Deep Science Publishing
https://doi.org/10.70593/978-81-988918-5-3_9

DeepScience
Open Access Books

Chapter 9: Telemedicine and remote patient management through emerging digital platforms

9.1. Introduction

Telemedicine is the future of healthcare as this emerging digital technology can deliver healthcare seamlessly, filling the holes in the primary care system. In recent years, there has been growing interest in the application of telemedicine, and many patients have started to use telemedical services. The telemedicine platforms address many of the issues and needs of patients and providers, and this is why such services are growing at exponential rates. The pandemic brought telemedicine to the level of the hype that health information technologies have long sought. Providers were forced to adopt new care delivery models that leverage technology to accomplish the suspended care of chronic illness. Mitigating mortality and morbidity from disease in a population at high risk for severe outcomes from disease has been of paramount importance. Emerging technology might enable us to induce behavioral changes that transform high-risk patient populations into healthier and more vigilant ones (Bakalar, 2022; Dubey & Verma, 2022; El-Tallawy et al., 2024).

This current fear, newfound interest, and increasing confidence in telehealth represent a unique opportunity to alter the course of medicine, particularly useful in chronic disease management. The rapid changes in our disparity-impacted patient population and work-life affect adherence and can give rise to exacerbations of need. Accessible technology could allow us to address some of these practice improvements and prioritize adherence through novel check-in solutions. Telemedicine and remote patient management technology can coordinate and facilitate clinical interventions during these times. Emerging digital technology can support interdisciplinary care teams through innovative, alternate, and agile solutions when they are needed most. This chapter

discusses the various pieces of these new digital solutions architectures and the problem sets they can address. The essential ingredients for a successful program are nascent data ecosystems, accessible technology solutions, and community trust.

The fourth event happened in the early 2020s, when post-COVID accumulation of virtual patient contacts began making negative market contractions appear. These four events structured a short telemedicine history that ultimately contributed to the previous discussions about remote patient management and telemedicine. Let us now consider the waves of telemedicine that are mentioned above in more detail (Shen et al., 2021; Omboni et al., 2022; Persaud, 2022).

Fig 9.1: Telemedicine and Remote Patient Management

9.2. Historical Context of Telemedicine

Telemedicine is usually presented as a recent endeavor enabled by digital technologies. While such technologies did indeed open the field to broader use, the field itself is not that recent. For these reasons, our goal in this subsection is to provide a short historical overview that will support the discussion of the earlier chapters in this essay. Our central

contention is that four events triggered a cycle that resulted in the current importance of telemedicine, a cycle that had already been established earlier in the pre-internet era.

One of these events occurred in the 1960s and 1970s, when telecommunications-based telemedicine appeared in the US and in other Western countries, as well as in the USSR. The second event happened in 1989 when the adoption of the internet began in the US, followed by its adoption in Western Europe and in Japan. The third event took place in 2007 when mobile internet use began its fast growth, first in Japan with the adoption of the iPhone and then globally.

Telemedicine was born in the US, as one of the most westerly manifestations of the use of telecommunications for work, business, and service. The idea was in the air. In 1920, popular science writer Hugo Gernsback had suggested that future hospitals would, e.g. along with physicians using wireless and special cameras, be able to make instantaneous diagnoses and treatment recommendations.

9.3. Current Trends in Telemedicine

Telehealth technologies leverage widespread digital health technologies, such as mobile phones, tablets, laptops, and desktops to create new pathways for patient-centered, convenient, accessible, and efficient health care, and remote patient monitoring is key to the emerging telehealth infrastructure. Remote patient monitoring enables chronic disease management, medication management, post-operative recovery oversight, and surveillance for persistent symptoms of contagious illnesses and novel diseases as they transition through various phases of presentation and activity. It empowers parents to remotely monitor the feeding and weight gain of their newborns, patients to regularly track the management of their diabetes, blood pressure, and weight, and health care professionals to follow the recovery of knee and hip replacement patients such that their pains, progress, and possible adverse events can be remotely assessed on a daily basis.

