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Review Article

How Digital Health is Revolutionizing Healthcare and Contributing to Positive Health Outcomes

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Abstract

Digital health has been instrumental in revolutionizing healthcare by ensuring continuity of care, personalizing care, reducing errors and wastage, improving diagnostic accuracy, providing clinicians with decision-making support, and facilitating treatment and care beyond the clinical setting. All these benefits improve the quality of care and lead to positive health outcomes. It also improves patient satisfaction with care. Digital health can also be used to address the challenges that are currently facing healthcare systems. For instance, digital health can help to address the challenge of limited access. Digital health can also help to address the increasing patient needs and demands. However, the integration of digital health in healthcare systems still remains a challenge. Privacy and confidentiality concerns are major issues. Because of the nature of data stored in these systems, security breaches can have negative outcomes on care. Accuracy and reliability of data are also issues of concern. Addressing these challenges can make healthcare systems realize the benefits of digital technologies.

Keywords: digital health, digital technologies, revolutionizing healthcare, positive patient outcomes

Introduction

The last three decades have seen significant development and acceleration of digital technology. Significant transformations have been seen in different areas including in the healthcare sector with digital health becoming a key aspect of today's healthcare. Digital health is a concept that has its roots in eHealth. According to the World Health Organization Global Strategy, digital health refers to "the field of knowledge and practice associated with the development and use of digital technologies to improve health" (p.11).[1] Digital health entails the use of different types of technologies to manage health and illness and address patients' needs. Digital health can also be defined as the cultural transformation brought about by disruptive technologies that provide digital and objective data and make it accessible to caregivers and patients leading to better patient-healthcare provider relationships and improved shared decision-making.[2] Digital health has a wide scope. It can include wearable devices that play a key role in collecting health data, mobile health technology, telehealth, telemedicine, and even health information technology.[3] Digital health can also include technologies such as the Internet of Things, big data analytics, artificial intelligence (AI), and advanced computing. A paradigm shift towards digital health is undeniable. Using digital technologies in healthcare provides a lot of opportunities for digital consumers, healthcare providers, and stakeholders in the healthcare sector. Such technologies ensure continuity of care, personalization of care, reduced errors and wastage, improved diagnostic accuracy, and enhanced decision-making support. Digital health also provides an opportunity to address the challenges of ailing healthcare systems. Some of these challenges include limited access, changing patient demographics, poor design of processes, limited resources, increasing patient demands and needs, rising healthcare costs and inadequate financing.[4,5,6]

Digital technologies provide great opportunities for healthcare systems to address these challenges. The transformation these systems bring comes with a lot of advantages for all stakeholders involved. They include improved access to healthcare by reducing inadequacies in the healthcare system, improving the overall quality of care, personalizing care and addressing the aspect of cost in healthcare, improving decision-making, improving patient-provider communication and relationships, and strengthening healthcare systems.[7,8,9] Digital technologies can help to address the perennial problem of inadequate access, particularly for patients in remote areas. Digital technologies can also be used to facilitate targeted communication more so to healthcare users battling chronic conditions. Digital technologies can also facilitate decision-making by providing decision-making support. All these have the potential to transform healthcare systems and lead to positive health outcomes. This review seeks to establish how digital health technologies are transforming healthcare. The review will explore the impact of different types of technologies on healthcare, how they are changing healthcare, and how they are contributing to positive health outcomes.

The Power of Digital Health in Revolutionizing Healthcare

The significance of digital technologies in healthcare cannot be understated. Healthcare is one of the sectors that has always

embraced new technologies and innovations to enhance efficiency. The power of these technologies and innovations to transform healthcare and make it patient-centered, less costly, and improve outcomes have always been some of the factors that have made stakeholders in the sector embrace these technologies.[10] With such advancements in digital technology, every aspect of health and healthcare has embraced different digital healthcare tools and applications which have been instrumental in healthcare delivery. For instance, in health information, digitalized records have transformed how patient information is stored and shared among different healthcare providers which has increased access to healthcare and improved the quality of care.[11] Personal health devices have made it easier to monitor and access patients. Diagnostics is another area that has seen great transformation because of the adoption of digital health technologies. Other areas that have seen a great transformation as a result of digital technology adoption are imaging, telemedicine, surgery, pharmacy, and knowledge integration, among others. According to Abernethy et al., digital innovations offer a lot of potential when it comes to continuity of care, improving diagnosis and treatment, ensuring patients receive support beyond traditional medical settings, providing support to patients who are self-managing their illnesses, minimizing errors, and ensuring healthcare providers get the necessary support and aide in decision-making.[8]

