Review paper

AI-Driven Medical Innovations: Transforming Healthcare through Data Intelligence

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Abstract

Background and aim: This article delves into the transformative role of Artificial Intelligence (AI) in the healthcare sector. Its primary objective is to explore how AI is revolutionizing healthcare, particularly in the domains of diagnostics, personalized treatment plans, and predictive analytics.

Methods: The methodology includes a comprehensive review of literature and real-world cases, aiming to highlight how AI's data processing and pattern recognition abilities are transforming healthcare. It examines AI-driven algorithms, which empower healthcare professionals in precise and efficient real-time diagnoses, and investigates the development of predictive analytics models facilitated by AI's integration into healthcare.

Results: The outcomes of this examination reveal AI's remarkable potential in healthcare. AI-powered algorithms are significantly enhancing disease diagnostics, leading to improved accuracy and speed. Moreover, they are facilitating the development of personalized treatment plans tailored to individual patient profiles. The integration of AI has also led to the creation of predictive analytics models, driven by AI, which can identify high-risk individuals and predict disease outbreaks. This not only optimizes resource allocation but also enhances operational efficiency, ultimately resulting in improved patient outcomes.

Conclusion: In conclusion, the integration of AI in healthcare represents a revolutionary force that promises enhanced patient care, streamlined resource allocation, and groundbreaking advancements in medical research. This AI-driven era is propelling healthcare into a technologically advanced future that prioritizes the health and well-being of individuals and communities globally. As AI continues to evolve, its influence on healthcare will address the intricate challenges of the future, fostering a healthier and more advanced world.

Keywords: *Artificial Intelligence (AI), Medical Innovations, Healthcare Transformation, Data Intelligence*

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Introduction

Artificial Intelligence and enhanced data intelligence exist as a potent catalyst for change in the wide healthcare environment where the complexity of human biology intersects with the subtleties of medical practice. The heart of healthcare is being profoundly and fundamentally transformed every day by AI-driven medical technologies that are altering how we identify, treat, and comprehend diseases. A revolution that promises to improve patient care as well as the entire healthcare ecosystem is being sparked by the new era of healthcare, which is characterized by data-driven intelligence and machine learning. Healthcare's adoption of AI represents a major revolution rather than a simple addition. The time when medicine was primarily based on empirical research and the experience of seasoned practitioners is long past. With its superior data processing and pattern recognition skills, AI is already quickly establishing itself as a vital partner in the healthcare industry. In this article, we set out on a tour through this rapidly evolving environment, where the marriage of AI and healthcare holds forth the prospect of better diagnoses, individualized treatment regimens, and predictive healthcare analytics. We look into the ways that AI is enhancing the skills of healthcare professionals, giving them the ability to provide more precise diagnoses, examine enormous datasets in real-time, and design treatment plans according to each patient's particular need. Additionally, the benefits of AI in healthcare go beyond just the clinical setting. Operations in the healthcare industry, resource management, and even medical research are all integrated. It is maximizing resource allocation, increasing operational effectiveness, and reducing costs in healthcare institutions, eventually improving patient experiences. We look into a future where healthcare is not only more exact but also more accessible and effective as we start this investigation into AI-driven medical advances. In this future, AI will not only be a tool, but also a partner, enabling healthcare workers to access new fields of medical knowledge and provide patients with better care. Join us on a voyage into the realm of AI-powered healthcare, where the possibilities are endless and the pursuit of better patient outcomes offers hope, efficiency, and precision as the boundaries of what is possible continue to be pushed.

1. *Artificial Intelligence*

Artificial intelligence (AI) refers to the capability of computer-controlled digital devices or robots to perform tasks typically associated with intelligent beings. This encompasses processes like reasoning, comprehension, generalization, and learning from experiences. While the concept of a "thinking machine" date back to ancient times, significant advancements in AI have materialized in recent decades. Historical milestones in AI include the formulation of the Turing Test, the coining of the term "artificial intelligence" by John McCarthy, and the creation of the Mark 1 Perceptron by Frank Rosenblatt. More recent accomplishments in AI involve notable events such as IBM's Deep Blue defeating Garry Kasparov in chess and Google's DeepMind triumphing over Lee Sodol in the game of Go. Despite these achievements, AI development has been marked by ongoing debates and challenges, including questions about the validity of the Turing Test and the limitations of neural networks [1], [2].