Remote patient monitoring using smartphone biosensors and peripherals takes convenience and accessibility to a new level. Mobile devices' integrated sensors for proximity detection, digital camera for visible and near-infrared imaging, accelerometer, gyroscope, and microphone for motion, sound, and vibration detection enable wireless and mobile collection of critical health data throughout the 24-hour day without employing external devices. When a smartphone is equipped with external biosensor peripherals for blood glucose monitoring, blood gas analysis, ultrasound imaging, and biomarker analysis, individuals can regularly, autonomously, and remotely track time-varying features of their chronic conditions and the local emergence of novel diseases. Further, demographic, geographic, and climate analyses of health data can identify at-

risk populations and provide surge capacity for specialty clinics in urban centers while ensuring serious patient safety issues are addressed.

This includes the transmission of ECG readings and vital signs to the provider, sending alerts and alarms whenever the measured parameters are out of range. These devices can also track and transmit exhaled breath gas composition in patients, emitting mobile alerts whenever concentrations exceed limit values. Medical robots can support remote surgical operations, allowing highly complex and elaborate laparoscopic or thoracic surgeries to be performed from afar by expert surgeons.

Fig 9.2: Current Trends in Telemedicine

9.4. Technological Advancements in Digital Platforms

In recent years, technological advancements in telemedicine and remote patient management have witnessed exponential growth, leading this field to enable healthcare access to people from remote areas, or those unable to leave their homes due to certain conditions. The last decade has seen novel and promising telemedicine service implementations, enabling efficient monitoring and management of chronic and acute

disease states. These services seem ample, ranging from tele-consultations solely relying on audio-visual communication technologies, to remote patient monitoring using specialized kits sent to patients' homes, enabling complex examinations such as ECG, spirometry, ultrasound, or even point-of-care laboratory testing. Advancements in artificial intelligence, mobile health applications, wearable health technology, medical robots are playing key roles in advanced telemedicine implementations, optimizing and streamlining telemedicine service workflows and services, achieving better patient outcomes, and improving user experience. This chapter included sections regarding these emerging technologies, elucidating their challenges and potential use cases in the telemedicine world. Artificial Intelligence-powered systems can aid decision making during medical consultations, assist physicians in diagnosing and managing cases in several branches of medicine, and work as risk stratification, triaging, and predicting systems. Mobile health applications allow ingenious native and hybrid app designs, using smartphone or portable computer device capabilities to provide telementoring, templated decision making or remote patient data collection. Wearable health technologies can continuously monitor patients' health.

9.4.1. Artificial Intelligence in Telemedicine

Artificial intelligence (AI), by which we mean the use of algorithms and software to approximate the cognition of the human brain, is rapidly becoming a vitally important, even necessary, technology in remote patient management. With increasing demand, the use of AI to assist doctors with clinical workflows and diagnostic assessments is becoming common. While it is often said that AI will take away a large number of jobs from the physician workforce, the reality is that AI will assist, rather than displace, physicians. Just as other forms of technology can enhance physician diagnosis and clinical decision-making, so too will AI.

There are some AI-assisted technologies in use today that can assist in patient-physician encounters. For instance, deep natural voice dialogue systems can provide previsit patient interaction akin to the interaction that would normally occur between patient and receptionist or biller. Some systems examine the patient’s complaint, medical history, medication allergies, and contraindications from the patient’s current medications. These applications markedly enhance efficiency in how telehealth encounters are conducted. Other software programs are deployed to provide navigational assistance to patients via smartphones and smart speakers. Of particular concern to physicians is the extent to which the patients' health-related need for navigation assistance is so prominent that patients employ applications that provide dire responses based on health words used in inquiries to retrieve embarrassing or shocking responses based on their health

complaints. At best, patients need to be educated to understand that the responses summarize microdata and big data predictions but cannot provide medical diagnoses.

9.4.2. Mobile Health Applications

With rapid advancements and innovations in mobile and wireless technologies, Mobile Health applications are gaining rapidly growing interest among the public, and the domain of mHealth is experiencing explosive growth in large part along with the exponential growth of mobile communications. Mobile Health Applications are often defined or abbreviated as mHealth Apps, which are software applications on mobile devices specifically designed to help patients complete health-related tasks, as well as aid physicians in the management of their patients' healthcare. The role of mobile apps in Healthcare is becoming essential, as it improves clinical outcomes, enhances patient and physician education, increases physician efficiency and patient safety, and assures compliance.

