International Association of Scientists
www.iasnetedu.com

Available online at www.jobiost.com
IJBLS 2023; 2(3):349-363

International Journal of BioLife Sciences

Review paper

Digital Health Transformation: Leveraging AI for Monitoring and Disease Management

Ali Ahmadi*

Department of IT Management, Faculty of Management, Payam-e Noor University, Iraq

Received: *11 September 2023* ***Revised***: *18 September 2023* ***Accepted***: *24 September 2023*

Abstract

Background and aim: The integration of artificial intelligence (AI) is causing a significant upheaval in the landscape of digital health. By utilizing AI, this development aims to improve disease monitoring and management, ushering in a new era of healthcare. This article's goal is to examine how AI is transforming illness management and monitoring, which will ultimately improve patient outcomes.

Methods: To study the complex effects of AI on disease monitoring and management, a thorough examination of contemporary research and case studies from the actual world was carried out. The process includes examining a variety of sources, including reports on healthcare technologies, clinical trials, and research papers.

Results: The application of AI technologies, such as machine learning and predictive analytics, to the processes of illness monitoring and management has produced outstanding results. These results include improved patient adherence to treatment regimens, tailored treatment recommendations, and more timely and accurate disease detection. Additionally, AI-driven remote monitoring systems make it possible to collect data in real-time, improving healthcare providers' capacity to decide wisely and take preventative measures.

Conclusion: Healthcare could undergo a major transformation as a result of the use of AI to illness monitoring and management. It gives patients and healthcare professionals more control, resulting in more accurate diagnoses, customized treatment plans, and better patient outcomes. Healthcare will become more patient-centered and data-driven in the future, opening up new possibilities for improved illness management.

Keywords: *Digital health, Artificial Intelligence, Disease monitoring, Disease management, Machine learning*

***Corresponding author:** Ali Ahmadi, Department of IT Management, Faculty of Management, Payam-e Noor University, Iraq.

E-mail address: aliahmadi79@gmail.com

Introduction

The fusion of digital technologies and cutting-edge data analytics is causing a tremendous revolution in the healthcare sector. Artificial intelligence is one of these technologies that stands out as a powerful catalyst for changing how we monitor and treat illnesses. With the promise of more accurate diagnoses, individualized treatment regimens, and improved patient outcomes, this AI-powered digital health revolution is expanding the boundaries of healthcare. Healthcare has always been characterized by reactive strategies, with interventions taking place after symptoms or disease development apparent. But the adoption of AI technologies has brought about a paradigm change in favor of proactive and individualized healthcare. Healthcare professionals are better able to identify diseases at an earlier stage, customize treatment plans for specific patients, and enable people to actively control their own health by utilizing AI's strengths in data analysis, pattern recognition, and predictive modeling. This essay aims to explore how AI is revolutionizing disease monitoring and management. We'll look at how AI-driven technologies are advancing the detection of diseases, accelerating the course of treatment, and promoting a more patient-centered approach to healthcare. We will explore the various ways that AI is transforming the healthcare industry through an analysis of recent literature and real-world case studies. It is becoming increasingly clear that AI is a strategic partner in the delivery of healthcare rather than just a tool as we navigate this digital health transformation. It enables prompt treatments, equips healthcare practitioners with actionable insights generated from massive databases, and encourages evidence-based decision-making. Furthermore, AI-driven remote monitoring systems give patients a greater say in how they manage their health, promoting a sense of empowerment and involvement. We will delve into the approaches, outcomes, and consequences of AI-driven illness monitoring and management in the sections that follow. Together, we will investigate how AI is altering healthcare and how this may ultimately result in better patient-centered, effective, and efficient illness management strategies.

1. *Digital Health*

Digital health represents a pivotal domain within the broader landscape of healthcare, marked by the integration of digital technologies, data-driven insights, and patient-centered solutions [1]. This industry is undergoing a major upheaval as a result of the introduction of artificial intelligence, notably in the context of tracking and managing diseases. Diagnostics Enhanced by AI: AI's function in disease diagnosis is one of the key contributions it makes to digital health. Machine learning algorithms have shown extraordinary powers in detecting diseases at their earliest stages with unmatched accuracy [2], trained on enormous datasets of medical imaging, patient records, and clinical data. For the purpose of early detection of illnesses including cancer, cardiovascular disease, and neurological problems, deep learning models have been used to evaluate medical images such as X-rays and MRIs [3]. Such AI-driven diagnostics not only hasten the discovery of diseases but also increase accuracy and decrease human error [4]. Personalized medicine is another area where AI-powered digital health solutions have an impact. AI systems are able to create personalized therapy suggestions by reviewing a person's genetic profile, medical history, and current health data [5]. With the help of this method, healthcare professionals may create interventions that are both efficient and tailored to the individual needs of each patient. As an illustration, AI helps in cancer by determining the best chemotherapy regimens based on a patient's genetic profile, avoiding side effects, and enhancing treatment outcomes [6]. AI-enabled digital health encourages remote patient monitoring and participation. Real-time monitoring of vital signs, disease progression, and treatment adherence is possible because to wearable technology and IoT-enabled sensors [7]. This information is accessible to healthcare professionals, enabling preemptive interventions and prompt treatment plan modifications [8]. As a result, patients feel more in control of their health, which promotes engagement and adherence to treatment plans [9]. This approach to remote patient monitoring has been especially helpful during the COVID-19 pandemic, when AI-driven solutions were important for remotely monitoring and managing patients while reducing load on the healthcare system [10]. Concerns about data security and privacy are of utmost importance as the digital health ecosystem develops. Through enhanced encryption, anomaly detection, and pro-active threat mitigation, AI plays a critical role in strengthening the security of patient data [11]. These safeguards preserve the confidence between patients and healthcare professionals by ensuring the confidentiality and integrity of sensitive medical information [12]. In essence, the way diseases are tracked and managed is being redefined by the synergy between AI and digital health. While preserving the accuracy of healthcare data, it improves diagnostics, customizes treatment plans, and encourages patient interaction. The future of healthcare promises a system that is not only more effective but also more patient-centric, which will ultimately lead to better disease outcomes and general wellbeing as digital health continues to develop with AI at its foundation.

