



Case Report

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Harnessing Digital Transformation in Healthcare: A Pathway to Enhanced Efficiency and Patient Care

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Abstract

Background: The health of individuals and organizations in healthcare is impacted by digital transformation. Wearable technology, virtual reality, and the Internet of Things have played a role in changing healthcare organizations and how they operate. Patients and their families will now have a wider array of healthcare options and a more thoughtful experience, ushering in a new era of healthcare focused on the patient.

Methods: This article seeks to examine the shifts occurring in the health sector as a result of digital transformation. A systematic bibliographic review is conducted for this goal, using PubMed, Scopus, Science Direct, and Cinahl databases spanning from 2015 to 2024. Our methodology, influenced by Wester and Watson's approach, categorizes related articles using a concept-focused method and an improvised classification system to determine the types of categories used to depict literature subjects.

Results: In response to growing challenges, the health and care system must ensure it has the necessary skills, leadership, and culture to fully leverage the benefits of digitalization.

Conclusions: Embracing digital transformation in healthcare is more than just a technological update; it represents a significant change with the power to transform patient care and operational effectiveness. As we progress through the digital era, it will be essential to adopt these advancements in order to create a health system that is more attentive, effective, and focused on the needs of patients, while also acknowledging possible obstacles and advantages that come with this change in technology.

Keywords: Digital Transformation; Healthcare; Patient Care; Telemedicine; Operational Effectiveness

Abbreviations: DT: Digital transformation; ICT: Information and Communication Technologies; HC: HealthCare; PHR: Personal Health Record; EMR: Electronic Medical Records; EHR: Electronic Health Records; AI: Artificial Intelligence; IoT: Internet of Things; IoMT: Internet of Medical Things

Introduction

Digital transformation (DT) encompasses all the alterations a company makes to leverage emerging technologies, digital platforms, and the internet. It is a continual process that presents chances for companies, yet demands the appropriate infrastructure and training. This involves the integration of digital technologies in companies and their effects on society. Technologies like digital platforms, cloud computing, the Internet of Things, artificial intelligence, and blockchain technology contribute to digital transformation. Fields like agriculture, transportation, energy, financial services, telecommunications, industry, and healthcare are experiencing considerable effects, transforming people's lives. Nowadays, DT technologies can optimize production methods, minimize emissions and waste, boost business competitiveness,

and introduce new services and products to the marketplace. The trend of DT implementation influences multiple domains of business research, including strategy and marketing, as well as information systems, greatly shaping the business environment. One sector significantly impacted by DT is healthcare (HC), encompassing all services provided by healthcare professionals aimed at preserving physical and mental well-being. HC, along with DT's digital transformation, generates fresh business prospects and inventive business frameworks to tackle challenges in healthcare, value generation, and concerns associated with the aging population, among other issues [1,2].

The integration of digital transformation in healthcare is becoming ever more essential. A comprehensive review of all

existing academic literature regarding the use of DT in healthcare, encompassing books, journals, theses, and conferences, revealed significant research interest in this area over the past twenty years, emphasizing that digital transformation in healthcare has become an irreversible process. Nevertheless, this study has primarily concentrated on the technology, neglecting to address the associated effects produced. Examining DT from a worldwide viewpoint would be beneficial to comprehensively grasp all involved parties, including patients, hospitals, pharmaceutical firms, and public authorities, who leverage technology to generate value in enhancing care quality. Most research concerning DT and healthcare frequently overlooks the viewpoints of stakeholders, even while acknowledging their importance [3-5].

Considering all this information, the research question of this article is: In what ways can digital transformation be executed in healthcare to transform patient care and improve operational effectiveness? This inquiry seeks to investigate optimal strategies and practices for utilizing digital technologies in healthcare, emphasizing how these advancements can enhance patient outcomes, optimize healthcare operations, and tackle the unique challenges encountered by different stakeholders. This article seeks to offer insights on the beneficial use of technology in healthcare by examining how digital tools can enhance efficiency while primarily focusing on improving the quality of care provided.

Methods

Purpose of the study

This article's purpose is to explain the advantages of digital transformation be executed in healthcare to transform patient care and improve operational effectiveness. At present, there is a shortage of conceptual frameworks that address patient involvement with these technologies. Thus, the purpose of this paper is to lay the groundwork for a conceptual framework to be used in upcoming studies.

Material and Analysis

The study utilized literature on digital transformation be executed in healthcare to transform patient care. The validation and qualification of the publications' methodologies were determined by how closely they corresponded with the subject matter. The review of literature used certain databases and digital journals, among other sources: Scopus, PubMed, Elsevier Direct, Medline, EBSCO, CINAHL, PsycINFO and Web of Science. Sources of information were found through keyword-based searches in such databases, online repositories and digital libraries, while considering the publication date, author and the article type. The literature chosen consisted of research articles deemed important for addressing the research inquiries raised in this study.

Results

The Importance of Digital Transformation in Healthcare

Digital transformation in healthcare is necessary to adapt the system to the modern demands of the digital age. The healthcare

sector has faced significant challenges such as inefficient resource management, increased public expenditure and poor-quality services. These problems require radical changes to improve the quality of care and increase the efficiency of the system. The renewal process that has been underway in recent years aims to simplify health services and create infrastructure that meets the existing needs of citizens, while improving the cost-quality ratio. The European Commission defines e-health as the use of Information and Communication Technologies (ICT) in healthcare products, services and management. This implementation implies organizational reforms and the development of new skills to enhance the health, efficiency and productivity of citizens. Digital health is related to the interaction between patients and healthcare professionals, the exchange of data between different institutions, and communication between patients and healthcare professionals. In medicine, the application of digital health focuses on personal care, which is critical for therapeutic, diagnostic or preventive procedures, and requires the delivery of medical, health or social services in new ways [6-8].