The smartphone or tablet App is typically a small software package capable of supporting specific functions and uses. App capabilities range from simple health tracking tools to more advanced, novel, and sophisticated mobile technologies that utilize a variety of unique sensors such as cameras, accelerometers, magnetometers, proximity sensors, gyroscopes, glucose sensors, thermometers, and various other biosensors. Native and web-based mHealth Apps can increase access to health information and make patient and provider communication safer and more efficient. They can improve patient engagement, enhance access to care, reduce costs, and increase clinical efficiency. Moreover, a growing number of mHealth Apps are being developed utilizing technologies such as Augmented Reality, Artificial Intelligence, Machine Learning, gamification, and Virtual Reality. There are currently more than 300,000 available mHealth Apps worldwide aimed at supporting a multitude of healthcare-related tasks.

9.4.3. Wearable Health Technology

Wearable health devices are increasingly being used in remote patient monitoring, especially with patients suffering from chronic diseases like obesity, hypertension, diabetes, and other cardiovascular disorders. During the pandemic, their use became popular in early detection, monitoring, and diagnosis of more serious symptoms of infection. Wearable medical devices are handy personal devices that measure vital signs. Typically, these devices measure cardiovascular activity by capturing the electrical signals of each heartbeat using sensors placed on the wrist. Some devices also estimate blood oxygen concentration and provide cryotherapy through cooling pads and fans.

These devices provide their services through an integrated digital platform comprising sensors, the internet, a mobile application, and cloud storage, processing, and analysis technology that are designed to monitor, track and prevent health issues, such as tachycardia, sleep apnea, and false activation of panic alarms.

The need for reliable medical wearable technology increased due to the increased incidence of chronic diseases, the proliferation of the elderly segment of the population and their need for established communication in case of emergencies, the demand for continuous and real-time health data, and the increased digitization of the health sector. Major investment organizations started promoting research and products related to body sensor networks and the integration of ubiquitous computing with sensor technology and fabrics. Major changes in the healthcare system towards automation, data-driven decision making, demand for wearable/wireless sensors due to their advanced features, such as small mass, minimal complication, low energy consumption, and integration with various functions have led to a number of new products, technologies, applications, and successful pilot runs. Furthermore, the demand for development of a new generation of wearables that can interface with other networked devices for new applications, especially in patients suffering from chronic diseases, has increased.

9.5. Remote Patient Management Strategies

The goal of all remote patient management is to increase a patient's ability and motivation to be self-sufficient in decision making and management of their health. This requires a psychologically safe environment and frequently some early physician-patient contact and/or the use of telephone-based health coaching. Once the patient is engaged to take responsibility for their own health and be engaged in healthy self-care and management there is less need to conduct video visits unless a new health issue arises. There is increasing recognition that behavioral change is the key to longer-term success and outcome. Telephone-based health coaching based on motivational interviewing and enabling self-efficacy have been found to accelerate the development of self-determination skills and behavioral changes that lead to a higher level of engagement. Digital technology makes these changes possible within days or weeks and monitors the patient's engagement in their own health and wellbeing. Which has been shown to lead to increased adherence to health goals and sustained behavioral change and subsequently improved outcomes.

Digital Platforms

Given the reach of these technologies chronic condition management is no longer limited to post-hospitalization periods. And can encompass both the acute exacerbations of chronic health issues as well as sustained chronic health issue self-management going

forward. The capability of technology enabled remote patient management offers the opportunity to reduce costs of care while also improving outcomes and access for a greater share of the population. In the past decade there has been increasing evidence of the efficacy of remote management of chronic patient populations which has led all major payers to recognize that video visits need to be reimbursed at parity with in-person visits.

