Health Informatics

Homero Rivas
Thomas Boillat *Editors*

Digital Health

From Assumptions to Implementations

Second Edition

Springer

Health Informatics

This series is directed to healthcare professionals leading the transformation of healthcare by using information and knowledge. For over 20 years, Health Informatics has offered a broad range of titles: some address specific professions such as nursing, medicine, and health administration; others cover special areas of practice such as trauma and radiology; still other books in the series focus on interdisciplinary issues, such as the computer based patient record, electronic health records, and networked healthcare systems. Editors and authors, eminent experts in their fields, offer their accounts of innovations in health informatics. Increasingly, these accounts go beyond hardware and software to address the role of information in influencing the transformation of healthcare delivery systems around the world. The series also increasingly focuses on the users of the information and systems: the organizational, behavioral, and societal changes that accompany the diffusion of information technology in health services environments.

Developments in healthcare delivery are constant; in recent years, bioinformatics has emerged as a new field in health informatics to support emerging and ongoing developments in molecular biology. At the same time, further evolution of the field of health informatics is reflected in the introduction of concepts at the macro or health systems delivery level with major national initiatives related to electronic health records (EHR), data standards, and public health informatics.

These changes will continue to shape health services in the twenty-first century. By making full and creative use of the technology to tame data and to transform information, Health Informatics will foster the development and use of new knowledge in healthcare.

Homero Rivas • Thomas Boillat
Editors

Digital Health

From Assumptions to Implementations

Second Edition

Springer

Editors
Homero Rivas
Mohammed Bin Rashid University of Medicine and Health Sciences, Design Lab
Dubai, United Arab Emirates

Thomas Boillat
Mohammed Bin Rashid University of Medicine and Health Sciences, Design Lab
Dubai, United Arab Emirates

ISSN 1431-1917 ISSN 2197-3741 (electronic)
Health Informatics
ISBN 978-3-031-17665-4 ISBN 978-3-031-17666-1 (eBook)
https://doi.org/10.1007/978-3-031-17666-1

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

Chapter 1
An Introduction to Digital Health: Current and Future Trends

Homero Rivas and Thomas Boillat

Abstract Over the last 25 years, life as we know it has changed considerably. Starting from generation Z (born after 1996), the young generations are true citizens of a digital world. Ever since their birth, information and communication technologies (ICTs) have been very pervasive in all aspects of their lives. On the other hand, older generations, including all adults, represent a group of digital immigrants that grew up without such technology. Only a few years ago, digital health was not a common term in our lexicon much less something well understood by patients and most care providers. Since the beginning of the COVID-19 pandemic, circumstances have changed globally and the ecosystem has become fertile for the rapid expansion of digital health. Most if not all large healthcare systems, pharmaceutical companies, medical device companies, etc. have groups dedicated solely to digital health. Visionary medical schools are implementing an increasing number of digital health courses in their curriculums or at least in their informal courses. Entrepreneurs have identified great opportunities to innovate and create ingenious, cost effective, and sustainable value propositions in digital health. Venture Capital (VC) investment has exponentially increased over the last few years on a scale not seen for a very long time, either in healthcare or even in other industries. This chapter highlights this unique growth and transformation being experienced by digital health and healthcare in general.

Keywords Digital Health · Wearables · Telemedicine · Artificial intelligence
Virtual reality · Augmented reality · Mobile health

H. Rivas · T. Boillat (✉)
Design Lab, Mohammed Bin Rashid University of Medicine and Health Sciences,
Dubai, United Arab Emirates
e-mail: Homero.Rivas@mbru.ac.ae; Thomas.Boillat@mbru.ac.ae