2. *Data Intelligence*

Data Intelligence signifies the convergence of data analytics, artificial intelligence, and cutting-edge technology to extract meaningful insights, patterns, and actionable insights from extensive and intricate datasets. It transcends traditional data analysis by employing AI algorithms not only for data processing but also to unveil concealed trends, foresee future outcomes, and facilitate informed decision-making. Across various sectors like healthcare, finance, and industry, Data Intelligence empowers organizations to tap into the full potential of their data. This empowers them to streamline processes, elevate decision-making quality, and foster innovation. Its pivotal

role lies in the transformation of raw data into valuable knowledge, enabling businesses and institutions to maintain competitiveness and navigate a data-rich landscape [3], [4]. In the realm of enterprise-scale organizations, Data Intelligence encompasses the tools and methods employed to gain a deeper understanding of the information they collect, store, and employ to enhance their products and services. By applying AI and machine learning to their stored data, organizations harness the power of Data Intelligence. While some may use these terms interchangeably, a clear distinction exists between Data Intelligence and Data Analytics. Both pertain to data collection for business improvement. However, Data Intelligence specifically entails gathering disparate data elements and employing AI to discern past events and their causes. In contrast, Data Analytics involves using this information to generate actionable forecasts of future occurrences. Initially, Data Intelligence emerged to provide accurate background context for more precise reporting. However, given the burgeoning volume of data collected, the need arose to assign value to the data itself. This prompted a forensic approach to qualify data assets by probing their origins, collection times, and primary purposes [5].

3. Methodology

This research on AI-Driven Medical Innovations in healthcare is guided by a structured methodology. We began with an extensive literature review, collecting data from reliable sources and conducting interviews with experts in healthcare and AI. Our analysis of this data revealed patterns and trends, while case studies provided real-world examples. Ethical considerations were paramount, and peer review validated our findings. This comprehensive approach ensures a holistic understanding of how AI is transforming healthcare.

4. Expected Outcomes

The article's diverse expected results on AI-Driven Medical Innovations in healthcare aim to give readers a thorough knowledge of the revolutionary effects of artificial intelligence on the medical industry. Readers can anticipate diving deep into the real-world uses of AI while learning how it is transforming patient care, diagnosis, treatment, and healthcare administration. Through case studies, real-world examples will be used to show how AI-driven innovations are already having a noticeable impact on healthcare outcomes. In order to shed light on concerns like patient privacy, data security, and responsible AI use, ethical questions around AI in healthcare will be examined. The essay will also look to the future, giving hints about new developments and patterns in AI-driven medical advancements. Healthcare professionals will get insightful knowledge about how AI is transforming their roles and responsibilities and enabling better decision-making, improved patient care, and increased operational effectiveness. Additionally, the wider impact on healthcare systems—from cost-savings to better accessibility and care—will be carefully considered. The study might spur additional investigation and invention at the nexus of AI and healthcare, inspiring scientists, researchers, and technologists to open up new vistas. In order to secure the moral and responsible use of AI in healthcare, policymakers and regulators will develop an understanding of the need for the proper legislation and policies. The essay will conclude by highlighting the global reach of AI-driven medical advancements and demonstrating how they have the potential to revolutionize healthcare systems all across the world. Overall, these anticipated results will turn the article into a useful resource for a wide range of readers curious about the future of healthcare and the crucial role of AI.

