobile tracing applications for several purposes, including diagnosis, disease's prevention, treatment, and follow-up (Omboni et al., 2022).

According to a report by the University of Kansas Center for Telemedicine & Telehealth (KUCTT), there was an over 300% increase in telehealth training sessions within the first eight months of the pandemic (Wright et al., 2022). B.C. Ministry of Health offered more than 80% of staff requiring support, indicating an average level of professional satisfaction of around 60% in increasing confidence and knowledge to use telehealth tools after training (Vodiraju, 2022).

The critical role of digital platforms in sustaining healthcare delivery during crisis periods was highlighted. They provided automated reminders to patients at pre-specified intervals before appointments and offered a list of available dates and times stated by the healthcare provider to reduce communication barriers. Furthermore, it enables staff to spend more time on higher-value activities (Vodiraju, 2022).

### 4.5.2 Online Counselling and Psychology Services

The psychological impact of the pandemic is a support indicator that underscores the need for readily accessible mental health services based on an overall increase in emotional disturbances, distress, panic, insomnia, depression (Urrutia et al., 2021), substance abuse, stigmatization, racism, and suicidal ideation (Kaye et al., 2020).

British Columbia Ministry of Health witnessed a surge in online counseling and psychology platforms, offering a lifeline to individuals grappling with stress, anxiety, and other mental health challenges (Urrutia et al., 2021).

Platforms such as B.C.'s Virtual Mental Health Supports provide free, confidential access to mental health services, exemplifying how digital solutions effectively allow patients to meet increased demands for psychological support (British Columbia, 2023). The seamless transition to online services addressed the immediate needs during the pandemic and set a new standard for mental health care accessibility (Gajarawala & Pelkowski, 2021).

### 4.6 Corporate Investments in Digital Health

The transformation within B.C.'s healthcare sector caught the attention of internet connectivity and privacy, telemonitoring infrastructure, interoperability, regulatory restrictions, and reimbursement, with the primary services executed by video conferencing, telephone, and remote monitoring (Kaye et al., 2021).

Market capitalization brought the growth opportunity to virtual care companies creating fee codes to let physicians and health care professionals bill provincial health insurance plans for virtual services, using these platforms, supported by Zoom or Teams platforms to license every professional to care for their patients through hospital umbrella or creating startups to step up and innovate digital health industry (Health Canada, 2023). Canadian Government recognized the potential of digital health and made substantial investments in developing health-focused platforms and applications, helping startups mature in months (Government of Canada, 2021).

Telus Health, for example, expanded its suite of digital health solutions, offering virtual care, electronic medical records, mental call lines, and pharmacy management systems, and experienced an increase of more than 600% in some provinces, including an expansion of British Columbia virtual healthcare investment over $1.2Bi for accelerating implementation of the services (Health Canada, 2023). These investments signify a broader industry trend toward recognizing health as a fundamental technological innovation and investment area, promising enhanced efficiency, patient satisfaction and accessibility, and market recognition to further management competition advancements in health (Vodiraju, 2022).

## 4.7 Post-Pandemic Adaptations and New Business Models

### 4.7.1 Virtual Hiring and Telehealth to Increase Healthcare Efficiency

The digitalization in the healthcare sector, accelerated by the COVID-19 pandemic, has introduced significant efficiencies, time accessibility, cost-saving measures in hiring processes, and operational patient care delivery. In British Columbia, these innovations have enhanced the operational aspects of healthcare and profoundly impacted the accessibility and quality of care Programs (B.C. Gov News, 2021). The advantages of these new strategies are the possibility's transformative role of telehealth platforms and technological advancements in efficiency and productivity health (Vodiraju, 2022).

### 4.7.2 Telehealth Platforms Enhancing Patient Care and Professional Efficiency

Telehealth platform services have become a cornerstone in providing healthcare services, offering significant time savings for professionals and boosting the capacity to assist more patients. The advantages of telehealth in B.C.'s healthcare industry include: (B.C. Gov News, 2022, September 29).

**Enhanced Patient Accessibility:** Telehealth services allow customers to obtain customized medical care from the convenience of their own homes, saving time and money on travel. This especially rewards people living in distant places or those with mobility challenges (Stoumpos et al., 2023).

**Efficient Management of Professional Time:** Healthcare workers may better manage appointments, focusing less on administrative chores and more on patient care. The ability to see patients remotely may decrease wait times between sessions, allowing more patients to be seen (Hallem et al., 2021).

**Reduced Costs on Operational Expenses:** Telehealth allows healthcare practitioners to minimize the requirement for physical office space, equipment, and administrative expenditures. These savings can improve service quality or increase care services (Hallem et al., 2021).

**Engagement with Patients and Customer Satisfaction:** Telehealth services are more convenient and accessible, which increases patient participation and happiness. Patients often prefer virtual visits over in-person ones and adhere to prescribed therapies, resulting in improved health results (Stoumpos et al., 2023).

### 4.7.3 Profitability and Sustainability in Digital Healthcare

The digital transformation within the healthcare sector aggregates the services provided, and the shift towards virtual hiring and the proliferation of telehealth services exemplify the increasing demand for staff recruiting. The implementation of telehealth has catalyzed the growth of new businesses and market trends and presented new paradigms for a new generation of profitability patterns and ethical considerations aligned with sustainability (B.C. Gov News, 2022, October

31). This evolution is particularly evident in B.C., highlighting where healthcare innovations have contributed to economic growth, customer satisfaction through service utilization, and set new benchmarks for sustainable healthcare delivery (B.C. Gov News, 2021):

**Reduced Operational Costs:** Digital healthcare solutions, including telehealth and virtual hiring platforms, significantly reduce operational costs. For healthcare providers, expenses related to physical infrastructure, in-person consultations, and administrative tasks are notably decreased. These savings can contribute to improved profit margins (Vodiraju, 2022).

**Expanded Market Reach:** Telehealth services enable healthcare practitioners and stakeholders to reach a broader patient base through a vast Canadian population, including remote and underserved communities. This expansion fulfills a critical healthcare demand while creating new revenue streams for digital health providers and businesses involved, insurance companies, and private services (Health Canada, 2023).

**Efficiency Gains:** Virtual hiring processes streamline recruitment, reducing the time and cost of hiring new staff. For telehealth businesses, the efficiency of digital platforms enables servicing a more significant number of patients without a corresponding increase in staffing levels, further enhancing profitability (Wright et al., 2022).

**Long-term Patient Engagement:** Telehealth services facilitate continuous patient engagement, preventive treatment, and follow-ups, potentially reducing the demand for more intensive healthcare services in a short period and associated expenditures over time and location integration. This digital model supports sustainability and emphasizes long-term health outcomes to use resources efficiently (Milella et al., 2021).

**Innovation and Continuous Improvement**: The competitive nature of digital healthcare encourages continuous innovation and development, driving technological improvements in patient care approach, service delivery, and operational efficiency. This innovation cycle supports the long-term sustainability of healthcare businesses by ensuring their time flexibility while remaining adaptable and responsive to evolving healthcare needs (Patterson et al., 2022).

### 4.8 Environmental Benefits in the Healthcare Sector

The shift towards digital healthcare delivery models has notable environmental benefits, including reduced need for travel and lower paper use due to electronic records and digital communications (Stoumpos et al., 2023). These changes contribute to a smaller carbon footprint for the healthcare industry.

#### 4.8.1 Economic and Social Sustainability

The growth of the digital healthcare sector in B.C. has broader implications for economic and social sustainability, focused not only on maximizing patient throughput and optimizing insurance reimbursements as prior but also incrementing the economic viability with a lean towards cost-effectiveness, time optimization, and resource savings (Hallem et al., 2021). By creating high-quality jobs, attracting investment, and improving access to healthcare, these innovations contribute to a more robust and resilient economy (Wright et al., 2022).

Moreover, by addressing healthcare disparities and making care more accessible, digital health initiatives support social sustainability goals, including improved health outcomes and reduced inequalities by strengthening community health initiatives and programs to address mental health and well-being on a larger scale (Hassani et al., 2021).

### 4.8.2 New Healthcare Businesses Models for the Digital Transformation Era

The quick transition toward digital healthcare solutions, prompted by the COVID-19 pandemic and sustained during and in the post-pandemic era, has fostered a favorable landscape for Canadian innovation and entrepreneurship with tangible assimilation in British Columbia (British Columbia, 2023). This digital healthcare transformation has changed traditional healthcare delivery methods and exposed new business possibilities and company approach opportunities, driving economic development, expansion growth, and enhancing patient care (Seetharaman, 2022).

### 4.8.3 Emergence of Telehealth Startups

The demand for telehealth services has led to numerous startups focused on providing virtual care platforms and patient-centered approaches, converting workforce solutions, traditionally in-person, to live virtual scenarios (Stoumpos et al., 2023). These companies have innovated in various niches within the telehealth domain, including mental health services, chronic condition management, and primary care (Public Health Agency of Canada, 2023).

Startups such as VirtualClinic+ and MindHealthBC have emerged, virtual hiring and remote workforce management, enabling practices to broaden into a talent pool to offer flexible working conditions and deliver customized telehealth services that respond to the particular needs of randomized patient populations in BC (Haldane et al., 2019). These new businesses have expanded access to healthcare services by leveraging technology to break down geographical barriers, particularly for underserved communities (Seetharaman, 2022).

### 4.8.4 Digital Health Solutions Providers

Beyond the direct patient care approach, the digital transformation solutions in healthcare have resulted in businesses dedicated to supporting the national healthcare system's infrastructure (Clark et al., 2021). Companies that provide electronic medical records (EMR) systems, digital appointment scheduling, and healthcare analytics have risen dramatically and increased profitability (Seetharaman, 2022). These significantly contribute to the efficiency and effectiveness of healthcare delivery on local and national scales, allowing providers to manage patient data better, simplify operations, and improve treatment outcomes (Shuvo et al., 2015). Companies like WELL Health Technologies have grown fast, offering digital health solutions to clinics, hospitals, and healthcare practitioners throughout BC and Canada (Clark et al., 2021).

### 4.8.5 Virtual Hiring and Workforce Solutions

Adopting virtual hiring practices has also created opportunities for new ventures specializing in digital recruitment and workforce management solutions for the healthcare sector (B.C. Gov News, 2022). Businesses such as MedHire and HealthMatch BC have developed platforms that efficiently match healthcare professionals with job opportunities (Stoumpos et al., 2023). These platforms help healthcare institutions address staffing needs and support healthcare professionals in finding roles that match their skills and preferences, contributing to overall job satisfaction and retention in the sector (Omboni et al., 2022).

### 4.8.6 Influence on Economic Growth

Following implementing a new payment model to recruit, retain, and support healthcare practitioners, the rise of new companies in the healthcare technology industry has significantly contributed to B.C.'s economic growth. These businesses have played an essential role in the

province's economy by attracting investment, generating jobs, and encouraging innovation in medical equipment and medicines (Shaver, 2022). Furthermore, as these enterprises grow and adapt, they continue to draw health informatics expertise and investment to British Columbia, cementing the region's image as a powerhouse for healthcare digital innovation and contributing to a more robust public health infrastructure (The Canadian Press, 2020).

### 4.9 Technology Partnership as Covid-19 Response

British Columbia evinced that technology has played an essential role in combating the COVID-19 crisis by linking genomics, disease, and COVID-19 datasets with a secure data-sharing model created by CGI to provide data to analyze and cure the medical syndrome. Additionally, chatbots were popular communication channels to reach an enormous audience, collect feedback, and plan improvements for scalability and live agent support (CGI, n.d.).

Multiple case studies examined how the partnership between Canadian healthcare and tech companies worked well in fighting the COVID crisis. This analysis involved using a virtual care platform, a secure messaging platform, and data science to improve public health organizations (Harish et al., 2022). Although the study could not provide more factual data, it suggests that building public and private partnerships is a reliable strategy for maintaining resilient health systems.

### 4.10 Health App Usage and Revenue Trends

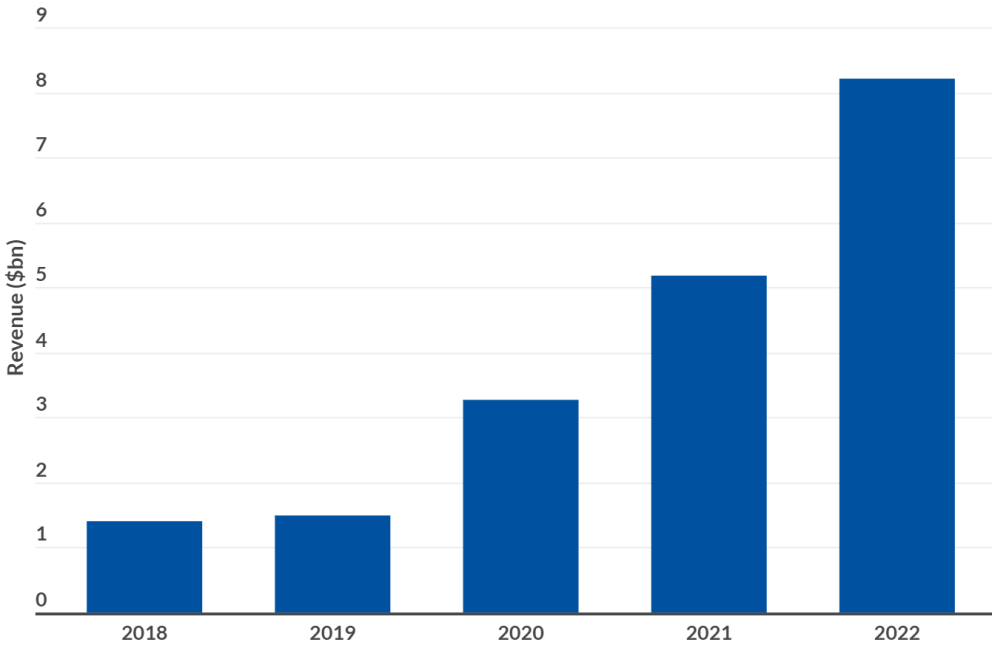
The increase in the need for self-monitoring individual health has led to the development of several mobile health applications serving numerous areas such as diet and exercise management, reproductive health, water consumption, cardiovascular health, and others. During the COVID-19 pandemic, individuals faced restrictions in gym access and gained weight due to

less activity. Some weight loss apps emerged as a solution to this problem by providing customized diet plans; however, they cannot assist in contemplating individual mental conditions (Wylie, 2024).

