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RESEARCH ARTICLE

Innovative Healthcare Digital Transformations During and After the COVID-19 Pandemic Crisis

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ABSTRACT

Objective: Almost all countries have faced enormous financial, economic, operational, and clinical pressure since the coronavirus disease 2019 (COVID-19) pandemic raised numerous challenges in healthcare services/ businesses. The United States adopted various healthcare strategies and applied them successfully to reduce pandemic mortality rates in the last couple of years. This article focused on various innovative digital transformation strategies used in healthcare businesses/ services, including the role of digitization, digital transformative technologies, and different communication methods to overcome pandemic and post-pandemic periods.

Methods: This study systematically reviewed articles on the early pandemic, the pandemic, and post-pandemic periods, and the related literature was collected using MEDLINE, Medical Subject Headings (MeSH), and medRxiv platforms with appropriate search terms. Articles are categorized based on the title, journal, and publication date. Most of the articles were classified based on the kinds of digital technologies used.

Results: Many countries have used various digital platforms and technologies to manage numerous issues caused by the pandemic. The organizations' healthcare managers mostly use electronic media to communicate with co-workers and patients. A swift shift in business strategies is required during and after the pandemic; customers are seriously considering a stress-free consumer experience through trusted organizations. The demand for innovation in healthcare has dramatically increased, using advanced technology implementations that raise healthcare businesses to a new horizon with digitalization and a consumer-friendly atmosphere; moreover, it supports branding and organizational reputation in the healthcare field.

Conclusion: Many businesses have adopted digital technologies to reach customers and improve their experiences since they can enjoy streamlined services, build brands/ credibility, and gain patient loyalty. Digitalization is promising, and several benefits have been identified from using digital healthcare. The government should invest more in public health sectors to promote digitalization since the pandemic-like scenario is unpredictable.

Keywords: Healthcare, digital technologies, innovations, business, crisis

Introduction

The coronavirus disease 2019 (COVID-19) pandemic was reported at the end of 2019 and described as creating severe acute respiratory syndrome that could lead to systemic illness with multiorgan complications[1] like cardiovascular, pulmonary, neurologic, and psychological due to viral infection[2]. The potentially broader and insidious effects of such a condition could prolong other medical complications even after recovery[3]. US Centers for Disease Control and Prevention (CDC) published about 283,906 infection cases among healthcare workers in December 2019, up to 24 times more prevalent than the public[1]. Patient hospital admissions were reduced dramatically with the onset of the pandemic, which caused unprecedented health and economic disruptions in the nation[4,5]. Deep financial losses for healthcare providers due to a substantial reduction in hospitals/ services, office practices, rural and safety-net providers, and an unexpected increase in demand for health services[6]. The pandemic promoted revenues to hospitals from specialized acute patient care departments, but a decline in revenue from routine clinical services imposed unexpected costs on many healthcare systems. About 1 million employment reductions in the healthcare system were reported in the first six months of the pandemic, the business for well-paid services collapsed, shortages of poorly compensated services, and undersupply of services became less financially attractive[7]. The pandemic significantly impacted healthcare systems' operations, expenses, and revenues, and hospitals' economic/ financial impacts are little known. Many hospitals are forced to meet hospitalized patients' resources and resource-intensive needs, manage employee shortages, address differences in access and outcomes, and deal with financial struggles caused by the increased system expenses[8]. High costs and scarcity of medical supplies, investment in extra resources, spending on training, securing large volumes of personal protective equipment, and space reconfiguration, coupled with unprecedented inflation, created higher organizational expenses. The main reasons for the disruption of healthcare services delivery include the shortages of medicines, diagnostics, and other technologies[8]. Hospitals canceled many elective surgeries, outpatient visits, primary care visits, cancer screenings, and hospital admissions during the peak pandemic in 2020, and the financial impact of cancelations was significant. In the last few years, healthcare systems have faced enormous, multifaceted clinical, operational, human resource, economic, and financial crises.