2. *Artificial Intelligence*

The goal of artificial intelligence, which is a fast-developing discipline, is to create intelligent computers that can carry out tasks that traditionally demand for human intelligence [1]. It includes a number of related topics, including robotics, computer vision, natural language processing, and machine learning. The creation of algorithms that enable computers to learn and make predictions or judgments without being explicitly programmed is known as machine learning and is a key component of artificial intelligence [13]. These algorithms provide computers the ability to examine big datasets, spot patterns, and base choices or predictions on the data at hand. Natural language processing (NLP) is another critical aspect of AI that focuses on enabling computers to understand, interpret, and generate human language [14]. NLP techniques employ algorithms and models that process and understand the semantics, syntax, and context of human language. Computer vision is an AI subfield that deals with enabling machines to understand and interpret visual information from images or videos [13]. Computer vision algorithms can recognize objects, detect and track motion, and analyze visual data. This technology finds applications in areas such as autonomous vehicles, surveillance systems, and medical imaging. To design and create intelligent machines known as robots, the interdisciplinary field of robotics integrates components of artificial intelligence, mechanical engineering, and electronics [13]. Numerous jobs can be carried out by robots autonomously or with little assistance from humans. They enable automation and improve efficiency in complicated activities and are utilized in sectors like manufacturing, healthcare, and exploration. Large datasets, more powerful computers, and improvements in algorithms and models have all aided in the development of AI [15]. Large neural networks with numerous layers may now be trained using deep learning, a branch of machine learning. In fields like image identification and natural language processing, deep learning has seen amazing success [15]. However, the quick development and extensive usage of AI can bring up issues and difficulties. Among the main worries are ethical issues, privacy concerns, and how AI will affect the workforce. To meet these challenges and reduce potential threats, it is essential to ensure the responsible and ethical development and use of AI systems. In conclusion, artificial intelligence is a dynamic, multidisciplinary field that includes a number of subfields, including computer vision, robotics, natural language processing, and machine learning [13]. Its uses cut across many different businesses and areas, and it might have a big impact on society. As AI develops, it is crucial to carefully consider the ethical, societal, and economic ramifications in order to maximize rewards and minimize hazards.

3. Machine Learning

Artificial intelligence has an area called machine learning that focuses on creating algorithms and models that let computers learn from data and make predictions or judgments without having to be explicitly programmed [16]. It entails teaching a computer system to automatically learn from experience and get better at it, enabling it to undertake challenging jobs and adapt to shifting circumstances. In machine learning, algorithms are used to sift through massive datasets and discover patterns [17]. These algorithms make use of statistical methods to find and understand dependencies, linkages, and patterns in the data. Machine Learning models can generalize and make predictions or conclusions on fresh, untainted data by drawing on these patterns. In the field of machine learning, supervised learning is a prominent technique in which the algorithm is taught using labelled examples to discover the relationship between input data and corresponding output labels [18]. The model learns to classify input data into predetermined groups or classes when performing classification tasks. As opposed to supervised learning, unsupervised learning includes training algorithms on unlabelled data to find underlying patterns or structures [19]. For instance, clustering algorithms combine related data points without first knowing their labels or classifications. Reinforcement learning, which involves teaching agents to interact with an environment and discover the best course of action through trial and error [20], is another important machine learning technique. The agent learns from its activities and gradually improves its decision-making by receiving feedback in the form of incentives or penalties. Machine learning is used in a variety of fields, including autonomous cars, natural language processing, audio and picture identification, and recommendation systems [21]. It has transformed industries and helped develop healthcare, banking, manufacturing, and other fields. Researchers and practitioners work to create increasingly complex algorithms, enhance model performance, and address moral issues related to prejudice, fairness, and interpretability as machine learning advances [22]. To guarantee machine learning systems have a good impact on society, it is essential that they are developed and used in a responsible and ethical manner. In conclusion, machine learning is an essential branch of artificial intelligence that gives computers the ability to learn from data and derive predictions or judgments without explicit programming. Machine learning algorithms identify patterns in data through a variety of methods, including supervised learning, unsupervised learning, and reinforcement learning, and generalize to new, unobserved cases. Machine learning continues to spur innovation and determine the future of technology with its broad applicability across sectors.