Benefits of Digital Technologies in Healthcare

Improving Diagnostic Accuracy

One of the benefits of digital technologies in healthcare is advancing diagnosis leading to better diagnostic accuracy and improved care outcomes. One of the challenges that is constantly facing healthcare is making timely and accurate diagnoses. Inaccurate diagnosis costs healthcare systems millions of dollars in unnecessary treatments and procedures and contributes significantly to poor disease outcomes. The recent years have seen significant advancement in diagnostics with medical imaging improving significantly as technology advances. AI is one area that can significantly improve medical diagnostics although it is in the early stages. Different studies have shown that AI can improve diagnostic accuracies and efficiencies with areas such as machine learning leading to better image analysis and the ability to identify new areas of biomarkers.[12] Using imaging biomarkers can lead to great accuracy in the diagnostic process and enhance decision-making. Considering machine learning is dependent on the accuracy of data input, ensuring the quality of data input can help to address the challenges and difficulties experienced in diagnosis and increase accuracy.[13] For healthcare providers, such data can enhance decision-making and lead to better care outcomes. Research is emerging that AI presents greater opportunities for improved diagnosis more so in diseases such as cancer.[14,15] AI is important when it comes to examining large datasets which leads to greater accuracy and efficiency in diagnosis.[14] AI can also be used in breast cancer imaging with its accuracy being comparable to that of radiology.[15] As such, digital technologies offer a lot of potential when it comes to improving the accuracy of medical diagnosis. They can help to address the challenge of misdiagnosis and the associated costs. Timely diagnosis is also associated with optimal patient outcomes.[16]

Supporting Clinical Decision-Making

Digital technologies are also helping to improve treatment by supporting healthcare professionals with treatment decisions. Technologies such as clinical decision support (CDS) are proving to be instrumental when it comes to supporting decision-making and ensuring the offered treatment is more accurate.[17,18] It does this by providing timely information, particularly at the point of care which allows the clinician to combine their knowledge with suggestions provided by CDS systems to make decisions. Although clinical decision support systems emerged in the 1970s, they have undergone significant transformations in recent years allowing for better healthcare integration and hence improved decision-making.[18] CDS systems are associated with better treatment outcomes because they improve precision and lead to improved patient safety.[19] These systems enhance patient safety because they reduce medication errors more so those associated with drug interactions.[18] Other benefits that are associated with clinical decision support systems are improved administrative functions, cost containment, better adherence to clinical guidelines, better diagnostics support, and enhanced decision support. Research has shown that clinical decision support systems have significant potential when it comes to revolutionizing healthcare systems and improving patient outcomes.[20,21,22]

Supporting Personalized Treatment

Digital health can also help to personalize care and ensure that the needs of patients are met. Meeting patient needs is a significant challenge that affect many healthcare systems today. Patients present with more comorbidities with most cooccurring making care provision difficult. Digital health can help by personalizing care. Electronic health records (EHRs) for example can enable physicians to personalize patient care based on the data and patient information that is stored in these systems. EHRs enable clinicians to access patient data and information with ease. Data such as medical history, genetic profiles, vital signs, diagnosis, and patient demographics can enable clinicians to provide personalized treatment and make precise interventions. The advancement of AI offers even more promise when it comes to personalizing treatment.[13] AI has great potential when it comes to capturing patient data, experiences with care, and outcomes in real time.[23] Wearable smart sensors are able to capture crucial patient information and enable fast data transmission making it possible to provide care to patients faster and based on their needs.[24] AI can also enable clinicians to predict outcomes.[25] It also has the ability to analyze complex datasets which are critical when it comes to the treatment of diseases such as cancer. Such predictions can be used to tailor treatment to patient needs. Machine learning algorithms with the potential to make predictions based on genomic information and biomarkers can also ensure patient treatment is tailored to meet their needs. According to Subramanian et al., precision medicine helps to create and improve diagnosis, therapeutic interventions, and disease prognosis.[26] This is possible through large complex datasets that incorporate aspects such as individual genes, function, and environmental variations. Such datasets can enable researchers to predict risks with more accuracy. Clinicians can also be able to tailor interventions to each individual based on the available data. Personalizing treatment plays a significant role when it comes to care outcomes. It provides a great opportunity to improve the quality of care, optimize patient outcomes, and lead to greater patient satisfaction.

