

An impact of digital technologies on healthcare and patient outcomes: A review

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Abstract

Digital technology has fundamentally transformed healthcare delivery, exerting profound influence on patient outcomes. This paper delves into the roles played by telemedicine, electronic health records (EHRs), and mobile health applications in augmenting healthcare services. The objective is to scrutinize the ways in which these digital innovations enhance healthcare delivery and patient outcomes, while also identifying the attendant challenges in their adoption. To achieve this, a rigorous literature review encompassing peer-reviewed articles, reports, and case studies that examine the impact of digital technology in healthcare settings was conducted. The findings underscore that digital technology significantly bolsters patient care by enhancing access, operational efficiency, and diagnostic accuracy. Nonetheless, persistent challenges such as safeguarding data privacy, ensuring interoperability across systems, and managing implementation costs continue to pose significant hurdles.

Keywords: Digital Technology; Healthcare Delivery; Digital health; Pharmacy; Healthcare; Technologies; Data

1. Introduction

As essential hubs in the healthcare system, pharmacies play a critical and complex role in patient care. Pharmacies have developed into essential partners in promoting health, guaranteeing medication safety, and improving the general well-being of patients, going beyond their traditional role of dispensing medications. [1] As specialists in medications, pharmacists are essential in making sure that patients are given the appropriate drugs at the right dosage. They evaluate possible drug interactions, interpret prescriptions, and give patients important information about their drugs, such as how to take them and any possible negative effects. [2] Furthermore, pharmacies play a key role in supporting public health campaigns. They act as easily accessible locations for health screenings, immunizations, and preventative care. [3] Pharmacists frequently give vaccinations, including flu shots, and offer advice on how to avoid getting sick. [4] In order to maximize patient care, pharmacists work in tandem with doctors, nurses, and other healthcare professionals, making them vital members of the healthcare team. They take part in managing medication therapy by recommending safer and more effective treatment plans, modifying dosages, and offering insights into possible drug interactions. Patients will receive thorough and well-coordinated care thanks to this cooperative approach, which takes into account not only their medication requirements but also their general health and wellbeing. Additionally, pharmacies are centers for patient empowerment and education. Pharmacists enable patients to actively engage in their healthcare journey by providing them with informational materials, health apps, and one-on-one consultations. They serve as a guide for dietary choices, lifestyle adjustments, and chronic illness management techniques. A sense of accountability and ownership is fostered by this patient-centric approach, which enhances general wellbeing and health outcomes. [5] A period of revolutionary shifts in healthcare delivery has been ushered in by the COVID-19 pandemic, which has sped up the adoption and development of digital health systems. The world saw an unparalleled rise in the incorporation of

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digital technologies into healthcare practices due to the problems of social distancing, overburdened healthcare systems, and an urgent need for remote solutions. [6] The extensive use of telehealth services has been one of the noteworthy developments. The ease and effectiveness of telehealth were welcomed by both patients and medical professionals, which caused a paradigm shift in the conventional approach to healthcare delivery. [7] Healthcare workflow optimization has also been greatly aided by digital health systems. These technological developments support more effective and efficient healthcare delivery in addition to improving clinical decision-making. [8] To improve patient care, pharmacies have embraced digital health technologies in addition to the traditional method of physically dispensing medications. Automated dispensing systems, medication adherence apps, and electronic prescribing systems increase productivity by streamlining procedures and lowering errors. [9] Pharmacists can now provide more direct patient care, including consultations, medication therapy management, and individualized health advice, thanks to technological advancements. By facilitating remote consultations and increasing access to professional advice for patients in remote or underserved areas, telepharmacy services further broaden their scope. [10] Pharmacies actively work to reduce risks because medication safety is a top priority. By guaranteeing precise dispensing, the use of technologies like barcoding and Radio Frequency Identification Systems (RFID) helps reduce medication errors. Pharmacists apply their knowledge to find and fix prescription inconsistencies, inform patients of possible dangers, and put plans in place to improve medication use safety. [11] The increasing need for better patient care, medication management, and overall healthcare efficiency has made the "integration of digital health technologies into pharmacy services" a paradigm shift in the medical field. The understanding that technological developments have the ability to solve long-standing issues in the pharmacy landscape and improve the standard of healthcare delivery serves as the justification for the study's investigation into how digital health technologies affect pharmacy services and patient care. Utilizing technological solutions to improve medication management, lower errors, and boost overall pharmacy operations efficiency is imperative as the healthcare landscape grows more complex. Finding best practices and optimizing their integration into routine pharmacy procedures require an understanding of how much these technologies enhance workflow. With the potential to completely transform the patient-pharmacist relationship, this study attempts to evaluate how digital health technologies affect patient care. Patients now have unheard-of access to tools and information for managing their health thanks to the development of wearable technology, remote patient monitoring, and health apps. Furthermore, the reasoning behind the study is based on the larger framework of healthcare system change. Analyzing these technologies' systemic effects offers insights into the possibility of long-lasting, scalable improvements that can help patients and pharmacies more broadly.