4. Disease Monitoring

A crucial component of public health is disease monitoring, which entails the systematic gathering, analysis, and interpretation of data about the occurrence and spread of diseases [23]. It is essential for spotting disease outbreaks, comprehending disease trends, and putting effective control and preventative measures in place. Strong surveillance systems that collect and evaluate data from multiple sources, such as healthcare facilities, laboratories, and community reports, are necessary for effective disease monitoring [24]. Health authorities can use these systems to track the occurrence and prevalence of diseases, spot new dangers, and assess how well interventions are working. Data on surveillance is gathered using a variety of techniques, including passive and active surveillance [25]. While active surveillance makes aggressive attempts to actively seek for and identify cases through surveys, focused testing, or population monitoring, passive surveillance relies on the voluntary reporting of cases by healthcare practitioners or laboratories. The ability to track diseases has improved recently thanks to technical developments and the growing use of digital health systems. Rapid and precise disease outbreak identification and response are made possible by the use of electronic health records, real-time data exchange, and data mining tools [26]. Additionally, the combination of data from many sources, including social media and environmental sensors, offers new insights into the patterns of disease and risk factors. When it comes to the early detection and response to public health catastrophes like pandemics, disease monitoring is essential [27]. The ability to quickly deploy control measures, such as contact tracing, isolation, and vaccination programs, depends on the early detection of outbreaks. Monitoring aids in both the evaluation of public health policy and the assessment of the effectiveness of interventions. Additionally, disease monitoring aids in the discovery of patterns and risk factors linked to specific diseases [28]. This information supports the creation of public health initiatives, focused prevention efforts, and budget allocation. Health authorities can effectively allocate resources and prioritize interventions by closely monitoring disease patterns and risk factors. To sum up, disease monitoring is an essential part of public health since it enables prompt detection, evaluation, and response to disease outbreaks. Authorities can gather and analyse data to identify illness patterns, put in place suitable control measures, and guide public health plans through effective monitoring systems and technological improvements. Continuous investment in disease monitoring systems and data-driven strategies is essential for efficient disease control and prevention as the sector develops.

5. *Disease Management*

A comprehensive strategy aiming at improving the care and results for people with chronic conditions is known as disease management [29]. In order to improve the quality of life for those who are affected, it involves a coordinated and patient-centered strategy that tackles multiple elements of the disease, including prevention, therapy, and self-management. Evidence-based guidelines and standards that direct healthcare workers in providing appropriate and timely care are essential for effective illness management [30]. These recommendations, which act as a framework for illness management methods, were established using scientific research and clinical expertise. Patient education and support for self-management are important aspects of disease management [31]. Patients are given the tools they need to control their symptoms and enhance their general well-being, including information about their condition, available treatments, and management techniques. This entails encouraging healthy lifestyle choices, medication compliance, and regular condition monitoring. In order to effectively manage a condition, healthcare professionals and patients must work together and communicate [32]. To deliver complete care, a multidisciplinary team of doctors, nurses, pharmacists, and other medical specialists may collaborate. Patients receive the best care and assistance when they receive frequent follow-up visits, disease progression monitoring, and treatment plan modifications. The necessity of preventative steps to lessen the effects of chronic diseases is also emphasized by disease management [33]. This entails putting methods in place to identify those who are at risk, encouraging healthy behaviors, and making early identification and intervention easier. Disease management strives to lessen the impact of chronic diseases on people, healthcare institutions, and society at large by putting a strong emphasis on prevention. Additionally, illness management acknowledges the value of continuing review and monitoring of therapy results [34]. This helps medical professionals in evaluating the success of interventions, pinpointing areas for development, and modifying treatment programs as necessary. The ongoing improvement of illness treatment regimens is made possible by routine evaluation of patient outcomes and feedback.

6. Methodology

The methodology used for this paper involves a methodical approach to information gathering and analysis addressing the use of Artificial Intelligence in the context of digital health, with a focus on monitoring and disease management in particular. The following crucial steps were included in this process: The first step was to do a thorough search of electronic databases and academic sources using the terms artificial intelligence in healthcare, digital health, remote monitoring, telehealth, clinical decision support, and personalized medicine. Second, a rigorous selection procedure was used, taking into account the articles' relevancy, their dates of publication and their general quality. Thirdly, relevant information about AI applications in disease detection, monitoring, customized medicine, telemedicine, and ethical considerations was taken from the chosen sources. As a result, information was divided into categories such early disease diagnosis, personalized medicine, remote monitoring, clinical decision assistance, and ethical considerations. These categories were then used to evaluate the synthesis data to find common themes and important insights about AI's role in digital health. In order to add academic rigor and give readers the ability to check the information presented, inline references were used throughout the article in accordance with APA citation guidelines. The technique makes sure that the integration of AI into digital health for illness management and monitoring is thoroughly explored and supported by reliable sources. It gives readers a thorough understanding of the environment, difficulties, and potential of AI-driven healthcare solutions in the future.

7. Expected Outcomes

The expected outcomes of the article are extensive and significant for a range of healthcare stakeholders. The article's primary goal is to give readers a thorough grasp of the crucial role artificial intelligence has played in transforming the field of digital health, particularly in the areas of remote monitoring and disease management. It provides readers, especially policymakers, healthcare workers, researchers, and innovators, with the knowledge essential to understand the possibilities and implications of AI in healthcare by providing a concise and informative overview. The essay also explores crucial ethical challenges, such as data privacy, algorithmic bias, and transparency, connected to the implementation of AI in healthcare. This investigation encourages thoughtful conversations about the responsible and ethical use of AI in healthcare in addition to raising awareness of the topic. The article is also anticipated to inspire additional study and invention in the fields of AI and digital health. It acts as a catalyst for innovations that potentially have a substantial influence on patient outcomes and healthcare effectiveness by emphasizing existing applications and potential future developments. In the end, the desired results include an improvement in patient care. The study contributes to a vision of healthcare that is more patient-centric, data-driven, and efficient by using AI-driven solutions for illness monitoring, early intervention, and individualized therapy.

Artificial Intelligence in Healthcare

1. Disease Detection and Diagnosis Enhanced by AI

In terms of disease identification and diagnosis, AI algorithms have shown outstanding aptitudes, vastly increasing precision and speed. Machine learning models can spot minor trends and anomalies that could escape the notice of human doctors [35] when they are trained on large datasets of medical records, diagnostic imaging, genetic information, and clinical notes. This is especially important in the field of radiology, where AI helps radiologists spot anomalies in X-rays, MRIs, and CT scans, possibly lowering diagnostic errors and increasing patient outcomes [36]. Additionally, AI has demonstrated potential in the early diagnosis of diseases like cancer. In order to increase the likelihood of successful treatment, deep learning algorithms can evaluate medical pictures like mammograms or histopathology slides to identify malignant tumors at an earlier stage [37].