The Use of AI across Different Industries

Artificial intelligence has discovered a myriad of applications across diverse industries, disrupting conventional procedures and fostering innovation. In healthcare, AI plays a pivotal role in disease

diagnosis, examination of medical records, and the development of personalized treatment plans [6]. The financial sector benefits from AI-driven algorithms, which facilitate automated trading, risk assessment, and fraud detection [7]. Transportation logistics have seen notable improvements thanks to AI, notably through the introduction of autonomous vehicles [8], [9]. In resource management and energy optimization within the energy sector, AI contributes significantly. Retail industries leverage AI for supply chain optimization, demand forecasting, and tailored product recommendations [10]. AI's transformative potential extends to entertainment, manufacturing, cybersecurity, and customer service [11], revolutionizing practices in these sectors. Its adaptability and capacity for transformation position it as a formidable tool with global implications, expediting progress across industries and shaping their future. Furthermore, AI offers substantial benefits in the realm of human education [12]. While concerns exist regarding AI's potential influence on human cognition [13], it often involves the breakdown of complex problems into manageable components, allowing for solutions to be devised for each component, thereby addressing the original issue effectively [14].

AI in Healthcare: A Necessity for Improved Diagnosis

Artificial intelligence integration into healthcare has become essential for transforming diagnosis accuracy and improving patient care. By utilizing the capacity of machine learning to examine huge and complicated healthcare datasets, AI-driven algorithms have demonstrated impressive talents in disease detection and risk assessment [15]. Radiology is one such area where AI has made great progress. By quickly spotting irregularities in diagnostic pictures including X-rays, MRIs, and CT scans, AI works with radiologists to improve their diagnostic abilities [16]. This collaboration has the potential to drastically cut down on diagnostic mistakes, improving patient outcomes. The revolutionary changes brought about by AI in medical imaging are especially notable. Images may include complex patterns and abnormalities that defy human perception, but machine learning models are excellent at spotting them. These algorithms have the ability to quickly evaluate and understand complex visual data, enabling earlier recognition and treatment of a variety of medical diseases. AI's aptitude at identifying minute anomalies in radiological images has enormous promise in the context of cancer diagnosis. The likelihood of successful treatment and patient quality of life can both be improved by this prompt detection. Beyond improving diagnostic precision, AI is integrated into the healthcare system to improve its effectiveness. AI enables healthcare workers to devote more time to sophisticated medical decision-making and individualized patient care by speeding up the interpretation of diagnostic pictures and assisting in the preliminary assessment of medical data. The transformative role of AI in healthcare is corroborated by multiple sources in the field. It aligns with the findings of Esteva et al., who highlight the potential of deep learning in healthcare [15]. The collaboration between AI and radiologists is a burgeoning area, as discussed by Erickson et al., underscoring the significance of AI in medical imaging [16].

Enhancing Treatment Personalization

The use of artificial intelligence in healthcare marks the beginning of a revolutionary era that will redefine diagnostic precision, patient care, and treatment personalisation. AI-driven algorithms have shown outstanding talents in disease detection and risk assessment, revolutionizing the healthcare industry [15]. These algorithms are supported by the power of machine learning. The lasting effects of AI on radiology are an excellent example of how it might improve diagnosis accuracy. AI works seamlessly with radiologists to quickly spot anomalies in diagnostic pictures,

including X-rays, MRIs, and CT scans, making a strong argument for lowering diagnostic errors and improving patient outcomes [16]. Beyond diagnosis, AI's contribution to improving treatment customization is crucial. A lot of people are becoming interested in the idea of personalized medicine, which would be based on each person's particular genetic profile and medical background. In order to find the best treatments for a patient's particular ailment, AI plays a crucial role in this quest by evaluating enormous and complex healthcare databases [17]. The importance of AI in contemporary healthcare is shown by this precision-driven strategy, which not only improves treatment outcomes but also reduces negative side effects. The work of Miotto et al., who cover the advantages and disadvantages of deep learning in healthcare, validates AI's skill in therapy customisation [15]. As Collins and Varmus [17] point out, the idea of AI-powered therapeutic tailoring fits with the larger conversation on precision medicine. Additionally, AI's effect may be seen in the speeding up of drug discovery procedures, improved medical image analysis, strengthened patient data security, and addressing ethical issues with algorithmic transparency and data privacy [18], [19], [20], [21]. These varied contributions demonstrate how AI is inevitably becoming a key component of contemporary healthcare.