H. Rivas, T. Boillat (eds.), *Digital Health*, Health Informatics,
https://doi.org/10.1007/978-3-031-17666-1_1

1.1 Introduction

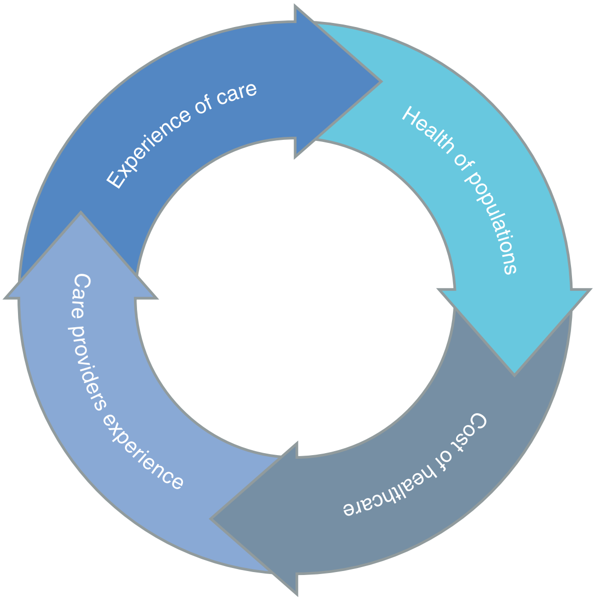
In our first book, “Digital Health – Scaling Healthcare to the World” (Rivas and Wac 2018), we described the opportunity offered by Digital Health Technologies (DHT) to improve the delivery and quality of care and wellbeing, and to reduce healthcare costs. In this regard, we explained the role of mobile health and wearable technologies in tracking quality of life, the use of augmented and virtual realities to treat mental diseases, the implementation of 3D printing in medical education and clinics, and the use of drones to deliver care to areas that are difficult to access. The book also includes discussions on existing challenges in the healthcare system and initiatives that use DHT to redesign it. When the book was written, the Apple Watch celebrated its first anniversary. To date, more than 100 million units have been sold (Rogerson 2021); moreover, few years back, the smartwatch demonstrated its ability to detect atrial fibrillation in one of the largest clinical trials, involving almost half a million participants (Perez et al. 2019). Similarly, in the U.S. between 2019 and 2020 alone, amid COVID-19, the volume of telehealth delivery increased by 38 times, allowing medical professionals to maintain a relationship with their patients by delivering care remotely (Bestsennyy et al. 2021). When it comes to artificial intelligence, 80% of the algorithms used for health-related applications were approved by the U.S. Food and Drug Administration (FDA) between 2018 and 2021 (The Medical Futurist 2021). The creation of the Digital Health Center of Excellence by the FDA in 2020 also marked the increasing development and role that digital health plays in the healthcare system (Health C for D and R 2021).

Defined by the World Health Organization (WHO) as “the use of information and communications technology in support of health and health-related fields” (WHO 2017), DHT encompass a wide range of technologies from electronic medical records to telehealth, mobile health, wearables, augmented and virtual realities, and also paradigms such as blockchain and artificial intelligence. To understand the adoption and impact of DHT compared to traditional health innovation such as X-ray, Magnetic Resonance Imaging (MRI), or ultrasound, it is important to look at the origins and types of the aforementioned technologies. On one hand, technologies such X-ray, MRI, and ultrasound were designed specifically for healthcare based on thoroughly analyzed needs, and sold and installed by specially trained personnel. On the other hand, DHT such as mobile health, wearables, or virtual reality, were designed for serving multiple industries with unclear needs and expectations. These differences are also highlighted by the way some researchers and practitioners compare the evolution of health technologies with those of the four industrial revolutions (Li and Carayon 2021). In this vision, healthcare 1.0 includes traditional patient encounter, diagnosis, and treatment; healthcare 2.0 relies on medical equipment, such as ultrasound, CT scans, and surgical and life support equipment including ventilators as well as monitoring devices such as continuous EKG and pulse oximeter among many others. Healthcare 3.0 encompasses the use of electronic medical records, patient portals, telemedicine, and virtual visits. Finally, healthcare 4.0 utilizes the Internet of Things (IoT), wearables, cloud computing. and artificial intelligence to deliver personalized medicine. When comparing healthcare with industrial revolutions, it is clear that from revolutions 3.0 upwards, the technologies used become increasingly less specific to the industry. For companies and hospitals in particular, this means that additional work is required to understand how the identified needs can be addressed by a technology, a task that is not required by specific devices used in revolutions 1.0 and 2.0. In addition, though hospitals and clinics had the pressure from other institutions to acquire medical equipment, with healthcare 4.0 the demand comes from patients and medical professionals. Before healthcare 4.0, hospitals and clinics were the innovation-driven forces, with equipment and know-how to which only a few people had access. To describe changes in industry forces, researchers and practitioners use the term "consumerization" or "bottom-up innovation" whereby customers are pushing industry to adopt a new technology (Moschella et al. 2014). Nowadays, many patients use mobile applications to track their food or wear activity trackers to measure their number of steps or amount of sleep, thereby collecting health-related information that hospitals do not have access to and do not know how to trust or use (Ho et al. 2017).