Wearable technology has significantly changed healthcare by offering numerous health monitoring facilities, such as smartwatches. Data gathered from wearable devices is stored in cloud storage, raising concerns about managing sensitive information collected by these apps. However, health and wellness apps attained 15% of the total health and fitness technology revenue, generating $4.12 billion in 2022 and $8.21 billion in 2023. Furthermore, the Health & Fitness App Report 2024 forecasts the revenue to rise to $35.7 billion by 2030 (Wylie, 2024). This estimate shows enormous growth potential in the health sector, allowing businesses to innovate and thrive.

**Figure 12**

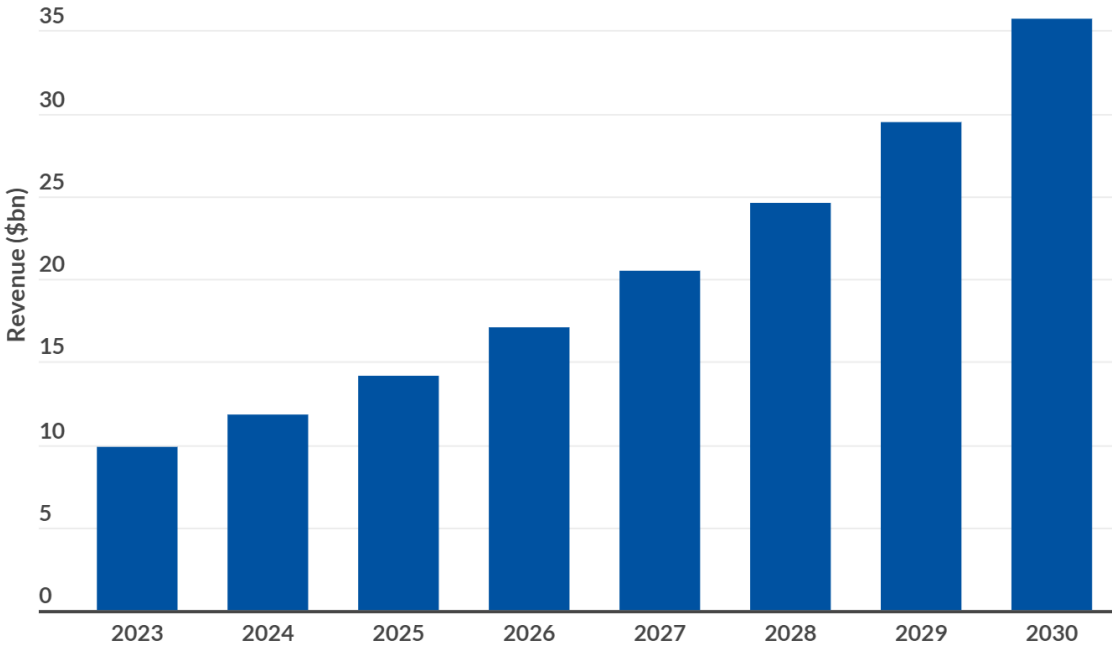
*Health App Sector Annual Revenue 2018 to 2022 ($bn)*




*Note: Adapted from "Health App Revenue and Usage Statistics" by Wylie, 2024, Business of Apps.*

**Figure 13**

*Health App Sector Annual Revenue Forecast 2023 to 2030 ($bn)*




*Note:* Adapted from "Health App Revenue and Usage Statistics" by Wylie, 2024, Business of Apps.

### 4.11 TELUS mHealth Technology

TELUS Health space® emerged as the first Canadian online platform offering access, management, and sharing of health information. It is a central hub connecting Electronic Medical Records (EMRs), Personal Health Records (PHRs), wearable health devices, mHealth applications, and existing information systems. Canada Health Infoway conferred TELUS pre-implementation certification as a consumer health platform for its services in hospitals, clinics, health authorities, and other health organizations.

The introduction of Telus Health Mycare for consumers and Telus Health Virtual Care for employers has transformed the virtual care approach, facilitating healthcare providers to safely support patients virtually, specifically during the challenging COVID-19 time. Telus'

allegiance to developing its health reach is evident in initiatives like the launch of the Telus Health LivingWell companion on Apple Watch, which grants Canadians personal emergency response service.

Additionally, Telus has scaled its Health for Good program, launching a new mobile health clinic across various Canadian cities to provide primary care and support services to individuals experiencing homelessness. Telus has bridged the gap in healthcare accessibility, especially for vulnerable populations,  and empowers individuals to take proactive control of their health. Telus's continued investment in healthcare innovation promises to revolutionize the Canadian healthcare landscape further, fostering a healthier and more equitable society for all.

### 4.12 Virtual Physicians at HealthLink BC

HealthLink BC emergency iDoctor-in-assistance (HEiDi) service was introduced in British Columbia in response to the COVID-19 pandemic, aiming to provide patients with timely healthcare advice and reduce pointless emergency department visits or clinics. From April to August 2020, callers to the 811-phone service were eligible for referral to HEiDi if classified as needing care within 24 hours by registered nurses. Virtual physicians conducted consultations via video conferencing, assessing patients' health concerns and providing appropriate advice and care. The service handles common health problems, including gastroenterology, respiratory, and dermatology (HealthLink BC, n.d.).

For phone consultations, patients are advised to choose a distraction-free private location. For video consultation, patients must install the Zoom app, test audio and video connection, and join the meeting using the provided link. Measures to ensure security include using password-

protected Wi-Fi, keeping the application up to date, and emphasizing both modes of consultation (HealthLink BC, n.d.).

An electronic medical record system (MOIS, Bright Health) was also employed to securely obtain and transfer callers' health information and summarize the paramount complaints from 811 registered nurses to virtual physicians. This is acknowledged for continuous communication and data sharing between healthcare professionals, confirming complete assessment and informed decision-making. Overall, the incorporation of this technology has enabled actual remote triage and healthcare support, improving accessibility and efficiency in healthcare delivery during the COVID-19 pandemic.

### 4.12.1 BC Virtual Visit

BC virtual visit denotes a substantial development in mobile health (mHealth), offering patients convenient and secure video consultations with Island Health and affiliated healthcare providers from any location with Internet access. This innovative solution permits patients to use their personal smartphones, tablets, or computers for virtual visits, rationalizing the healthcare delivery method and dropping barriers to access care through synchronized provisions with healthcare providers or Island health clinic patients can seamlessly transition to virtual care aided by complete Technical Support available around the clock (Island Health, n.d.).

For healthcare workers, BC virtual visit is a more modern tool to match traditional face-to-face and telehealth visits, escalating their capability to connect with patients remotely and deliver timely care. The platform's user-friendly interface and extensive training resources allowed consultants to adapt quickly to this new mode of healthcare delivery by implementing virtual care. Island Health and its allied clinics have established an assurance that they will

leverage technology to enhance patient access and improve overall health conditions in the digital age (Island Health, n.d.).

### 4.12.2 Development made to the Island Health app after covid 19

Several new features have been added to enhance the virtual visit experience. Firstly, a doctor running late notification now alerts patients in the waiting room that their doctor is delayed, ensuring transparency and patience during scheduling delays. Secondly, the BC virtual visit username will synchronize with the island health Active Directory, supporting the profile with official records for accuracy. Additionally, training sessions offer ongoing support and education for users, allowing them to navigate the platform efficiently and effectively. These updates reflect a commitment to improving user experience and optimizing virtual delivery care with Island Health Services in 2024 (Island Health's Virtual Care Services Team, 2024).

During 2023, the Island Health virtual care service team offered updates and guidance in their newsletter covering various features BC virtual visits include. Declaration of new features such as confirmation dialogs, existing waiting room or video call support for Microsoft Edge on Mac devices, and introduction of patient-preferred name fields and provider connect page for the provider-to-provider call. Additionally, the newsletter discusses active changes like rescheduling appointments and cessation of Saturday support for patients. Virtual health technical services also deliver reminders about best practices for using the platform, such as logging in with Island Health sign credentials and requesting providers for appointments, as well as updates on upcoming changes like the implementation of a single sign-on SSO (Island Health's Virtual Care Services Team, 2023).

In 2022, the Island Health virtual care providers initiated several developments and updates to upgrade busy virtual visits' functionality and user experience. These incorporated

implementing features such as the ability to pop out participants' videos during calls for a picture-in-picture view, active speaker occupied during calls to focus on the present speaker, and the option to view an explicit participant's profile during calls for improved situation. Additionally, new notifications were presented for provider-to-provider communication, including request presence. The team also conducted a provincial assessment survey to gather feedback and improve the platform based on changing requirements, prepared through monthly drop-in training sessions. The team has also upgraded the desktop application for Island Health management computers to enhance the platform's usability, accessibility, and functionality, aligning to provide adequate care solutions for patients and providers (Island Health's Virtual Care Services Team, 2022).

In 2021, the Island Health virtual care service team was more aligned toward enhancing the functionality and integration of BC virtual visits to streamline virtual care delivery. This led to noteworthy progress in the BC virtual visit-Cerner integration, with rationalized updates to improve user experience and accessibility across desktop and iOS applications. New features, such as test calls for health professionals, an advanced patient profile search function, and an additional participant option for iOS app users, were presented to facilitate other communications. Furthermore, efforts were made to confirm platform compatibility and security, plus the transition from MyVirtual visit to BC virtual visit and updates to patient profile creation forms and data remediation processes. The team also prioritized user support and instruction by initiating live training sessions and offering quick access to Technical Support resources throughout the year. These initiatives aim to improve virtual care delivery and adapt to growing healthcare needs and technical advancements (Island Health's Virtual Care Services Team, 2021).

In 2020, the Island Virtual Care Services team started various initiatives to enhance the functionality and accessibility of BC virtual visits, aligning with the growing needs of patients and healthcare providers. These efforts included enhancing the user interface, such as improved audio and video testing for clients and adding new features like the facility for patients to rejoin a call. Additionally, the team concentrated on improving the Technical Support infrastructure, with variations in the patient Technical Support line hours of operation and contact number. They also eased learning opportunities for users with the help of live online education sessions and requested feedback to evaluate and enhance MyVirtualVisit. These activities aim to improve the virtual care experience, ensure continuity of care, and align with reporting standards while celebrating milestones like reaching 10,000 visits and beginning new intranet resources (Island Health's Virtual Care Services, 2020).

# Chapter 5

## 5 Comparative analysis of Telehealth success in both public and private sectors in British Columbia's healthcare system

### 5.1 Methodology

This study delineates methodology from three primary data sources to analyze the telehealth applicability in British Columbia's landscape and another complementary database from government statistics prevalence. The first data source was from Telus's annual reports, which concentrated on critical metrics such as health service revenue, virtual care members, healthcare lives covered, and digital health transactions. These reports provide valuable insights into Telus's performance and growth within the telehealth sector, allowing for better perlustrations of the company's financial health and operational efficiency.

Furthermore, this study leverages secondary data from Infoway's annual service, which assesses Canadians' attitudes, usage patterns, and present perceptions regarding digital health services, focusing on British Columbia. This analysis aims to evaluate the efficiency of telehealth business models across the healthcare system's private and public sectors. By comparing data from surveys conducted over the past five years, the study seeks to identify trends, assess customer behavior, and understand the evolving landscape of telehealth adoption in the province.

Through a combined analysis of Telus's annual reports and Infoway's survey data, this study provides a complete picture of the telehealth usage in British Columbia's landscape, shedding light on the factors driving success and areas for advancement. The insights collected from this methodology will inform strategic decision-making and contribute to developing

telehealth services tailored to the needs of the healthcare providers and patients in British Columbia's healthcare ecosystem.

Additionally, the third Statistics Canada database provides the evaluation criteria to analyze the effectiveness of these methods in terms of labor market utilization, how they are used in service providers' employment and retention, business models in healthcare practices, and the expected goal of improving healthcare service delivery.

This sequential evaluation methodology allows for a comprehensive understanding of the strengths and weaknesses of various healthcare practices, providing valuable insight into areas that may require improvements or changes. It also identifies if the telehealth model presents successful practices and strategies during these urgent resource allocations, which can be replicated or adapted in other healthcare settings, including staff training, market employability, and patient satisfaction, to keep pace with the demands of an ever-changing healthcare sector.

### 5.2 Source of Data

**Source 1:** The primary data source for this analysis was obtained from Telus's annual reports, mainly focusing on metrics such as health services revenue, virtual care members' healthcare lives cover, and digital health transactions. These reports offer invaluable insights into Telus's entertainment and prospective development within the telehealth sector, providing an inclusive analysis of the company's financial strength and operational efficiency. This study aims to understand the level of adoption of Telus's myCare app for online consultations within the healthcare sector of British Columbia by analyzing the changing patterns in healthcare services revenue and the increasing count of Virtual Care members. Moreover, monitoring the expansion of the Healthcare Lives covered for BC residents provides insight into how Telus's health

services are utilized in the region, stressing their impact on health Equity and services utilization within BC's healthcare landscape (Telus, 2022).

Moreover, examining the digital health transactions made through Telus before, during, and after the pandemic offers valuable insights into telehealth utilization patterns among BC residents. This data enables us to uncover emerging trends of change seen in customer preferences for digital health services, particularly in response to the COVID-19 pandemic.

**Source 2:** Infoway has persistently gathered data through annual surveys to review Canadians' sentiments, usage patterns, and perspectives on digital health services. These insights have proven invaluable in appreciating digital tools' potential to transform the healthcare landscape in Canada. This study deals explicitly with evaluating the effectiveness of the telehealth business model across the private and public sectors of British Columbia's healthcare system, spanning both pre-pandemic and post-pandemic eras. Leveraging the extensive data collected by Infoway through surveys conducted over the past five years, the analysis compares various metrics such as survey responses like virtual care services utilization, electronic personal health information access, and mental health services usage. This comparative analysis aims to provide a thorough understanding of the telehealth landscape in British Columbia, highlighting the factors contributing to success and areas requiring improvements. Ultimately, the goal is to guide strategic decision-making and healthcare providers' clinical practice in British Columbia's healthcare ecosystem (Canadian Institute for Health Information, 2023).