Facilitating Continuity of Care

Additionally, digital health enhances continuity of care which is instrumental in ensuring quality of care and positive outcomes. Continuity of care remains a great challenge in healthcare systems today despite advances in technology. Factors such as shortage of physicians and changes in health insurance contribute to lower rates of continuity of care.[27] (Goodwin, 2021). Ensuring continuity of care is vital because it is associated with positive outcomes, greater patient satisfaction, and more confidence in healthcare systems.[27,28] Discontinuity in care is associated with high medical costs and high rates of readmissions. Digital health technologies offer a lot of potential

when it comes to ensuring continuity of care. Systems such as electronic health records are able to capture and organize patient data in a way that can be viewed by different healthcare providers caring for the patient hence ensuring continuity of care.[29] EHRs contain a patient's medical information which has crucial data such as diagnosis, medical history, allergies, and medications among others. Having access to such information is vital in ensuring continuity of care. Digital health technologies facilitate the interoperability of healthcare data. Such interoperability is vital when providing care particularly if the patient is receiving care from different healthcare providers. There is evidence documenting the importance of Health Information Exchange (HIE) and interoperability more so on improving coordination of care and overall care outcomes.[8] HIE and interoperability can also reduce costs associated with care provision because they reduce disjointed care, improve care quality, and enhance efficiency.[30] Health Information Technology (HIT) can help when it comes to HIE. Such systems are instrumental in ensuring care continuity and effective care coordination. A study by Dowding et al. shows that HIT can be used to support care continuity, particularly in home care by ensuring there is information continuity across the different settings.[31]

However, though digital technology has significant potential when it comes to ensuring continuity of care, interoperability remains a challenge because of issues such as incomplete medical records, failure to embed such systems in healthcare, and lack of clear direction on how data from different EHRs can be incorporated effectively in healthcare systems.[8] Addressing these challenges can lead to better interoperability and continuity of care.

Supporting Interventions Beyond Clinical Settings Through Telemedicine

Telemedicine is another area that has significantly revolutionized healthcare and contributed to positive patient outcomes. Telemedicine supports interventions beyond the clinical settings which makes it instrumental in increasing the accessibility of healthcare services particularly for underserved populations.[9] Telemedicine incorporates different technological developments. For instance, consumer-facing apps and monitors facilitate data collection and can help monitor patients for any warning signs or deterioration of their condition.[8] Other telemedicine technologies that play a role include mobile health, virtual reality, video conferencing, telemonitoring, teleconsulting, telecardiology, and telerehabilitation among others.[32] Research has shown that telemedicine is crucial when it comes to revolutionizing how care is provided and improving patient outcomes. this is particularly the case for individuals who are not able to visit healthcare providers on a regular basis such as the elderly, those living with disabilities, or those living in rural areas where health facilities are scarce.[33] Telemedicine also has a lot of potential for individuals living with chronic conditions who are self-managing their conditions and who may require healthcare provider support. Telemedicine can help to bridge this gap and ensure that patients receive the support they need without having to visit healthcare facilities.[34] During COVID-19, telemedicine played a critical role in bridging the gap in healthcare by ensuring that patients were able to consult with their healthcare providers and receive non-acute care amidst the lockdown.[32,35] Telemedicine is expected to get better as greater advancement in digital technology continues. AI is expected to offer greater opportunities for telemedicine and to revolutionize the sector to ensure it offers more opportunities for patients. For example, integrating AI into telemedicine can enhance how healthcare is provided including better patient monitoring, better access to patient information, advancement in medical knowledge, improved diagnosis, and improved outcomes due to better insights.[36]

Despite the advantages offered by telemedicine, challenges still exist that make it difficult to benefit fully from these technologies. For instance, equipment costs can be a hindrance factor when it comes to implementing telemedicine in healthcare. Other challenges are connectivity issues, resistance to new diagnostics technologies, and lack of patient beliefs and trust in telemedicine.[9] The integration of AI in telemedicine also presents some challenges. Some of these are concerns about patient safety, concerns about patient safety, regulatory compliance issues, and inadequate education and training on how to properly use AI-powered telemedicine.[37] Overcoming these challenges can ensure that patients continue to benefit from telemedicine.