1.2 Current Trends

DHT are increasingly used in healthcare by different stakeholders from clinicians to administrative staff and patients. To contextualize the impacts DHT have on the health system, in this section we present the latest technologies alongside the "Quadruple Aim" for healthcare optimization. This framework was initially developed for the delivery of high-value care (i.e., Triple Aim) and then revisited as the Quadruple Aim in 2014 (Berwick et al. 2008; Bodenheimer and Sinsky 2014). The Quadruple Aim framework suggests four dimensions for the delivery of high-value care (Bodenheimer and Sinsky 2014): (1) improving the individual experience of care; (2) improving the health of populations; (3) reducing per capital cost of healthcare; and the newly added d) improving the experience of providing care. The latter dimension not only includes work recognition but also dignity and respect with which the medical staff is (should be) treated as well as the requirements addressed in terms of education, training, tools, financial support, and encouragement. The Quadruple Aim framework is often represented as a circle to highlight the continuous required improvement of each dimension and their relationship with one another as shown in Fig. 1.1.

Fig. 1.1 Quadruple Aim framework



1.2.1 Improving the Health of Populations

The first step in improving the health of populations lies with connecting with people. With social media platforms, information has no temporal or geographical barriers unlike traditional media such as radio, newspapers, or TV. Take Mikhail "Mike" Varshavski, a family medicine doctor practicing in New Jersey (USA). Dr. Mike publishes short videos on YouTube and Instagram mostly to demystify medicine and simplify medical concepts. Since 2016, his videos have been viewed more than 1.2 billion times on YouTube (Varshavski 2021) alone. While many find his work controversial and more medical entertainment than true medical education, he has been successful in effectively communicating to the masses through a video digital platform. Not only do social media platforms empower the voice of their content creators, but they also create a communication channel with their viewers by means of comments that viewers can post. During the first months of the COVID-19 pandemic, an important number of physicians relied on social media platforms to fight against misinformation, relying on scientific evidence to provide a neutral analysis of the situation (Topf and Williams 2021). Another technology that has been increasingly leveraged for digital health purposes is the smartphone. Smartphones, also called mobile devices, are used by more than 6 billion people around the world (Statista 2021), offering them opportunities to better understand their behavior and health, or toward changing "bad" habits. Additionally, data collected from mobile device users open new avenues for medical professionals to connect and gain understanding of people's lifestyle, behaviors, and conditions

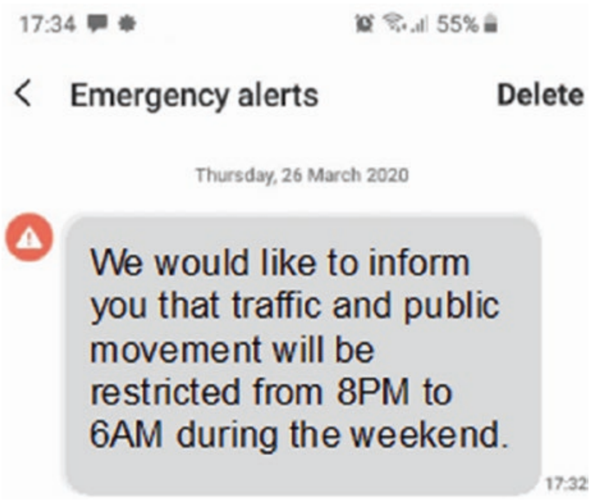


Fig. 1.2 Example of an alert message sent by the police to all citizens' mobile devices during COVID-19

(Bradway et al. 2017). The combination of mobile devices and health is defined as mHealth and described by the World Health Organization as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" (WHO 2011). Definitely, COVID-19 helped people understand the value of mHealth with the use of apps to inform the population of new decisions and restrictions (Fig. 1.2), and to trace people with whom a COVID-positive person was in contact and forecast areas that will be most prevalent to see clusters emerging based on the number of close contacts, people's movement, and density of living (Kamalov et al. 2021).

Looking at the last years, the number of mHealth apps has not increased much, with 318,000 in 2017 (IQVIA 2017) against 350,000 in 2020 (Olsen 2021) in both Android and Apple stores. There are, however, more interesting facts to discuss. In 2019 alone, 100,000 new mHealth apps were published, demonstrating an important turnover and potential market saturation. In addition, the nature of mHealth apps is evolving from apps covering general needs such as tracking exercises, fitness activities, and eating diets to apps that support specific diseases such as mental health, diabetes, hypertension, or women's health (IQVIA 2017). Second, over the last 5–10 years, mHealth apps have become more active in the way they support their users. Not only do they collect and monitor data, but they also suggest interventions in order to help the user change his or her behavior. For instance, a group of researchers demonstrated that sending customized text messages was efficient to help patients suffering from coronary heart disease change their behavior when it comes to reducing the amount of smoking and increasing physical activities (Chow et al. 2015). Over the last 5 years, an increasing number of mHealth apps have leveraged machine learning algorithms to provide a higher level of data analysis, thus offering new opportunities. For instance, a small Swiss startup developed a mobile app that can measure blood pressure from data collected from a mobile device's camera (Schoettker et al. 2020). With so many available apps, the bigger challenge for users lies in finding the most appropriate ones. The growth in health apps is poorly aligned with the capacity of evaluation of such apps. A few years back, the FDA had approved much less than 1% of those apps for clinical use. Most innovators and entrepreneurs of health apps purposely target the "wellness market" in order to bypass the legal challenges and strict regulation processes required for FDA-regulated apps or digital devices. Moreover, customer reviews may in theory represent some helpful feedback to prospective app customers although very often their content is superficial and of no real value. One might think that it would be of some benefit if the application stores would categorize mHealth apps that have undergone systematic evaluation, even when there is only a paucity of apps. In a 2017 study, out of the 3296 mHealth apps analyzed, only 11 had been analyzed for their effectiveness (Buechi et al. 2017).