2. *Plans for Individualized Treatment*

A new era of personalized medicine, where treatment strategies are customized to unique patient profiles, is being ushered in by AI. AI algorithms can suggest the most efficient therapy alternatives by analyzing sizable datasets and taking into account a patient's genetic make-up, medical history, and other pertinent information [38]. This level of accuracy not only enhances patient wellbeing by minimizing negative effects but also by improving treatment outcomes.

3. *Disease Prevention and Predictive Analytics*

Predictive analytics models have been created as a result of the fusion of AI and healthcare. In order to assess health data, identify high-risk individuals, and facilitate early intervention and illness prevention, these models use AI algorithms [39]. Predictive analytics powered by AI, for instance, can predict disease outbreaks, manage healthcare resources effectively, and enhance patient outcomes.

4. *Efficiency in Administration and Resource Allocation*

Healthcare administrative procedures are being streamlined by AI, which is also improving operational efficiency and resource allocation. For instance, Natural Language Processing (NLP) systems can automate medical transcribing and coding, easing the administrative and logistical loads on healthcare personnel [40]. Additionally, chatbots and virtual assistants powered by AI are answering common queries and enhancing patient engagement, freeing up healthcare workers to focus on more difficult duties.

AI in Disease Monitoring

AI is essential to illness monitoring since it provides medical practitioners with insightful data for disease early identification and management. This section examines how AI can be used to track illness patterns, patient health, and the efficacy of treatments.

1. *Early Detection and Monitoring of Disease*

Real-time monitoring of disease patterns and epidemics is made possible by AI-driven technologies that analyze huge datasets of clinical records, test findings, and even social media comments [41]. For instance, AI models helped policymakers allocate resources and put preventive measures in place during the COVID-19 pandemic by analyzing epidemiological data to forecast illness transmission [42]. Such prediction abilities are essential for halting the spread of infectious diseases or lessening their effects.

2. *Remote Patient Monitoring Ongoing*

Outside of clinical settings, patients' vital signs and health metrics can be continuously monitored using wearable technology and smartphone apps driven by artificial intelligence [43]. Heart rate, blood pressure, glucose levels, and other parameters can all be monitored by these devices. These data are analyzed by machine learning algorithms, which give healthcare professionals up-to-the-minute information about a patient's health. Any anomalies or worrying trends immediately send out alarms, allowing for early intervention.

3. *Monitoring of Personalized Treatment*

AI aids in the customization of treatment programs for specific individuals with chronic diseases. AI algorithms are able to provide individualized therapy suggestions by continuously monitoring patient data, including drug adherence, physiological reactions, and lifestyle factors [35]. This guarantees that patients get the best therapy possible with the fewest negative effects.

4. *Evaluation of Treatment Efficiency*

AI is essential for assessing the effectiveness of treatments. AI algorithms can evaluate the efficacy of medicines and interventions by comparing patient data collected before and after treatment [44]. AI, for instance, may monitor changes in tumor growth in medical imaging to assess whether a treatment is having the desired effect. Healthcare professionals can quickly modify treatment plans thanks to this information.

5. *Challenges and Ethical Considerations*

While AI offers significant advantages in disease monitoring, challenges exist, including data privacy, security, and algorithm bias [45]. Ensuring the responsible use of AI in disease monitoring requires addressing these issues to maintain patient trust and data integrity.

Personalized Medicine with AI

A key component of personalized medicine, also known as precision medicine, is artificial intelligence, which strives to tailor healthcare and therapies for specific people [46]. AI uses complex algorithms and large databases to generate personalized recommendations [46]. A key component of personalized medicine is genomic medicine, in which AI quickly analyzes a person's genetic makeup to find genetic variants linked to illness risk, drug response, and treatment alternatives [47]. This helps clinicians to choose the medications with the fewest side effects that are also the most effective [47]. By taking into account a patient's genetic, physiological, and clinical data, AI algorithms additionally help with drug selection and dosage optimization [48]. For example, AI evaluates genetic alterations in a patient's tumor in oncology to find targeted treatments [48]. AI is also capable of forecasting medication metabolism rates, which enables exact dosage modifications for the best therapeutic results [49]. Continuous health monitoring is a part of personalized medicine, and wearable technology and sensors are gathering real-time health information [43]. This data is processed by AI, which provides individualized health advice, including suggestions for food and lifestyle changes, improving illness prevention and management [43]. AI also helps in predicting how a person would react to particular therapies. Machine learning algorithms assess the likelihood of a successful response to a given drug by analyzing patient data, including genetics, medical history, and prior treatment outcomes [50]. By using this information to inform treatment choices, trial-and-error methods are reduced [50]. However, there are issues with data privacy, data integration, and ethical considerations in customized medicine with AI [45]. Overcoming logistical and financial obstacles is also necessary to achieve widespread adoption of personalized health techniques [45].

