State of the Art and Future Applications of Digital Health in Chile

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Abstract---*This article explores how new digital health technologies can transform health care and disease management in Chile and other Latin American economies. Digital Medicine has the potential to democratize healthcare by allowing patients to become more involved in their wellbeing. This can provide instant guidance and information on a healthy lifestyle, which can be tailored to individuals. Constant health monitoring through digital technology can help solve easily diagnosable health problems or provide direct support to patients who are in control of their own health. These transformative technologies are paving the way for the next generation of healthcare. In the article you will discover the implications digital health has on various stakeholders, for example, how digital health benefits patients and healthcare professionals. It will also consider the opportunities and challenges surrounding the technology involved.*
Keywords---*digital medicine, healthcare, medtech, public health, technology*

Introduction

Technological advances have contributed to the transformation of the healthcare system in many ways. For example, robotic-assisted surgeries and digital records and databases. Change is constant within the healthcare system. It is a growing network that is always looking for ways to improve. Recent technological advances have led to a push in the healthcare system to improve patient care. Digital medicine is a wide range of technological systems. These systems aid in diagnosis and treatment without the constant assistance and guidance of a healthcare professional, such as a physician, surgeon, and nurse. In doing so, they provide independence to patients and allow them to actively monitor the health of citizens (Barello et al., 2020; Simonetti et al., 2020).

Methodology

The methodology proposed for the development of the article is based on a rigorous literature review that responds to the new research needs in the field of digital medicine and the use of technological systems in the health sector. We have chosen to analyze international literature and a series of published articles, to lead the reader to a broad scenario that allows to understand at a qualitative level the implications of technological and intellectual evolution in the way clinical information are stored, recorded, and generated. This has made possible the development of digital medicine, potentially more accurate, more efficient, more experimental, and more distributed than current medical practice. The critical steps in the creation of digital medicine involve a careful analysis of the impact that new technologies may have on the development towards a new paradigm of medical care in Chile (Day et al., 2013; Hood & Flores, 2012).

Literature review

Digital health is the convergence of digital technologies with healthcare, lifestyles, and society to improve the efficiency of healthcare delivery and make medications more personalized and accurate. "Digital medicine can be defined as digital technologies and products that directly impact the diagnosis, prevention, monitoring and treatment

of a disease, condition or syndrome. This includes telemedicine, digital diagnostic tests, biotechnology, digital therapeutics, and immersive technologies such as virtual and augmented reality" (Topol, 2015).

Digital medicine

Objectives of digital medicine to use in the 21st century to transform the public and private healthcare system. Digital medicine uses wearable devices and applications that make it easy to track a patient's condition. This data can then be collected and communicated with physicians from a variety of specialties. Previously, this would have been difficult to do. The goal of digital medicine is to improve patient care delivery by tracking diseases to create personalized disease management and care processes. This can be achieved through various types of technology and devices, such as implantable and wearable technology. The use of digital technology enables constant monitoring of patients to identify the early onset of disease, as well as the patient's daily behavior. Digital medicine can be used for preventive purposes, showing problems that will develop unless corrective action is taken. This can be achieved by using DNA sequencing to identify and diagnose diseases in humans. Big data can also be used to aid in diagnosis and treatment (Barra Novoa et al., 2021; Susilo et al., 2021).

As technology brings the world closer together, it can be used to actively engage patients with physicians. Patients and physicians can now communicate with other healthcare professionals around the world to get a second opinion. The use of digital technology also means that physicians can gather a substantial amount of information to detect disease patterns. These could lead to early treatment and prevention of outbreaks. All the above can be made possible by transforming the healthcare system into a digital network. Then, technology can be used to initiate a much-needed change in the delivery of care and the practice of medicine. It is important that physicians, patients, and engineers work closely together when designing digital health systems. This ensures that all stakeholders understand the complex challenges related to healthcare (Steinhubl et al., 2015; Becker et al., 2014). End users, such as physicians and patients, must also be involved in the design process to create an efficient solution that meets their needs. Digital tools not only record clinical data, but they also can transform the information and generate medical information. In doing so, digital technology potentially creates a more accurate, more efficient, more experimental, and more distributed medical practice than ever before. As with any new technology, there are critical steps to ensure that the impact of the technology is carefully analyzed and evaluated. This is necessary to ensure that it will create a new way of working in healthcare with minimal disruption (Blevins et al., 2018; Purcell, 2011).

Traditional medicine

The clinical practice involves an evaluation of a patient by a physician for the purpose of diagnosing, prognosticating, treating, and preventing a disease, condition or syndrome using clinical judgment. This judgment is established by an examination of the patient's medical history, followed by a medical interview and a physical evaluation to identify signs and symptoms. Several diagnostic methods are used to help rule out diseases. These are based on information provided by the patient and diagnostic tests. Throughout the diagnostic process, the patient is required to develop a level of trust in the physician's judgment and proposed treatment. The outcome is based on the patient reporting in detail to the physician about his or her symptoms and the physician's interpretation. Second judgments are rare as they depend on the complexity of the patient's condition and the availability of a specialist. It can also be a costly and time-consuming process. This means that the diagnostic process is mainly between the patient and the physician (Haines et al., 2006; Vance et al., 2009).