Another technology that has been shown to have a big impact on improving the health of populations is wearable and comprises all devices whose embedded sensors and analytic algorithms can track, analyze, and guide the wearers' behavior (Schüll 2016). Activity trackers and smartwatches are most probably the most common and known wearable technology. In one of the largest clinical trials ever conducted, involving 400,000 participants and published in the New England Journal of Medicine, a group of researchers demonstrated the ability of the Apple Watch to detect atrial fibrillation (Perez et al. 2019). With an increasing number of embedded sensors, such as oxygen saturation, electrocardiogram, and blood pressure monitoring, wearables have shown great potential in remotely monitoring mildly symptomatic patients during COVID-19 and will most probably continue to do so beyond the pandemic (Islam et al. 2020). Wearables have been shown to help children suffering with autism recognize the emotions of other children. The researchers used the affordances of a pair of smart glasses (i.e., Google Glass) to analyze the facial expressions of children in the field of view of the child suffering from autism and then display in his or her screen whether the children are smiling and being happy, sad, or angry to name of few (Daniels et al. 2018).

1.2.2 Reducing the Cost of Healthcare

Chronic diseases such as obesity, cancer, and diabetes account for a majority of healthcare costs of developing countries along with lifestyle choices (e.g., alcohol, tobacco, food). Lately, researchers and governments have been leveraging machine learning algorithms and data science in general to predict early obesity using data collected during medical visits (Triantafyllidis et al. 2020). These predictions have allowed governments to create targeted interventions such as awareness campaigns as well as changes in policies. When it comes to cancer prevention, the combination of mHealth and machine learning has allowed for the screening of skin cancer. From a picture taken with a mobile device, a machine learning algorithm is able to identify whether the mole is malignant or benign. Already used by millions of people, not only can these mHealth apps save people's life, but they also reduce treatment costs by identifying skin cancer at an early stage (SkinVision 2021).

1.2.3 Improving the Experience of Care

When broken down, experience of care often includes elements of scheduling (e.g., how and when can a specialist be booked), accessing the medical facility, registration, waiting, reception of the care by medical professionals, discharge, and reception of medication. Until recently, this traditional model of care delivery requiring a patient to visit a physician in a clinical setting had been prevalent in the majority of the world. It did not change due to new technological advancements, but mostly due to the restriction of movement caused by the COVID-19 pandemic. Within a very short amount of time, governments and hospitals chose telemedicine to permit mildly ill patients to get the supportive care they need while minimizing their exposure to other acutely ill patients (Portnoy et al. 2020). The pre-identified barriers that prevented a larger scale adoption of such technology, including a breakdown in the relationship between the patient and the physician, had a much lower impact than expected (Hollander and Carr 2020). An increasing number of hospitals have integrated telemedicine as part of their portal, allowing patients to search and find a specialist, book an appointment based on their preferences, run a telemedicine consultation from their personal computer or mobile device, receive an electronic prescription, and access their discharged report from the comfort on their home.

1.2.4 Improve Care Provider Experience

Though to date digital health has primarily targeted patients, some technologies have had indirect and direct impacts on the care provider experience. These impacts can be at the same time positive and negative. Electronic Medical Records (EMR) is most probably the technology that has been researched and discussed the most. On one hand, many concerns have been raised with regard to the impact of EMR on medical professionals' wellbeing due to their lack of usability (Shanafelt et al. 2016); on the other hand, they have allowed care providers to access, trace, share, and analyze data of multiple patients with limited effort, leading to better care (Khalifa 2017; Rathert et al. 2019). Telemedicine is a technology that has had more direct impact by allowing physicians and other medical professionals to save time by more efficiently sorting patients and redirecting them to specialists (Mahtta et al. 2021). For physicians practicing home visits or living in rural areas, this allows them to consult more patients while reducing risks linked to driving (Mahtta et al. 2021). As described above, telemedicine has been key to delivering care but also to protect care providers from infection (Hoffman 2020). During the COVID-19 pandemic, several DHT were used in several studies to better understand the amount of stress on care providers and to preventively identify people at risk of burnout or mental and physical breakdowns (Goodday et al. 2021). Several techniques were used to collect objective and subjective data from surveys, mobile applications, activity trackers, smart rings, and video calls with specialists.