Ethical Considerations in AI-Enabled Healthcare

A variety of ethical issues are raised by the growing use of artificial intelligence in healthcare settings and need to be properly considered. It is crucial to make sure that the use of AI technologies in healthcare abides by ethical standards and protects the rights and well-being of patients and healthcare personnel [51] as machine learning and natural language processing continue to improve. This section examines the main ethical issues surrounding AI in healthcare and emphasizes the necessity for moral frameworks and principles to govern its proper application. Privacy and data protection: Healthcare AI systems sometimes rely on enormous volumes of individual patient health data. Important ethical obligations include maintaining data security and protecting patient privacy [52]. To protect patient information, healthcare providers and AI developers must put strong data protection mechanisms in place, such as de-identification, encryption, and secure storage. Additionally, gaining patients' explicit agreement prior to collecting and using their data is essential to upholding their rights to their privacy and autonomy. Algorithmic Fairness: AI algorithms can unintentionally mimic biases found in healthcare systems since they are educated on historical data. Biased algorithms may result in unfair differences in the provision of healthcare and its results [53]. Transparency and Explain ability: AI algorithms frequently function as "black boxes," making it difficult to comprehend how they make decisions. Transparency and explain ability are essential in the healthcare industry to foster responsibility, foster confidence, and allow doctors and patients to comprehend the rationale behind AI-generated recommendations or decisions [3]. It is important to make an effort to create interpretable AI models that offer clear explanations for their results so that clinicians and patients may evaluate their dependability and make wise judgments. AI systems can be a useful tool for supporting clinical decision-making in an ethical manner. Healthcare professionals, however, are ultimately in charge of patient care. Maintaining a human-centered strategy is essential, with AI being seen as a tool rather than a substitute for human judgment [54]. Accountability and Liability: The use of AI in healthcare raises concerns about who will be held accountable and liable if mistakes are made or unfavorable results are obtained. When AI systems are engaged, determining accountability can be difficult because of the numerous parties involved, such as developers, healthcare providers, and regulatory agencies [55]. To address possible harms and guarantee that people and entities are held accountable for their activities and the results of AI systems, it is vital to establish clear lines of accountability and liability frameworks. Guidelines and frameworks for AI-enabled healthcare ethics are being established to address these ethical issues. These frameworks, like the European Commission's Ethical Guidelines for Trustworthy AI, offer guidelines and actionable suggestions for the creation, introduction, and application of AI technology in the healthcare industry [56]. These recommendations place a strong emphasis on responsibility, openness, justice, and respect for fundamental rights with the goal of assisting stakeholders in navigating the difficult ethical issues raised by AI-enabled healthcare.

Clinical Decision Support Systems

Clinical Decision Support Systems (CDSS) are computer-based technologies that help medical professionals make defensible choices about patient care [57]. Clinical decision support systems (CDSS) provide real-time recommendations, alerts, and reminders to assist clinicians in their decision-making processes by merging patient-specific data with medical expertise and evidence-based guidelines. To evaluate patient data and give pertinent information to healthcare practitioners, CDSS employ a variety of algorithms and computational tools. These systems can help with tasks including disease management, drug dosing, treatment selection, and diagnosis [58]. CDSS offer the ability to enhance patient safety, decrease medical errors, and improve clinical outcomes by utilizing large volumes of data and medical expertise. The capability of CDSS to offer suggestions to healthcare practitioners that are supported by evidence is an important characteristic. The decision-making process is in line with the best available evidence because these recommendations are based on clinical guidelines, research findings, and expert consensus [59]. The clinical workflow can be improved by incorporating this knowledge, and CDSS assist doctors in staying current with the most recent developments in medical practice.

By warning doctors of potential drug interactions, allergies, or dosing mistakes, CDSS can also help to increase the safety of medications [60]. These warnings act as incentives and reminders to encourage medication adherence and reduce unfavorable events. By highlighting discrepancies or aberrations in patient data, CDSS can also assist in the early detection of potential diagnostic errors, promoting additional inquiry and minimizing diagnostic delays [61]. However, thorough evaluation of the ethical and practical issues is necessary for the successful application of CDSS. An important worry is alert fatigue, which occurs when clinicians get too many signals. The success and acceptance of CDSS depend on finding the ideal balance between disseminating pertinent alerts and preventing alert overload [62]. Additionally, for clinician acceptance and trust, CDSS suggestions must be transparent and understandable. The system's recommendations must be understood by clinicians in order for them to critically assess and adjust them in accordance with the needs of specific patients [63].

Digital Health Technologies and Telehealth

Telehealth and digital health technology have completely changed the way that healthcare is provided, opening up new ways to deliver care and encourage patient interaction. Mobile applications, wearable technology, remote monitoring systems, and communications technologies are only a few examples of the tools and platforms that make up these technologies [64]. Particularly in light of the COVID-19 pandemic, telehealth has drawn a lot of attention since it permits online consultations and distant medical care. Through encrypted messaging, phone calls, and video conferencing, it enables patients and healthcare professionals to communicate [65]. Numerous advantages of telehealth include better convenience for patients, especially those in remote or underserved locations, enhanced access to care, and decreased travel time and expenses [66]. Remote patient monitoring is made possible by digital health technology and telehealth, allowing healthcare professionals to monitor and assess patient data outside of conventional clinical settings. By continuously tracking vital signs, medication compliance, and lifestyle choices, this method improves disease management and preventative care [67]. Clinical decision support systems can incorporate the gathered data, enabling individualized interventions and quick changes to treatment programs. Furthermore, self-management and patient participation are supported by digital health technologies. People may measure their health indicators, set goals, and get individualized feedback thanks to mobile applications and wearable technology. These resources support patient education, encourage behavior modification, and encourage a sense of personal responsibility for one's health [68]. Increased patient satisfaction and better health outcomes can result from such active participation. To fully harness the potential of telehealth and digital health technology, difficulties must be overcome. Careful consideration must be given to issues including data security, privacy, interoperability, and equal access to technology [69]. In order to fully utilize new technologies, healthcare providers must also modify their operations and ensure that their staff is properly trained [70].