Key factors of digital medicine

The international literature, and especially that developed in the UK, states that to improve patient care, the key factors that digital medicine should address the following key factors:

1) Disease prevention
   This can be achieved using mobile technology, such as wearable devices, implantable devices and smartphones that collect and analyze data to prevent future illness and disease. Preventive action can help people stay well for longer and use fewer hospital services. Digital medicine can help people proactively monitor and manage their health before a condition worsens (Kersey, 1996; Hagedoorn, 1990).
2) Early diagnosis

This is possible by using technology to monitor a patient's health. As an example, wearable technology can be used to track conditions prior to a diagnosis. In addition, a heart rate monitor can inform the user of changes in their heart rate, prompting them to speak to a medical professional. This leads to treatment of a previously undiagnosed condition. Another example of how digital medicine can enable early diagnosis is software that can be used to digitally observe a tissue sample. This can then be shared online with practitioners around the world, providing a second opinion. Both examples can result in quick and efficient diagnoses. Diagnosing a patient earlier means that the necessary steps to improve the outcome of their condition and modify its progression can be taken sooner. This can help people self-manage more effectively, reducing the need for hospital admission.

3) Efficient treatment

Not all consultations are necessary in a clinic or hospital. Rather than being limited to surgery hours and GP availability, technology can be used to provide remote consultations at a more convenient time for the patient. This has the potential to reduce the number of ER visits and admissions by monitoring patients remotely. As such, pressure on overburdened hospitals, physicians and medical professionals is reduced.

4) Rehabilitation

Smartphone apps and remote technologies can be used to track patient rehabilitation and recovery. This allows the patient and the healthcare professional to monitor the patient's recovery, ensuring that the patient is performing the correct rehabilitation exercises. These processes can improve the patient's recovery rate.

Patient expectation and need

Technology can be used as a support mechanism to help patients stay well and manage their illnesses. It can also improve care for people with chronic or complex conditions.

1) Time and Cost

The introduction of digital medicine into the healthcare system can generate time- and cost-saving benefits for patients and healthcare professionals. Some of these benefits include:
a) Reduced hospital admissions
b) Fewer adverse drug reactions and prescription drugs
c) Reduced medical errors

2) Remote diagnosis and treatment

Recent advances in the way information and images are stored and shared digitally allow users to access and store substantial amounts of data remotely. They provide real-time information through image-sharing platforms. Instant data exchange and access to data can generate innovative ideas and discussions in different parts of the world. It can help get a second opinion when there is uncertainty and provide support. All of this can be accomplished from the comfort of an individual's own home. Online platforms that host physicians and medical social networks give patients access to experts and communities that can help empower them. This can help them address their conditions and concerns at an early stage (Liddell et al., 2008; Lupton, 2017).

The impact of digital medicine on healthcare professionals

Digital medicine can impact the roles of healthcare professionals in different ways:

1) Doctors

Digital technology can be used to constantly monitor patients and provide remote rehabilitation. This has the potential to give doctors more time to interact with their patients. As such, this can lead to improved quality of care and better patient outcomes.

2) Nurses

Digital technologies can perform repetitive tasks, for example, taking blood pressure. They can also perform administrative functions such as scheduling appointments and referrals. This can free up nurses' time, allowing them to care for patients in a more meaningful way and provide greater attention and emotional support.

3) Care assistants

Technology-based care has the potential to support face-to-face and remote care. This can be done by using technology to enable constant patient monitoring and communication, which helps care assistants provide a personal touch to those in need.

4) Physicians

Digital pathology is used to analyze tissue samples to diagnose diseases such as cancer. Instead of using traditional microscopes and glass slides, the slides are scanned into a computer and are available for review wherever the physician is located. The pathology team at St. James's in England has reported that more than 99% of cases are assessed using digital pathology, with microscopes being used only in exceptional cases. The use of such technology allows physicians to share opinions and collaborate on complex cases quickly, without having to be in the same place as a glass slide. This provides time-efficient internal and external consultations. Physicians can provide answers immediately because they have access to the images (Morley & Cashell, 2017; England, 2016).

Challenges and opportunities in medical care

Interdisciplinary work creates opportunities to improve products and services by gathering a variety of perspectives and inputs. The healthcare system in Chile and Latin America currently faces several key challenges, including:

1) An aging population
2) A growing population due to increasing immigration rates
3) Evolving health care needs
4) Closure of services due to centralization

As a result of these factors, the healthcare system in Chile requires efficient methods and processes to improve the quality of healthcare while keeping costs to a minimum. Technology is helping to achieve this. The combination of healthcare and technology allows healthcare professionals to access premium tools and resources. This can help them make properly informed diagnoses and deliver efficient outcomes. An interdisciplinary approach to innovation can help develop an effective product. The teams involved contain members from different backgrounds, medical fields, and professions. Typically, they will include the users, the designer, the engineer, and a representative of the funding agency. They can share their experience, knowledge, and skills to develop an innovative product that benefits diagnosis, treatment, and patient care (Ebert & Duarte, 2018; Imison et al., 2016).