**Source 3:** Regarding British Columbia's healthcare sector, the data from Statistics Canada provides valuable insights into employment trends and recruitment activities. This includes information on job vacancies, employment rates, and shifts in workforce demographics specific to BC and across Canada, providing the challenges and opportunities within the province's

healthcare industry and analyzing changes over the recent years. Furthermore, it explores the impact of the COVID-19 pandemic on fluctuations in healthcare employment metrics, drawing on Statistics Canada's labor force reports. Examining the shifts in employment patterns, specifications of job openings, and staff shortages during and after the pandemic makes it possible to reveal the demographical demand, critical trends, and whether the “hybrid” telehealth system positively affects overall health outcomes.

### 5.3 Statistical Analysis using MS Excel

This study utilizes the t-test, Paired Two Sample for Means, in Ms. Excel to compare the means of various metrics across different periods. These metrics, gathered through the abovementioned data, reflect Canadians' use and perception of digital healthcare services. To perform the t-test in Excel, a unique tool called data analysis Toolpak is installed, which employs the following steps.

1. Click the data tab in Excel; if data analysis is listed in the “Analyze” section, excel already contains the required tools to perform the t-test. Otherwise, navigate to the ”File” tab then, click “options,” and finally go to “add-ins.”
2. In the “Manage” drop-down menu, choose “Excel Add-Ins” and click OK.
3. A pop-up window appears; check the box next to “Analysis Toolpak” and then click OK.
4. Once the Toolpak is installed, click on the data analysis from the data tab to perform the required analysis.

### 5.4 Telus Virtual Healthcare Service

The COVID-19 pandemic necessitated a rapid shift towards telehealth services on a global scale. Telus has positioned itself as a promising player in transforming healthcare delivery within British Columbia through technological advancements. This paper analyzes Telus's business performance trends and dynamics, revealing its impact on healthcare access, patient outcomes, and regional market dynamics.

**Table 1**

*Telus Telehealth Performance Overview*

| Metric | 2020 | 2021 | 2022 |
|---|---|---|---|
| **Health Services Revenue** | 448 | 521 | 913 |
| **Virtual Care Members** | 1.7 | 2.8 | 4.5 |
| **Healthcare Lives Covered** | 16.9 | 20.6 | 67.7 |
| **Digital Health Transactions** | 534.9 | 551.1 | 580.5 |

*Note*. Table created by retrieving data from *Dingle, M. (2022). Annual segment statistics Table. In TELUS, Making the world of difference: Annual report 2022 (p. 38). Copyright 2022 by TELUS*

#### 5.4.1 Discussion

The analysis of critical metrics for Telus's telehealth business, as in Table 1, shows several noteworthy insights. Firstly, it tells us about Telus's experience of substantial growth in Health services revenue over the past three years, with revenue surging from 448 in 2020 to 913 in 2022. The significant rise in telehealth use underscores the surging demand for such services.

This trend highlights Telus's successful strategy for capitalizing on the telehealth market (Telus, 2022).

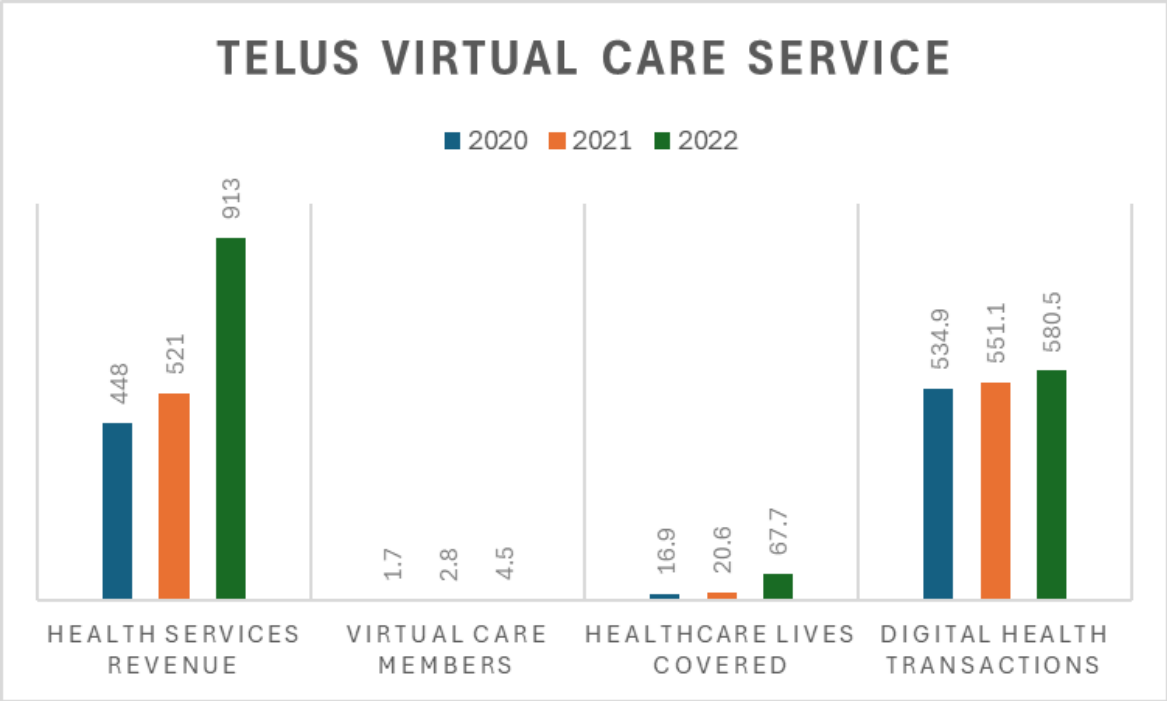
Secondly, virtual care members have grown steadily, rising from 1.7 million in 2020 to 4.5 million in 2022. This upward trend infers a growing adaptation of the tennis telehealth platform. However, for BC residents, the rise of telehealth is a direct result of its convenience, accessibility, and the growing shift toward virtual healthcare solutions (Telus, 2022).

Third, Telus has significantly increased its healthcare coverage, with life coverage rising from 16.9 in 2020 to 67.7 in 2022. This development highlights that Telus is now ensuring that more individuals get access to quality healthcare services with the help of innovative technology (Telus, 2022).

Lastly, the volume of digital health transactions has constantly risen, increasing from 534.9 in 2020 to 580.5 in 2022. This trend indicates Canadians' rising acceptance and utilization of digital healthcare services provided by the Telus telehealth platform. The growing volume of digital transactions reflects a broader shift towards digital health solutions, driven by convenience, accessibility, and the need for safer health options, particularly during and after the COVID-19 pandemic (Telus, 2022).

**Figure 14**

*Telus Telehealth Performance Overview*




*Note.* Chart created by retrieving data from *Dingle, M. (2022). Annual segment statistics Table. In TELUS, Making the world of difference: Annual report 2022 (p. 38). Copyright 2022 by TELUS*

The column chart in Figure 1 illustrates the performance of Telus *virtual care business* metrics over three years, visually portraying key indicators such as virtual care members, telehealth life covered, and digital health transactions. The chart reveals a substantial upward trend in these metrics, indicating the growth and impact of Telus's telehealth service within the healthcare landscape.

Moreover, data analysis reveals an extensive increase in virtual care memberships from 2020 to 2022, suggesting a growing acceptance and adaptation of telehealth services by British Columbians. This trend is noteworthy as the social shifts towards remote healthcare delivery, especially during and after the pandemic, with the demand for telehealth solutions following in

response to social distancing measures and the need for safer healthcare options. Furthermore, the increase in Healthcare Lives Covered by Telus telehealth service emphasizes the company's dedication to improving healthcare accessibility and addressing disparities in healthcare delivery. The outstanding increase in healthcare lives underscores Telus's role in bridging the gap in healthcare access, particularly in remote regions where traditional health services are minimal.

### 5.4.2 Inference

Based on data gathered from Telus annual reports over the past three years and calculated p-values from the paired t-test, the statistical significance of these values is centered substantially on them.

**Hypothesis**

- **Null Hypothesis ($H_0$):** There is no significant difference in the revenue growth of Telus before and after the COVID-19 pandemic, suggesting that the pandemic has no substantial impact on Telus revenue growth.
- **Alternate Hypothesis ($H_1$):** There is a significant difference in the revenue growth of Telus before and after the COVID-19 pandemic, indicating that the pandemic had a noticeable effect on Telus's financial performance.

The null hypothesis cannot be rejected as the p-value exceeds the predetermined significance level 0.05, indicating a lack of statistical significance. This suggests that any observed difference in the Telus performance metrics between the consecutive years is not statistically meaningful. Such a scenario could imply that Telus has maintained a relatively stable performance trajectory throughout the examined period, with fluctuation that falls within the bounds of normal variability.

However, it is essential to note that while the lack of significance suggests no substantial deviation in the performance, it does not inherently imply that Telus's performance has remained stagnant. Instead, it indicates that any observed change is not statistically significant at the 0.05 level.

**Table 2**

*The p-value From the Paired t-test*

| P(T<=t) one-tail | 2020 | 2021 | 2022 |
|---|---|---|---|
| **2020** | | 0.128 | 0.142 |
| **2021** | 0.128 | | 0.145 |
| **2022** | 0.142 | 0.145 | |

| P(T<=t) two-tail | 2020 | 2021 | 2022 |
|---|---|---|---|
| **2020** | | 0.257 | 0.285 |
| **2021** | 0.257 | | 0.291 |
| **2022** | 0.285 | 0.291 | |

*Note.* A table was created to perform the t-test in MS Excel by retrieving data from *Dingle, M. (2022). Annual segment statistics Table. In TELUS, Making the world of difference: Annual report 2022. Copyright 2022 by TELUS*

During the pandemic, there was a notable increase in telehealth utilization as people pursued alternative healthcare options. With its established virtual care infrastructure, Telus likely experienced growth in metrics such as members and digital health transactions. However, the extent to which the pandemic directly influenced Telus's performance metrics requires more in-depth analysis and empirical evidence. Future research could explore the specific impact of the pandemic on the Telus virtual care business and how it contributed to the observed pattern of performance over time.

**5.5 Comparative analysis of telehealth adaptation in public and private sectors based on data collected from the survey.**

Telemedicine in BC witnessed a significant transformation before the COVID-19 pandemic, marked by a steady increase in the residents' adaptation to digital health technologies and healthcare providers' platforms. A substantial increase in the percentage of individuals using healthcare provider portals increased from 10% in 2018 to 59% in 2022. This trend shows the growing awareness and preference of digital platforms among healthcare guidance, reflecting an evolving landscape in healthcare delivery (Canadian Medical Association, 2018).

Furthermore, e-mental health services emerged as one of the most used services by the residents of British Columbia, from 8% in 2018 to 39% in 2022. This increase shows the awareness and acceptance of digital mental health interventions by the residents of British Columbia. Similarly, there was a substantial rise in the proportion of people accessing their medical records electronically, increasing from 19% in 2018 to an impressive 83% in 2022. This trend depicts a shift towards patient empowerment and engagement in healthcare information management.

Moreover, the adaptation of virtual visits and consultations has also grown tremendously, reflecting an increasing flexibility in telemedicine for remote patients' access to healthcare services. These findings show that the evolving landscape of telemedicine in British Columbia was present even before the pandemic and has paved the way for future advancement in digital technologies and practices in the province (Canadian Medical Association, 2018).

**Table 3.**

*Digital Health Survey Data*

| British Columbia, my eHealth Excelleris Technologies | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| **Health Care Provider Portals** | NA | 12% | 66% | 64% | 59% |
| **Use of e-mental health service in the past 12 months** | NA | 12% | 19% | 12% | 39% |
| **Ever accessed personal medical records electronically, %** | NA | 36% | 39% | 45% | 83% |
| **prescription renewal** | NA | 12% | 17% | 19% | 19% |
| **virtual visit** | 38% | 44% | 47% | 58% | 83% |
| **telephone consultation** | 6% | 13% | 49% | 45% | 72% |
| **video consultation** | 4% | 9% | 14% | 17% | 60% |

*Note. Table created by retrieving data from the Canadian Institute for Health Information. (2019, 2020, 2021, 2023). Data compiled from the Canadian Digital Health Survey reports: 2019 Survey of Canadians Summary Report, 2020 Canadian Digital Health Survey, 2021 Canadian Digital Health Survey, and 2022 Canadian Digital Health Survey: What Canadians Think—copyright 2019, 2020, 2021, 2023 by Canadian Institute for Health Information.*

### 5.5.1 Technique Employed

To comprehend and understand the adaptation of telemedicine technology in British Columbia, this paper has divided the survey data from info over the past five years into today's segments for different years. 2019-2020 represents the pre-pandemic phase, so 2020-2021 attained the dynamic during the pandemic. Additionally, data from 2021 to 2020 offer insight

into the post-pandemic landscape call ma, allowing us to carefully examine the trend and pattern in telemedicine utilization over different phases.

### 5.5.2 Comparative Analysis of Telemedicine Utilization in British Columbia during 2019-2020

Understanding the dynamics of telemedicine adaptation during the COVID-19 pandemic and analyzing data from British Columbia spanning 2019-2020 are necessary. This analysis uses a t-test for paired-two-sample means to assess changes in telemedicine dynamics and their significance during a pandemic. The Null hypothesis $H_0$ states there is no significant difference in telemedicine utilization between 2019 and 2020, whereas the alternative hypothesis H1 shows a substantial difference between these years.

In the MS Excel worksheet, click on the data tab, go to the analysis group, click data analysis, and then a t-test for paired-two-sample means. A dialog box will appear; for variable one range, choose the column under 2019; for variable two, select the column under 2020 and set the Alpha value to 0.05. Finally, the output range will be chosen to obtain the t-test results for 2019 and 2020. It shows a moderate positive correlation, as indicated by the Pearson coefficient = 0.306, between 2019 and 2020, indicating some alignment in trends during the pandemic.

However, despite a positive correlation, the observed rise in mean shows that telemedicine utilization did not reach the statistical significance level as Commonly accepted in research ($p > 0.05$). Moderate significance levels($p = 0.041$ for one-tail, $p = 0.082$ for two-tail) reveal a potential trend, indicating a decline in telemedicine utilization during the pandemic. The null hypothesis is accepted, indicating no statistically significant difference in telemedicine utilization between 2019 and 2020. These findings reveal that although telemedicine adaptation

has increased over the years, the change has been due to technological infrastructure readiness, regulatory frameworks, and shifting patient preferences.