Digital transformation does not alter the connection between the patient and the health system (including nurses, doctors, etc.), but modifies how health care is provided. This encompasses both the execution of medical procedures (like via telemedicine) and the arrangement of associated services. It is generally recognized that digital technology provides numerous benefits, including efficiency, transparency, flexibility, and cost savings. These attributes position digital health as a reliable approach to mitigate issues and inefficiencies within the system, while enhancing citizen involvement [6,9].

Digital health provides efficiency and cost savings, minimizing resource utilization for both healthcare providers and citizen-users. Higher productivity is attained by minimizing medical errors, removing unnecessary treatments, shortening waiting lists, lowering the necessity for citizen travel, and streamlining access to patient information. Moreover, employing electronic records minimizes or removes the necessity for paper, resulting in reduced costs and enhanced service quality. Although the clear opportunity for savings exists, realizing these advantages will not be swift, as considerable investment in technical infrastructure and ICT systems is necessary. Moreover, large-scale educational initiatives are necessary to foster a technological culture among health professionals and the public. Additionally, digital health offers transparency, enabling all actions to be monitored and documented, allowing individuals to see who has viewed their medical information and when. It is also adaptable, enabling use across various devices like computers, tablets, and smartphones, and can be enhanced to accommodate increasing demands by boosting computing power, bandwidth, storage, and servers [10,11].

In summary, digital transformation in healthcare is essential for enhancing care quality and system efficiency, presenting the chance for a more contemporary, effective, and patient-focused method to health [6].

Benefits for Patients Arising from Digitalization of Healthcare

Digital innovation offers notable advantages to the lives of citizens, which can be outlined as follows:

- i. Awareness and participation in medical health:** Gaining access to medical information is now quicker and more engaging than it was a few years back. People, regardless of being unwell or well, frequently look for information regarding different facets of their health and desire to participate actively in the decision-making concerning their own health as well as that of their family members. This aids in decreasing the information gap between doctor and patient, and the quick access to tailored information facilitates interaction with other patients and doctors, enhancing the quality of care [12].
- ii. Reducing travel:** eHealth facilitates the provision of information and services, including sickness certificates and prescriptions, without requiring physical travel. This conserves time and is especially advantageous for individuals who lack convenient access to these services. Using electronic devices and tools to monitor health from home enhances life quality and decreases the necessity for hospital stays [13].
- iii. Simplifying access to data:** Establishing digital patient records consolidates all essential medical data, lowering the chances of medical mistakes and enhancing patient safety. Medical errors may be minimized through effective data management, lowering the chances of negative events and the necessity for unnecessary medical consultations. Encouraging open data and enhancing the flow of information among regions simplifies access to patients' medical records, even if they are situated in various areas [14].

All these benefits demonstrate the importance of ICT in healthcare, with its increasing focus on citizens. The EU's 2020 strategy aimed to provide European citizens with secure and easy access to their medical data and the widespread adoption of telemedicine services. This change of perspective focuses on the needs and demands of citizens, with the aim of improving their health and quality of life [15].

Improving Operational Efficiency in Healthcare

Cutting-edge technologies offer a variety of tools that can improve operational efficiency within the healthcare sector. DT is revolutionizing healthcare and enhancing operational effectiveness, resulting in notable decreases in health treatments and improved support procedures in hospitals. The former pertains to the treatment and care of patients, which encompasses therapy, diagnosis, and surgical procedures. The latter encompasses all administrative back-office activities that assist in delivering care, including financial operations, equipment upkeep, and drug management [16]. Telemedicine allows, for example, to provide specialized advice to all citizens without having to leave their homes. Still, it reduces administrative costs by allowing appointment scheduling through an app [17].

Electronic Health Records (EHRs) have a lot of data: medical history, demographics, medications and lab test results, allergies, medical images, vital signs, personal statistics like billing details, weight and age. The information stored in the system must be a precise representation of the patient's current state. They offer the ability to access a full medical history without manually looking through past records, avoiding the chance of locating outdated or duplicated records, and simplifying the search for important diagnostic information [18].

AI and machine learning technologies have been implemented to optimize administrative and management processes in the healthcare sector. AI systems can reduce the burden on clinicians by automating processes such as billing and coding. Consequently, healthcare professionals can focus on patient treatment, resulting in enhanced efficiency, reduced errors, and ultimately, savings for medical institutions. Employing AI in administrative roles improves resource distribution and optimizes hospital functioning. It is essential for hospitals to boost competitiveness, elevate care quality, and reduce expenses [19].

To sum up, advancements in technology like digital tools and systems, the utilization of scientific data for patient-focused care, and the emphasis on leadership skills and succession will shape the future of healthcare management. As changes in the healthcare system continue, healthcare managers need to be flexible, dynamic, proactive and innovative to better address emerging challenges and opportunities [20].

Strengthening Accessibility and Equality in Healthcare

In the USA, one of the most developed and technologically advanced countries in the world, it is estimated that at least 21 million people do not have access to electronic devices. Unsurprisingly, in other countries, especially developing countries or countries with an ageing population, the numbers and percentages of citizens without access to technological devices are even higher. Moreover, in areas such as rural or mountainous regions, internet access is often limited or non-existent due to inadequate signal coverage [21].

Even if access to the internet and electronic devices were widely available, equal use of digital health by all patients would not be ensured due to technology illiteracy and limited literacy in new digital technologies. Differential economic situation of citizens, which hinders the possibility of fair access to mentors, educational materials and monitoring on new technologies [22].