1.3 Future Trends

Aligned with the title of this book, “Digital Health: From assumptions to implementations,” the trends presented below leverage existing DHT and are foreseen to be implemented within 3 years (Fig. 1.3). With the increasing adoption of DHT by the population, patients will play a bigger role in the health system, first through the amount and variety of data that patients will be collecting but most importantly by sharing that data with medical professionals. Though to date many people already use activity trackers to collect physical activity level, sleep, and heart rate, future activity trackers will be able to collect blood glucose levels, detect toxins, vitamins, or micronutrients, and perform molecular diagnostics through biosensors among others (Parkhey and Mohan 2019). In addition, we foresee an increasing use of home testing triggered in most countries by different types of COVID tests. By monitoring diagnostic test results sent from devices worn by patients at home, the clinic or general practitioner will decrease the cost and risk of cross infection while improving the comfort of the patient. All data collected by the patient will be either automatically or manually transferred into his or her Personal Medical Records (PMR). PMR or PHR (Personal Health Records) capture health data entered by individuals and provide centralized and easy-to-access information related to the care of those individuals (Tang et al. 2006). Until recently, maintaining a PMR mostly meant copying information from one or more Electronic Medical Record (EMR). However, with the increasing amount of data collected by patients, there is now an incentive for hospitals and clinics, in addition to software vendors, to centralize that data and share it. Big players, such as Amazon and Microsoft, have developed such centralized PMR that can be shared with hospitals and clinics in some countries only. In the meantime, researchers look into more decentralized and traceable solutions by leveraging blockchain (Chen et al. 2019). From a medical professional perspective, an increasing number of tests will be performed in local clinics or health hubs located in malls, train stations, or in high-density living areas. Tests requiring more advanced technologies and skills will be performed by regional hospitals. On-demand, data will be integrated in a national EMR and synchronized with the patient’s PMR. Both will be connected to a data analysis layer that will use deidentified health data to provide recommendations to the patients and the medical professionals. Such service is, for instance, being offered by Microsoft and Amazon but at a local (hospital) level only. By using PMR and EMR data at a national level, the recommendations will gain in relevance and efficiency. Such recommendations will promote preventive routines and quality of life through personalized and

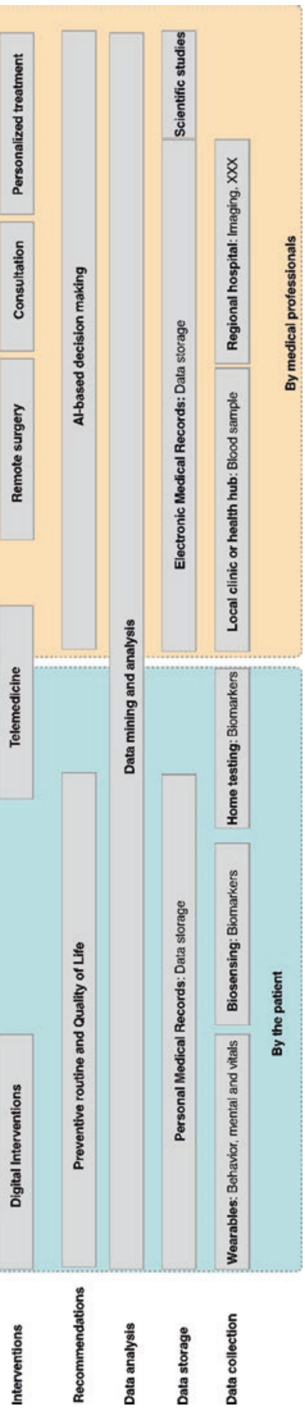


Fig. 1.3 Digital Health Technologies—patient and medical professional perspectives

action-based digital interventions. The data analysis layer will support medical professionals' interventions by leveraging artificial intelligent-based decision making. Medical professionals' decisions will, therefore, be seconded for safer and more accurate medicine. Remote interventions, such as telemedicine and surgery, will be leveraged to ensure that the patient is treated under the best conditions. The use of 3D-printed drugs will be more common to deliver personalized treatment. With the recent commercialization and certification (e.g., FDA for the U.S.) of non-proprietary 3D printers dedicated to drugs such as the FabRx M3DIMAKER, one might expect a high use of such techniques for very specialized treatments.