### 5.5.3 Comparative Analysis of Telemedicine Utilization in British Columbia during 2020-2021

Proceeding further with the analysis of telemedicine trends during the COVID-19 pandemic, the data collected from Infoway in 2020 and 2021 is utilized for performing T test for paired two sample mean. This analysis aims to understand the changes in telemedicine utilization patterns and their significance as the pandemic progresses. Null Hypothesis $H_0$ shows no significant difference in telemedicine utilization between 2020 and 2022, while the alternative hypothesis $H_1$ suggests an essential difference between these two years. The analysis outcome shows a strong positive correlation, Pearson coefficient = 0.956, between telemedicine matrices for 2020 and 2021; this indicates a high degree of alignment during the pandemic.

However, despite a slight increase in mean telemedicine utilization from 2020 to 2021, the difference did not reach statistical significance as $P > 0.05$. Moderate significance levels($p = 0.300$ for one tail, $p = 0.601$ for two tail reveal potential trends in telemedicine adaptation during pandemic years; therefore, the null hypothesis is accepted, indicating no statistically significant differences in telemedicine utilization between 2020 and 2021. This finding suggests that while telemedicine remains an important healthcare landscape during the pandemic, changes in utilization patterns were not significant enough to guarantee a substantial difference between two years.

### 5.5.4 Comparative Analysis of Telemedicine Utilization in British Columbia during 2021-2022

As the COVID-19 pandemic ended, attention shifted to understanding the flight of telemedicine adaptation in BC during the post-pandemic era. Analyzing telemedicine trends in BC between 2021 and 2022 provides essential insights into changes in BC based on some key metrics and their consequence for the future of digital health in the province. Data on telemedicine utilization in BC is analyzed statistically using a T-test for paired 2 sample means. Computed mean values, variance, Pearson correlation coefficient, statistic, and associated P value allowed for assessing the significance of the observed change in telemedicine metrics post-pandemic. The null hypothesis $H_0$ for this analysis shows no significant difference in telemedicine utilization between 2021 and 2022, while the alternate hypothesis $H_1$ suggests a substantial difference in telemedicine utilization between the two years.

The analysis discovers a moderate positive correlation, represented by the Pearson coefficient = 0.674, between telemedicine matric in 2021 and 2022, indicating a degree of alignment in trends during the post-pandemic period. Notably, there has been an increase in mean telemedicine utilization from 2021 to 2022, with the observed difference reaching statistical significance p=0.018 for two-tail tests. This surge in telemedicine utilization reflects a continuous dependence on telemedicine for healthcare delivery in BC post-pandemic. In this case, the null hypothesis is rejected, indicating a statistically significant difference in telemedicine utilization between 2021 and 2022. This finding suggests that telemedicine adaptation experienced a notable increase post-pandemic, representing an essential shift in healthcare delivery practices in BC. This surge in telemedicine utilization reflects evolving

patient preferences, improved technological infrastructure, and ongoing policy initiatives promoting digital health in the province.

### 5.6 A Comparative Analysis of Pre-Pandemic and Post-Pandemic Shift in Telemedicine Adoption

To obtain a complete picture of how a change in telemedicine has been implemented from 2019 to 2022, the analysis was conducted using the T-test paired with two sample mean samples of the mean from 2019 to 2022, revealing significant insight into the telemedicine landscape. There has been a prominent increase in variables one and two, with the mean values rising from 0.197 to 0.593, respectively. This trend shows real growth in telemedicine utilization in the past five years. Furthermore, the variance in variables one and two has also increased, indicating more significant variability in telehealth usage. This shows how the residents of BC engaged with telehealth services, reflecting the evolving preferences and needs of the province.

The Pearson correlation coefficient= 0.672 indicates a strong positive correlation between 2019 and 2022, suggesting a high association in telehealth trends over these years. This correlation stability in the healthy utilization pattern is maintained throughout the analysis. The T-test of (-5.982) with a p-value of 0.001(two-tail) indicates that the observed mean difference between variables one and two is statistically significant. This finding suggests that the increase in telemedicine utilization from 2019 to 2022 is not merely due to the chance but exhibits a genuine trend in telemedicine adaptation in BC. The analysis highlights a significant and consistent increase in telemedicine utilization in British Columbia from 2019 to 2020. This upward trend underscores the growing importance of telemedicine services in the region. It emphasizes the need for continued investment and innovation in telehealth infrastructure and services to meet the evolving healthcare needs of BC residents.

### 5.6.1 Inference

Our statistical analysis, which focuses on pre-pandemic and post-pandemic telehealth utilization in British Columbia, aimed to assess the impact of the COVID-19 pandemic on telemedicine adoption rates.

**Hypothesis**

- **Null hypothesis ($H_0$):** There is no significant difference in telemedicine adaptation in BC based on Infoway survey scores before and after the COVID-19 pandemic. This implies stable adoption rates.
- **Alternate hypothesis ($H_1$):** There is a significant difference in telemedicine adaptation in BC based on Infoway survey scores before and after the COVID-19 pandemic. This suggests a change in usage.

**Table 4**

*The p-value (one-tail) Derived from Statistical Tests*

| P(T<=t) one-tail | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|
| 2019 | | 0.041 | 0.022 | 0.001 |
| 2020 | 0.041 | | 0.3 | 0.011 |
| 2021 | 0.022 | 0.3 | | 0.009 |
| 2022 | 0.001 | 0.011 | 0.009 | |

*Note. Table created by retrieving data from the Canadian Institute for Health Information. (2023, February). 2022 Canadian Digital Health Survey: What Canadians Think (pp. 12-35), Canadian Institute for Health Information. (2021). Canadian Digital Health Survey 2021: What Canadians Think (pp. 12, 31-33, Canadian Institute for Health Information. (2020, December 2). Canadian Digital Health Survey:*

*What Canadians Think (pp. 32-36). Access to Digital Health Services: 2019 Survey of Canadians Summary Report (pp. 4-7).*

**Table 5**

*The p-value (two-tail) Derived from Statistical Tests*

| P(T<=t) two-tail | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|
| **2019** | | 0.082 | **0.045** | **0.001** |
| **2020** | 0.082 | | 0.600 | **0.023** |
| **2021** | **0.045** | 0.600 | | **0.018** |
| **2022** | **0.001** | **0.023** | **0.018** | |

*Note. Table created by retrieving data from the Canadian Institute for Health Information. (2023, February). 2022 Canadian Digital Health Survey: What Canadians Think (pp. 12-35), Canadian Institute for Health Information. (2021). Canadian Digital Health Survey 2021: What Canadians Think (pp. 12, 31-33, Canadian Institute for Health Information. (2020, December 2). Canadian Digital Health Survey: What Canadians Think (pp. 32-36). Access to Digital Health Services: 2019 Survey of Canadians Summary Report (pp. 4-7).*

The analysis of P values derived from statistical t-tests presented in Table 4 and Table 5 revealed statistically significant differences ($P < 0.05$). This statistically significant result allows us to reject the null hypothesis in telehealth utilization between pre-pandemic and post-pandemic periods.

The data analysis suggests we can dismiss the idea that telehealth adoption remained unchanged. The observed changes are unlikely due to random chance and point towards a substantial shift in telemedicine usage in BC, likely driven by the COVID-19 pandemic, as supported by the alternate hypothesis.

### 5.7 Comparative Statistic analysis from pre- to post-pandemic scenarios

One of the profound impacts of the COVID-19 pandemic from a business perspective has been significantly seen in the employment outlook and will not be taken for granted across the job reforms, hiring, and retaining processes in various healthcare sectors, including physicians, psychologists, counselors, and chiropractors, but perhaps surgeons in training (Clark et al., 2021). Because of the employment necessity growth, the increasing number of retirements, and the new virtual consultation modalities that allowed the adaptation from several services and treatments to new virtual flexibility and follow-ups, the increasing recruitment of more professionals boomed to reach the market demand forced the technological system to embrace the unemployed workers of the practical scenario through an occupational training which brought updates to average job vacancy rate and health care positions availability to the new technology advancements across British Columbia's province (Clark et al., 2021).

Continued growth and aging of the province's population, besides the restricted supply of workers, also motivated crucial changes in several areas during the pandemic, including healthcare delivery to achieve the high demand for professionals, adaptations of existing businesses, and evolution to new types of startups and entrepreneurship, worldwide concerns about social and environmental sustainability, telehealth solutions to facilitate patients adherence to treatment, and healthcare solutions to professionals in daily routine that brought space accommodation, time efficiency, and economic growth contribution (Health Canada, 2023).

#### 5.7.1 Navigating Shifts in Healthcare Employment

During the pandemic, over 351,000 healthcare positions were available in British Columbia (Statistics Canada, 2024), compared to an increase of 24,700-yearly employment recruitment before the pandemic and 22,000-yearly employment after the pandemic (Statistics

Canada, 2024) (Government of Canada, 2023). The most dramatic was represented by only 20% of the professionals who demanded to fill the gaps across the province and a rate of 15% of the patients complaining about not receiving adequate health care services (Government of Canada, 2023). By drawing a scenario of uncertainty, high levels of exhaustion, and stressful shifts, aligned to strict online education and training requirements to be able to address a considerable number of patients, procedures, and general staff shortages, with labor force reduction and increasing retirement rate, this sector represented over 11% of growing employment rate in 2020 and 2021 (Government of Canada, 2023).

### 5.7.2 Statistical Relevance

To scale the employment opportunity in British Columbia regarding the effects of telehealth and the pandemic implications in the labour market, the Statistics Canada Report 2024 over labour force characteristics throughout the years in healthcare and social assistance. British Columbia and Canada were analyzed yearly throughout 2018-2023 and compared biannually in pre-pandemic (2018-2019), pandemic (2020-2021), and post-pandemic (2022-2023) to create Table 1, as shown *in the Appendix A section.* Following the provincial examination, the authors measured Data Analysis by using Microsoft Excel 365, with the tool T-Test Paired with Two Samples for Means to achieve T Critical with one-tail and two-tail, and p-value with a *confidence level of 95%,* as shown by the **Table 2** *in the Appendix B section*.

The trend calculation on T-Tests revealed a statistical significance in employment characteristics regarding pre- and post-pandemic comparisons with a prominent increase in variables one and two, as shown in **Table 2** *in Appendix B.* The Mean Values rise from 327.9 to 370.85, as shown in **Table 2** *in the Appendix.*

### 5.7.3 Correlational Inference

Data provided by Statistic Canada (2024) and analyzed by the authors in **Table 2 in** Appendix B also reflected a *Pearson correlation of 1* in observations one and two of the Mean variables *Employment in BC and Employment in Canada* through the attached years, meaning a *linear association* and a *perfect positive relationship of the variables*, moving in the same direction for increasing demand for employment in health care providers between the period analyzed (2018-2023), with a *statistic significance* in general employment in BC and nationally in Canada due to the pandemic to pos-pandemic transition, by new job opportunities and "hybrid" healthcare adaptation in the telehealth implementation trough the highlighted years, in comparison to the pre-pandemic period.

**Table 6**

*T-test analysis for one-tail representation of Tables 1 and 2 in Appendix A & B*

| P(T<=t) one tail | 2018-2019 | 2020-2021 | 2022-2023 |
|---|---|---|---|
| **2018-2019** | | 0.33178 | **0.01296** |
| **2020-2021** | 0.33178 | | 0.11669 |
| **2022-2023** | **0.01296** | 0.11669 | |

*Note:* Table developed by the author by retrieving data from Statistics Canada. (2024, January 05). Labor force characteristics by industry, annual x 1,000.

**Table 7**

*T-test analysis for two-tail representation of Tables 1 and 2 in Appendix A & B*

| P(T.=t) two tail | 2018-2019 | 2020-2021 | 2022-2023 |
|---|---|---|---|
| **2018-2019** | | 0.66355 | **0.02592** |
| **2020-2021** | 0.66355 | | 0.23338 |
| **2022-2023** | **0.02592** | 0.23338 | |

*Note:* Table developed to show T-test analysis for two-tail representation of Tables 1 and 2 adopted from Statistics Canada (2024, January 05).

Our analysis aimed to investigate the impact of the COVID-19 pandemic on unemployment rates within British Columbia's telehealth sector.

**Hypothesis**

**Null Hypothesis ($H_0$):** The employment rate in the telehealth sector has not changed significantly pre- and post-pandemic (This implies stable job numbers)

**Alternate Hypothesis ($H_1$):** The employment rate in the telehealth sector has changed significantly pre- and post-pandemic. (This suggests a shift in employment)

The t-test comparisons conducted on Microsoft Excel 365 between the pre-pandemic (2018-2019) and post-pandemic (2022-2023) periods yielded statistically significant results, p-values 0.012962 (one-tailed) and 0.025924 (two-tailed). These p-values, falling below the conventional threshold of 0.05, allow us to reject the null hypothesis.

In simpler terms, the data suggests we could dismiss the idea that telehealth employment rates remained unchanged. The observed difference is unlikely due to random chance and points towards a substantial change in telehealth employment within BC. As supported by the alternate

hypothesis, this change could be linked to the increased demand for telehealth services during the pandemic.

Due to the scarcity of professionals and the high demand for professional duty in healthcare consultation channels, it is suggested that the research be amplified to three more variables regarding recruiting processes: full-time, part-time, and unemployment (Statistics Canada, 2024). However, these measures did not reflect statistical significance in provincial or national evaluations (Statistics Canada, 2024).

### 5.7.4 Post-Pandemic Projections

The post-pandemic scenario highlighted an increase of two over three in mainly ambulatory health care services provision and nursing and residential care facilities, compared to one-third in hospital and urgent demands (Government of Canada, 2024 March 19). Government of Canada's ongoing Analysis of key labor market indicators (2024) suggests that "the number of pandemic job seekers was insufficient to fill the job openings and retirement rates due to a shortage of workers and high demand in an occupational group in the recent pre-pandemic years and job expectancy at that time."

Projections to the post-pandemic evaluation drive trends not just related to British Columbia but the whole Canadian reality, reflecting an excellent demand projection of 25%, forecasting a population rising more than 6.5 million by 2041, with the seniors around 65% over the period (Government of Canada, 2023), and wage report to stimulate health care in hospitals, ambulatory and residential care services to increase by over twenty percent on the demand before the pandemic (Government of Canada, 2024 March 19) due to the larger population growing at an average rate of 1.5% yearly (Government of Canada, 2023).