Subsequently, the convergence of restricted entry to technological innovation and electronic digital illiteracy extremely restricts patients from taking advantage of a few possibilities involving digital well-being. This holds especially true in minority populations, seniors and rural residents. And with widespread technological illiteracy, people in underprivileged communities are exceedingly susceptible when it comes to safeguarding their personal and medical data. They vulnerable to hacking or other crimes like impersonation [23,24]. A study discovered that people

with poor technical skills and limited education often do not make full use of health apps, causing them to stop using them before completion. These people are unhappy with the health applications they must utilize [25,26].

Ensuring equal opportunities for individuals to access digital health services requires working together with various parties, ideally representing every country. It is essential to make sure that technological education is available to all individuals, regardless of where they are located. At the same time, global organizations and governments must ensure that funding is available for all patients to access reliable internet and technology [27].

Examples Of Innovative Health Technologies

Technology has revolutionized the field of healthcare by enhancing the way illnesses are diagnosed and treated. The incorporation of technology in healthcare has introduced fresh capabilities and tools that are altering how doctors handle data and provide services to patients. Innovative technologies such as Big Data, 5G, blockchain, and telemedicine are revolutionizing the healthcare industry [28].

Big data in health

The term “Big Data in healthcare” refers to large amounts of data collected automatically and periodically, stored electronically and used again to improve the performance of the healthcare system. Big Data has revolutionized the management, analysis and use of data and healthcare is no exception. Healthcare professionals can leverage this data by significantly reducing treatment costs, preventing duplication and increasing overall quality of life. The main challenge for companies is to turn their data into strategic resources. This means that the effectiveness of the use of Big Data in healthcare depends, and on how the data is integrated and communicated to patients and physicians. The data comes from the patient, including diagnoses, treatment procedures, test results, as well as from external sources such as social media, mobile devices and mobile health apps [29].

On the one hand, the use of Big Data offers the possibility of providing personalized medical care. On the other hand, the overall management of healthcare systems can be made more efficient. The biggest opportunities are identified in the transition from reactive to predictive and proactive healthcare. With data analysis, we can examine the cause-and-effect relationships between various variables describing the patient’s vital functions, thus helping to prevent disease exacerbation. This allows for more timely and appropriate care, reducing healthcare costs and moving from a ‘reactive’ to a ‘predictive’ approach [30]. The “reactive” approach focuses on treatment after the first symptoms are already visible, with fragmented data and unintegrated IT systems. In contrast, the “predictive” approach we are pursuing will allow for the prediction of diseases without the appearance of symptoms [31].

In addition, the use of bulk data in healthcare is commonly found in so-called data aggregation systems, such as Personal

Health Record (PHR), Electronic Medical Records (EMR), EHR. The key difference between EHR and EMR is interoperability: the EMR connects to a single healthcare system, while the EHR aggregates and delivers data from multiple systems to create a single patient-centered record. The main goal of electronic health records (EHRs) is to provide and analyze large volumes of diverse, and extract useful information through decision-making and analytical tools. The main advantages of EHR systems include:

- i. Provide complete and accurate information, with automatic management of patient data.
- ii. Direct access to patients’ medical records from digital data transformation.
- iii. Improve diagnosis, minimizing medical errors.
- iv. Facilitating healthcare by supporting decision making.
- v. Reduce costs by minimizing the use of paper documents.

Of interest is the Personal Health Record (PHR), which is an electronic record that remains under the control of the citizen and can include data from various sources, with the possibility of customization and sharing. New digital ICT technologies enable the processing of huge volumes of data, but it is essential that healthcare processes and systems know how to manage them in a reliable and intelligent way [31-33].

The Potential of 5G

The fifth generation of mobile networks, or 5G, is expected to have a significant impact on the use and accessibility of healthcare services for doctors and patients in the near future. This technology aims to increase the efficiency and flexibility of network applications through higher data transmission speeds. In the healthcare sector, the impact of 5G is expected to be significant. According to studies by Swedish multinational Ericsson, in 2026 healthcare providers could benefit from revenue opportunities of \$76 billion due to the transformation that 5G will bring about [34].

This technology will enhance the ability to support telemedicine services and remote medical visits by adding sensors and virtual reality systems to teleconferences. According to a study by PwC (2020), which refers to the so-called ‘Internet Tactile’, this technology will enable interaction between humans and cyber-physical systems, creating the feeling of being physically close. For example, the tactile Internet could allow a doctor to perform a procedure on a patient in another location, with the movements being instantly recreated by computerized equipment. Remote monitoring through wearable devices, 5G networks and data analytics is considered part of the “Internet of the Body”, where the human body transmits data through digital tools [35].

Despite the advantages of the new generation of mobile networks, there are significant challenges that need to be addressed. The digitization of services and documents in the healthcare sector offers many opportunities, but also raises issues of security and privacy. The main issues relate to security

and privacy, as digital interactions generate large amounts of data that can reveal sensitive information about individuals' health. It is critical for healthcare companies to adhere to the technical and administrative requirements of EU Regulation 2016/679 (GDPR) to avoid risks of data breaches and loss [36]. E-Health must be ready to address the problems related to data security and privacy. Ensuring security is essential to protect personal data: security refers to the infrastructure that prevents unauthorized access, while privacy refers to the protection of sensitive personal information. EU Regulation 2016/679 on personal data processing and privacy, which came into force in 2018, highlights the importance of its implementation in the healthcare sector due to the management of sensitive data and the risk of leakage [37,38].