1.1. Digital health technologies

Pharmacies have seen a radical change as a result of digital health technologies, which have improved the general standard of healthcare services and changed long-standing procedures. Medication adherence apps, telepharmacy services, and electronic prescribing systems have all been integrated to improve medication management procedures, streamline pharmacy operations, and lower manual task errors. In addition to improving operational effectiveness, the integration of digital health technologies into pharmacy services has raised the standard of patient-centered care that pharmacies offer. [12] Better control of medication Pharmacy medication management has been transformed by digital health initiatives, especially the use of e-prescribing systems and medication adherence apps, which have ushered in a new era of accuracy, efficiency, and patient involvement. The introduction of e-prescribing has simplified the prescription procedure by substituting electronic formats for conventional handwritten prescriptions. This speeds up the entire medication dispensing process and lowers the possibility of mistakes brought on by illegible handwriting. [13] Real-time access to electronic prescriptions by pharmacists allows for speedier dispensing and prompt interventions, like spotting possible drug interactions or therapeutic duplications. [14] Moreover, e-prescribing fosters seamless communication between healthcare providers and pharmacies, promoting a collaborative approach to patient care. [15]

At the same time, apps for medication adherence have become effective resources for improving patient involvement and encouraging regular adherence to recommended routines. By offering patients individualized drug schedules, dosage reminders, and educational materials, these applications enable patients to actively participate in their own health management. [16] By providing useful information about drug interactions, side effects, and appropriate administration techniques, pharmacists can use these apps to support medication counseling. [17] Pharmacists can track patient adherence, spot trends, and take proactive measures if problems emerge thanks to the real-time data these apps generate. Medication adherence apps improve health outcomes and foster a more cooperative pharmacist-patient relationship by removing obstacles to adherence and encouraging a deeper comprehension of prescribed medications. Apps for medication adherence and e-prescribing together can have a synergistic impact on pharmacy medication management. In addition to streamlining administrative procedures, the smooth integration of patient-focused apps and electronic prescriptions can improve the general standard of patient care.

1.2. Enhanced communication and collaboration

Pharmacy communication and collaboration have been redefined by digital health initiatives driven by tele-pharmacy services and improved interoperability, creating a more responsive and interconnected healthcare ecosystem. A crucial element that allows for remote consultations between patients and pharmacists is telepharmacy services. This not only makes it easier for people in underserved or remote areas to get professional pharmaceutical advice, but it also makes it possible to conduct medication management reviews and timely interventions without being physically close. [18] Additionally, telepharmacy improves cooperation between medical Professionals, giving pharmacists the opportunity to confer with doctors and other medical specialists in order to guarantee care coordination and enhance treatment strategies. [19] Interoperability, or the smooth exchange of data between various healthcare systems, enhances pharmacy communication even more. Improved interoperability makes it easier for medical professionals to share critical patient information, such as prescription histories, allergies, and treatment plans. By using this shared information to guide their decisions, pharmacists can increase patient safety and lower the risk of unfavorable outcomes. In order to deliver integrated and patient-centered services, pharmacists can collaborate closely with other healthcare team members, including doctors and nurses, thanks to interoperability. [20] Efficient workflow and automation

The combination of pharmacy managements systems and automated dispensing systems has revolutionized workflow efficiency and automation in pharmacies. Pharmacy management systems free up pharmacists' time to focus on patient care rather than administrative tasks by enabling electronic prescription processing, inventory control, and billing. [21] Additionally, these digital systems increase accuracy by lowering the potential for human error associated with traditional paper-based processes. [22] Workflow efficiency is further increased by the use of automated dispensing systems, which precisely dispense medications using technology. These systems, which often use robotics and barcoding technology, benefit patients by reducing the risk of dispensing errors and ensuring that patients receive the right medications in the right dosages.