Better Population Health Management

Digital health also offers great opportunities when it comes to improving population health. Digitization offers great opportunities to improve population health through prevention and health promotion.[38] For instance, health information systems play a key role when it comes to surveillance and monitoring for diseases. Systems such as EHRs have the ability to organize and analyze patient information which can be used to carry out surveillance and assess for risks of communicable diseases.[39] Innovations in digital health continue to hold significant potential when it comes to the management of population health. For example, innovations such as AI, machine learning (ML), and data mining, offer a lot of potential when it comes to managing population health more so the prediction aspect.[13] Healthcare stakeholders can utilize machine learning algorithms to analyze data and create predictive models for disease. Research has shown that ML predictive models can be used to diagnose both infectious and non-infectious diseases.[40,41] Predictive models can be used in disease forecasting. With the quality of medical data that is available from these models, it becomes easier to forecast disease patterns, make early detection, and design effective treatment solutions.[41] This is particularly the case for chronic diseases which in most cases are detected late making it difficult to achieve positive treatment outcomes. By analyzing patient data, medical history, demographics, and lifestyle factors, it becomes possible to identify patients who are at a higher risk of developing chronic diseases and hence design early interventions to target these populations.[13]

Similarly, predictive models can be used to make detections and classifications for infectious diseases.[40] Such predictions are instrumental in improving population disease outcomes and reducing the overall costs of managing diseases. Therefore, digital health can be used to improve population health by identifying and addressing issues the root issues that contribute to disease. AI offers a lot of potential when it comes to making predictions about disease which is vital when it comes to conducting disease surveillance which makes it instrumental in revolutionizing healthcare.

Facilitating Patient Education

In addition to improving population health management through surveillance and predictions, digital health can improve overall population health outcomes through patient education. Digital health has been vital in providing patient education.[42] Different types of digital technologies can be used to provide patient education. For instance, text messaging is one type of digital technologies that has revolutionized how patient education is provided in healthcare.[43] Text messaging can be used to provide patient education on different aspects of health including the dangers of smoking or even excessive drinking.[44] It can also be used to educate patients on the importance of physical activity when it comes to addressing diseases such as

diabetes and cardiovascular disease.[45,46] Text messaging can also be used to remind patients of doctors' appointments and the need to take medications. Text messaging as a form of digital health is effective when it comes to patient education because of its ability to reach a lot of people. A large segment of the global population owns phones even in remote locations which makes text messaging an effective measure of providing patient education. Reminders sent through text messages can be timed effectively to ensure they lead to a greater response rate from the people they are targeting.

In addition to text messaging, there are other forms of digital technologies that can be used to provide patient education. Some of these technologies include wearable devices, mobile applications, telehealth, social media, and AI. Wearable devices can be used to increase patient engagement with healthcare.[47] The devices provide data that can be analyzed and used to provide the needed information which can be used to provide patient education.[48] Healthcare providers can educate patients on behaviors that promote good health such as engaging in physical activity, healthy eating, and leading a healthy lifestyle by use of these devices. They can also use these devices to provide education to patients who do not have access to healthcare facilities such as those in rural areas, those who are homebound, and the elderly. These devices provide data that can help healthcare providers to provide the necessary interventions when needed.[48]

Mobile devices and applications have also shown to have significant potential when it comes to providing patient education. Mobile devices and applications have a lot of functions in healthcare provision. According to Ventola, they can be used to perform different functions including information management, maintaining health records, providing access to health records, scheduling appointments, consulting, communicating, gathering information, monitoring patients, and aiding in decision-making.[49] The ability of mobile devices and applications to perform these functions and hold key patient information makes them instrumental when it comes to providing patient education. Healthcare providers have this information at their fingertips and they can use it to tailor education interventions targeted at patients.[50] This education can improve the patient's level of knowledge and subsequently lead to positive outcomes.