The worker distribution across the province, beyond full-time or part-time workers, is essential to analyze the general duty distribution of these professionals in order to expose themselves. They struggle with overwhelming procedures and shifts with team members or caring for patients, operating and monitoring medical equipment, doing surgery, and participating in community needs assessment. Both pandemic and post-pandemic surveys revealed almost the totality of full-time providers and the pandemic had a female gender predominance, compared to the post-pandemic without gender relation of importance and regarding the other health care occupations, especially in the development of immunization programs, disease screening, and follow-up treatments.

Statistics Canada Labour Force Survey, Government of Canada (2023, March 19) (2024), and Job bank studies were used to basis the following projection period to highlight the period comprehending pre-pandemic, pandemic and forecast the post-pandemic comparison of the healthcare occupations, which moved towards balanced and expected conditions to increase educational and technological attainment of workers in more than 90% of the expectancy to hybrid models of care, economic professional growth, and wage value (Government of Canada, 2024 March 19).

### 5.7.5 British Columbia's response to healthcare demand and workforce challenges

Employment in general health care and allied service providers, including chiropractors, psychologists, counselors, and social assistants, were incredibly required during the pandemic time and affected in their role by the social-economic status in public services' applicability, primary and specialist care and public insurance, reflecting an average growth of hybrid services of 6,500 (1.7%) year-over-year since 2020 (Dunlop et al., 2020).

The healthcare sector deals with an acute shortage of healthcare professionals, as mentioned previously, particularly nurses and family doctors; in an estimation, 1 in 5 British Columbians do not have a family physician (Dunlop et al., 2020). In response, the Government of British Columbia announced an adaptation to new safety protocols and technology to provide care effectively and a new payment model for family doctors, set to go into effect in February 2023, based on a fee-for-service model. (B.C. Gov News, 2022, October 31).

Under the existing model, physicians are compensated mainly based on the number and type of procedures they carry out (B.C. Gov News, 2021). however, the new model will allow for compensation to vary according to additional criteria, such as the time spent with a patient, the number of patients seeing in a day and how many patients they support through their office, the complexity level of the disease or issues a patient is struggling with, and administrative costs currently paid directly by family doctors (B.C. Gov News, 2022, October 31).

In addition to the new physician payment model, the provincial Government has agreed to a tentative three-year physician master agreement (PMA) that will effectively increase support for family doctor practices by raising the Business Cost Premium, which covers operating expenditures. The agreement also includes funding for rural programs, Indigenous reconciliation, more funding for hiring employees and workplace safety, new payment rates to address issues of income disparity, and new hourly premiums for after-hours services (B.C. Gov News, 2022, October 31).

The Government of British Columbia is also facilitating the rehiring of support workers by provincial health authorities and funding stabilization announced by the province of $118 million to support family doctors with overhead costs (B.C. Gov News, 2022, October 31). Under Bill 47, up to 4,000 workers who had been privately contracted are now being rehired in a

long-term commitment, as an example of Vancouver Coastal Health and Fraser Health regions did in October 2021(B.C. Gov News, 2022, October 31).

## Conclusion

The rapid expansion of digital technologies is reforming healthcare accessibility and delivery worldwide, encouraging an evolution in care standards. The integration of telemedicine into British Columbia's healthcare system has been accelerated by the COVID-19 pandemic, improving access to primary care services, reducing costs, decreasing wait times, and facilitating staff recruitment processes. Innovative services are instrumental in safely delivering care, particularly for patients in remote rural areas who face challenges accessing in-person, long-time-waiting appointments.

Data analysis from Telus, Infoway, and Statistics Canada reveals significant growth in telehealth use, particularly a post-pandemic increasing trend, with prominent vital metrics such as health service revenue, virtual care members, and digital health transactions showing upward trends. These trends underscore Telus' effective strategy in capitalizing on the telehealth business market, becoming increasingly satisfying and profitable, and improving healthcare access and outcomes for British Columbians. Infoway's survey data and statistical analysis also offer valid perceptions of digital health services' applicability patterns, adaptation, and patient interaction, focusing on British Columbia variances.

The comparative analysis of telehealth in British Columbia across the pre-pandemic pandemic and post-pandemic periods leverages three data sources to evaluate performance metrics adaptability and employability.

The analysis of Telus's performance metrics during these periods yielded p-values ranging from 0.129 to 0.145. This range falls within an interval considered normal variation, indicating that the observed changes are not statistically significant. Consequently, we cannot

reject the null hypothesis, suggesting that Telus's performance remained stable throughout these periods.

In contrast, the analysis of critical Infoway adaptability metrics showed growth. The comparison between all years revealed p-values ranging from 0.0005 to 0.3, indicating an apparent change in telehealth use. Particularly between 2019-2020 and 2020-2021. These specific years fall below the conventional significance level of 0.05, suggesting a notable rise in telehealth use during these periods. Here, we can reject the null hypothesis, highlighting significant adaptability and growth in telehealth utilization.

Statistics Canada's analysis of employability, prompted by the urgent introduction and utilization of telemedicine, reveals evolving trends and patterns. The pre-and post-pandemic comparisons show statistical significance, with a one-tail- p-value of 0.013 and a two-tail p-value of 0.026. This indicates substantial development in telehealth-related employability trends related to telehealth. The significant growth in telehealth utilization during the post-pandemic period suggests a sustained reliance on telehealth for healthcare delivery in the province, allowing us to reject the null hypothesis for employability as well.

Through this combined analysis, telehealth is increasingly prominent, rising continuously since the transformative impact of the pandemic on its utilization in British Columbia, especially in the post-pandemic era. Based on the insights gathered from Telus' annual reports, Infoway's survey, and Statistic Canada's analysis, we aim to contribute with a database to further strategic decision-making to the development of more telehealth services and identify factors driving success and areas for improvement for healthcare providers and demographic patient distribution in the province.

This study acknowledges several limitations due to time constraints and the size of the population analyzed through secondary data. The analysis focuses primarily on the data from Telus as a single private business model, Infoway surveys, and Statistics Canada as a tool to offer an ideation of employment rates in British Columbia, comparing the national and provincial in restricted years to pre- and post-pandemic general comparison. Ideally, this study would have included data from various telehealth service providers to offer a complete picture of British Columbia's telehealth landscape. This broader perspective would have allowed for comparing different business models, hypothetically revealing variation in performance service delivery or patient demographic served.

Further, the study relies on statistical analysis, overlooking the valuable insights that user feedback could provide. Understanding patient experiences and satisfaction levels is crucial for assessing telehealth platform usability and effectiveness. Additionally, the statistically significant changes underscore the transformative impact of the pandemic on telehealth utilization in British Columbia, which is shaping the future of healthcare delivery in the province.

These limitations generate a need for further research on telehealth in British Columbia. Longitudinal studies can reveal if the recent surge in telehealth use is sustained after the immediate crisis and identify any long-term trends or challenges. Additionally, research is needed to explore the factors influencing telehealth adoption post-pandemic, such as patient preferences, healthcare provider attitudes, and system-level considerations. Understanding these drivers will inform strategies to enhance telehealth uptake and effectiveness.

Future research should leverage these data from pilot projects, gather user feedback, and track technological advancements to identify a journey of improvement to functionality and usability of telemedicine platforms, focusing on the sustainability of this surge in telehealth use

and the factors influencing its adoption post-pandemic. Additionally, comparative research examining telehealth utilization across different regions, healthcare systems, and demographic groups can provide insight into variations in telehealth adaptation and inform strategies to address disparities in access to healthcare services.

By addressing this research priority, healthcare providers and stakeholders can harness the full potential of telehealth to improve access to care, enhance patient outcomes, and build a more resilient and equitable healthcare system in British Columbia and beyond. This study underscores the importance of telehealth in transforming healthcare delivery in British Columbia. It highlights the need for continued investment, innovation, and policy initiatives to support the adaptation and integration of telehealth services into the healthcare system. By doing so, we can ensure improved access, efficiency, and outcomes for patients and healthcare providers across the province.

## References

Abraham, A., Jithesh, A., Doraiswamy, S., Al-Khawaga, N., Mamtani, R. & Cheema, S. (2021, November 8). Telemental Health Use in the COVID-19 Pandemic: A Scoping Review and Evidence Gap Mapping. *Frontiers in Psychiatry*. 12:748069. doi: 10.3389/fpsyt.2021.748069.

Agarwal, P., Kithulegoda N., Umpierre, R., Pawlovich, J., Pfeil, J. N., D'Avila, O. P., Goncalves, M., Harzheim, E. & Ponka, D. (2020, February). Telemedicine in the driver's seat: new role for primary care access in Brazil and Canada. *Canadian Family Physician. 66*(2), pp. 104-111. https://www.cfp.ca/content/66/2/104.full

AReSS Puglia. (2023, July 06). Revolutionizing patient care: unleashing the potential of digital innovation. DT4Regios. https://dt4regions.eu/dt-book/dt-stories/revolutionizing-patient-care-unleashing-potential-digital-innovation

Asiri, A., AlBishi, S., AlMadani, W., ElMetwally, A. & Househ, M. (2018, October). The use of Telemedicine in Surgical Care: a Systematic Review. *26*(3). Pp. 201-206. *Acta Inform Med. National Library of Medicine*. doi: 10.5455/aim.2018.26.201-206

Aziz, S. R. & Ziccardi, V. B. (2009). Telemedicine using smartphones for oral and maxillofacial surgery consultation, communication, and treatment planning. *Journal of Oral and Maxillofacial Surgery*, *67*(11): 2505-9. https://doi.org/10.1016/j.joms.2009.03.015

Bamiah, M., Brohi, S., & Chuprat, S. (2012, December). A study on the significance of adopting the cloud computing paradigm in the healthcare sector. In *2012 International Conference on Cloud Computing Technologies, Applications and Management (ICCCTAM)* (pp. 65-68). IEEE. https://ieeexplore.ieee.org/abstract/document/6488073/

Barbieri, D., Giuliani, E., Del Prete, A., Losi, A., Villani, M., & Barbieri, A. (2021). How Artificial Intelligence and New Technologies Can Help the Management of the COVID-19 Pandemic. International Journal of Environmental Research and Public Health, 18(14), 7648. Retrieved February 20, 2024. https://doi.org/10.3390/ijerph18147648

Barnett, M.L. & Huskamp, H. A. (2020). Telemedicine for Mental Health in the United States: Making Progress, Still a Long Way to Go. *Psychiatric Services, 71*(2) :197-198. https://doi.org/10.1176/appi.ps.201900555

Baumgart, D. C. (2020). The digital advantage in the COVID-19 response: a perspective from Canada's largest integrated digitalized healthcare system. *NPJ Digital Medicine*, *3*(1), 114. Retrieved February 26, 2024. https://www.nature.com/articles/s41746-020-00326-y

BC Children's Hospital (n.d.). Partnerships. BC Children's Hospital. http://www.bcchildrens.ca/globalhealth/partnerships

BC Gov News. (2021, November 14). Boosting support, hiring to enhance service in Northern Health. *BC Gov News*. Retrieved from https://news.gov.bc.ca/releases/2021HLTH0165-001795

BC Gov News. (2022, September 29). New health workforce strategy improves access to health care, puts people first. *BC Gov News*. Retrieved from https://news.gov.bc.ca/releases/2022HLTH0059-001464

BC Gov News. (2022, October 31). B.C. health-care system strengthened by new payment model for doctors. *BC Gov News*. Retrieved from https://news.gov.bc.ca/releases/2022HLTH0212-001619

Beheshti, L., Kalankesh, L. R., Doshmangir, L. & Farahbakhsh, M. (2022). Telehealth in a Primary Health Care: A Scoping Review of the Literature. *Perspectives in Health*

*Information Management.19*(1): 1n. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9013222/

BestdoctorOnline.com (2020). 200+ Telemedicine Providers by State. *bestodctoronline.com*. https://www.bestdoctoronline.com/resources/telemedicine-providers-by-state/

Bhaskar, S., Bradley, S., Chattu, V. K., Adisesh, A., Nurtazina, A., Kyrykbayeva, S., Sakhamuri, S., Yaya, S., Sunil, T., Thomas, P., Mucci, V., Moguilner, S., Israel-Korn, S., Alacapa, J., Mishra, A., Pandya, S., Schroeder, S., Atreja, A., Banach, M. & Ray, D. (2020, October 16). Telemedicine Across the Globe-Position Paper From the COVID-19 Pandemic Health System Resilience PROGRAM (REPROGRAM). International Consortium (Part 1). Front Public Health. 8:556720. doi: 10.3389/fpubh.2020.556720.

Bohr, A. & Memarzadeh, K. (2020, June 26) The rise of artificial intelligence in health care applications. Elsevier. pp. 25–60. doi: 10.1016/B978-0-12-818438-7.00002-2

Bourgeault, I. L., Maier, C. B., Dieleman, M., Ball, J., MacKenzie, A., Nancarrow, S. & Sidat, M. (2020, May 29). The COVID-19 pandemic presents an opportunity to develop more sustainable health workforces. *Human Resources for Health 18*(1), pp.1-8. https://doi.org/10.1186/s12960-020-00529-0

Bradbury, A., Patrick-Miller, L., Harris, D., Stevens, E., Egleston, B., Smith, K., ... & Domchek, S. (2016). Utilizing remote real-time videoconferencing to expand access to cancer genetic services in community practices: a multicenter feasibility study. *Journal of medical Internet research*, *18*(2), e23. https://www.jmir.org/2016/2/e23/

British Columbia (2023, November 29). Virtual mental health support. Retrieved from https://www2.gov.bc.ca/gov/content/health/managing-your-health/mental-health-substance-use/virtual-mental-health-supports%23gethelp

Bullard, T. B., Rosenberg, M. S., Ladde. J., Razack, N., Villalobos, H. J. & Papa, L. (2013). Digital images taken with a mobile phone can assist in the triage of neurosurgical patients to a level 1 trauma centre. *Journal of telemedicine and telecare. 19*(2):80–83. DOI: 10.1177/1357633x13476228

Burks, K., Shields, J., Evans, J., Plumley, J., Gerlach, J. & Flesher, S. (2022, May 23). A systematic review of outpatient billing practices. *SAGE Open Medicine*. doi: 10.1177/20503121221099021.