Since the pandemic disturbed the healthcare sector permanently and likely changed healthcare delivery options, sequelae on the organizational framework remain primarily unknown in 2020[9]. Digitalization is critical since the pandemic devastated organizations and traditional marketing methods are no longer effective[10]. In the health sector, the current pandemic accelerates the growth of digital solutions and is expected to increase patient telemedicine rapidly even more in the future; furthermore, digital methods such as emails, mobile phone apps, artificial intelligence, chatbots, etc., are also available widely for communications and improve businesses in the healthcare sector. To enhance the effectiveness of healthcare delivery, all organizations responded to the pandemic by rapidly adopting digital technology solutions and advanced technology methods. Digital medical technology has solved many challenges

in society, such as phone apps used by patients to trace medical facilities, remote triage emergency services, etc. Many digital solutions have been developed to face challenges/ emergencies and are expected to consolidate in the future. The various solutions can be categorized according to the patient's needs, such as treatment, diagnosis, prevention, adherence, patient engagement, and lifestyle[11]. The research aims to understand the types/ effectiveness of digital solutions to mitigate the impacts of the pandemic on healthcare business/ services and examine different aspects of contemporary medical systems involved in the initial response. Since the COVID pandemic affected all businesses, digitalization offered medical technology companies technologically advanced tools to improve engagement with healthcare systems, employees, and patients. They utilized internet-based facilities that provided them with digital technology platforms operating from desktops, smartphones, laptops, and tablets used by consumers, which has turned business upside down. Patients also used digital devices to find appropriate health products and services for diagnosis and treatments during the pandemic; they realized that digital platform is a more convenient way to purchase goods and services (e.g., AI, chatbots, EHRs, big data, robotics, sensors, telehealth, mobile apps, and telemedicine)[12]. New technology platforms and digital media provided many novel opportunities to expand business regionally or internationally, accelerate new communication methods, offer new services, and compete with larger enterprises globally. The present article explores the role of various innovative digital transformations used in healthcare, including digital transformative technologies and different communication methods, to successfully tackle pandemic-like scenarios during and after pandemic periods.

Material and methods

This retrospective study involved no patient participation, so institutional review board approval is not required for this review analysis. In the last few years, many businesses have used digital technologies to safely enhance healthcare planning, disease diagnosis, improve high-quality treatments, etc. The authors systematically reviewed articles on the early pandemic, the pandemic, and post-pandemic stages, and the related literature was discovered by using MEDLINE, Medical Subject Headings (MeSH), and medRxiv platforms with appropriate search terms of digital technologies in response to the pandemic. They established study characteristics based on the article title, published journal, and publication date. A database was developed based on the studies, and a spreadsheet in Microsoft Excel supported the extraction of various study characteristics. The extracted papers were classified based on the technology used in the articles and the type of patient/ customer needs addressed. Most of the articles were classified based on the kinds of digital technologies as inclusion criteria; a minimum of three investigators checked the titles and abstracts of the identified studies.

Results

Digital health is a term commonly used to represent mHealth, wearable devices, health information technology (IT), telehealth, telemedicine, and personalized medicine, according to the Food and Drug Administration (FDA) in the United States. The FDA recognizes

that the healthcare apps used in medicine for clinical decision-making are based on artificial intelligence, machine learning, digital technology, etc., a healthcare revolution. The tools support medical diagnosis/treatment accuracy, enhance healthcare delivery, and use digital platforms/ connectivity/software and sensors for healthcare-supporting uses. In medicine, digital technologies have a wide range of applications, from general wellness to complex medical device applications. There are many benefits detected using digital technologies in healthcare, such as reduced inefficiencies, improved access, reduced costs, increased quality, and made medicine more personalized for patients. To enhance the clarity of the practical usage, the FDA provided action topics related to digital health support to balance the benefits and risks. Suppose the software artificial intelligence and machine learning contents used in medical devices put effort into caring for cybersecurity, device software functions, data systems, interoperability, telemedicine, and wireless medical devices. Digital health provides continued assistance to patients at home, preserves health workers, reduces the need for hospitalization, and limits virus spread during the pandemic. Digital technologies allowed opportunities to make digital measurements of oxygen saturation respiratory support, monitor frail patients from home, reduce pressure on the hospitals, and manage digital contact tracing and vaccination through intelligent technology. The pandemic is a significant stimulus for the expansion of digital health related to improving medical and technological knowledge, resolving long-standing problems related to management such as reimbursement, introducing new treatment processes, etc. All the mentioned factors are essential to continue the battle against the pandemic and to achieve stable healthcare models for the future post-pandemic era; moreover, the business practices can be improved by applying some crucial points, such as search engine optimization, social media marketing, pay per click advertising, reputation management, and email marketing.