Deliberately, we did not mention some key advancements such as precision medicine or precision nutrition, which are without doubt shaping predictive, preventive, personalized, and participatory medicine (Moore 2020). We argue, however, that precision medicine does not really fall under the DHT category although some services such as 23andMe leverage mobile health as a communication channel between the customers and the company.

Ultimately the adoption of DHT will depend on the ability of the medical sector, the government, and the technology companies to understand the needs of patients and of each other. Tech companies now have chief medical officers to identify clinical needs and constraints. Governments are pushing hospitals to adopt and integrate their EMR while the average U.S. hospital has 16 different EMR (Sullivan and Why 2018). Digital Health Technologies are, without doubt, disrupting medicine—but the journey is only at its beginning.

References

Berwick DM, Nolan TW, Whittington J. The triple aim: care, health, and cost. Health Aff. 2008;27(3):759–69.

Bestsennyy O, Gilbert G, Harris A, Rost J. Telehealth: A post-COVID-19 reality? [Internet]; 2021. Available from: https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/telehealth-a-quarter-trillion-dollar-post-covid-19-reality

Bodenheimer T, Sinsky C. From triple to quadruple aim: care of the patient requires care of the provider. Ann Fam Med. 2014;12(6):573–6.

Bradway M, Carrion C, Vallespin B, Saadatfard O, Puigdomènech E, Espallargues M, et al. mHealth assessment: conceptualization of a global framework. JMIR mHealth and uHealth. 2017;5(5):e7291.

Buechi R, Faes L, Bachmann LM, Thiel MA, Bodmer NS, Schmid MK, et al. Evidence assessing the diagnostic performance of medical smartphone apps: a systematic review and exploratory meta-analysis. BMJ Open. 2017;7(12):e018280.

Chen Y, Ding S, Xu Z, Zheng H, Yang S. Blockchain-based medical records secure storage and medical service framework. J Med Syst. 2019;43(1):1–9.

Chow CK, Redfern J, Hillis GS, Thakkar J, Santo K, Hackett ML, et al. Effect of lifestyle-focused text messaging on risk factor modification in patients with coronary heart disease: a randomized clinical trial. JAMA. 2015;314(12):1255–63.

Daniels J, Haber N, Voss C, Schwartz J, Tamura S, Fazel A, et al. Feasibility testing of a wearable behavioral aid for social learning in children with autism. Appl Clin Inform. 2018;9(01):129–40.