Blockchain in Healthcare

A blockchain is a distributed digital ledger, public or private, in which transactions or data are linked in interconnected blocks, making them almost immutable and unquestionable by all nodes in the network. The revolutionary aspect of this technology is the ability to create and manage a database where information, generated through transactions, is recorded in a way that allows it to be monitored without modification. This technology does not require intermediaries, as the blockchain network provides access to the distributed register of transactions to all participants. In the healthcare sector, blockchain could be used to verify a patient's digital identity, track prescriptions and the frequency of medication use by patients, as well as ensure the correct application of medical devices and treatment protocols. In addition, smart contracts can monitor information provided by medical devices, ensuring their proper functioning [39].

However, blockchain technology achieves better results when there is a variety of information sources, trust in the validity of transactions, removal of intermediaries and a common consensus on the security of the system. As with the internet, the blockchain benefits from an increase in the number of its users. Nevertheless, personal information must be handled with care, especially in the healthcare sector, where privacy is paramount. Blockchain offers significant advantages, such as immutability and transparency, which help reduce the risk of data theft. In addition, blockchain automation can reduce administrative complexity and improve healthcare efficiency. Examples of the application of blockchain technology in healthcare include [40]:

- i. Entering prescriptions for medicines into a distributed system where pharmacists are automatically updated without the need for paper prescriptions.
- ii. Automation of the supply chain for traceability of medicines, ensuring the origin of medicines and preventing counterfeit medicines.
- iii. The adoption of blockchain to manage electronic medical

records, allowing patients to control their data and transfer it wherever needed, even internationally.

Telemedicine

As has been repeatedly highlighted in this article, telemedicine and remote monitoring practices are some of the most advanced tools offered by technology in the health sector, offering the advantage of saving significant financial resources in the public health sector. Telemedicine can be described as the ability to deliver healthcare through new technologies, mainly ICT, even when the doctor or other healthcare professional and the patient are in remote areas. It involves the transmission of information and data of a medical nature, such as text, sound, images or other necessary formats, for the prevention, diagnosis, treatment and continuous monitoring of patients. This new way is not intended to replace traditional health services, but to offer a tool that strengthens the relationship between patient and health professional. It can be used for various purposes in the health sector, such as [41,42]:

- i. Secondary prevention: Providing health services for diseases that have not yet manifested themselves.
- ii. Diagnosis: An evaluation of a patient's symptoms to understand their disease or pathology.
- iii. Treatment: Provision of therapeutic services.
- iv. Rehabilitation: providing rehabilitation care at home for patients who need it.
- v. Continuous monitoring: Monitoring the health status of patients.

It should be noted that healthcare organizations are increasingly moving towards a virtual care environment following the COVID-19 pandemic. The use of telemedicine has increased, as has remote patient support and monitoring. In this sense, the new coronavirus acts as a catalyst for innovations already underway [43].

Healthcare is changing rapidly due to new technologies such as Big Data, 5G, Blockchain and telemedicine. These changes are helping doctors and health systems reduce costs and make it easier for all citizens to access healthcare services. But the problem arises when these new technologies are used many times, and that is in personal data protection. Going into the digital era means that healthcare needs to adapt accordingly. Healthcare professionals must be provided with strict rules to keep information safe, systems monitored for functionality and knowledge given more understanding of new technologies. More importantly, by continuously studying the impact of new technologies on healthcare and implementing changes accordingly we can fortify that these newer tools are employed as they should be used ensuring all inhabitants have a good health in our heavily technology-oriented world.

Improving Patient Experience Through Digital Transformation

Digital transformation is transforming how patients use healthcare systems and fundamentally changing it to a more interactive, personalized experience. Digital transformation in the healthcare space isn't just a behind-the-scenes technological facelift. This is a transformation that does not only stem from the care of patients, but which also offers more security and makes healthcare even better ecosystem. However, the advent of digital technologies (including Electronic Health Records/Telemedicine/AI/IoT) have also brought broad benefits necessitating a transformation in how care is delivered and experienced [44].

DT has led to an enormous advance in patient care, but it is individualized, available and whole. Technologies like telemedicine allow patients to receive care from anywhere, giving them far more access and breaking down geographical barriers that make healthcare less integrated. An informed, up-to-date and cross-provider coordinated look at a patient's medical history is also enabled now by EHRs. Unlocking this knowledge requires artificial intelligence and machine learning algorithms to comb through mountains of data, providing the insights necessary for accurate diagnosis with precise treatment plans - utilizing no less than a precision medicine approach that tailors care based on an individual's genetics as well as lifestyle & environment [45]. Furthermore, IoT devices and wearable technology allow real-time monitoring of the health condition of a patient 24/7 which can help to detect problems early on in order for fine-tuning interventions or care plans to provide better treatment.

It is indeed digital technologies that are essential to protecting patient safety. With EHRs, there is a lower risk of errors since it makes sure that healthcare providers have quick access to accurate and complete information about their patients. AI-supported tools aid in improved disease diagnosis, earlier detection of adverse events prior to onset and decreased risk for complications. The digital platforms also enable safe and secure packaging of telemedicine services, which means the need for physically visiting hospitals can be avoided thereby reducing the exposure to possible hospital acquired infections. Continuous monitoring provided by IoMT devices also improves patient safety, as it allows for the timely detection of any changes in condition that can be addressed [46].

Through digital transformation, the efficiency of healthcare operations has become drastically better. Artificial Intelligence (AI) and digital systems: AI-driven automation of administration tasks would help reduce burden on healthcare staff so that they have more time for patients. EHRs streamline documentation and make patient information more readily available to improve communication between clinicians in different settings. AI-based algorithms also help in resource management, such as scheduling patient meetings and occupancy of hospital beds that lead to efficient use of healthcare resources. Digital enables the scale of

telemedicine service delivery, reaching larger patient populations without needing a lot more infrastructure [47].