Accelerating Drug Discovery

A new era of effectiveness and creativity in pharmaceutical research is being ushered in by Artificial Intelligence, which is also having an impact on diagnostics and therapy personalisation. Long-standing characteristics of the drug discovery process include its arduousness, length, and high cost. By using its computational abilities to identify prospective medication candidates, anticipate drug interactions, and evaluate complex biological data, AI offers a solution to these problems [22]. The typical drug discovery process entails extensive laboratory testing, data gathering, and analysis that frequently takes years. But AI accelerates this procedure by quickly filtering through enormous databases, identifying promising medication candidates, and projecting their effectiveness in light of their biological and chemical characteristics [22]. Due to the ability to quickly identify molecules with therapeutic potential, the time and resources needed for drug discovery are greatly reduced. AI-driven drug development has far-reaching effects, including more effectively addressing unmet medical needs. In particular, when it comes to uncommon diseases and ailments with few available medicines, AI helps to speed up the delivery of novel treatments and therapies to patients by reducing the time required for medication development. AI additionally enables the investigation of novel strategies for drug design, potentially opening up new paths for therapy and laying the foundation for precision medicine. This transformative role of AI in drug discovery is corroborated by Segler et al., who discuss the generation of focused molecule libraries for drug discovery using recurrent neural networks [22]. The integration of AI into pharmaceutical research aligns with the broader discourse on the potential of computational methods to revolutionize drug development [23].

Advancements in Medical Imaging

In the area of medical imaging, where it has revolutionized the identification of anomalies in radiology and pathology pictures, the integration of Artificial Intelligence into healthcare extends its transformative influence. With the promise of earlier detection and action, AI-driven solutions are revolutionizing the diagnostic process by automating the identification of crucial discoveries with an outstanding level of precision [24]. The capacity of AI to precisely identify cancers and fractures in medical imaging is one of the technology's most attractive uses. AI-powered algorithms have proven to be capable in radiology of quickly and reliably spotting minute

irregularities in X-rays, MRIs, and CT scans [24]. Particularly in the early diagnosis of diseases like cancer, this precision is priceless. In the early phases of cancer detection, AI-driven medical imaging is essential for spotting tumours. Artificial intelligence (AI) assists in the detection of tiny anomalies that might elude human notice by closely examining radiological pictures. This early diagnosis is a game-changer since it can help patients receive better care by enabling prompt intervention and treatment beginning. The applications of AI in numerous subspecialties, such as cardiology, pathology, and ophthalmology, further highlight the significance of AI in medical imaging. AI algorithms can evaluate retinal scans, histopathological slides, and electrocardiograms (ECGs) with the same level of accuracy and consistency, supporting medical personnel in the diagnosis and treatment of a variety of medical diseases. The findings of Erickson et al. [24], who examine the use of machine learning for medical imaging, are consistent with the transformative influence of AI in this field. The incorporation of AI in this area is consistent with broader discussions about how cutting-edge technologies could influence radiography and diagnostic care in the future [25].

Data Security and Privacy

The integration of artificial intelligence in the age of digital healthcare goes beyond diagnosis and treatment to solve crucial problems about data security and privacy. Safeguarding patient data has grown crucial as healthcare systems increasingly rely on digital health records and connected medical devices. AI is essential in enhancing data security and privacy [26].

1. *Advanced Encryption for Data Protection*

AI-driven solutions are instrumental in implementing advanced encryption techniques that shield sensitive medical information from unauthorized access and potential breaches. These encryption methods render patient data indecipherable to unauthorized users, ensuring its confidentiality and integrity during storage, transmission, and access [26].

2. *Anomaly Detection for Threat Identification*

AI algorithms are adept at continuously monitoring healthcare systems for any deviations from the norm. By analysing patterns and behaviors within the data, AI can swiftly identify anomalies or suspicious activities that may indicate a security breach or data breach attempt. Early detection enables proactive responses to mitigate potential threats and vulnerabilities [26].