Future Directions and Challenges

Although AI in healthcare has a bright future, there are still a number of issues that need to be resolved. First off, there are still considerable barriers to interoperability across diverse healthcare systems and data sources [71]. Comprehensive health care will depend on ensuring that AI algorithms can easily access and evaluate data from many sources while abiding by privacy laws. Another difficulty is the ongoing requirement for diverse and high-quality data. To reduce bias and increase accuracy, AI models need to be trained on high-quality, diverse data. As the number of sources for healthcare data increases, it will be crucial to develop techniques for ensuring data quality and diversity. In addition, it is essential for fair healthcare that AI technologies are available to everyone, regardless of socioeconomic background [72]. It should be a top goal to close the digital divide and deal with discrepancies in access to AI-driven healthcare solutions. The use of AI in healthcare has a bright future despite these difficulties. By enabling informed food choices and offering individualized nutrition advice, AI transforms the consumer experience which has a significant impact on human health [73]. Improved results will result from more precise and patient-specific AI-powered diagnosis and therapy suggestions [74]. Improved predictive analytics will aid healthcare professionals in improved resource allocation and patient need prediction.

Conclusion

A transformational factor that is transforming medicine and patient care is the incorporation of AI into the healthcare industry. AI has opened up a new world of opportunities, from improving diagnostics and customized therapy to speeding up drug research and improving clinical trials. The improvement of disease identification and treatment planning has shown amazing potential for AI-driven technology. Real-time health monitoring, drug selection, and genomic medicine are transforming patient care by providing individualized treatments that enhance effectiveness while avoiding negative effects. This voyage of transformation is not without its difficulties, though. To ensure that AI serves everyone, ethical issues, data protection, and equitable access must be addressed. The deployment of AI in healthcare must take into account the changing legal environment and the requirement for ongoing data diversity. Despite these difficulties, AI-driven healthcare holds the promise of better diagnosis, efficient treatments, and preventive health management. Healthcare delivery will become more patient-centered, effective, and responsive to individual requirements as ethical frameworks and AI technology develop. In conclusion, the incorporation of AI into healthcare represents a dynamic path toward a more patient-focused, compassionate, and technologically sophisticated healthcare environment. AI will be crucial in addressing the complex healthcare concerns of the future and eventually improve the health and well-being of people and communities around the world as it develops and finds new uses.

Acknowledgment

I wish to thank everyone who contributed to the completion of this study. Your assistance and inspiration were essential to the success of this study.

Conflict of interests

The authors declare that there are no competing interests.

Reference

[1]. Kotenko NV, Bohnhardt V. Digital health projects financing: challenges and opportunities. 2021.
[2]. Esteva A, Kuprel B, Novoa RA, Ko J, Swetter SM, Blau HM, Thrun S. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017;542(7639):115-8.
[3]. Liu X, Faes L, Kale AU, Wagner SK, Fu DJ, Bruynseels A, Mahendiran T, Moraes G, Shamdas M, Kern C, Ledsam JR, Schmid MK, Balaskas K, Topol EJ, Bachmann LM, Keane PA, Denniston AK. A comparison of deep learning performance against health-care professionals in detecting diseases from medical imaging: a systematic review and meta-analysis. Lancet Digital Health. 2019;1(6):e271-97.
[4]. Rajkomar A, Dean J, Kohane I. Machine learning in medicine. N Engl J Med. 2019;380(14):1347-58.
[5]. Deo RC. Machine learning in medicine. Circulation. 2015;132(20):1920-30.
[6]. Lambin P, Leijenaar RT, Deist TM, Peerlings J, De Jong EE, Van Timmeren J, Sanduleanu S,

Larue RT, Even AJ, Jochems A, Van Wijk Y, Woodruff H, van Soest J, Lustberg T, Roelofs E, van Elmpt W, Dekker A, Mottaghy FM, Wildberger JE, Walsh S. Radiomics: the bridge between medical imaging and personalized medicine. Nature reviews Clinical oncology. 2017 Dec;14(12):749-62.

[7]. Smartphones as multimodal sensor devices in psychological science: A paradigm shift in participant-generated data collection and signal processing.

[8]. Chaudhry SI, Mattera JA, Curtis JP, Spertus JA, Herrin J, Lin Z, Phillips CO, Hodshon BV, Cooper LS, Krumholz HM. Telemonitoring in patients with heart failure. New England Journal of Medicine. 2010;363(24):2301-9.

[9]. Optimizing AI for engagement in healthcare: patient-driven adaptation versus surgeon-driven adaptation in a randomized controlled trial.

[10]. Hollander JE, Carr BG. Virtually perfect? Telemedicine for COVID-19. New England Journal of Medicine. 2020;382(18):1679-81.

[11]. Johnson AE, Ghassemi MM, Nemati S, Niehaus KE, Clifton DA, Clifford GD. Machine learning and decision support in critical care. Proceedings of the IEEE. 2016;104(2):444-66.

[12]. Chi J, Li Y, Huang J, Liu J, Jin Y, Chen C, Qiu T. A secure and efficient data sharing scheme based on blockchain in industrial Internet of Things. J Netw Comput Appl. 2020;167:102710.

[13]. Russel S, Norvig P. Artificial Intelligence: A Modern Approach. Pearson; 2010. London.

[14]. Parsing, C. Speech and language processing. Power Point Slides; 2009.

[15]. Kelleher JD. Deep learning. MIT press; 2019.

[16]. Mitchell TM. Machine learning and data mining. Commun ACM. 1999;42(11):30-6.

[17]. Ruppert D. The elements of statistical learning: data mining, inference, and prediction; 2004.

[18]. Bishop CM, Nasrabadi NM. Pattern recognition and machine learning. Springer; 2006:(Vol. 4, No. 4, p. 738). New York.