Canadian Institute for Health Information. (2023). 2022 Canadian Digital Health Survey: What Canadians Think. Retrieved April 2024 from https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/benefits-evaluation/6434-2022-canadian-digital-health-survey-what-canadians-think?Itemid=101

Canadian Institute for Health Information. (2022). Virtual Care in Canada: Strengthening Data and Information. https://www.cihi.ca/sites/default/files/document/virtual-care-in-canada-strengthening-data-information-report-en.pdf

Canadian Institute for Health Information. (2021). Canadian Digital Health Survey 2021: What Canadians Think. Retrieved April 2024 from https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/benefits-evaluation/4011-canadian-digital-health-survey-2021-what-canadians-think

Canadian Institute for Health Information. (2020, December 2). Canadian Digital Health Survey: What Canadians Think. Retrieved April 2024 from https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/benefits-evaluation/3856-canadian-digital-health-survey-what-canadians-think?Itemid=101

Canadian Institute for Health Information. (2019). Access to Digital Health Services: 2019 Survey of Canadians Summary Report. Retrieved April 2024 from https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/benefits-evaluation/3786-access-to-digital-health-services-2019-survey-of-canadians-summary-report

Canadian Medical Association. (2018, December). 2018 Canadian Physician Survey: Physicians' Use of Digital Health and Information Technologies in Practice. Retrieved April 2024 from https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/benefits-evaluation/3643-2018-canadian-physician-survey

Canada Health Infoway & Canadian Medical Association. (2021). The 2021 National Survey of Canadian Physicians: Understanding digital health and information technology use. Retrieved April 2024 from https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/benefits-evaluation/3935-2021-national-survey-of-canadian-physicians

Canada Health Infoway & Canadian Medical Association. (2021). The 2021 National Survey of Canadian Physicians. Retrieved April 2024 from https://www.infoway-inforoute.ca/en/component/edocman/resources/reports/benefits-evaluation/3935-2021-national-survey-of-canadian-physicians

Carrier Sekani Family Services. (2024). COVID-19 Support Centre. Carrier Sekani Family Services. Services section. https://www.csfs.org/covid

Chen, J., Li, K., Zhang, Z., Li, K., & Yu, P. S. (2021). A Survey on Applications of Artificial Intelligence in Fighting Against COVID-19. *ACM Computing Surveys*, *54*(8), 1–32. Retrieved February 22, 2024. https://doi.org/10.1145/3465398

ChiroTouch. (2022, September 9). *How New Chiropractic Technology has Changed the Profession.* ChiroTouch. https://chirotouch.com/resources/article/technology-has-changed-the-chiropractic-profession/

CGI. (n.d.). Helping British Columbia's health sector digitize and automate COVID-19 data. Retrieved March 5, 2024, from https://www.cgi.com/canada/en-ca/case-study/artificial-intelligence/helping-british-columbias-health-sector-digitize-and-automate

Clark, E., Singhal, S. & Weber, K. (2021, January 4). The future of healthcare: Value creation through next-generation business models. *McKinsey & Company*. https://www.mckinsey.com/industries/healthcare/our-insights/the-future-of-healthcare-value-creation-through-next-generation-business-models

College of Physiotherapists of Ontario. (n.d.). Virtual Practice. *College of Physiotherapists of Ontario.* https://www.collegept.org/registrants/virtual-practice-in-physiotherapy/

Cottrell, M. A. & Russell, T. G. (2020). Telehealth for musculoskeletal physiotherapy. Musculoskeletical Science Practice. *Elsevier*. 48:102193. doi: 10.1016/j.msksp.2020.102193.

CTV News Vancouver Island. (2020, March 23). B.C. launches COVID-19 support app. Retrieved February 26, 2024, from https://vancouverisland.ctvnews.ca/b-c-launches-covid-19-support-app-1.4864678

da Fonseca, M.H., Kovaleski, F., Picinin, C.T., Pedroso, B. & Rubbo, P. (2021, September 21). E-Health Practices and Technologies: A Systematic Review from 2014 to 2019. *Healthcare (Basel), 9*(9):1192. doi: 10.3390/healthcare9091192

Daman, R., Tripathi, M. M., & Mishra, S. K. (2016). Cloud Computing for Medical Applications & Healthcare Delivery: Technology, Application, Security and Swot Analysis. In *Proc.*

*ACEIT Conf.* (pp. 155-159). https://www.researchgate.net/profile/Repu-Chand/publication/299454908_Cloud_Computing_for_Medical_Applications_Healthcare_DeliveryTechnology_Application_Security_and_Swot_Analysis/links/56f90d4c08ae38d710a2f6c8/Cloud-Computing-for-Medical-Applications-Healthcare-DeliveryTechnology-Application-Security-and-Swot-Analysis.pdf

Demartines, N., Otto, U., Mutter, D., Labler, L., von Weymarn, A., Vix, M. & Harder, F. (2000). An evaluation of telemedicine in surgery: telediagnosis compared with direct diagnosis. *Archives of Surgery*. *135*(7):849–853. DOI: 10.1001/archsurg.135.7.849

Dhalla, I. A. & Tepper, J. (2018). Improving the quality of health care in Canada. *Canadian Medical Association Journal*, *190*(39). doi: 10.1503/cmaj.171045

Ding, X., Clifton, D., Ji, N., Lovell, N. H., Bonato, P., Chen, W., Yu, X., Xu, Z., Wang, Q., Yin, B., Feng, G. & Zhang, Y. T. (2021). Wearable sensing and telehealth technology with potential applications in the coronavirus pandemic. *IEEE reviews in biomedical engineering*, *14*, 48-70. Retrieved February 21, 2024. https://ieeexplore.ieee.org/abstract/document/9090987/

Dunlop, S., Coyte, P. C., McIsaac, W. (2020, March 27). Socio-economic status and the utilization of physicians' services: results from the Canadian National Population Health Survey. Social Science and Medicine. *Elsevier*. *51*(1), pp.123-133. https://www.sciencedirect.com/science/article/abs/pii/S0277953699004244

Gajarawala, S.N. & Pelkowski, J. N. (2021, February 17). Telehealth Benefits and Barriers. The Journal for Nurse Practitioners. Elsevier, 17(2):218-221. DOI: https://doi.org/10.1016/j.nurpra.2020.09.013

Galiny Team (2019). Chiropractic Trends: A Comprehensive Look at Emerging Innovations. Galiny Chiropractic & Massage. https://galiny.com/chiropractic-trends-a-comprehensive-look-at-emerging-innovations/

Gershuni, O., Orr, J. M., Vogel, A., Park, K., Leider, J. P., Resnick, B.A. & Czabanowska, K. (2023, February 24). A Systematic Review on Professional Regulation and Credentialing of Public Health Workforce. International Journal Environmental Research and Public Health.;20(5):4101. doi: 10.3390/ijerph20054101.

Glazier, R. H. (2023). Our role in making the Canadian health care system one of the world's best: How family medicine and primary care can transform-and bring the rest of the system with us. *Canadian Family Physician, 69*(1):11-16. doi: 10.46747/cfp.690111.

Government of Canada. (2021, July 7). Virtual care policy framework. *Canada.ca* https://www.canada.ca/en/health-canada/corporate/transparency/health-agreements/bilateral-agreement-pan-canadian-virtual-care-priorities-covid-19/policy-framework.html

Government of Canada. (2022, January 25). Infection prevention and control for COVID-19: Interim guidance for acute healthcare settings. *Canada.ca* https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/infection-prevention-control-covid-19-second-interim-guidance.html

Government of Canada (2023, February 01). *Job bank: British Columbia Sector Profile: Health Care*. Labour Market Information Section. Job bank. https://www.jobbank.gc.ca/trend-analysis/job-market-reports/british-columbia/sectoral-profile-health-care

Government of Canada. (2024, February 22). Corporate Information: Public Health Agency of Canada 2024-25 Departmental Plan. *Canada.ca* https://www.canada.ca/en/public-health/corporate/transparency/corporate-management-reporting/reports-plans-priorities/2024-2025-departmental-plan.html

Government of Canada. (2024, March 19). *Job bank: Job outlooks for General practitioners and family physicians.* Labour Market Information Section. Job bank. https://www.jobbank.gc.ca/outlookreport/occupation/24431

Government of Canada. (n.d.). Medical Doctor in Canada. Labour Market Information Section. Job Bank. https://www.jobbank.gc.ca/marketreport/outlook-occupation/24432/ca

Haldane, V., Chuah, F. L. H., Srivastava, A., Singh, S. R., Koh, G. C. H., Seng, C. K. & Legido-Quigley, H. (2019, May 10). Community participation in health services development, implementation, and evaluation: A systematic review of empowerment, health, community, and process outcomes. *PLoS One, 14*(5):e0216112. doi: 10.1371/journal.pone.0216112.

Hallem, A., Javaid, M., Singh, R. P. &Suman, R. (2021). Telemedicine for healthcare: Capabilities, features, barriers, and applications. *Elsevier*. doi: 10.1016/j.sintl.2021.100117

Harish, V., Samson, T. G., Diemert, L., Tuite, A., Mamdani, M., Khan, K., McGahan, A., Shaw, J. A., Das, S., & Rosella, L. C. (2022, December 14). Governing partnerships with technology companies as part of the COVID-19 response in Canada: A qualitative case study. PLOS Digital Health. https://doi.org/10.1371/journal.pdig.0000164

Hassani, K., McElroy, T., Coop, M., Pellegrin, J., Wu, W. L., Janke, R. D., & Johnson, L. K. (2021). Rapid implementation and evaluation of virtual health training in a subspecialty

hospital in British Columbia, in response to the COVID-19 pandemic. *Frontiers in Pediatrics*, *9*, 638070. DOI: 10.3389/fped.2021.638070

Hassanien, A. E., Dey, N., Borra, S. (2021). Medical Big Data and Internet of Medical Things. Advances, Challenges and Applications. www.aitskadapa.ac.in

Hawe, N., Seaton, C. L., Corman, K., Burton, L., & Rush, K. L. (2023). 'A lot less time on small talk': Rural patient perspectives on shifting to technology-enabled healthcare in Canada during COVID-19. *SSM-Health Systems*, *1*, 100002. Retrieved April 2024 from https://www.sciencedirect.com/science/article/pii/S2949856223000028

Health Canada. (2023, October 10). Canada signs $1.2 billion bilateral agreement with British Columbia to improve health care over three years. Canada.ca https://www.canada.ca/en/health-canada/news/2023/10/canada-signs-12-billion-bilateral-agreement-with-british-columbia-to-improve-health-care-over-three-years.html

HealthLink BC. (n.d.). Virtual physician. Retrieved from https://www.healthlinkbc.ca/virtual-physician

Hincapié, M. A., Gallego, J. C., Gempeler, A., Piñeros, J. A., Nasner, D., & Escobar, M. F. (2020). Implementation and usefulness of telemedicine during the COVID-19 pandemic: a scoping review. *Journal of primary care & community health*, *11*, 2150132720980612. Retrieved February 26, 2024. https://journals.sagepub.com/doi/abs/10.1177/2150132720980612

House, A. M., & Roberts, J. M. (1977). Telemedicine in Canada. *Canadian Medical Association Journal*, *117*(4), 386. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1879771/

Houser, S. H., Flite, C.A. & Foster, S. L. (2023, January 10). Privacy and Security Risk Factors Related to Telehealth Services - A Systematic Review. *Perspectives in Health*

*Information Management, 20*(1):1f. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9860467/

Huebner, C. & Flessa, S. (2022, July 22). Strategic Management in Healthcare: A Call for Long-Term and Systems-Thinking in an Uncertain System. *International Journal of Environment Research of Public Health, 19*(14):8617. doi: 10.3390/ijerph19148617.

Islam, M. K. & Gilmour, H. (2024, March 20). Access to specialized health care services among older Canadians. *Statistics Canada*. **DOI:** https://www.doi.org/10.25318/82-003-x202400300002-eng

Island Health. (n.d.). BC Virtual Visit information for health care professionals. Retrieved from https://www.islandhealth.ca/our-services/virtual-care-services/bc-virtual-visit/bc-virtual-visit-information-health-care-professionals

Island Health's Virtual Care Services Team. (2024, February). BC Virtual Visit Newsletter. Retrieved from https://www.islandhealth.ca/sites/default/files/virtual-care/bcvirtualvisit/documents/newsletter/bc-virtual-visit-newsletter-february-2024.pdf

Island Health's Virtual Care Services Team. (2023, December). BC virtual visit newsletter. https://www.islandhealth.ca/sites/default/files/virtual-care/bcvirtualvisit/documents/newsletter/bc-virtual-visit-newsletter-december-2023.pdf

Island Health's Virtual Care Services Team. (2022, December). BC virtual visit newsletter. https://www.islandhealth.ca/sites/default/files/virtual-care/bcvirtualvisit/documents/newsletter/bc-virtual-visit-newsletter-december-2022.pdf

Island Health's Virtual Care Services Team. (2021, November). BC virtual visit newsletter. https://www.islandhealth.ca/sites/default/files/virtual-care/bcvirtualvisit/documents/newsletter/bc-virtual-visit-newsletter-nov-2021.pdf

Island Health's Virtual Care Services Team. (2020, December). BC virtual visit newsletter. https://www.islandhealth.ca/sites/default/files/virtual-care/bcvirtualvisit/documents/newsletter/bc-virtual-visit-newsletter-dec-2020.pdf

Isson, J. P. (2018, March 22). The Power of UDA in Healthcare and Medical Research. *Unstructured Data Analytics*, 237. https://onlinelibrary.wiley.com/doi/10.1002/9781119378846.ch8

Jennett, P., & Watanabe, M. (2006). Healthcare and telemedicine: ongoing and evolving challenges. *Disease Management & Health Outcomes*, *14*(Suppl 1), 9-13. DOI: 10.2165/00115677-200614001-00004

Kaptchuk, T. J. & Eisenberg, D. M. (1998, November 9). Chiropractic: Origins, Controversies, and Contributions. *Arch Internal Medicine, 158*(20):2215–2224. doi:10.1001/archinte.158.20.2215

Kaye, A. D., Okeagu, C. N., Pham, A. D., Silva, R. A., Hurley, J. J., Arron, B. L., Sarfraz, N., Lee, H. N., Ghali, G. E., Gamble, J. W., Liu, H., Urman, R. D. & Cornett, E. M. (2021). Economic impact of COVID-19 pandemic on healthcare facilities and systems: International perspectives. *Best Practice & Research Clinical Anaesthesiology, 35*(3), pp. 293-306. https://doi.org/10.1016/j.bpa.2020.11.009.