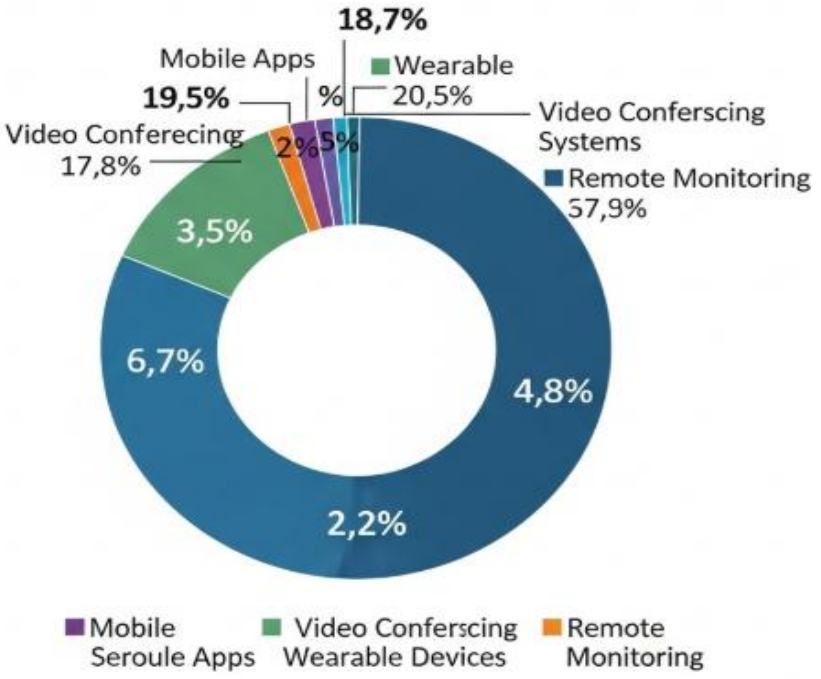

Fig : Telemedicine and Remote Patient Management Through Emerging

9.5.1. Chronic Disease Management

Remote patient management (RPM) has emerged as one of the most promising solutions to address some of the post-COVID-19 pandemic challenges. These challenges, which include the sustained adoption of telemedicine to access outpatient healthcare services, improving patient engagement and quality of life, and curbing healthcare costs through avoiding unnecessary healthcare utilization, are quite suitable for emergent digital health platforms. RPM is much more than merely providing wearable sensors or mobile apps for chronic disease management. Healthcare systems are asking for proven solutions to help close what is known as the care gap. These solutions would allow clinicians to optimize the follow-up of patients with chronic diseases between routine office visits, as well as, through a combination of remote monitoring and artificial intelligence, and reducing the number of hospitalizations and emergency department visits. This chapter

first describes the RPM ecosystem, with a detailing of the key stakeholders and the principles upon which it bases, and then focuses on how third-party digital platforms are helping healthcare systems and clinical entrepreneurs to create, operate, and grow RPM programs.

Chronic diseases are conditions that generally require long-term medical attention; rarely, they are cured completely. Patients suffering from chronic diseases require long-term care and monitoring, often receive limited support between hospital visits, and suffer from serious self-management difficulties. The growing burden of chronic diseases is resulting in increased healthcare expenditure. Chronic diseases impose considerable social burden and cost. RPM can address both concerns, and so RPM solutions have emerged in the field of telemedicine/telehealth as a powerful strategy to support patients with chronic diseases.

9.5.2. Post-Operative Care

Telemedicine has effectively facilitated post-operative care by enabling at-home observations after surgery, especially during the COVID-19 crisis. Various procedures have adopted remote monitoring of patients post-surgery through wearable devices. With advancements in sensors and monitoring devices over the years, it has enabled the potential of using telemedicine to efficiently monitor the healing process of surgical wounds and the area surrounding the surgery. Such procedures include orthopedic procedures, incubation and remaining COVID-19 positive patients, monitoring systems, photobiomodulation, pneumonectomy, ventricular assistive devices, robotic-assisted laparoscopic surgical procedures, and other surgical procedures.

Remote observations using telemedicine can reduce the number of follow-up visits post-surgery. It increases accessibility to patient data by doctors that can help in the remote detection of complications. Moreover, it offers a rapid response to such complications preventing and thereby reducing adverse effects. Integrating telemedicine in surgical practice can sum up to better patient satisfaction, faster follow-up, reduced length of hospital stay, and reduced hospital charges, which can provide excellent care to patients in a shorter time and allow subsequent patients to receive surgery faster. Also, telemedicine can be effectively used post-elective surgery with the aid of wearable patient monitor devices to monitor vitals for a user-defined alarm protocol to notify if complications arise along with wireless transfer of surgical datasets.