The development of the World Wide Web (WWW), the Internet, and digital technologies, including technology platforms such as desktops, smartphones, laptops, and tablet devices, changed the healthcare business upside-down worldwide; anyone can compete against others on this digital platform without borders. The healthcare sector provides digital media opportunities to expand into new horizons, apply new online communication techniques, offer new services, and compete on a single, larger platform with other businesses[13]. Most customers search the internet for online information about healthcare options to learn about pandemic-related health problems. The use of digital technology by healthcare systems increased by 50% to reach healthcare consumers, and about 48% of healthcare providers increased revenue growth by digital investment in the organizations. There are several benefits associated with digitalization in the healthcare industry, and the development of the internet and digitalization supports the healthcare industry in many ways, such as making healthcare more accessible, immediate reach audiences, raising awareness about brands and medicine, making driven decisions, and reduce cost per acquisition. The research identified that the most useful innovative digital transformation strategies used in healthcare services/ businesses are

search engine optimization, pay-per-click advertising, video marketing, social media marketing, mobile marketing, content marketing, and email marketing methods to expand business seamlessly. Consumers are comfortable now with the stress-free and trustworthy business experience with advanced technology, and the demand for innovative healthcare applications has increased. The introduction of digitalization on electronic platforms has enabled businesses to grow and create new orders in the future[14]. Research and analytics involve data-driven decision-making processes in digital business using key performance indicators (KPIs) and Google Analytics to explore the effects of digitization in business. Future trends in digital transformation in healthcare may include developments using Artificial Intelligence, virtual reality, and telehealth[15]. The pandemic fueled the growth of digital health technologies in healthcare business/ service areas and public health surveillance using virtual care in many countries.

Discussion

Digitalization in healthcare supports widening the reach and promotion of healthcare systems, clinics, hospitals, and professionals using electronic channels, and these digital channels create cost-effective business options using internet-based search engines, social media, and content[16]. Current technologies such as AI, virtual reality, and automation also enhance healthcare service/ business promotion efforts to concentrate on patient experience[17]. Medical clinics can use digital resources, including websites, to connect patients online and share the most relevant time-sensitive information with the audience. Recent technological advancements have made the healthcare field more accessible to the general public, and increased digital healthcare-based telemedicine, digital medical records, electronic health platforms, and online appointment bookings have been noticed in the past couple of years[7].

Digital methods support the promotion of products and services to expand the healthcare services/ business, and digital technology attracts patients and offers quality health services that create satisfaction and possibilities for the recommendation of additional health facilities[18]. Time-sensitive digitalization creates patient satisfaction, engagement, and loyalty to clinical services, which helps expand healthcare businesses online[19]. A reliance on hospital websites supports the determination of clinical facilities, doctors, and diagnostic procedures due to the availability of the most accurate and up-to-date information[20]. The public can research healthcare facilities and share appropriate reviews about visiting experiences that could help encourage others to look for the same facilities in the future. Many people use social media platforms, content marketing, etc., for customer engagement, trust, and loyalty, and these are recognized as more effective in persuading customer loyalty[20]. Organizations need special care about the security of the accounts created, mainly social media accounts. Problems may arise, including security issues, guidance for digital platforms, patient privacy, regulatory issues, lack of staff interest, lack of infrastructure to respond to complaints, and other responsibilities for internet business. Management consistency and commitment are essential to use digital technology in organizations requiring adequate infrastructure, finance, and workforce resources. Appropriate electronic communication with an experimental tone should be sent out before the integration,

and offline integration with an online business approach is necessary to succeed[14].

The United States healthcare sector is quickly transitioning to innovative digital business tactics due to a rapid shift in consumer behavior, present demand for personalized experiences, and cost estimations[21]. Developing a solid foundation for the healthcare system consists of redefining goals, analyzing competitors, identifying target demographics, and formulating HIPAA-compliant strategies[22]. The organization's management should monitor reviews continuously, showcase positive testimonials, and address negative feedback to develop customer trust and loyalty. Initially, defining healthcare business goals involves several steps. The steps are to identify the target audience, conduct a competitive analysis, develop a healthcare business strategy, and search engine optimization for healthcare providers[23]. Social media marketing for healthcare involves building brand awareness, patient engagement, targeted advertising, email marketing in healthcare, and automated chatbots. Healthcare providers' reputation management monitors reviews, addresses negative feedback, and showcases positive testimonials to improve businesses and attract new patients.