Keenan, T. P. (2020). Trying for the trifecta: Telehealth meets AI meets cybersecurity. *Scitech Lawyer*, *17*(1), 10-15. Retrieved February 22, 2024. https://search.proquest.com/openview/6402b0181aeea2400a88d9e46104302b/1?pq-origsite=gscholar&cbl=38541&casa_token=7Xj3vccxpysAAAAA:lLIHhjyXWbn4aI2RI2Ck9kuARuontotuyPCfsYqS3YfuUvyj4QdPwfHkqsm9iW6yzofqk30

Khabeer, A. K. A. (2022). The Vital Role of cloud healthcare During the COVID-19 pandemic. Retrieved February 26, 2024. https://www.researchgate.net/profile/Amen-Al-Khafaji-3/publication/359203190_The_Vital_Role_of_Cloud_Healthcare_During_COVID-19_Pandemic/links/62541abe4f88c3119cf2729b/The-Vital-Role-of-Cloud-Healthcare-During-COVID-19-Pandemic

Kichloo, A., Albosta, M., Dettloff, K., Wani, F., El-Amir, Z., Singh, J., Aljadah, M., Chakinala, R. C., Kanugula, A.K., Solanki, S. & Chugh, S. (2020, August 8). Telemedicine, the current COVID-19 pandemic and the future: a narrative review and perspectives moving forward in the USA. Family Medicine and Community Health. *BMJ Journals*, *8*(3):e000530. doi: 10.1136/fmch-2020-000530

Koloski, R. (2020, July 17). *Transforming Healthcare in the Age of the Coronavirus*. Medecision. https://www.medecision.com/medecision-transforming-healthcare-in-the-age-of-the-coronavirus/

Kondylakis, H., Katehakis, D. G., Kouroubali, A., Logothetidis, F., Triantafyllidis, A., Kalamaras, I., ... & Tzovaras, D. (2020). COVID-19 mobile apps: a systematic review of the literature. *Journal of medical Internet research*, *22*(12), e23170. Retrieved February 26, 2024. https://www.jmir.org/2020/12/e23170/

Kim, E. J., & Kim, J. Y. (2023, May 27). The Metaverse for Healthcare: Trends, Applications, and Future Directions of Digital Therapeutics for Urology. *International Neurourology Journal*. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10263160/

Kulbatski. (2016). Blood-Monitoring Disposable Smart Patch Delivers Blood Thinners On-Demand. Retrieved from www.medgadget.com/2016/11/blood-monitoring-disposable-smart-patch-delivers-blood-thinners-demand.html

Lee, S. K., Rowe, B. H. & Mahl, S. K. (2021). Increased Private Healthcare for Canada: Is That the Right Solution?. *Healthcare Policy, 16*(3):30-42. doi: 10.12927/hcpol.2021.26435

LeFebvre, R., Peterson, D. & Haas, M. (2012). Evidence-Based Practice and Chiropractic Care. *Journal of Evidence-Based Integrative Medicine*. https://doi.org/10.1177/2156587212458435

Lu, L., Zhang, Y., Tang, X., Ge, S., Wen, H., Zeng, J., Wang, L., Zeng, Z., Rada, G., Ávila, C., Vergara, C., Tang, Y., Zhang, P., Chen, R., Dong, Y., Wei, X., Luo, W., Wang, L., Guyatt, G., Tang, C. & Xu, N. (2022, February 25). *Evidence on acupuncture therapies is underused in clinical practice and health policy*. BMJ. doi: https://doi.org/10.1136/bmj-2021-067475

Lundin, J., & Dumont, G. (2017). Medical mobile technologies–what is needed for a sustainable and scalable implementation on a global scale?. *Global health action*, *10*(sup3), 1344046. https://www.tandfonline.com/doi/full/10.1080/16549716.2017.1344046

MacNeil, M., Koch, M., Kuspinar, A., Judzwishin, D., Lehoux, P. & Stolee, P. (2019, February). Enabling health technology innovation in Canada: Barriers and facilitators in policy and regulatory processes. Health Policy. *Elsevier, 123*(2). 203-214. https://doi.org/10.1016/j.healthpol.2018.09.018

Mathur, P., Srivastava, S., Xu, X., & Mehta, J. L. (2020). Artificial intelligence, machine learning, and cardiovascular disease. *Clinical Medicine Insights: Cardiology*, *14*, 1179546820927404 https://journals.sagepub.com/doi/abs/10.1177/1179546820927404

Martin D., Miller A. P., Quesnel-Vallée A., Caron N. R., Vissandjée B. & Marchildon G. P. (2018, April 14). Canada's universal health-care system: achieving its potential. *Lancet. 2018 Apr 28; 391(10131):1718-1735*. doi: 10.1016/S0140-6736(18)30181-8

McMahon, M., Nadigel, J., Thompson, E., & Glazier, R. H. (2020). Informing Canada's health system response to COVID-19: priorities for health services and policy research. *Healthcare Policy, 16*(1), 112. Retrieved February 21, 2024. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7435075/

Milella, F., Minelli, E. A., Strozzi, F. & Croce, D. (2021, May 19). Change and Innovation in Healthcare: Findings from Literature. *Clinicoecon Outcomes Res, 13:395-408*. doi: 10.2147/CEOR.S301169

Mintzberg, H. (2017) *Managing the Myths of Health Care: Bridging the Separations Between Care, Cure, Control, and Community*. eBook. Berrett-Koeehler Publishers. https://eds.p.ebscohost.com/eds/detail/detail?vid=3&sid=8725421d-fbba-47ce-8572-2d0818761fb9%40redis&bdata=JkF1dGhUeXBlPXNzbyZhdXRodHlwZT1zc28mY3VzdGlkPW5zMDEyNDUyJnNpdGU9ZWRzLWxpdmUmc2NvcGU9c2l0ZQ%3d%3d#AN=1457716&db=nlebk

Monaghesh, E. & Hajizadeh, A. (2020, August 1). The role of telehealth during COVID-19 outbreak: a systematic review based on current evidence. *BMC Public Health, 20*(1):1193. https://doi.org/10.1186/s12889-020-09301-4

Nair, L. & Adetayo, O. A. (2019, May 16). Cultural Competence and Ethnic Diversity in Healthcare. *Plastic and Reconstructive Surgery-Global Open, 7*(5):e2219. doi: 10.1097/GOX.0000000000002219.

Omboni, S., Padwal, R. S., Alessa, T., Benczúr, B., Green, B. B., Hubbard, I., Kario, K., Khan, N. A., Konradi, A., Logan, A. G., Lu, Y., Mars, M., McManus, R. J., Melville, S., Neumann, C. L., Parati, G., Renna, N. F., Ryvlin, P., Saner, H., Schutte, A. E. & Wang, J. (2022). The worldwide impact of telemedicine during COVID-19: current evidence and

recommendations for the future. *Conn Health Telemed 2022*;1:7-35. http://dx.doi.org/10.20517/ch.2021.03

Ondiege, B., Clarke, M., & Mapp, G. (2017). Exploring a new security framework for remote patient monitoring devices. *Computers*, *6*(1), 11. https://www.mdpi.com/2073-431X/6/1/11

Owens, B. (2018, September 24). Telemedicine on the rise but lagging in Canada. Canadian Medical Association Journal, *190*(38) E1149-E1150 DOI: https://doi.org/10.1503/cmaj.109-5634

Patterson, P. B., Roddick, J., Pollack, C. A., & Dutton, D. J. (2022). Virtual care and the influence of a pandemic: Necessary policy shifts to drive digital innovation in healthcare. In Healthcare Management Forum, *SAGE Publications*, *35*(5), pp. 272–278. DOI: 10.1177/08404704221110084

Peachman, R. R. (2023). *Public Health Is Having a crisis. Prevention*, *75*(11), 66–75. https://eds.p.ebscohost.com/eds/detail/detail?vid=1&sid=8725421d-fbba-47ce-8572-2d0818761fb9%40redis&bdata=JkF1dGhUeXBlPXNzbyZhdXRodHlwZT1zc28mY3VzdGlkPW5zMDEyNDUyJnNpdGU9ZWRzLWxpdmUmc2NvcGU9c2l0ZQ%3d%3d#AN=172430752&db=asn

Pereira-Azevedo, N. M., & Venderbos, L. D. (2018). eHealth and mHealth in prostate cancer detection and active surveillance. *Translational andrology and urology*, *7*(1), 170. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5861289/

Picot, J. (2009, January 29). Telemedicine and telehealth in Canada: forty years of change in the use of information and communications technologies in a publicly administered health care system. *Telemedicine Journal*, *4*(3), 199-205. DOI: 10.1089/tmj.1.1998.4.199

Provincial Health Services Authority. (2021). British Columbia hits one million virtual video visits. Retrieved from http://www.phsa.ca/about/news-stories/news-releases/2021-news/british-columbia-hits-one-million-virtual-video-visits

Public Health Agency of Canada. (2023, October/November). Health Promotion and Chronic Disease Prevention in Canada. Research, Policy and Practice. *Public Health Agency of Canada*. *43*(10/11). https://www.canada.ca/content/dam/phac-aspc/documents/services/reports-publications/health-promotion-chronic-disease-prevention-canada-research-policy-practice/vol-43-no-10-11-2023/hpcdp-vol-43-no-10-11-2023.pdf

Qureshi, F., & Krishnan, S. (2018). Wearable hardware design for the internet of medical things (IoMT). *Sensors*, *18*(11), 3812. https://www.mdpi.com/1424-8220/18/11/3812

RDSM. (n.d.). Telemedicine Network. *RSDM. Network section*. https://www.rdsm.eu/network.html

Research & Markets. (2015, May 05). *Global Home Healthcare Global Market 2015 – Forecast to 2020.* Globe Newswire. https://www.globenewswire.com/en/news-release/2015/05/05/732072/28124/en/Global-Home-Healthcare-Global-Market-2015-Forecast-to-2020.html

Rifi, N., Rachkidi, E., Agoulmine, N., & Taher, N. C. (2017, October). Towards using blockchain technology for eHealth data access management. In *2017 fourth conference on advances in biomedical engineering (ICABME)* (pp. 1-4). IEEE. https://ieeexplore.ieee.org/abstract/document/8167555/

Robie, D. K., Naulty, C. M., Parry, R.L., Motta, C., Darling, B., Micheals, M., Poropatich, R. K. & Gomez, E. R. (1998). Early experience using telemedicine for neonatal surgical

consultations. *Journal of Pediatric Surgery. 33*(7):1172–1177. DOI: 10.1016/s0022-3468(98)90554-1

Roytman, G. R., Coleman, B. C., Corcoran, K. L., Goertz, C. M., Long, C. R., Lisi, A. J. (2021). Changes in the Use of Telehealth and Face-To-Face Chiropractic Care in the Department of Veterans Affairs Before and After the COVID-19 Pandemic. J Manipulative Physiol Ther. (7):584-590. doi: 10.1016/j.jmpt.2021.12.002

Saaei, F. & Klappa, S. G. (2021). *Rethinking Telerehabilitation: Attitudes of Physical Therapists and Patients*. Journal of Patient Experience. doi: 10.1177/23743735211034335

Sarasohn-Kahn, J. (2020, June 25). *How Telehealth and Health Equity Can Survive After COVID-19*. Medecision. https://www.medecision.com/how-telehealth-and-health-equity-can-survive-after-covid-19/

Scott, R. E. & Mars, M. (2013, July 30). Principles and framework for eHealth strategy development. *Journal of Medical Internet Research, 15*(7):e155. doi: 10.2196/jmir.2250.

Seetharaman, P. (2022) Business models shifts: Impact of Covid-19. *International Journal of Information Management. Elsevier*. doi: 10.1016/j.ijinfomgt.2020.102173

Shah, A.Q., Noronha, N., Chin-See, R., Hanna, C., Kadri, Z., Marwaha, A., Rambharack, N., Ng, J. Y. (2023). The use and effects of telemedicine on complementary, alternative, and integrative medicine practices: a scoping review. *BMC Complement Medicine and Therapies, 23*(1):275. doi: 10.1186/s12906-023-04100-x

Shaver, J. (2022). The State of Telehealth Before and After the COVID-19 Pandemic. Primary Care: Clinics in Office Practice. *Elsevier, 49*(4):517-530. doi: 10.1016/j.pop.2022.04.002

Shore, J. H., Schneck, C.D. & Mishkind, M.C. (2020). Telepsychiatry and the coronavirus disease 2019 pandemic—Current and future outcomes of the rapid virtualization of psychiatric care. *JAMA Psychiatry* DOI: 10.1001/jamapsychiatry.2020.1643

Shuvo, T. A., Islam, R., Hossain, S., Evans, J. L., Khatun, F., Ahmed, T., Gazi, R. & Adamas, A. M. (2015, October 30). E-Health Innovations in LMICs of Africa and Asia: A Literature Review Exploring Factors Affecting Implementation, Scale-up, and Sustainability. *Innovation and Entrepreneurship in Health. Taylor & Francis Online.* https://doi.org/10.2147/ieh.s88809

Simpson, J. K. (2012, January 19). The Five Eras of Chiropractic & the future of chiropractic as seen through the eyes of a participant observer. *Chiropractic & Manual Therapies*. doi: 10.1186/2045-709X-20-1

Sinha, S., Kern, L. M., Gingras, L. F., Reshetnyak, E., Tung, J., Pelzman, F., ... & Sterling, M. R. (2020). Implementation of video visits during COVID-19: lessons learned from a primary care practice in New York City. *Frontiers in Public Health*, *8*, 514. Retrieved February 24, 2024. https://www.frontiersin.org/articles/10.3389/fpubh.2020.00514/full

Statistics Canada. (2024, January 05). Labour force characteristics by industry, annual x 1,000. Statistics Canada. Retrieved from https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1410002301&pickMembers%5B0%5D=1.1&pickMembers%5B1%5D=2.2&pickMembers%5B2%5D=4.1&pickMembers%5B3%5D=5.1&cubeTimeFrame.startYear=2018&cubeTimeFrame.endYear=2023&referencePeriods=20180101%2C20230101