9.5.3. Mental Health Support

Remote patient management of mental health conditions has emerged as an important application of telemedicine. Studies from the early period of the pandemic highlighted mental health challenges across the general population as a result of the crisis. Several papers described worsening of pre-existing mental health issues in patients with schizophrenia, bipolar disorder, and major depressive disorder. Novel conditions associated with decreased feelings of social connectedness, greater loneliness, more severe depression, greater psychological distress, and greater general anxiety were also reported. Older adults with mild cognitive impairment and subjective cognitive decline were found to be at high risk for experiencing adverse emotional states during the pandemic. Children were not spared either, with reports suggesting worsening of externalizing and internalizing problems. Anxiety or related outcomes were the most frequent among children and adolescents and studies reporting telehealth services among young patients were the most frequently cited.

In addition to the general population, pandemic-related stressors were found to have triggered or exacerbated conditions of vulnerable groups, including health care workers, frontline workers, pregnant individuals, and children and adults experiencing domestic violence or abuse. Moreover, disruption of pre-existing mental health interventions and treatment services, as were seen during the pandemic, caused additional distress to some individuals suffering from substance use. The detrimental effect on people of different ages and backgrounds led to an overwhelming demand for mental health services.

9.6. Conclusion

Herein, we discussed the theoretical foundation and a multitude of applications that may leverage the potential of digital connectivity and computation to bring healthcare closer to patients and communities. These emerging digital platforms enable and facilitate telemedicine and remote patient management, and comprehensive remote healthcare, thus overcoming the limitations imposed by physical travels. Mounting requirements for patient-centered and cost-effective healthcare have highlighted the need for innovations that couple the expertise of healthcare professionals with the digital tools to amplify their impact, in turn paving the way for the technologies discussed in this chapter. We addressed traditional and gamified Digital Behavioral Therapeutics for the treatment of mild to moderate mental health, substance use, and sleep disorders, as well as Digital Therapeutics adjuncts for the management of cardiometabolic diseases. We described emerging business models and important trends, such as preventative and comprehensive remote care, the use of artificial intelligence and Chatbots, and the combination of digital therapeutics with Remote Patient Monitoring tools.

More recently, however, digital psychiatry has expanded beyond the purview of mental diseases, and led an extraordinary exploration of digital solutions for insomnia, narcolepsy, restless legs syndrome, and other sleep disorders. It is expected that the coupled effect of recent advances in computing technology with increasing population demand, regulatory incentives to expand access to care through telemedicine, and the recognition that diseases do not follow the traditional boundaries of care specialties will unlock progress towards innovative biosolutions for chronic diseases that will be pre-emptive, preventive, and focused on intervention during the prodromal and active disease periods. These novel approaches will be less burdened by founder effects, and more effective in customizing healthcare solutions to individual health conditions, choosing from a vast array of traditional and digital lifestyle medicines.

9.6.1. Future Trends

Digital technologies are entering the medical field with the possibility of revolutionizing the way patients are diagnosed, treated, and monitored. Technologies in health care are an opportunity to facilitate these processes and overcome some of the barriers facing those in desperate need of help. With the potential to not only increase accessibility for various populations at risk of issues with social injustice but also to extend services to the general population while decreasing the costs within the healthcare system. However, such usage must be well designed and controlled. In particular, currently available technologies to measure health parameters are not always compatible among them, data safeguard must be the first concern of any stakeholder. Moreover, their quality must be ascertained since their accessibility could lead to the generation of a huge amount of data not always ensuring higher precision regarding a diagnosis or understanding the evolution of a disease.

Physicians remain responsible for the patient-care process. The emerging digital platforms already describe what the algorithms to use are, what tests and evaluations should be used for what type and stage of pathology, etc. while generating a huge amount of data about diseases. This massive amount of intelligence allows also to speed up the time for innovation of any new medical technology as algorithms on specific conditions could be developed based on a healthy population in a more effective mode than today – i.e. by researching rare events and pathologies that are looked for based on epidemiology only – where early-stage postures are still far behind available analog technologies. Data originating from digital technologies will affect pre-market assessment of new technologies using a more refined and focused approach. Simultaneously, the quick access to a wider population will create the basis for a new

digital surveillance – beyond the simple monitoring the past and not considering the new technologies.

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