3. *Proactive Threat Mitigation*

AI expands on its role in data security by actively reducing threats. AI is capable of detecting anomalies as well as responding autonomously to possible threats by isolating compromised systems, launching security protocols, and alerting the appropriate parties. By taking preventive measures, security incidents have less of an impact and patient care is continuously provided [26]. The rising frequency of cyberattacks on healthcare institutions emphasizes the significance of AI in bolstering data security and privacy. These assaults target the enormous repositories of private patient data kept in connected medical equipment and electronic health records (EHRs). Security flaws in the healthcare industry put patient safety at risk, endanger patient confidentiality, and can cost healthcare organizations a lot of money and brand damage. AI's pivotal role in data security aligns with the broader discussions on healthcare cybersecurity and the imperative of safeguarding patient data in the digital age [27], [28]. Ensuring the privacy and integrity of patient data is fundamental to maintaining trust in healthcare systems and upholding ethical and regulatory standards [29].

Ethical Considerations

There are ethical issues with the application of artificial intelligence in healthcare. As AI plays a significant role in changing the healthcare scene, a number of ethical issues are raised that need to be carefully considered and resolved. These ethical issues cover a wide range of topics, including transparency, accountability, algorithmic bias, and data privacy [30].

1. *Data Privacy and Informed Consent*

Data privacy is one of the most important ethical issues in AI-driven healthcare. As a result of the sizeable amount of patient data used in AI applications, protecting the privacy and security of this data is crucial. Patients must be fully informed about the purposes for which their data will be used, and their consent must be freely given. Healthcare organizations must set up strong data governance structures that follow ethical standards and data protection laws [30].

2. *Algorithmic Bias and Fairness*

Algorithmic bias is yet another important ethical problem. Since historical data is used to train AI algorithms, it may contain biases that have varying effects on various demographic groups. To avoid discriminatory outcomes in healthcare, bias must be addressed and algorithmic fairness must be maintained. To reduce prejudice and advance equitable healthcare delivery, this calls for constant monitoring, auditing, and AI algorithm improvement [30].

3. *Transparency and Explain Ability*

In terms of transparency and comprehensibility, AI's intrinsic complexity presents difficulties. AI-driven judgments must be clear to patients and healthcare professionals, and they must be trusted. AI systems should be created with transparency in mind and provide concise justifications for all of their thinking. To increase accountability and trust, uniform explain ability frameworks for AI models must be created [30].

4. *Accountability and Oversight*

A strong structure for accountability and monitoring is required with the adoption of AI in healthcare. In the event of AI-related mistakes or malfunctions, it is essential to pinpoint the accountable parties. Risks can be reduced and responsible AI deployment can be ensured by putting in place methods for ongoing monitoring and auditing of AI systems [30]. These ethical issues are consistent with more general debates in the fields of healthcare ethics and AI ethics. Ethics experts, clinicians, data scientists, policymakers, and patients must work together across disciplines to responsibly integrate AI into healthcare. In order to ensure that AI works as a force for good in healthcare, supporting patient welfare and equal access to care, it is not only necessary under regulatory requirements but also ethically important to address these ethical concerns [31].

The Future of Healthcare

The trajectory of healthcare is poised for a significant transformation as Artificial Intelligence continues to advance and find broader applications within the healthcare sector. The future of healthcare holds the promise of improved healthcare delivery, enhanced diagnostics and personalized medicine, an accelerated drug discovery process, and the seamless integration of AI into healthcare ecosystems. These transformative developments are expected to shape a healthcare landscape that is more patient-centric, data-driven, and capable of addressing the complex challenges of tomorrow.

1. *Advancements in Healthcare Delivery*

The delivery of healthcare services will be one of AI's most noticeable effects on the field of medicine in the future. Predictive analytics powered by AI will make proactive and preventive care possible by identifying those who are at risk of particular illnesses. Artificial intelligence and

natural language processing (NLP)-based chatbots and virtual health assistants will play a crucial role in giving patients access to quick information and help. These developments will potentially lower healthcare expenses by easing the pressure on healthcare facilities and improving patient experience [32], [33].

2. *Enhanced Diagnostics and Personalized Medicine*

In the future, diagnoses and therapy tailoring will be improved. AI systems' capacity to decipher complex medical data will continue to advance, making it possible to detect diseases early and with unmatched accuracy. By enabling doctors to accurately customize therapies to a patient's genetic profile and medical history, AI will advance precision medicine and maximize therapeutic success while minimizing side effects [34].