Digital technology provides many options for healthcare providers to connect with customers in real-time, which opens possibilities to deliver personalized care to consumers since technology has become highly advanced and integrated into daily lives[24]. Unlocking the immense potential of the digital revolution through strategic digital business embraces digital transformation to meet every customer's unique needs. Digitalization in business needs support from technical experts to create website design and development, paid advertising, and search engine optimizations, as well as support improving online presence, retaining existing consumers, attracting new customers, and growing organization revenue. Various business organizations cleverly used the opportunity of digital business to support, reach out, expand, and improve consumer experiences. Digital strategies have helped as a significant tool for healthcare businesses during the pandemic and are highly accessible to ordinary people who want to purchase and meet daily needs[25]. The remarkable incorporation of digital healthcare techniques supports increasing patient engagement, creating extraordinary business growth, improving brand recognition, facilitating medical services, making educated decisions, and exploring various treatment alternatives[26,27]. Since digital technologies in healthcare need an in-depth understanding, continuous efforts are required to improve and develop professional skills and remain ahead of the competition. Leveraging healthcare digitalization is significant to gain business growth in the field; digital platforms open equal opportunity to everyone and achieve brand recognition in the field; furthermore, several applications of digitalization can be found in the healthcare sector, including patient acquisition, patient engagement, education, targeted marketing campaigns, online appointment scheduling, telemedicine, and virtual care[28]. Many studies reported favoring investing in healthcare digitalization due to many advantages, such as 24/7 accessibility, demographic targeting, brand visibility/ reach, cost-effectiveness, and real-time feedback[29-31].

Limitations of the study:

The studies did not consider different grades of innovation and scalability for all digital

technologies reported in healthcare, so they used the highest innovation grade/ assigned scalability to the technologies to write this research. The literature review considered various digital solutions and designs but did not include specific details of the technology used by multiple institutions to maintain the study quality and eliminate bias. Limitations of reporting particular details of digital technology, including the digital division and organizational aspects, are not considered to include[32]. The digital divide shows the difficulty in accessing infrastructures, especially from the most technologically advanced countries, and the population literacy level. Organizational factors include the scattered distribution of available tools, heterogeneity, integration, interconnection, lack of multidisciplinary approach, heavy privacy regulations, lack of clear guidelines, and lack of reimbursement. Implementing such highly advanced technologies needed a high cost, disruption in patient-provider interactions, compatibility with existing systems, and sustainability[33]. Digital technology brings many challenges, including gaps and challenges in essential health, information technology, integration, and governance. Some of the studies captured early phases/impacts of the pandemic and need continuous research follow-up as more data will be available.

Looking future ahead:

Digital healthcare can transform patient care and outcomes through and beyond the pandemic by optimizing current digital health solutions through provider-facing electronic health records, computerized decision support, clinical data exchange, patient portals, virtual care, population-based data repositories, and public healthcare solutions[34]. They have identified numerous promising developing technologies such as artificial intelligence and machine learning, sensing technologies, apps, precision medicine, virtual/augmented reality, robotics, and cloud solutions for future digital transformations in the healthcare field. The strengths and weaknesses of the current healthcare system, including public health and global healthcare, were exposed by the pandemic that accelerated the usage of digital technology solutions. Many governance and pre-pandemic solutions were restructured or abandoned to surpass pandemic healthcare effects. Many promising emerging technologies have successfully faced challenges posed by the pandemic, and further data resources and tools are required to support effective decision-making and eliminate barriers limiting emerging technology usage.

Conclusion

Several businesses have used digital transformation innovations during the pandemic to reach customers, improve consumer experience, maintain loyalty, and brand healthcare organizations. Digitalization in the healthcare system is essential today to get a broad population and those seeking healthcare information to diagnose and treat diseases. Today, consumers and suppliers can experience streamlined services, make informed choices, and research different treatment options; moreover, technology provides a digital platform for building brands/ credibility and gaining patients' loyalty. People require sound technical knowledge and consistent efforts to operate through digital media in the healthcare field. A focus on public health and clinical solutions is necessary, surpassing the effects of the