By automating the dispensing process, pharmacists can devote more time to overseeing medication therapy, managing patient interactions, and consulting with patients. This enhances the pharmacy's overall workflow. [23] This digital transformation ensures that pharmacists can concentrate their abilities on patient-focused tasks, improving patient care and the overall pharmacy experience, in addition to making pharmacy operations more precise and effective. [24]

1.3. Remote patient monitoring

A new era of patient care in pharmacies has been brought about by digital health initiatives, especially with the integration of remote patient monitoring made possible by wearable technology and remote sensors. By continuously monitoring vital signs, physical activity, and other health metrics, wearable technology—such as fitness trackers and smartwatches—with sensors that monitor health allows patients to take an active role in their care. Pharmacists can use the data produced by these devices to learn more about the health of their patients, spot patterns, and customize treatment regimens.[25] Additionally, pharmacists can make proactive interventions and treatment plan modifications thanks to real-time health information provided by remote sensors, which are frequently integrated into home-based monitoring devices. Pharmacists can now remotely monitor patients with chronic conditions thanks to this technology, which guarantees early problem detection and encourages prompt interventions. [26] In addition to improving patient engagement, the combination of wearable technology and remote sensors in the pharmacy setting promotes better patient outcomes and general well-being by enabling a more thorough and proactive approach to healthcare Customized healthcare.

1.4. Enhanced medication safety

By combining cutting-edge technologies like barcode and RFID technology with drug interaction alerts, digital health initiatives have greatly improved medication safety in pharmacies. Because they guarantee precise dispensing, barcode and RFID technology are essential in lowering the possibility of medication errors. By comparing them with electronic prescriptions and patient records, these technologies allow pharmacists to confirm the identity and dosage of medications. Pharmacists can improve medication dispensing accuracy by using RFID tags or barcode scanning, which reduces the possibility of giving the incorrect medication or dosage and mitigates errors related to manual processes. Real-time medication profiles of patients are analyzed by pharmacy management systems with drug interaction alert features, which highlight possible drug interactions. Instant alerts give pharmacists vital information to weigh the advantages and disadvantages of particular drug combinations. [38] In order to prevent adverse reactions and improve overall medication safety, this proactive approach empowers pharmacists to step in and work with healthcare providers to alter treatment plans as needed. These programs not only protect the health of patients but also highlight how digital health technologies can foster a culture of constant improvement and medication safety awareness in the pharmacy

setting. These digital health initiatives are positioned to become more and more important in improving medication safety procedures and raising the bar for care that pharmacies offer as technology develops.

1.5. Impact of Telemedicine on Healthcare Delivery

Telemedicine has improved accessibility and convenience, which has had a major impact on healthcare delivery. Specialist consultations are accessible to patients in underserved or remote areas without requiring them to travel great distances. This has proven especially helpful in follow-up care and chronic disease management.

1.6. Electronic Health Records (EHRs)

Telemedicine can improve patient outcomes by enabling prompt interventions and ongoing monitoring, according to studies. For example, improved disease management and fewer readmissions to hospitals have been linked to remote monitoring of long-term conditions like diabetes and hypertension. By cutting down on travel expenses and wait times, telemedicine also improves patient satisfaction. Electronic Health Record Definition and Adoption (EHRs) Digital copies of patient charts are called electronic health records, or EHRs. They include all of the patient's medical history, diagnoses, prescriptions, treatment plans, dates of vaccinations, and test results. Initiatives to increase the effectiveness and quality of healthcare have fueled the adoption of EHRs. Electronic Health Records' Effect on Healthcare Delivery Because EHRs increase the accuracy and accessibility of patient data, they have fundamentally altered the way healthcare is delivered. Rapid access to and exchange of patient data among healthcare providers improves care coordination and continuity. This lowers the possibility of medical mistakes and makes it easier to make more informed choices. Electronic Health Records' Effect on Patient Results Improved patient outcomes have been associated with the use of EHRs. For instance, by using automated reminders for follow-up appointments and preventive care, EHRs facilitate proactive management of chronic diseases. By giving medical professionals access to the most recent clinical guidelines and research, they also promote evidence-based practice.