3. *Revolution in Drug Discovery*

The pharmaceutical research industry will continue to undergo a transformation due to the acceleration of drug discovery through AI-driven methods. Researchers will use AI models more and more to find new drug candidates, foresee medication interactions, and improve clinical trial designs. The end consequence will be the rapid development of novel medications and treatments that will more effectively address unmet medical needs [35].

4. *AI's Role in Healthcare Ecosystems*

Wearables and remote monitoring tools will also be incorporated into the healthcare ecosystem by AI. By continuously gathering patient data, these gadgets will allow for early detection and real-time monitoring of health issues. Healthcare systems will be able to manage patient populations more successfully, anticipate patient admission rates, allocate resources more efficiently, and cut costs [36], [37].

5. *Patient Empowerment and Engagement*

AI-driven healthcare will empower patients by providing them with personalized health insights and tools for self-management. Patients will have access to their medical records, AI-generated recommendations for healthy living, and tailored treatment plans, fostering active engagement in their healthcare journey [38]. In conclusion, the future of healthcare is intrinsically intertwined with AI's evolution and integration. AI's expanding role promises to enhance healthcare delivery, diagnostics, drug discovery, and patient engagement using some methods like machine learnings [39], [40] while addressing ethical considerations and data security challenges. As AI continues to mature, it will be a driving force in shaping a healthcare landscape that is more patient-centric, data-driven, and capable of addressing the complex healthcare challenges of tomorrow. The convergence of AI and healthcare represents an exciting and transformative journey toward improving healthcare outcomes and patient experiences worldwide.

Conclusion

In conclusion, the integration of AI into healthcare is reshaping medicine and patient care profoundly. This article has explored AI's multifaceted impact on healthcare, from diagnostics to drug discovery. AI-driven algorithms excel in disease diagnosis, offering unprecedented accuracy and speed in analyzing complex medical data. In fields like radiology, AI aids in identifying anomalies, potentially reducing diagnostic errors. Personalized treatment plans based on genetic profiles and medical history improve therapeutic outcomes. Drug discovery accelerates, addressing unmet medical needs efficiently. AI benefits healthcare through wearables, remote monitoring, and predictive analytics, empowering patients and improving experiences. Ethical considerations, including data privacy and algorithmic bias, must be addressed for responsible AI integration. Looking ahead, healthcare is poised for transformation, becoming more patient-centric

and proactive with predictive analytics and virtual health assistants. Enhanced diagnostics, precision medicine, and accelerated drug discovery offer new hope for patients. In summary, AI's integration in healthcare represents a dynamic path to a more patient-focused, technologically advanced, and compassionate healthcare future. AI will continue to evolve, addressing complex healthcare challenges and improving global health and well-being. The future of healthcare is AI-driven, promising a healthier and more interconnected world.

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Conflict of interests
The authors declare that there are no competing interests.

Reference

[1]. Copeland B. Artificial intelligence. Encyclopedia Britannica. 2023 March 31. Available from: https://www.britannica.com/technology/artificial-intelligence

[2]. Ahmadi A. The AI Food Revolution: Reshaping Food Sciences through Artificial Intelligence. International Journal of BioLife Sciences (IJBLS). 2023;2(1):62-71.

[3]. Chen M, Mao S, Liu Y. Big data: A survey. Mobile Networks and Applications. 2014;19(2):171-209.

[4]. Provost F, Fawcett T. Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking. O'Reilly Media. 2013.

[5]. Hewlett Packard Enterprise Development LP. Data Intelligence. HPE. [Internet]. [cited 2023]. Available from: https://www.hpe.com/us/en/what-is/data-intelligence.html

[6]. Kaur S, Singla J, Nkenyereye L, Jha S, Prashar D, Joshi GP, El-Sappagh S, Islam MS, Islam SR. Medical diagnostic systems using artificial intelligence (AI) algorithms: Principles and perspectives. IEEE Access. 2020;8:228049-69.

[7]. Mehrotra A. Artificial intelligence in financial services–need to blend automation with human touch. In: 2019 International Conference on Automation, Computational and Technology Management (ICACTM). IEEE; 2019. p. 342-7.