Goodday SM, Karlin E, Alfarano A, Brooks A, Chapman C, Desille R, et al. An alternative to the light touch digital health remote study: the stress and recovery in frontline COVID-19 health care workers study. JMIR Form Res. 2021;5(12):e32165.
Health C for D and R. Digital Health Center of Excellence [Internet]. FDA. FDA; 2021 [cited 2021 Nov 22]. Available from: https://www.fda.gov/medical-devices/digital-health-center-excellence
Ho K, Yao C, Lauscher HN. Health apps, wearables, and sensors: the advancing frontier of digital health. B C Med J. 2017;59(10):503–6.
Hoffman DA. Increasing access to care: telehealth during COVID-19. J Law Biosci. 2020;7(1):lsaa043.
Hollander JE, Carr BG. Virtually perfect? Telemedicine for COVID-19. N Engl J Med. 2020;382(18):1679–81.
IQVIA. Digital Health Apps [Internet]. 2017 [cited 2021 Dec 11]. Available from: https://www.iqvia.com/insights/the-iqvia-institute/reports
Islam MM, Mahmud S, Muhammad LJ, Islam MR, Nooruddin S, Ayon SI. Wearable technology to assist the patients infected with novel coronavirus (COVID-19). SN Comput Sci. 2020;1(6):1–9.
Kamalov F, Cherukuri A, Sulieman H, Thabtah F, Hossain A. Machine learning applications for COVID-19: a state-of-the-art review. arXiv preprint arXiv:210107824. 2021.
Khalifa M. Perceived benefits of implementing and using hospital information systems and electronic medical records. In: ICIMTH; 2017. pp. 165–8.
Li J, Carayon P. Health Care 4.0: A vision for smart and connected health care. IISE Trans Healthcare Syst Eng. 2021;11:1–10.
Mahtta D, Daher M, Lee MT, Sayani S, Shishehbor M, Virani SS. Promise and perils of telehealth in the current era. Curr Cardiol Rep. 2021;23(9):115.
Moore JB. From personalised nutrition to precision medicine: the rise of consumer genomics and digital health. Proc Nutr Soc. 2020;79(3):300–10.
Moschella D, Neal D, Opperman P, Taylor J. The "Consumerization" of Information Technology. In: Leading Edge Forum [Internet]. 2004 [cited 2014 Jun 9]. Available from: http://www.smaele.nl/edocs/Taylor-Consumerization-2004.pdf
Olsen E. Digital health apps balloon to more than 350,000 available on the market, according to IQVIA report [Internet]. MobiHealthNews. 2021 [cited 2021 Dec 10]. Available from: https://www.mobihealthnews.com/news/digital-health-apps-balloon-more-350000-available-market-according-iqvia-report
Parkhey P, Mohan SV. Biosensing applications of microbial fuel cell: approach toward miniaturization. In: Mohan SV, Varjani S, Pandey A, editors. Microbial electrochemical technology [Internet]. Amsterdam: Elsevier; 2019 [cited 2022 Jan 3]. pp. 977–97. (Biomass, Biofuels and Biochemicals). Available from: https://www.sciencedirect.com/science/article/pii/B9780444640529000406
Perez MV, Mahaffey KW, Hedlin H, Rumsfeld JS, Garcia A, Ferris T, et al. Large-scale assessment of a smartwatch to identify atrial fibrillation. N Engl J Med. 2019;381(20):1909–17.
Portnoy J, Waller M, Elliott T. Telemedicine in the era of COVID-19. J Allergy Clin Immunol Pract. 2020;8(5):1489–91.
Rathert C, Porter TH, Mittler JN, Fleig-Palmer M. Seven years after Meaningful Use: Physicians' and nurses' experiences with electronic health records. Health Care Manag Rev. 2019;44(1):30–40.
Rivas H, Wac K. Digital health. Cham: Springer; 2018.
Rogerson J. Apple Watches are used by over 100 million people, but that's just the beginning [Internet]. TechRadar; 2021 [cited 2021 Nov 22]. Available from: https://www.techradar.com/news/apple-watches-are-used-by-over-100-million-people-but-thats-just-the-beginning
Schoettker P, Degott J, Hofmann G, Proença M, Bonnier G, Lemkaddem A, et al. Blood pressure measurements with the OptiBP smartphone app validated against reference auscultatory measurements. Sci Rep. 2020;10(1):1–12.

Schüll ND. Data for life: wearable technology and the design of self-care. BioSocieties. 2016;11(3):317–33.

Shanafelt TD, Dyrbye LN, Sinsky C, Hasan O, Satele D, Sloan J, et al. Relationship between clerical burden and characteristics of the electronic environment with physician burnout and professional satisfaction. In: Mayo Clinic Proceedings. Amsterdam: Elsevier; 2016. p. 836–48.

SkinVision. SkinVision | Skin Cancer Melanoma Detection App | SkinVision [Internet]. 2021 [cited 2021 Dec 14]. Available from: https://www.skinvision.com/

Statista. Smartphone users from 2016 to 2021 [Internet]. Statista. 2021 [cited 2021 Dec 5]. Available from: https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/

Sullivan T. Why EHR data interoperability is such a mess in 3 charts [Internet]. Healthcare IT News. 2018 [cited 2022 Jan 3]. Available from: https://www.healthcareitnews.com/news/why-ehr-data-interoperability-such-mess-3-charts

Tang PC, Ash JS, Bates DW, Overhage JM, Sands DZ. Personal health records: definitions, benefits, and strategies for overcoming barriers to adoption. J Am Med Inform Assoc. 2006;13(2):121–6.

The Medical Futurist. FDA-approved A.I.-based algorithms [Internet]. The Medical Futurist. [cited 2021 Nov 22]. Available from: https://medicalfuturist.com/fda-approved-ai-based-algorithms/

Topf JM, Williams PN. COVID-19, social media, and the role of the public physician. Blood Purif. 2021;50(3–4):415–21.

Triantafyllidis A, Polychronidou E, Alexiadis A, Rocha CL, Oliveira DN, da Silva AS, et al. Computerized decision support and machine learning applications for the prevention and treatment of childhood obesity: A systematic review of the literature. Artif Intell Med. 2020;104:101844.

Varshavski M. Doctor Mike - YouTube [Internet]. 2021 [cited 2021 Dec 9]. Available from: https://www.youtube.com/c/DoctorMike

WHO. mHealth: new horizons for health through mobile technologies. Geneva: World Health Organization; 2011.