1.7. Mobile Health Applications

Mobile health (mHealth) applications, which are electronic resources that promote wellness and health on smartphones and tablets, have become increasingly popular as a result of the growing use of mobile devices. These applications provide a range of services, including telehealth consultations, fitness tracking, medication reminders, and appointment scheduling. HealthCare Delivery Impact of mHealth Apps mHealth apps have transformed healthcare delivery by enabling patients to actively manage their own health, including self-monitoring and self-management by allowing patients to track their symptoms, medication compliance, and lifestyle changes, and by allowing medical professionals to remotely monitor patients and provide timely interventions. Mobile Health Apps' Impact on Patient Outcomes This study suggests that mHealth applications can improve patient outcomes by promoting healthy behaviors and improving disease management. For example, diabetes management apps have been shown to improve glycemic control and reduce complications. Additionally, mHealth apps improve patient engagement and treatment plan adherence, which leads to better health outcomes.

2. Methodology

This study uses a systematic literature review methodology to examine the effects of digital technology on healthcare delivery and patient outcomes.

- Literature Search: Relevant articles were located using databases such as PubMed, Google Scholar, and IEEE Xplore. "Digital technology in healthcare" was one of the keywords. "telemedicine," "patient outcomes," "mobile health applications," and "EHRs."
- Screening: Only papers published within the last ten years were selected in order to ensure the data's currency and applicability. Duplicate records and non-English publications were excluded.
- Data Extraction: Key information regarding the impact of digital technologies on patient outcomes and healthcare delivery was extracted from the selected articles' study design, sample size, findings, and conclusions.
- Analysis: To find common trends, advantages, and difficulties related to the use of digital technologies in healthcare, the extracted data was subjected to a thematic analysis.
- Synthesis: To give a thorough picture of how digital technologies are changing patient outcomes and healthcare delivery, the findings were combined.

3. Discussion

The efficiency of healthcare delivery and patient outcomes has significantly improved as a result of the adoption of digital technology. Access to healthcare has improved thanks to telemedicine, particularly in underprivileged areas. By offering precise and easily accessible patient data, EHRs have raised the standard of care. Better health outcomes have resulted from giving patients the tools they need to actively engage in their care through mobile health applications. To fully reap the benefits of digital technologies in healthcare, a number of obstacles must be overcome. The growing amount of private patient data being stored electronically raises serious privacy and security issues. Another major obstacle to the smooth exchange of patient data is interoperability across various healthcare systems. Another obstacle may be the expense of setting up and maintaining these technologies, especially for smaller healthcare organizations.

Using Telemedicine to Close the Access Gap in Healthcare The significance of telemedicine was further underscored by the COVID-19 pandemic, which reduced the risk of virus transmission by facilitating safe patient-doctor interactions [34].

Telemedicine has fundamentally altered the delivery of healthcare by enabling access to medical care in remote and underserved areas. Two examples of this technology that enhances the management of chronic diseases by facilitating the real-time tracking of patient health metrics are virtual consultations and remote patient monitoring (RPM). For example, RPM can help manage conditions like heart failure and enable timely medical interventions by monitoring for signs of fluid accumulation [28]. Despite its benefits, telemedicine has a number of disadvantages, including uneven legal frameworks, issues with digital literacy, and unequal access to technology.

These obstacles must be removed if telemedicine is to reach its full potential. To properly support telehealth services, policies must change. This includes state-by-state uniformity in regulations and reimbursement schemes [46]. Additionally, by reducing the need for physical travel, telemedicine can ease the burden on healthcare facilities while providing timely care, particularly in remote areas [33]. Patients with chronic illnesses who need frequent monitoring and follow-up benefit most from continuous care management made possible by telemedicine [32].