Personalized Medicine and Tailored Treatments

The digital transformation of science and society is occurring everywhere, reignited by the COVID-19 pandemic at an almost unprecedented speed. There is an equally urgent need for digital reform in diagnostics and personalized medicine. Historically, personalized or precision medicine initiatives have not been equipped to seamlessly capture patient experiences and clinical outcomes at scale in real-world contexts [48]. But the rapid development of these traditional technologies, as well as wearable smart sensors, wireless connectivity, artificial intelligence (AI), and the Internet of Medical Things (IoMT) is key to transforming how personalized medicine research will be conducted. In addition to facilitating systems research, digital reform has the potential to move personalized medicine and some areas of systems science progress in additional directions [49]:

- i. Real Time Deep Phenotype Analysis: The detailed phenotype analysis, together with patient-reported outcomes (Pro's) provides accurate health monitoring.
- ii. High Throughput Study of Omics and In-depth Phenotype Differences: Comprehensive omics studies combined with detailed phenotyping assess biological functioning to promote personalized medicine,
- iii. The Integration between Epigenetic Mechanisms-Genetics-Proteomic-Metabolic-Homologies should provide a comprehensive picture regarding the underlining susceptibility/protective mechanisms involved in disease pathophysiology that will eventually lead us into development new intervention strategies.
- iv. Digital Clinical Trials: Deployment of digital clinical trials lead to real-time data collection and analysis of the treatment strategies with high precision & effectiveness.

Increasing Patient Participation and Self-Management

Digital tools empower patients to take an active role in their healthcare. Mobile apps and web-based platforms provide access to medical information, appointment scheduling and direct communication with healthcare providers. This increased participation leads to better health outcomes and higher patient satisfaction [41]. Self-management support programs are based on a complex sequence of outcomes. The creators of these programs expect to change patients' behavior, increasing their self-efficacy and knowledge. Improved behavior is expected to lead to better disease control, which in turn will lead to better patient outcomes, reducing the use of healthcare services, particularly preventive emergency room visits and hospital admissions, and ultimately reducing costs. This case sequence gives self-management support programs multiple objectives and ultimate evaluation points. The main goal, however, is to change people's behavior.

The main aim of these programs is to bring about a change in patients' behavior, providing them with the means to manage their health better. Through self-management and the enhancement of self-efficacy, patients strive to succeed:

- i. Better knowledge of the disease: Understanding the treatments available and the impact of the disease.
- ii. Coordination and continuity in health care: Ensuring coherent care from different healthcare providers.
- iii. Symptom management: managing pain and disability.
- iv. Adjusting to the psychological consequences of the illness: Coping with emotions such as fear and depression, both for themselves and their families.

The main objectives of a self-management programmes include:

- i. Solving problems related to the illness: interpreting symptoms and maintaining daily activities.
- ii. Medication management: Compliance with special diets and use of medical devices.
- iii. Cognitive management of symptoms: relaxation, distraction and rephrasing of the exercise.
- iv. Emotion management: adjusting to emotions caused by the illness, such as anger and sadness.
- v. Communication skills: Cultivate collaboration with physicians and develop new meaningful behaviors.
- vi. Support from the social environment: connecting patients and families for mutual support.
- vii. Goal setting: helping patients to set realistic and achievable goals for their health.

These programmes are key tools in the effort to improve patients' quality of life, enhancing their ability to manage their illnesses in a more effective and coordinated way [50,51].

Challenges and Barriers to Digital Transformation

Digital health has been growing in recent years, but it remains a relatively new and unfamiliar area for many citizens. Governments need to create conditions that facilitate the understanding and proper implementation of these technologies. However, there are significant barriers that need to be addressed for effective use of digital health technologies.

Personal Data and Ethics

Digital health raises serious issues regarding the protection of patients' personal data. Information stored in digital applications or passed on to the treatment team is not always covered by traditional medical standards, such as bioethics and medical confidentiality. Data is often collected and processed by private companies, which inform users with discrete notifications and give

them the option to opt out if they do not agree to the terms. When users accept the terms, their data can be shared and processed without proper protection [52]. Non-medical personal data, such as locations, can also be combined with medical data, increasing the privacy risks for users. Proper use and deletion of personal information after an agreed period of time are critical for trust in digital health [53-56].

Efficiency of Application Use

The effectiveness and usability of digital health applications are critical parameters for their acceptance by the general public [57]. From 2014 to 2017, apps were more frequently subjected to usability tests, but testing methods remain anachronistic and do not include modern tests such as rapid eye movement testing [58]. Also, app usability often does not take into account the needs of people with disabilities, who make up 15% of the population. Inclusion of these individuals can enhance satisfaction and continued use of apps [59,60].

Information Quality

The quality of information provided through digital health is also important. Big data offers a wealth of information, but the quality of this data has not been adequately researched. The source of the information, its timeliness and its accuracy need to be considered. For example, if an application draws information from unreliable sources, the quality of the data may deteriorate and negatively affect patient health. The process of checking the validity of medical information, such as peer review in medical journals, is essential [61,62].

Exceptional Changing Circumstances

The COVID-19 pandemic highlighted the need for digital health systems to adapt to emergencies. Digitalization, although necessary, revealed weaknesses in the preparedness of health systems. FAIR (Findability, Accessibility, Interoperability, Interoperability, Reusability) principles can improve the use of digital data in emergencies by ensuring the correct and timely use of data. In addition, training health professionals in new technologies and data management is critical, as there will not be time to invest in education in emergencies [63].