WHO. Global diffusion of eHealth: making universal health coverage achievable: report of the third global survey on eHealth. World Health Organization; 2017. p. 156. Report No.: 9789241511780.

Chapter 2
How Mobile Technologies Are Changing the Life of Physicians and Patients in Hospitals

Frederic Ehrler and Katherine Blondon

Abstract The growing adoption of mHealth technology in hospitals by both patients and care-providers has the potential to modify in-depth the patient-provider relationship and to improve the quality as well as efficiency of care. However, this transformation must be accompanied by a clear strategy by the healthcare institutions to avoid the fragmentation of the initiatives that could lead not only to a sub-optimal experience for the patients but also to possible safety risks. Besides requiring to solve all the technical, regulatory and organizational problems, entering this new era will deeply transform the role and engagement of the patients in their journey as we progress towards a more collaborative vision of care. In this chapter, we present the main challenges associated with the deployment of a mHealth strategy at the institutional level, as well as from a care-provider and patient perspectives.

Keywords mHealth · Patient Generated Health Data · Empowerment · EHR Chronic diseases · Cybersecurity

2.1 Introduction

Since the emergence of the first mobile devices in the form of personal digital assistants (PDAs), people involved in healthcare have been interested in using mobile devices to improve healthcare processes, quality and efficiency. Dealing with one's health is a time- and energy-consuming task, which occupies one's attention continuously (MacGregor and Wathen 2014). This is especially true for patients with

F. Ehrler (✉)
IT Department, University Hospitals of Geneva, Geneva, Switzerland
e-mail: Frederic.Ehrler@hcuge.ch

K. Blondon
Medical Directorate, University Hospitals of Geneva, Geneva, Switzerland

H. Rivas, T. Boillat (eds.), *Digital Health*, Health Informatics,
https://doi.org/10.1007/978-3-031-17666-1_2

chronic conditions, who can spend up to 2 hours each day dealing with health issues (Jowsey et al. 2012). Mobile devices, which are kept within reach throughout the day, offer a privileged channel to reach people at any times (Vo et al. 2019). It also offers new opportunities to reach individuals of lower socio-economic status, who have more prevalent chronic diseases (Lowry et al. 1996). The healthcare sector has witnessed the rapid emergence of many new tools involving mobile technologies to support health care professionals with many important tasks (Ventola 2014a; Mosa et al. 2012), such as: information and time management; health record access and updates; communication and consulting; information gathering and researching references. Mobile tools have also demonstrated the potential to support patients' self-management for many chronic diseases such as hypertension, diabetes and cancer (Lalloo et al. 2017). New medical apps are created and launched daily and contribute in many ways to transform the way patients and providers deal with the healthcare continuum (Smahel et al. 2019). The World Health Organization global observatory of eHealth defines mobile health (mHealth) as “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, Personal Digital Assistants (PDAs), and other wireless devices”. MHealth includes different subcategories such as telemedicine that has become well-established amid COVID-19 restrictions and defined as “the communication or consultation between health professionals about patients using the voice, text, data, imaging, or video functions of a mobile device. But it can be applied to other situations; the management of chronic diseases of patients living at home is one example”.

In hospital settings, mobile technologies offer numerous opportunities for change: they can modify the way clinicians work and practice medicine (Ventola 2014b), empower patients, and improve patient-provider communication (Lu et al. 2018; Krohn 2015). This evolution started with the digitalization of the clinical documentation process that was initially supported by paper records. These records were initially designed to fulfill billing and legal requirements. The evolution toward the first electronic medical records systems often kept the same approach rather than being designed to facilitate and optimize clinician workflows (Evans 2016). As a result, the clinicians were forced to adapt their workflow to the electronic tools rather than having the tools adapted to their needs (Sieck et al. 2020). With the advent of mobile technologies and the rise of user-centered approach, the paradigm is slowly changing in the attempt to provide personalized tools adapted to the real need of the providers, rather than being considered as a support for administrative processes (Saparamadu et al. 2021; Molina-Recio et al. 2020; Bruce et al. 2020). These new tools provide ways for health professionals to more easily access their patients' data, as well as to explore larger databases to access the latest practice guidelines. Furthermore, mobile technology has deeply changed the role of patients in the care process and its relationship with healthcare professionals. It bolsters patient empowerment by enabling patients to be informed about their diseases, guided, prompted and reminded about self-management tasks, and helps keep track of their health. The evolution of this trend has led to the rise of several channels of communication between patients and providers, such as patient portals, emails or texting, all of which are more readily accessible with mobile technologies.