pandemic crisis in healthcare with digital solutions. Many articles displayed digitalization has a tremendous impact on healthcare business success, which increases demand for digital technologies, performance indicators of organizational values, rising engagement on social media, growth of product/service searches, growing demand for content platforms, and online demonstration of organizations. Healthcare digital technology innovations have reached new heights in this crisis, and most consumers are delighted with the present digital healthcare services. Several benefits have been identified using digital technologies in healthcare, including the spontaneous expansion of healthcare businesses, attracting new customers/patients, increasing healthcare brand awareness, improving customer trust, strengthening loyalty, encouraging hospital services, and promoting hospital services to relatives and family members. Hospital systems formulate decisions on digital media channels after careful internal discussions and determination of the goals by carefully analyzing possible customers, budgets, market shares, and marketing frequency in detail before going for a technology change, addition, or deletion. Healthcare leadership carefully formulates implementation strategies that include strategic leaders and continuously monitors and evaluates the progress of digital technology implementation. As future pandemics are unpredictable, the federal government should invest in public health sectors and promote digitalization to reduce the pressure on healthcare systems.

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References:

1. Praschan N, Josephy-Hernandez S, Kim DD, et al. Implications of COVID-19 sequelae for healthcare personnel. *Lancet Respir Med.* 2021;9(3):230-231. doi: 10.1016/S2213-2600(20)30575-0.

2. Rio C, Collins LF, Malani P. Long-term health consequences of COVID-19. *JAMA.* 2020; 324(17):1723-1724. doi:10.1001/jama.2020.19719

3. Lopez-Leon S, Wegman-Ostrosky T, Perelman C, et al. More than 50 long-term effects of COVID-19: A systematic review and meta-analysis. *Nature, Sci Rep.* 2021; 11: 16144. https://doi.org/10.1038/s41598-021-95565-8

4. Birkmeyer JD, Barnato A, Birkmeyer N, et al. The impact of the COVID-19 pandemic on hospital admissions in the United States. *Health Aff (Millwood).* 2020;39(11): 2010-2017. https://doi.org/10.1377/hlthaff.2020.00980

5. Barnett ML, Mehrotra A, Landon BE. Covid-19 and the upcoming financial crisis in health care. *NEJM Catalyst.* 2020. doi: 10.1056/CAT.20.0153

6. Boserup B, McKenney M, Elkbuli A. The financial strain placed on America's hospitals in the wake of the COVID-19 pandemic. *Am J Emerg Med.* 2021; 45: 530–531. doi: 10.1016/j.ajem.2020.07.007

7. Blumenthal D, Fowler EJ, Abrams M, et al. Covid-19 — Implications for the health care system. *N Engl J Med.* 2020; 383:1483-1488. doi: 10.1056/NEJMsb2021088

8. Haileamlak A. The impact of COVID-19 on health and health systems. *Ethiop J Health Sci.* 2021;31(6): 1073–74. doi: 10.4314/ejhs.v31i6.1

9. Paul J. Navigating strategic change process in healthcare organizations during unexpected crisis. *Med Res Arc.* 2024. https://doi.org/10.18103/mra.v12i3.5213

10. Dwivedi YK, Ismagilova E, Hughes DL, et al. Setting the future of digital and social media marketing research: Perspectives and research propositions. *Int Jour of Infor Mgmt.* 2021. https://doi.org/10.1016/j.ijinfomgt.2020.102168

11. Whitelaw S, Mamas MA, Topol E, et al. Applications of digital technology in COVID-19 pandemic planning and response. *Lancet Digit Health.* 2020;2(8): e435-e440. doi: 10.1016/S2589-7500(20)30142-4.

12. Hirko KA, Kerver JM, Ford S, et al. Telehealth in response to the COVID-19 pandemic: Implications for rural health disparities. *J Am Med Inform Assoc.* 2020;27(11):1816-1818. doi: 10.1093/jamia/ocaa156

13. Radu G, Solomon M, Gheorghe CM, et al. The adaptation of health care marketing to the digital era. *J Med Life.* 2017; 10(1): 44–46.

14. Pasaribu SB, Novitasari D, Goestjahjanti FS, et al. The impact and challenges of digital marketing in the health care industry during the digital era and the COVID-19 pandemic. *Front Public Health.* 2022;10:969523. doi: 10.3389/fpubh.2022.969523.

15. Dron L, Kalatharan V, Gupta A, et al. Data capture and sharing in the COVID-19 pandemic: A cause for concern. *Lancet Digit Health.* 2022;4(10):e748-e756. doi: 10.1016/S2589-7500(22)00147-9.