Overall, digital health offers significant opportunities, but requires continuous improvement of data protection processes, application usability, information quality and emergency preparedness. Relevant challenges need to be addressed to ensure that digital tools deliver reliable and safe healthcare.

Proposals for Digital Health Interventions

Digital health is constantly evolving, with many innovative proposals promising to significantly improve it. One such proposal is the development of wearable devices that resemble garments. These devices would monitor the wearer's vital signs (such as heart rate, breathing and blood pressure) without further intervention. To ensure the effectiveness of these technologies,

it is important that they have gone through several clinical trials that confirm their usefulness in improving patients' symptoms. Also, the applications must be adapted to the needs of the specific population, considering the language and dialects of the region [64].

However, the acceptance of remote monitoring and recording of patients' symptoms faces challenges that have yet to be fully resolved, even after the 2020 pandemic. More research is needed to develop and improve devices, applications and embedded AI, as well as their usability and functionality. It is also necessary to recruit trained staff to manage digital health software and technologies, both in healthcare facilities and remotely. Clinicians need to be trained and have access to tools that allow them to provide optimal care for their patients [65,66].

Conclusion

In summary, the digital revolution is having a significant impact on healthcare, reshaping systems worldwide. The implementation of innovative digital solutions can improve the accessibility, quality and flexibility of healthcare, both in Western and developing countries. However, it is critical to assess whether digital health services are achieving the objectives of health systems. The adoption of new digital services must be based on evidence of their performance against health system objectives. There are questions about the clinical effectiveness, verification, reliability and safety of new health technologies that need to be answered before they can be widely implemented. These technologies must undergo rigorous testing and clinical studies in accordance with ethical principles.

The lack of formal regulations and recommendations creates difficulties in adequately validating and adopting new digital health technologies. Proper scientific research is necessary before developing digital health products. Governments need to take a more active role in improving the decision-making process and the balance between centralized and decentralized activity. Preparing the healthcare system for digitization is important, including education, financial and regulatory conditions, and implementing monitoring systems to assess the impact of digitization. Healthcare is dependent on digital solutions, which makes the system vulnerable to new threats. Cybersecurity and information quality are critical to the safe operation of healthcare services. Electronic health records and other key systems are protected by firewalls and user identification systems. However, staff use of mobile devices and remote patient access increase cyber threats, requiring specialized expertise to protect data. In the future, healthcare will face new challenges, such as those brought about by the SARS-CoV-2 pandemic, and will need to invest in creating and adopting strategic plans. The aim is to use advanced technology for modern and efficient health systems capable of providing quality medical services under difficult conditions and in all sectors.

In conclusion, digital transformation is not just a technological upgrade for healthcare but a fundamental shift that has the potential to revolutionize patient care and operational efficiency. As we continue to navigate this digital age, embracing these innovations will be crucial for building a more responsive, efficient, and patient-centered healthcare system.

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References

1. Behera JK (2021) Digital Transformation and Its Impact: An Analytical Study. In *Digitization of Economy and Society* Apple, Academic Press, USA, pp. 27-49.
2. Kraus S, Schiavone F, Pluzhnikova A, Invernizzi AC (2021) Digital transformation in healthcare: Analyzing the current state-of-research. *Journal of Business Research* 123: 557-567.
3. Verhoef PC, Thijs Broekhuizen, Yakov Bart, Abhi Bhattacharya, John Qi Dong, Nicolai Fabian, et. al. (2021) Digital transformation: A multidisciplinary reflection and research agenda. *Journal of Business Research* 122: 889-901.
4. Nudurupati SS, Bhattacharya A., Lascelles D, Caton N (2015) Strategic sourcing with multi-stakeholders through value co-creation: An evidence from global health care company. *International Journal of Production Economics* 166: 248-257.
5. Kraus S, Durst S, Ferreira JJ, Veiga P, Kailer N, et al. (2022) Digital transformation in business and management research: An overview of the current status quo. *International Journal of Information Management* 63: 102466.
6. Amy Abernethy, Laura Adams, Meredith Barrett, Christine Bechtel, Patricia Brennan, et al. (2022) The Promise of Digital Health: Then, Now, and the Future. *NAM Perspectives* 6(22).
7. Igor Ilin, Victoria M. Iliashenko, Alissa Dubgorn, Manfred Esser (2022) Critical Factors and Challenges of Healthcare Digital Transformation, Springer Nature, USA, pp. 205-220.
8. Văidean VL, Achim MV (2022) When more is less: Do information and communication technologies (ICTs) improve health outcomes? An empirical investigation in a non-linear framework. *Socio-Economic Planning Sciences* 80:101218.
9. Iyanna S, Kaur P, Ractham P, Talwar S, Najmul Islam AKM (2022) Digital transformation of healthcare sector: What is impeding adoption and continued usage of technology-driven innovations by end-users? *Journal of Business Research* 153: 150-161.
10. Dubois A, Sielker F (2022) Digitalization in sparsely populated areas: between place-based practices and the smart region agenda. *Regional Studies* 56(10):1771-1782.