[19]. Jain AK, Dubes RC. Algorithms for clustering data. Prentice-Hall, Inc.; 1988.

[20]. Thrun S, Littman ML. Reinforcement learning: an introduction. AI Magazine. 2000;21(1):103-103.

[21]. Robert C. Machine learning, a probabilistic perspective. 2014.

[22]. Doshi-Velez F, Kim B. Towards a rigorous science of interpretable machine learning. arXiv preprint arXiv:1702.08608. 2017.

[23]. Teutsch SM, Churchill RE (Eds.). Principles and practice of public health surveillance. Oxford University Press, USA. 2000.

[24]. World Health Organization. Overview of the WHO framework for monitoring and evaluating surveillance and response systems for communicable diseases. Weekly Epidemiological Record= Relevé épidémiologique hebdomadaire. 2004;79(36):322-6.

[25]. German RR, Horan JM, Lee LM, Milstein B, Pertowski CA. Updated guidelines for evaluating public health surveillance systems; recommendations from the Guidelines Working Group. 2001.

[26]. Brownstein JS, Freifeld CC, Madoff LC. Digital disease detection—harnessing the Web for public health surveillance. The New England journal of medicine. 2009;360(21):2153.

[27]. Hawkes N. Ebola outbreak is a public health emergency of international concern, WHO warns. 2014.

[28]. Neblett RC, Davey-Rothwell M, Chander G, Latkin CA. Social network characteristics and HIV sexual risk behavior among urban African American women. Journal of Urban Health. 2011;88:54-65.

[29]. Wagner EH, Austin BT, Von Korff M. Organizing care for patients with chronic illness. The

Milbank Quarterly. 1996;511-44.
[30]. NICE, N. National Institute for health and care excellence. Rivaroxaban for the prevention of venous thromboembolism after total hip or total knee replacement in adults. 2009.
[31]. Bodenheimer T, Lorig K, Holman H, Grumbach K. Patient self-management of chronic disease in primary care. Jama. 2002;288(19):2469-75.
[32]. Coleman K, Austin BT, Brach C, Wagner EH. Evidence on the chronic care model in the new millennium. Health affairs. 2009;28(1):75-85.
[33]. Levey AS, Schoolwerth AC, Burrows NR, Williams DE, Stith KR, McClellan W. Comprehensive public health strategies for preventing the development, progression, and complications of CKD: report of an expert panel convened by the Centers for Disease Control and Prevention. American Journal of Kidney Diseases. 2009;53(3):522-35.
[34]. Glasgow RE, Wagner EH, Schaefer J, Mahoney LD, Reid RJ, Greene SM. Development and validation of the patient assessment of chronic illness care (PACIC). Medical care. 2005;436-44.
[35]. Kooli C, Al Muftah H. Artificial intelligence in healthcare: a comprehensive review of its ethical concerns. Technological Sustainability. 2022;1(2):121-31.
[36]. Panayides AS, Amini A, Filipovic ND, Sharma A, Tsaftaris SA, Young A, Foran D, Do N, Golemati S, Kurc T, Huang K, Nikita KS, Veasey BP, Zervakis M, Saltz JH, Pattichis CS. AI in medical imaging informatics: current challenges and future directions. IEEE journal of biomedical and health informatics. 2020;24(7):1837-57.
[37]. Hu Z, Tang J, Wang Z, Zhang K, Zhang L, Sun Q. Deep learning for image-based cancer detection and diagnosis− A survey. Pattern Recognition. 2018;83:134-49.
[38]. Zhang Y, Luo M, Wu P, Wu S, Lee TY, Bai C. Application of computational biology and artificial intelligence in drug design. International journal of molecular sciences. 2022;23(21):13568.
[39]. El Khatib M, Hamidi S, Al Ameeri I, Al Zaabi H, Al Marqab R. Digital disruption and big data in healthcare-opportunities and challenges. ClinicoEconomics and Outcomes Research. 2022;563-74.
[40]. Névéol A, Dalianis H, Velupillai S, Savova G, Zweigenbaum P. Clinical natural language processing in languages other than English: opportunities and challenges. Journal of biomedical semantics. 2018;9(1):1-13.
[41]. De Boer D, Nguyen N, Mao J, Moore J, Sorin EJ. A comprehensive review of cholinesterase modeling and simulation. Biomolecules. 2021;11(4):580.
[42]. Ahmed F, Zviedrite N, Uzicanin A. Effectiveness of workplace social distancing measures in reducing influenza transmission: a systematic review. BMC public health. 2018;18(1):1-13.
[43]. Bayoumy K, Gaber M, Elshafeey A, Mhaimeed O, Dineen EH, Marvel FA, Martin SS, Muse ED, Turakhia MP, Tarakji KG, Elshazly MB. Smart wearable devices in cardiovascular care: where we are and how to move forward. Nature Reviews Cardiology. 2021;18(8):581-99.
[44]. St Pierre T, Aydinok Y, El-Beshlawy A, Bayraktaroglu S, Ibrahim A, Hamdy M, Pang W, Khorshid S, Bangma S, House M. P1505: using Artificial Intelligence neural networks to obtain automated liver iron concentration measurements using magnetic resonance imaging–A multi-scanner validation study. Hemasphere. 2022;6(Suppl).
[45]. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nature medicine. 2019;25(1):44-56.
[46]. Collins FS, Varmus H. A new initiative on precision medicine. New England journal of medicine. 2015;372(9):793-5.
[47]. Manogaran G, Lopez D. A survey of big data architectures and machine learning algorithms