The management of patient data has been transformed by electronic health records (EHRs), which have improved clinical judgment and decreased medical errors. EHRs help healthcare providers better coordinate by combining different facets of patient care into a single system. To ensure timely follow-up care, an EHR, for example, can notify a primary care physician if a patient is admitted to the emergency department [29]. By identifying at-risk groups and enabling focused interventions, EHRs also aid in population health management [27]. However, there are many obstacles to overcome when implementing an EHR, including user resistance, data entry errors, and system interoperability. EHR interfaces are difficult for many healthcare providers, which hinders patient care. For EHR systems to be more effective and user-satisfied, their usability must be improved through better design and customization options [50]. All healthcare providers involved in a patient's care will have access to the most recent information if EHRs are integrated with other digital health tools, such as telemedicine platforms and mHealth applications, to form a cohesive healthcare system [31]. **Empowering Patients with Mobile Health Applications** Mobile health (mHealth) applications have emerged as powerful tools for improving patient self-management and engagement. By providing features like medication reminders, appointment scheduling, and health information access, these apps enable patients to take charge of their own health. Apps for diabetes management, for example, can monitor blood sugar levels, remind users to take their medications, and offer information on diet and exercise [30]. Better health outcomes have been associated with increased patient engagement and treatment plan adherence due to the ease and accessibility of mHealth apps [35]. Beyond individual patient care, mHealth apps can also support public health efforts by facilitating large-scale health data collection. For instance, during disease outbreaks, mHealth apps can track symptoms and monitor disease spread, providing valuable data for public health officials [39]. However, problems like user engagement and digital literacy can hinder the effectiveness of mHealth applications. To maximize their impact, mHealth apps must be designed with user-centered principles and ensure they provide accurate, evidence-based information [36].

3.1. Enhancing Interoperability and Integration

Enhancing the interoperability of EHRs, telemedicine platforms, and mHealth applications is necessary to reap the full benefits of digital health technologies. Interoperability, which ensures seamless information exchange between multiple systems, enables a comprehensive understanding of the patient's medical history. This seamless information flow is essential for effective care coordination, especially for patients with complex medical needs [37]. The goal of integration efforts should be to connect different tools into a single digital health ecosystem. An accurate and comprehensive picture of the patient's healthcare journey can be obtained, for example, by integrating telemedicine platforms with EHRs, which

guarantees that virtual consultation records are automatically added to the patient's health record [43]. Similarly, real-time patient data updates are made possible by integrating mHealth apps with EHRs, improving remote patient management and monitoring [45].

3.2. Challenges and Barriers

The broad adoption of digital healthcare technologies is still significantly hampered by technological issues like interoperability, data security, and privacy concerns. Because various systems may not be able to communicate with one another effectively, interoperability problems can result in fragmented care. Privacy and data security are also top priorities, especially in light of the growing amount of private patient data being kept on electronic devices. The integration of these technologies into current workflows is made more difficult by organizational issues such as reluctance to change and a lack of training [41]. Healthcare providers must navigate a complicated web of regulations intended to protect patient privacy and guarantee data security, which adds another layer of complexity [42].

3.3. Technological Challenges

Although there are many benefits to digital healthcare technologies, several barriers keep their widespread adoption. Technological barriers pose serious problems, including incompatibilities between different systems and concerns about privacy and data security. It's also crucial to ensure that all patients, regardless of their level of technological proficiency, can easily access and use digital tools [47].

3.4. Organizational Challenges

The integration of digital technologies into healthcare organizations' workflows can be difficult due to organizational barriers such as resistance to change, lack of training, and financial constraints. Strong leadership, extensive training programs, and infrastructure investment are necessary to overcome these obstacles [48].

3.5. Regulatory and Legal Challenges

The adoption of digital healthcare technologies is also impacted by legal and regulatory issues.

Making certain that rules like the Health Insurance Portability and in the US, the Health Insurance Portability and Accountability Act (HIPAA) is crucial for safeguarding patient privacy and data security. Policymakers, technology developers, and healthcare providers must work together to navigate the complicated regulatory environment [49].

3.6. Recommendations for Better Impact

3.6.1. Enhancing Interoperability

To make the most of digital healthcare technologies, system interoperability must be improved. Standardized processes and encouraging the use of open-source solutions can enhance data exchange and care coordination [40].