16. Golinelli D, Boetto E, Carullo G, et al. Adopting digital technologies in health care during the COVID-19 pandemic: Systematic review of early scientific literature. *J Med Internet Res.* 2020;22(11):e22280. doi: 10.2196/22280.

17. Haleem A, Javaid M, Qadri MA, et al. Artificial intelligence (AI) applications for

marketing: A literature-based study. *Int Jour of Intel Net*. 2022;1:119-132. https://doi.org/10.1016/j.ijin.2022.08.005

18. Khiong K, Tinggi S, Agama I, et al. Impact and Challenges of Digital Marketing in Healthcare Industries during Digital Era and Covid-19 Pandemic *Jour of Indust. Eng. & Mangt Res.* 2021;3:5

19. Pascucci F, Savelli E, Gistri G. How digital technologies reshape marketing: Evidence from a qualitative investigation. *Italian Jour of Marketing.* 2023;2023:27–58. doi: https://doi.org/10.7777/jiemar.v3i5.408

20. Sutton RT, Pincock D, Baumgart DC, et al. An overview of clinical decision support systems: benefits, risks, and strategies for success. *npj Digital Medicine.* 2020;3:17. doi: 10.1038/s41746-020-0221-y.

21. Stoumpos AI, Kitsios F, Talias MA. Digital transformation in healthcare: Technology acceptance and its applications. *Int J Environ Res Public Health.* 2023; 20(4): 3407. doi: 10.3390/ijerph20043407

22. Abernethy A, Adams L, Barrett M, et al. The promise of digital health: Then, now, and the future. *NAM Perspect.* 2022; 10.31478/ 202206e. doi: 10.31478/202206e

23. Elrod JK, Fortenberry JL. Target marketing in the health services industry: the value of journeying off the beaten path. *BMC Health Serv Res* 2018; 18(3): 923. https://doi.org/10.1186/s12913-018-3678-5

24. Butcher CJT, Hussain W. Digital healthcare: the future. *Future Healthc J.* 2022; 9(2):113–117. doi: 10.7861/fhj.2022-0046.

25. Veleva SS, Tsvetanova AI. Characteristics of the digital marketing advantages and Disadvantages. Mater. Sci. Eng. 2020; 940: 012065. DOI 10.1088/1757-899X/940/1/012065

26. Guze PA. Using technology to meet the challenges of medical education. *Trans Am Clin Climatol Assoc.* 2015;126: 260–270.

27. Paul J. What do medical physicists do? Leadership and challenges in administration and various business functions. *Adv Radiat Oncol.* 2022; 7(6): 100947. doi: https://doi.org/10.1016/j.adro.2022.100947

28. Haleem A, Javaid M, Singh RP, et al. Telemedicine for healthcare: Capabilities, features, barriers, and applications. *Sens Int.* 2021; 2:100117. doi: 10.1016/j.sintl.2021.100117

29. Nascimento IJB, Abdulazeem H, Vasanthan LT, et al. Barriers and facilitators to utilizing digital health technologies by healthcare professionals. *npj Digital Medicine.* 2023; 6:161. doi: 10.1038/s41746-023-00899-4.

30. Paul M, Maglaras L, Ferrag MA, et al. Digitization of healthcare sector: A study on privacy and security concerns. *ICT Express.* 2023; 9:571-588. https://doi.org/10.1016/j.icte.2023.02.007

31. Hashem TN. Social media strategies: Building brand awareness through digital platforms in health care sector. *Euro Eco Lett.* 13(4):352-364.

32. Gunasekeran GV, Tham YC, Ting DSW, et al. Digital health during COVID-19: Lessons from operationalizing new models of care in ophthalmology. *Lancet Digit Health.* 2021;3 (2):e124-e134. doi: https://doi.org/10.1016/S2589-7500(20)30287-9

33. Getachew E, Adebeta T, Muzazu SGY. Digital health in the era of COVID-19: Reshaping the next generation of healthcare. *Front. Public Health.* 2023;11:942703. doi: 10.3389/fpubh.2023.942703

34. Zelmer J, Sheikh A, Zimlichman E, et al. Transforming care and outcomes with digital health through and beyond the pandemic. *NEJM Catalyst.* 2022. doi: 10.1056/CAT.22.0053.