11. Affinito L, Fontanella A, Montano N, Brucato A (2022). How physicians can empower patients with digital tools. *Journal of Public Health* 30(4): 897-909.
12. Haleem A, Javaid M, Pratap Singh R, Suman R (2022) Medical 4.0 technologies for healthcare: Features, capabilities, and applications. *Internet of Things and Cyber-Physical Systems* 2: 12-30.
13. Johansson MA, Wolford H, Paul P, Pamela SD, Tai-Ho Chen, et al. (2021) Reducing travel-related SARS-CoV-2 transmission with layered mitigation measures: symptom monitoring, quarantine, and testing. *BMC Medicine* 94.
14. Faulkenberry JG, Luberti A, Craig S (2022) Electronic health records, mobile health, and the challenge of improving global health. *Current Problems in Pediatric and Adolescent Health Care* 52(1): 101111.
15. Marinelli S, Basile G, Zaami S (2022) Telemedicine, Telepsychiatry and COVID-19 Pandemic: Future Prospects for Global Health. *Healthcare* 10(10):2085.
16. Meng Tian, Yang Chen, Guanghao Tian, Wei Huang, Chuan Hu (2023) The role of digital transformation practices in the operations improvement in manufacturing firms: A practice-based view, *International Journal of Production Economics* 262: 108929.
17. Omboni S, Raj S Padwal, Tourkiah Alessa, Béla Benczúr, Beverly B Green et al. (2022) The worldwide impact of telemedicine during COVID-19: current evidence and recommendations for the future. *Connected Health* 1:7-35.
18. Yadav P, Steinbach M., Kumar V, Simon G (2018) Mining Electronic Health Records (EHRs). *ACM Computing Surveys* 50(6): 1-40.
19. Lee D, Yoon SN (2021) Application of Artificial Intelligence-Based Technologies in the Healthcare Industry: Opportunities and Challenges. *International Journal of Environmental Research and Public Health* 18(1):271.
20. Lee E, Daugherty J, Hamelin T (2019) Reimagine Health Care Leadership, Challenges and Opportunities in the 21st Century. *Journal of PeriAnesthesia Nursing* 34(1):27-38.
21. Graves JM, Abshire DA, Amiri S, Mackelprang, JL (2021) Disparities in Technology and Broadband Internet Access Across Ruralty. *Family & Community Health* 44(4): 257-265.
22. Yao R, Zhang W, Evans R, Cao G, Rui T, et al. (2022) Inequities in Health Care Services Caused by the Adoption of Digital Health Technologies: Scoping Review. *Journal of Medical Internet Research* 24(3): e34144.
23. Fisk RP, Gallan AS, Joubert AM, Beekhuysen J, Cheung, L, et al. (2023) Healing the Digital Divide with Digital Inclusion: Enabling Human Capabilities. *Journal of Service Research* 26(4): 542-559.
24. Selian AN, McKnight L (2017) The Role of Technology in the History of Well-Being: Transformative Market Phenomena Over Time. *The Pursuit of Human Well-Being*, Springer Nature, USA pp. 639-687.
25. Alqahtani F, Orji R (202) Insights from user reviews to improve mental health apps. *Health Informatics Journal* 26(3):2042-2066.
26. Sarkar U, Gato I Gourley, Courtney R Lyles, Lina Tieu, Cassidy Clarity, et al. (2016) Usability of Commercially Available Mobile Applications for Diverse Patients. *Journal of General Internal Medicine* 31(12): 1417-1426.
27. Mitchell M, Kan L (2019) Digital Technology and the Future of Health Systems. *Health Systems & Reform* 5(2): 113-120.
28. Siripurapu S, Darimireddy NK, Chehri A, Sridhar B, Paramkusam AV (2023) Technological Advancements and Elucidation Gadgets for Healthcare Applications: An Exhaustive Methodological Review- Part-I (AI, Big Data, Block Chain, Open-Source Technologies, and Cloud Computing). *Electronics* 12(3): 750.
29. Guo C, Chen J (2023) Big Data Analytics in Healthcare. *Knowledge Technology and Systems*, pringer Nature, Singapore pp. 27-70.
30. Jagadeeswari V, Subramaniaswamy V, Logesh R, Vijayakumar V (2018) A study on medical Internet of Things and Big Data in personalized healthcare system. *Health Information Science and Systems* 6(1): 14.
31. Dash S, Shakyawar SK, Sharma M, Kaushik S (2019) Big data in healthcare: management, analysis and future prospects. *Journal of Big Data* 6(1): 54.
32. Detmer D, Bloomrosen M, Raymond B, Tang P (2008) Integrated Personal Health Records: Transformative Tools for Consumer-Centric Care. *BMC Medical Informatics and Decision Making* 8(1): 45.
33. Stanhope V, Matthews EB (2019) Delivering person-centered care with an electronic health record. *BMC Medical Informatics and Decision Making* 19 (1): 168.
34. Georgiou KE, Georgiou E, Satava RM (2021) 5G Use in Healthcare: The Future is Present. *JSL: Journal of the Society of Laparoscopic & Robotic Surgeons* 25(4): e2021.00064.
35. PwC (2020) How can 5G connect a post-COVID healthcare ecosystem? *5G In Healthcare*.
36. Costantini F, Soncini G (2022) Healthcare data governance in the EU: Main challenges in personal data protection. *Endorobotics* pp. 319-336.
37. Azeez NA, Charles Van der Vyver (2019) Security and privacy issues in e-health cloud-based system: A comprehensive content analysis. *Egyptian Informatics Journal* 20(2): 97-108.
38. Thapa C, Camtep S (2021) Precision health data: Requirements, challenges and existing techniques for data security and privacy. *Computers in Biology and Medicine* 129: 104130.
39. Houtan B, Hafid AS, Makrakis DA (2020) Survey on Blockchain-Based Self-Sovereign Patient Identity in Healthcare. *IEEE Access* 8: 90478-90494.
40. Singh S, Kumar Sharma S, Mehrotra P, Bhatt P, Kaurav M (2022) Blockchain technology for efficient data management in healthcare system: Opportunity, challenges and future perspectives. *Materials Today: Proceedings* 62: 5042-5046.
41. Haleem A, Javaid M, Singh RP, Suman R (2021) Telemedicine for healthcare: Capabilities, features, barriers, and applications. *Sensors International* 2: 100117.
42. Kruse CS, Williams K, Bohls J, Shamsi W (2021) Telemedicine and health policy: A systematic review. *Health Policy and Technology* 10(1): 209-229.
43. Shen YT, Chen L, Yue WW, Xu HX (2021) Digital Technology-Based Telemedicine for the COVID-19 Pandemic. *Frontiers in Medicine* 8: 1-23.
44. Hermes S, Riasanow T, Clemons EK, Böhm M, Krcmar H (2020) The digital transformation of the healthcare industry: exploring the rise of emerging platform ecosystems and their influence on the role of patients. *Business Research* 13(3): 1033-1069.
45. Singh S, Bhatt P, Sharma SK, Rabi S (2021) Digital Transformation in Healthcare: Innovation and Technologies. In *Blockchain for Healthcare Systems*. CRC Press, USA, pp. 61-79.
46. Farahani B, Firouzi F, Chakrabarty K (2020) Healthcare IoT. In *Intelligent Internet of Things*. Springer International Publishing, USA pp. 515-545.