3.7. Investing in Training and Education

Encouraging continuous professional development can help healthcare providers stay up to date with the latest advancements, and investing in education and training for healthcare providers is essential to ensuring the effective use of digital tools. Thorough training programs should cover the technical aspects of digital technologies and their clinical applications [51].

3.8. Addressing Data Security and Privacy Concerns

In digital healthcare, protecting privacy and data security is crucial. Patient data can be protected by putting strong cybersecurity measures in place, such as multi-factor authentication and encryption. Informed consent for data sharing and patient education regarding data privacy can also foster trust and encourage the use of digital tools [52].

4. Future Directions for Use of Digital Technology in Healthcare

With continuous technological advancements poised to further transform healthcare delivery and patient outcomes, the future of digital healthcare looks bright. New technologies like blockchain, machine learning, and artificial intelligence (AI) have the potential to enhance data security, diagnosis, and treatment. Innovation can be stimulated, and the quality of healthcare services improved, by ongoing research and development in these areas [44].

4.1. Artificial Intelligence and Machine Learning

Artificial intelligence (AI) and machine learning (ML) have the potential to revolutionized the healthcare sector by enabling automated diagnostics, personalized medicine, and predictive analytics. AI-driven technologies can analyze vast amounts of data to identify patterns and provide insightful information that enhances clinical judgment and patient outcomes [53].

4.2. Blockchain Technology

Blockchain technology offers a secure and transparent way to manage medical data. By providing a decentralized and impenetrable ledger, blockchain can enhance data security, speed up administrative processes, and encourage system interoperability. Many of the present issues with data security and privacy can be resolved by implementing blockchain in the healthcare industry [54].

4.3. Telehealth Expansion

It is anticipated that telehealth services will continue to grow due to patient preferences and telecommunications technology advancements. A comprehensive digital healthcare ecosystem that enhances accessibility and patient outcomes can be created by combining telehealth with other digital tools like mHealth apps and remote monitoring devices [55].

5. Conclusions

Digital technologies like telemedicine, Electronic Health Records (EHRs), and mobile health applications (mHealth) have revolutionized healthcare delivery by improving accessibility, enhancing patient engagement, and fostering better health outcomes. Telemedicine helps bridge geographical gaps and offer timely access to medical care by enabling remote monitoring and consultations. This is particularly beneficial in rural or underprivileged areas. EHRs simplify the administration of medical records, ensuring efficient data exchange between healthcare providers. This enhances care coordination and makes informed clinical decisions easier. Similarly, by enabling self-management of chronic conditions, promoting adherence to treatment plans, and facilitating real-time health monitoring, mHealth apps empower patients. Despite the revolutionary benefits, integrating digital technology into healthcare systems is challenging. Given the potential for breaches and unauthorized access to private health data, data security and privacy concerns remain crucial and raise ethical and legal questions. Interoperability issues arise from disparate data formats and the disjointed nature of healthcare systems, impeding seamless information exchange between different healthcare providers and facilities. Additionally, the high costs of establishing and maintaining digital infrastructure pose a financial challenge, particularly for smaller healthcare practices and settings with limited resources. These problems need to be fixed if digital technologies are to reach their full potential in healthcare.

Future studies should concentrate on creating novel answers to these problems and investigating the potential of emerging digital technologies to further revolutionize healthcare. To establish an atmosphere that encourages innovation and guarantees the effective integration of digital technologies into healthcare systems, stakeholders including legislators, technology developers, and healthcare providers must work together.

In summary, even though digital technologies have already significantly improved patient outcomes and healthcare delivery, coordinated efforts are required to address current issues and optimize their effects. Digital technologies can continue to revolutionize healthcare delivery by tackling these issues and encouraging innovation, which will eventually result in more effective, efficient, and equitable healthcare systems around the world. Digital health technology integration has greatly improved patient care and changed pharmacy services. Medication adherence apps, telepharmacy services, and electronic prescribing systems have all increased operational effectiveness, decreased errors, and expedited pharmacy medication management procedures. These technological developments show a dedication to patient-centered care, enhanced medication safety, and a more proactive and interconnected healthcare ecosystem as pharmacies transform into digitally driven healthcare hubs. Additional developments that could enhance pharmacy services and, eventually, patient outcomes could be made as digital health technologies are further integrated.

Compliance with ethical standards

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The author declares no conflicts of interest.

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