Patient and physician involvement is key when developing a product for use in a healthcare setting. Both stakeholders will determine what they require, and their needs will create the usability requirements for the product. Then, the design team will develop a product based on the patient's and physician's needs. The design team must also ensure that the product meets the requirements of the funding source. Therefore, the involvement of an end user in this process is beneficial. Without this, there is the potential for designers to overlook basic elements that could have great benefit to the physician and patient (Taylor, 2015; Kanan & Bensalem, 2016).

Digital medicine opportunities

Digital medicine has created opportunities where the convergence of interests, opinions and ideas has resulted in a product readily available in the marketplace. The combination of different fields merging, for example, medicine and informatics, has created many opportunities for knowledge sharing. By doing so, specialists can develop innovative devices that would not be possible without interdisciplinary collaboration. As such, as the technology and healthcare sectors come together more easily, patients are sure to benefit from more of these advances in health and medicine.

Internet of things

The Internet of Things is a network of sensor-enabled physical devices connected to each other via the Internet. This connection makes it possible for devices to collectively collect and analyze data. The data obtained provides opportunities for patients to self-manage their care. The fitness watch is an example of a wearable device that combines software, hardware, and an Internet connection. It can use an accelerometer, gyroscope, compass, ambient light sensor, and an optical heartbeat sensor. The sensors on the wearable device allow the user to observe feedback on their daily activity. They allow tracking of:

1) Heartbeat
2) Number of calories burned throughout the day
3) Hours of quality sleep

4) Number of steps taken during a day

The fitness watch could also use Wi-Fi to wirelessly sync with wearable devices, allowing the user to view their health information on a larger screen. This allows the user to monitor their daily activity and observe how their interactions affect bodily functions. As a result, users can actively monitor their health for fitness purposes.

Big data

Big Data is the process of collecting data from numerous sources to identify patterns and trends to develop products and services tailored to customer needs. Big Data in healthcare can be used to revolutionize healthcare. Big Data-based big data can be defined as a large set of computer-analyzed data obtained from multiple sources. These could include transactional, machine-related, clinical, or social sources. Big Data can reveal patterns and trends related to specific aspects of the data. This allows those with access to tailor their products and services to meet customer needs and optimize operations and infrastructure (Taylor, 2015; Sadiku et al., 2020).

Benefits of big data for the healthcare industry

In the context of healthcare, big data refers to health data collected from numerous sources, including:

1) Electronic medical records
2) Medical imaging
3) Pharmaceutical research
4) Medical devices

Big data is distinct from traditional electronic medical and human health data used for decision making in that it is available in extraordinarily high volume. In addition, it is derived from many sources and is highly varied in structure and nature. IBM Watson a supercomputer that combines artificial intelligence with analytical software, developed a breakdown of Big Data into the following four dimensions (Data & Hub, 2015).

1) Volume: the size of the data
2) Velocity: the speed at which the data is generated
3) Variety: the different types of data
4) Veracity: the reliability of the data in terms of accuracy

The healthcare industry can benefit significantly from big data, as it is an organization that generates large amounts of data daily. Four areas where big data can help the healthcare system are as follows:

1) Internet of Things
   Any device that generates and shares data about a patient's health is part of the Internet of Things.
2) Care management
   Big data can be used to identify patterns of care and provide a broader view of evidence-based clinical practice. As such, obtaining big data from patient analytics can enable analysis of patient behavior that may have gone unnoticed before, e.g., hospital readmissions.
3) Predictive analytics
   This process analyses the probability of a future outcome based on historical data patterns. Predictive analytics can help improve care delivery by making informed decisions based on data about events before they happen.
4) Genomic sequencing
   Human genome sequencing uses a patient's genomic information to develop an individualized strategy for diagnosis and therapy. Big Data infrastructure provides an efficient and effective approach to discover patterns and process Big Data sets from numerous genomes.

Finally, Big Data can also be used outside the healthcare sector, helping other industries to achieve substantial gains. These benefits could be the development of new products, intelligent decision making, and a reduction in costs and time.

Conclusions

The rising cost of health care in Chile and Latin America has created a need to make the health care system more efficient and cost-effective. Appointments, referrals, missed appointments, misdiagnoses, and ambulance calls cost the health care system a considerable amount of time and money. Value-based medicine aims to provide cost-effective, science-based medical care that incorporates patient values that improve patients' life expectancy and quality of life. This approach could help monitor people remotely, prevent the likelihood of disease, and provide accurate medications and treatments. This not only benefits patients, but also physicians, nurses and other stakeholders within the healthcare system. Access to physicians working remotely could be an answer to the current unsustainable demand on the Chilean healthcare system. It could also help the implementation of more personalized patient care by giving physicians the time to support longer appointments through telephone and video consultations with patients. In turn, this could reduce waiting times in public hospitals and private clinics.

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