47. Patil S, Shankar H (2023) Transforming Healthcare: Harnessing the Power of AI in the Modern Era. *International Journal of Multidisciplinary Sciences and Arts* 2(2): 60-70.
48. Dopazo J, Douglas MayaMiles, Federico García, Nicola Lorusso, Miguel Ángel Calleja et al. (2021) Implementing Personalized Medicine in COVID-19 in Andalusia: An Opportunity to Transform the Healthcare System. *Journal of Personalized Medicine* 11(6): 475.
49. Manickam P, Siva Ananth Mariappan, Sindhu Monica Murugesan, Shekhar Hansda, Ajeet Kaushik et al. (2022) Artificial Intelligence (AI) and Internet of Medical Things (IoMT) Assisted Biomedical Systems for Intelligent Healthcare. *Biosensors* 12(8): 562.
50. Farley H (2020) Promoting self-efficacy in patients with chronic disease beyond traditional education: A literature review. *Nursing Open* 7(1): 30-41.
51. Van de Velde D, De Zutter F, Satink T, Costa U, Janquart S, et al. (2019) Delineating the concept of self-management in chronic conditions: a concept analysis. *BMJ Open* 9(7): e027775.
52. Martinez-Martin N, Dasgupta I, Carter A, Chandler JA, Kellmeyer P, et al. (2020) Ethics of Digital Mental Health During COVID-19: Crisis and Opportunities. *JMIR Mental Health* 7(12): e23776.
53. Karabekmez ME (2021) Data Ethics in Digital Health and Genomics. *The New Bioethics* 27(4): 320-333.
54. Saeb S, Zhang M, Karr CJ, Schueller SM, Corden ME, et al. (2015) Mobile Phone Sensor Correlates of Depressive Symptom Severity in Daily-Life Behavior: An Exploratory Study. *Journal of Medical Internet Research* 17(7): e175.
55. Karaferis D, Balaska D, Pollalis Y (2024) Artificial Intelligence and Robotics: Catalysts or Threats in the Development of Healthcare. *Biostat Biom Open Access J* 11(5): 555825.
56. Shaw JA, Donia J (2021) The Sociotechnical Ethics of Digital Health: A Critique and Extension of Approaches from Bioethics. *Frontiers in Digital Health* 3: 1-9.
57. Zapata BC, Fernández-Alemán JL, Idri A, Toval A (2015) Empirical Studies on Usability of mHealth Apps: A Systematic Literature Review. *Journal of Medical Systems* 39(2): 1.
58. Maramba I, Chatterjee A, Newman C (2019) Methods of usability testing in the development of eHealth applications: A scoping review. *International Journal of Medical Informatics* 126: 95-104.
59. Alajarmeh N (2022) Evaluating the accessibility of public health websites: An exploratory cross-country study. *Universal Access in the Information Society* 21(3): 771-789.
60. Sik-Lanyi C, Orbán-Mihálykó É (2019) Accessibility Testing of European Health-Related Websites. *Arabian Journal for Science and Engineering* 44(11): 9171-9190.
61. Papoutsis C, Reed JE, Marston C, Lewis R, Majeed A (2015) Patient and public views about the security and privacy of Electronic Health Records (EHRs) in the UK: results from a mixed methods study. *BMC Medical Informatics and Decision Making* 15(1): 86.
62. Antman EM, Emelia J Benjamin, Robert A Harrington, Steven R Houser, Eric D Peterson, et al. Acquisition, Analysis, and Sharing of Data in 2015 and Beyond: A Survey of the Landscape. *Journal of the American Heart Association* 4(11).
63. Scott BK, Geoffrey T Miller, Stephanie J Fonda, Ronald E Yeaw, James C Gaudaen, et al. (2020) Advanced Digital Health Technologies for COVID-19 and Future Emergencies. *Telemedicine and E-Health* 26(10): 1226-1233.
64. Shin SC, Ryu CY, Kang JH, Nam SH, Song YS, et al. (2004) Realization of an e-Health System to Perceive Emergency Situations. *The 26th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, USA* 3309-3312.
65. Benis A, Tamburis O, Chronaki C, Moen A (2021) One Digital Health: A Unified Framework for Future Health Ecosystems. *Journal of Medical Internet Research* 23(2): e22189.
66. Mann DM, Lawrence K (2022) Reimagining Connected Care in the Era of Digital Medicine. *JMIR MHealth and UHealth* 10(4): e34483.



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