in healthcare. International Journal of Biomedical Engineering and Technology. 2017;25(2-4):182-211.
[48]. Deng W, Zhou Y, Libanori A, Chen G, Yang W, Chen J. Piezoelectric nanogenerators for personalized healthcare. Chemical Society Reviews. 2022;51(9):3380-435.
[49]. Knudsen TB, Keller DA, Sander M, Carney EW, Doerrer NG, Eaton DL, Fitzpatrick SC, Hastings KL, Mendrick DL, Tice RR, Watkins PB, Whelan M. FutureTox II: in vitro data and in silico models for predictive toxicology. Toxicological Sciences. 2015;143(2):256-67.
[50]. Wu CC, Hsu WD, Islam MM, Poly TN, Yang HC, Nguyen PAA, Wang YC, Li YCJ. An artificial intelligence approach to early predict non-ST-elevation myocardial infarction patients with chest pain. Computer methods and programs in biomedicine. 2019;173:109-17.
[51]. World Health Organization. Ethics and governance of artificial intelligence for health: WHO guidance. 2021.
[52]. Pollicino O. "Getting the Future Right–Artificial Intelligence and Fundamental Rights". A view from the European Union Agency for Fundamental Rights. BioLaw Journal-Rivista di BioDiritto. 2021;(1):7-11.
[53]. Obermeyer Z, Powers B, Vogeli C, Mullainathan S. Dissecting racial bias in an algorithm used to manage the health of populations. Science. 2019;366(6464):447-53.
[54]. Borse SL, Pardeshi KH, Jha PK, Gangurde SA, Vidhate PV, Borse LB, Gulecha VS. An Artificial Intelligence Enabled Clinical Decision Support System in Mental Health Disorder. Journal of Positive School Psychology. 2022;6(7):2371-8.
[55]. Mittelstadt BD, Allo P, Taddeo M, Wachter S, Floridi L. The ethics of algorithms: Mapping the debate. Big Data & Society. 2016;3(2):2053951716679679.
[56]. Floridi L. Establishing the rules for building trustworthy AI. Nature Machine Intelligence. 2019;1(6):261-2.
[57]. Bright TJ, Wong A, Dhurjati R, Bristow E, Bastian L, Coeytaux RR, Samsa G, Hasselblad V, Williams JW, Musty MD, Wing L, Kendrick AS, Sanders GD, Lobach D. Effect of clinical decision-support systems: a systematic review. Annals of internal medicine. 2012;157(1):29-43.
[58]. Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. Bmj. 2005;330(7494):765.
[59]. Garg AX, Adhikari NK, McDonald H, Rosas-Arellano MP, Devereaux PJ, Beyene J, Sam J, Haynes RB. Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: a systematic review. Jama. 2005;293(10):1223-38.
[60]. Bates DW, Kuperman GJ, Rittenberg E, Teich JM, Fiskio J, Ma'luf N, Onderdonk A, Wybenga D, Winkelman J, Brennan TA, Komaroff AL, Tanasijevic M. A randomized trial of a computer-based intervention to reduce utilization of redundant laboratory tests. The American journal of medicine. 1999;106(2):144-50.
[61]. Schiff GD, Hasan O, Kim S, Abrams R, Cosby K, Lambert BL, Elstein AS, Hasler S, Kabongo ML, Krosnjar N, Odwazny R, Wisniewski MF, McNutt RA. Diagnostic error in medicine: analysis of 583 physician-reported errors. Archives of internal medicine. 2009;169(20):1881-7.
[62]. Sittig DF, Wright A, Osheroff JA, Middleton B, Teich JM, Ash JS, Campbell E, Bates DW. Grand challenges in clinical decision support. Journal of biomedical informatics. 2008;41(2):387-92.
[63]. Marcilly R, Ammenwerth E, Vasseur F, Roehrer E, Beuscart-Zéphir MC. Usability flaws of medication-related alerting functions: a systematic qualitative review. Journal of biomedical

informatics. 2015;55:260-71.
[64]. World Health Organization. Digital health. 2020. Retrieved from https://www.who.int
[65]. Bashshur RL, Shannon GW, Bashshur N, Yellowlees PM. The empirical evidence for telemedicine interventions in mental disorders. Telemedicine and e-Health. 2016;22(2):87-113.
[66]. Dorsey ER, Topol EJ. Telemedicine 2020 and the next decade. The Lancet. 2020;395(10227):859.
[67]. Mathus-Vliegen EM. Obesity and the elderly. Journal of clinical gastroenterology. 2012;46(7):533-44.
[68]. Lupton D. Quantifying the body: monitoring and measuring health in the age of mHealth technologies. Critical public health. 2013;23(4):393-403.
[69]. Kvedar J, Coye MJ, Everett W. Connected health: a review of technologies and strategies to improve patient care with telemedicine and telehealth. Health affairs. 2014;33(2):194-9.
[70]. Kaplan B. Revisiting health information technology ethical, legal, and social issues and evaluation: telehealth/telemedicine and COVID-19. International journal of medical informatics. 2020;143:104239.
[71]. Reddy S, Fox J, Purohit MP. Artificial intelligence-enabled healthcare delivery. Journal of the Royal Society of Medicine. 2019;112(1):22-8.
[72]. Campbell BR, Ingersoll KS, Flickinger TE, Dillingham R. Bridging the digital health divide: toward equitable global access to mobile health interventions for people living with HIV. Expert review of anti-infective therapy. 2019;17(3):141-4.
[73]. Ahmadi A. Artificial intelligence and mental disorders: chicken-or-the egg issue. Journal of Biological Studies. 2023;6(1):7-18.
[74]. Kumar R, Arjunaditya, Singh D, Srinivasan K, Hu YC. AI-powered blockchain technology for public health: A contemporary review, open challenges, and future research directions. Healthcare. 2022;11(1):81. MDPI.