Stefano, G. B. (2017). Robotic surgery: Fast forward to telemedicine. *Medical science monitor: international medical journal of experimental and clinical research*, *23*, 1856. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5404821/

Stoumpos, A. I., Kitsios, F. & Talias, M. A. (2023, February 15). Digital Transformation in Healthcare: Technology Acceptance and Its Applications. *International Journal of Environment Research and Public Health*, *20*(4):3407. doi: 10.3390/ijerph20043407

Telo, J. (2017). Blockchain Technology in Healthcare: A Review of Applications and Implications. *Journal of Advanced Analytics in Healthcare Management*, *1*(1), 1-20. https://research.tensorgate.org/index.php/JAAHM/article/view/15/14

Telus. (2019). Leading the World in Social Capitalism: 2019 Annual Report. Retrieved April 2024 from https://www.telus.com/en/about/investor-relations/reports/annual-reports/2019

Telus. (2020). Leading the world when the world needs us most: 2020 Annual Report. Retrieved April 2024 from https://www.telus.com/en/about/investor-relations/reports/annual-reports/2020

TELUS. (2021). TELUS 2021 Annual Report. Retrieved April 2024 from https://assets.ctfassets.net/fltupc9ltp8m/3wuVvVhUwDouNQIxLePmjG/6c58d9b8846eed43fd0bfa3c52018b00/TELUS-2021-annual-report_acc.pdf

TELUS. (2022). Making the world of difference: Annual report 2022. Retrieved April 2024 from https://www.telus.com/en/about/investor-relations/reports/annual-reports/2022

The Canadian Press. (2020, July 24). B.C. announces new funding for post-secondary health care education, training. Vancouver Sun. https://vancouversun.com/news/local-news/b-c-announces-new-funding-for-post-secondary-health-care-education-training

Uberoi, R., & Hausegger, K. (2021). COVID 19: Re-evaluation of Interventional Radiology. CardioVascular and Interventional Radiology, 44(6), 883–884. Retrieved February 22, 2024. https://doi.org/10.1007/s00270-020-02765-2

Urrutia, D., Manetti, E., Williamson, M. & Lequy, E. (2021). Overview of Canada's Answer to the COVID-19 Pandemic's First Wave (January–April 2020). *International Journal Environmental Research and Public Health*, *18*(13), 7131. https://doi.org/10.3390/ijerph18137131

Valsalan, P., Baomar, T. A. B., & Baabood, A. H. O. (2020). IoT Based Health Monitoring System. JCR, 7(4), 739-743. https://doi.org/10.31838/jcr.07.04.137

Verma, V., Chowdary, V., Gupta, M. K., & Mondal, A. K. (2018). IoT and robotics in healthcare. In *Medical Big Data and Internet of Medical Things* (pp. 245-269). CRC Press. https://aitskadapa.ac.in/e-books/AI&ML/BIG%20DATA/Medical%20big%20data%20and%20internet%20of%20medical%20things_%20advances,%20challenges%20and%20applications%20(%20PDFDrive%20).pdf#page=262

Vockley, M. (2017). Game-changing technologies: 10 promising innovations for healthcare. *Biomedical Instrumentation & Technology*, *51*(2), 96-108. https://meridian.allenpress.com/bit/article-abstract/51/2/96/142125

Vodiraju, R. (2022). How digital tools can help providers collect what they are owed. *Medical Economics*. https://www.medicaleconomics.com/view/how-digital-tools-can-help-providers-collect-what-they-are-owed

Waldeck, A., Srivastava, P., & Picken, H. A. (2020, September). Emerging stronger from the COVID-19 crisis: Recover, reposition, and redesign. *InnoSight*.

https://www.innosight.com/insight/emerge-stronger-from-the-COVID-19-crisis-recover-reposition-and-redesign/

Wright, S., Spaulding, R. & Henley, W. (2022). A Multipronged Digital Response to Increased Demand for Telehealth Support and Training During the COVID-19 Pandemic. *J. technol. behav. sci.* **7**, 73–80. https://doi.org/10.1007/s41347-021-00224-4

World Health Organization. (2020, March 11). *WHO: Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020*. World Health Organization. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

Weiss, C., Carriere, M., Fusco, L., Capua, I., Regla-Nava, J. A., Pasquali, M., Scott, J. A., Vittale, F., Unal, M. A., Mattevi, C., Bedognetti, D., Merkoçi, A., Tasciotti, E., Yilmazer, A., Gogotsi, Y., Stellacci, F & Delogu, L. G. (2020). Toward nanotechnology-enabled approaches against the COVID-19 Pandemic. ACS Nano, 14(6), 6383-6406. 2017 Fourth International Conference on Advances in Biomedical Engineering (ICABME). Retrieved February 25, 2024. https://pubs.acs.org/doi/abs/10.1021/acsnano.0c03697

Wennersbusch, D. (2021). The arrival of healthcare 2.0 in British Columbia: An evaluation of telemedicine and eHealth literacy as a barrier to access. https://summit.sfu.ca/item/34495

Wylie, L. (2024, January 8). Health App Revenue and Usage Statistics. Business of Apps. Retrieved from https://www.businessofapps.com/data/health-app-market/#:~:text=Revenue%20from%20health%20apps%20was,to%20%2435.7%20billion%20by%202030.

Zemmar, A., Lozano, A. M., & Nelson, B. J. (2020). The rise of robots in surgical environments during COVID-19. *Nature Machine Intelligence*, *2*(10), 566-572. Retrieved February 20, 2024. https://www.nature.com/articles/s42256-020-00238-2

# Appendix A

## Table 1

*Employment Data in Health care and social assistance labor throughout the years*

| | *2018* | *2019* | *2020* | *2021* | *2022* | *2023* |
|---|---|---|---|---|---|---|
| *BC* | *327.7* | *328.1* | *321.5* | *351.7* | *368.9* | *372.8* |
| *Canada* | *2,393.6* | *2,476.9* | *2,402.5* | *2,519.6* | *2,603.7* | *2,666.7* |

**Note**: Table developed by the author, adapted from Statistics Canada. (2024, January 05). *Labor force characteristics by industry, annual x 1,000*.

# Appendix B

## Table 2

*The adaptability of the labour market in health care employment from Pre- to Post-Pandemic*

t-Test: Paired Two Sample for Means

| | *Variable 1* | *Variable2* |
|---|---|---|
| Mean | 327.9 | 370.85 |
| Variance | 0.08 | 7.605 |
| Observations | 2 | 2 |
| Pearson Correlation | 1 | |
| Hypothesized Mean Difference | 0 | |
| Df | 1 | |
| t Stat | -24.542857 | |
| P(T<=t) one-tail | 0.01296238 | |
| t Critical one-tail | 6.31375151 | |
| P(T<=t) two-tail | 0.02592477 | |
| t Critical two-tail | 12.7062047 | |

*Note*: Table developed by the author by retrieving data from Statistics Canada. (2024, January 05). *Labor force characteristics by industry, annual x 1,000.*

## Appendix C

**Table 3.**

*Pre-pandemic Evaluation of Telemedicine Adaptability 2019-2020*

t-Test: Paired Two Sample for Means

| | *Variable 1* | *Variable 2* |
|---|---|---|
| Mean | 0.197143 | 0.358571 |
| Variance | 0.01989 | 0.038881 |
| Observations | 7 | 7 |
| Pearson Correlation | 0.306081 | |
| Hypothesized Mean Difference | 0 | |
| Df | 6 | |
| t Stat | -2.09032 | |
| P(T<=t) one-tail | 0.040781 | |
| t Critical one-tail | 1.94318 | |
| P(T<=t) two-tail | 0.081562 | |
| t Critical two-tail | 2.446912 | |

*Note*. Table created by retrieving data from *Sources: Canadian Institute for Health Information. (2020, December 2). Canadian Digital Health Survey: What Canadians Think (pp. 32-36). Canadian Institute for Health Information. (2019). Access to Digital Health Services: 2019 Survey of Canadians Summary Report (pp. 4-7). Copyright 2019 by Canadian Institute for Health Information.*

# Appendix D

**Table 4.**

*Pandemic era evaluation of telemedicine adaptability 2020-2021*

t-Test: Paired Two Sample for Means

| | *Variable 1* | *Variable 2* |
|---|---|---|
| Mean | 0.358571 | 0.371429 |
| Variance | 0.038881 | 0.044114 |
| Observations | 7 | 7 |
| Pearson Correlation | 0.956232 | |
| Hypothesized Mean Difference | 0 | |
| df | 6 | |
| t Stat | -0.55252 | |
| P(T<=t) one-tail | 0.300277 | |
| t Critical one-tail | 1.94318 | |
| P(T<=t) two-tail | 0.600555 | |
| t Critical two-tail | 2.446912 | |

*Note*. Table created by retrieving data from *Sources: Canadian Institute for Health Information. (2021). Canadian Digital Health Survey 2021: What Canadians Think (pp. 12, 31-33Canadian Institute for Health Information. (2020, December 2). Canadian Digital Health Survey: What Canadians Think (pp. 32-36). Retrieved April 2024, from* Copyright 2020 by Canadian Institute for Health Information.

# Appendix E

**Table 5.**

***Post-pandemic Evaluation of Telemedicine Adaptability 2021-2022***

t-Test: Paired Two Sample for Means

| | *Variable 1* | *Variable 2* |
|---|---|---|
| Mean | 0.371429 | 0.592857 |
| Variance | 0.044114 | 0.055357 |
| Observations | 7 | 7 |
| Pearson Correlation | 0.674435 | |
| Hypothesized Mean Difference | 0 | |
| Df | 6 | |
| t Stat | -3.23408 | |
| P(T<=t) one-tail | 0.008909 | |
| t Critical one-tail | 1.94318 | |
| | | |
| P(T<=t) two-tail | 0.017819 | |
| t Critical two-tail | 2.446912 | |

*Note. Table created by retrieving data from the Canadian Institute for Health Information. (2023, February). 2022 Canadian Digital Health Survey: What Canadians Think (pp. 12-35). Canadian Institute for Health Information. (2021). Canadian Digital Health Survey 2021: What Canadians Think (pp. 12, 31-33). Copyright 2021 by Canadian Institute for Health Information.*

# Appendix F

**Table 6.**

*Evaluation of Telemedicine Adaptability 2020-2022*

t-Test: Paired Two Sample for Means

| | *Variable 1* | *Variable 2* |
|---|---|---|
| Mean | 0.358571 | 0.592857 |
| Variance | 0.038881 | 0.055357 |
| Observations | 7 | 7 |
| Pearson Correlation | 0.568791 | |
| Hypothesized Mean Difference | 0 | |
| Df | 6 | |
| t Stat | -3.04418 | |
| P(T<=t) one-tail | 0.01134 | |
| t Critical one-tail | 1.94318 | |
| P(T<=t) two-tail | 0.022681 | |
| t Critical two-tail | 2.446912 | |

*Note. Table created by retrieving data from the Canadian Institute for Health Information. (2023, February). 2022 Canadian Digital Health Survey: What Canadians Think (pp. 12-35). Canadian Institute for Health Information. (2021). Canadian Digital Health Survey 2021: What Canadians Think (pp. 12, 31-33). Copyright 2021 by Canadian Institute for Health Information.*

# Appendix G

**Table 7.**

*Evaluation of Telemedicine Adaptability 2019-2021*

t-Test: Paired Two Sample for Means

| | *Variable 1* | *Variable 2* |
|---|---|---|
| Mean | 0.197143 | 0.371429 |
| Variance | 0.01989 | 0.044114 |
| Observations | 7 | 7 |
| Pearson Correlation | 0.520047 | |
| Hypothesized Mean Difference | 0 | |
| Df | 6 | |
| t Stat | -2.53089 | |
| P(T<=t) one-tail | 0.022313 | |
| t Critical one-tail | 1.94318 | |
| P(T<=t) two-tail | 0.044626 | |
| t Critical two-tail | 2.446912 | |

*Note. Table created by retrieving data from the Canadian Institute for Health Information. (2023, February). 2022 Canadian Digital Health Survey: What Canadians Think (pp. 12-35).. Canadian Institute for Health Information. (2021). Canadian Digital Health Survey 2021: What Canadians Think (pp. 12, 31-33). Copyright 2021 by Canadian Institute for Health Information.*

# Appendix H

**Table 7.**

*The transition from Pre-Pandemic to Post-Pandemic telemedicine adaptability*

t-Test: Paired Two Sample for Means

| | *Variable 1* | *Variable 2* |
|---|---|---|
| Mean | 0.197143 | 0.592857 |
| Variance | 0.01989 | 0.055357 |
| Observations | 7 | 7 |
| Pearson Correlation | 0.672328 | |
| Hypothesized Mean Difference | 0 | |
| Df | 6 | |
| t Stat | -5.98229 | |
| P(T<=t) one-tail | 0.00049 | |
| t Critical one-tail | 1.94318 | |
| P(T<=t) two-tail | 0.00098 | |
| t Critical two-tail | 2.446912 | |

*Note. Table created by retrieving data from the Canadian Institute for Health Information. (2023, February). 2022 Canadian Digital Health Survey: What Canadians Think (pp. 12-35).. Canadian Institute for Health Information. (2019) Access to Digital Health Services: 2019 Survey of Canadians Summary Report (pp. 4-7). Copyright 2019 by Canadian Institute for Health Information.*

# Appendix I

**Table 8.**

*Post-pandemic Evaluation of Telemedicine Adaptability 2020-2022*

t-Test: Paired Two Sample for Means

| | *Variable 1* | *Variable 2* |
|---|---|---|
| Mean | 0.358571 | 0.592857 |
| Variance | 0.038881 | 0.055357 |
| Observations | 7 | 7 |
| Pearson Correlation | 0.568791 | |
| Hypothesized Mean Difference | 0 | |
| df | 6 | |
| t Stat | -3.04418 | |
| P(T<=t) one-tail | 0.01134 | |
| t Critical one-tail | 1.94318 | |
| P(T<=t) two-tail | 0.022681 | |
| t Critical two-tail | 2.446912 | |

*Note. Table created by retrieving data from the Canadian Institute for Health Information. (2023, February). 2022 Canadian Digital Health Survey: What Canadians Think (pp. 12-35). Canadian Institute for Health Information. (2021). Canadian Digital Health Survey 2021: What Canadians Think (pp. 12, 31-33). Copyright 2021 by Canadian Institute for Health Information.*