Social media is an additional form of digital health that is being used to revolutionize healthcare and provide patient education. Different social media tools such as blogs, social networking platforms, wikis, and micro-blogs provide significant potential when it comes to providing patients with relevant information when it comes to healthcare.[42] Because of the enormous potential that social media offers when it comes to sharing information, it is a vital tool that can be used to reach a wide number of patients. The information on social media can be targeted to specific patient populations. Social media can also enhance patient engagement. Patient can engage in discussions about their health, gain more insights, and also receive the needed support regarding their care.[49] This is particularly the case for patients with chronic conditions who may not have access to community resources on how best to manage their care. Such patients can use social media to gain information regarding their conditions.

Emerging technologies such as AI and virtual reality are also showing great potential when it comes to patient education. AI can play a crucial role in patient education because it can offer personalized and interactive information to patients and their care providers. According to Nakhleh et al., AI-powered platforms such as ChatGPT could be used to help diabetes patients understand their diagnosis, monitor symptoms, treatment options, and the importance of adhering to their medications.[51] Patients can also use AI chatbots to carry out research on different health conditions. Although the accuracy of the information provided by such chatbots can be questionable, these chatbots demonstrate significant potential when it comes to providing patients with information. With further development, AI chatbots will have a lot of potential when it comes to providing patient education.

Reducing Errors and Wastage in Healthcare Systems

An additional benefit of digital health that has played a crucial role in revolutionizing healthcare is reducing errors and waste in the healthcare systems. One of the great transformations that digital health has brought into healthcare is improving patient safety. Research has shown that digitization of healthcare plays a critical role in reducing medication errors.[52,53] Medication errors mostly happen during ordering and prescribing. However, applications such as computerized patient order entry (CPOE) allow the clinician to process treatment instruction through computer applications which reduces errors during the ordering prescribing stage.[54] Using digital technologies to digitize health processes increases standardization and operational efficiency in healthcare systems which reduces errors and wastage.[8] Reducing errors and wastage in healthcare systems is associated with better quality of care, improved patient outcomes, and better patient satisfaction.

Challenges of Digital Health in Healthcare

Although digital health shows a lot of potential when it comes to revolutionizing healthcare and contributing to positive patient outcomes, implementation of these technologies across the board still remains a challenge. Various challenges exist regarding the integration and use of digital technologies in healthcare. One of the concerns emerging with regard to the use of digital technologies in healthcare is privacy concerns. Digital technologies pose privacy concerns if there are no adequate privacy measures in place to safeguard patient data.[55] Breaches of confidential data can happen and result in information theft.[56]

In addition to privacy concerns, confidentiality is also an area of concern that needs to be addressed for all stakeholders to benefit fully from digital health. Patient information is only meant to be shared with authorized personnel and should not be released or shared with unauthorized people.[13] Patients hold the right to authorize their data to be shared with others and in cases where patients are incapacitated and are unable to do so, a legal representative or guardian of the patient can share this information.[11] However, in some instances, confidentiality is breached making information fall into the wrong hands. Such security breaches threaten patient safety. As such, there is a need to put protection measures in place including firewalls, intrusion detection software, and encryption to safeguard data integrity and reduce the likelihood of breaches.

Ethical concerns also emerge with regard to data accuracy and the risk it poses to patients. The reliability and accuracy of data entered into these systems remain a challenge.[11] Inaccuracies in data entered into the systems can have an impact on care. Inaccuracies can increase the risk of errors and make clinicians prone to liabilities. Some clinicians may also misinterpret the data leading to wrong clinical decisions that can significantly impact patient safety.[57] Minimizing errors when entering patient data in these systems is vital to increase accuracy of the data and avoid errors that can threaten patient safety. It is also important to ensure that digital tools are underpinned by the right clinical support to ensure they meet the goal of optimizing care.[58]

Conclusion

Digital health has a lot of potential when it comes to revolutionizing healthcare and contributing to positive patient outcomes. Some of the benefits that are associated with digital health are personalizing care, enhancing continuity of care, reducing errors and wastage, improving diagnostic accuracy, providing clinicians with decision-making support, and facilitating treatment and care beyond the clinical setting. All these benefits can lead to positive care outcomes, improve the quality of care, and increase patient satisfaction in the healthcare systems. Although digital health has a lot of potential when it comes to transforming care, they also present some challenges. Integrating digital technologies in healthcare systems is not an easy undertaking. Privacy and confidentiality concerns remain a problem. Ethical concerns emerging from the accuracy and reliability of data can also affect implementation. Addressing these challenges can increase the benefits of digital health in healthcare.

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