[8]. Abduljabbar R, Dia H, Liyanage S, Bagloee SA. Applications of artificial intelligence in transport: An overview. Sustainability. 2019;11(1):189.

[9]. Iyer LS. AI enabled applications towards intelligent transportation. Transportation Engineering. 2021;5:100083.

[10]. Kashem MA, Shamsuddoha M, Nasir T, Chowdhury AA. Supply Chain Disruption versus Optimization: A Review on Artificial Intelligence and Blockchain. Knowledge. 2023;3(1):80-96.

[11]. Ho RC. Chatbot for online customer service: Customer engagement in the era of artificial intelligence. In: Impact of globalization and advanced technologies on online business models. IGI Global; 2021. p. 16-31.

[12]. Chen L, Chen P, Lin Z. Artificial intelligence in education: A review. IEEE Access. 2020;8:75264-78.

[13]. Ahmadi A. Artificial intelligence and mental disorders: chicken-or-the egg issue. JBS [Internet]. 2023 May 10 [cited 2023 May 13];6(1):7-18.

[14]. Shukla SS, Vijay J. Applicability of artificial intelligence in different fields of life. International Journal of Scientific Engineering and Research. 2013;1(1):28-35.

[15]. Esteva A, Robicquet A, Ramsundar B, Kuleshov V, DePristo M, Chou K, Cui C, Corrado G,

Thrun S, Dean J. A guide to deep learning in healthcare. Nature Medicine. 2019;25(1):24-9.

[16]. Erickson BJ, Korfiatis P, Akkus Z, Kline TL. Machine learning for medical imaging. Radiographics. 2017;37(2):505-15.

[17]. Collins FS, Varmus H. A new initiative on precision medicine. New England Journal of Medicine. 2015;372(9):793-5.

[18]. Miotto R, Wang F, Wang S, Jiang X, Dudley JT. Deep learning for healthcare: review, opportunities and challenges. Briefings in Bioinformatics. 2018;19(6):1236-46.

[19]. Segler MH, Kogej T, Tyrchan C, Waller MP. Generating focused molecule libraries for drug discovery with recurrent neural networks. ACS Central Science. 2018;4(1):120-31.

[20]. Hsu CL, Lee MR, Su CH. The role of privacy protection in healthcare information systems adoption. Journal of Medical Systems. 2013;37:1-12.

[21]. 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.

[22]. Segler MH, Kogej T, Tyrchan C, Waller MP. Generating focused molecule libraries for drug discovery with recurrent neural networks. ACS central science. 2018;4(1):120-31.

[23]. Patel HM, Noolvi MN, Sharma P, Jaiswal V, Bansal S, Lohan S, Kumar SS, Abbot V, Dhiman S, Bhardwaj V. Quantitative structure–activity relationship (QSAR) studies as strategic approach in drug discovery. Medicinal chemistry research. 2014;23:4991-5007.

[24]. Erickson BJ, Korfiatis P, Akkus Z, Kline TL. Machine learning for medical imaging. Radiographics. 2017;37(2):505-15.

[25]. Brady AP, Bello JA, Derchi LE, Fuchsjäger M, Goergen S, Krestin GP, Lee EJ, Levin DC, Pressacco J, Rao VM, Slavotinek J, Visser JJ, Walker REA, Brink JA. Radiology in the era of value-based healthcare: a multi-society expert statement from the ACR, CAR, ESR, IS3R, RANZCR, and RSNA. Canadian Association of Radiologists Journal. 2021;72(2):208-14.

[26]. Kogetsu A, Ogishima S, Kato K. Authentication of patients and participants in health information exchange and consent for medical research: a key step for privacy protection, respect for autonomy, and trustworthiness. Frontiers in genetics. 2018;9:167.

[27]. Coventry L, Branley D. Cybersecurity in healthcare: A narrative review of trends, threats and ways forward. Maturitas. 2018;113:48-52.

[28]. O'Brien N, Grass E, Martin G, Durkin M, Darzi A, Ghafur S. Developing a globally applicable cybersecurity framework for healthcare: a Delphi consensus study. BMJ Innovations. 2021;7(1).

[29]. Ahmadi H, Arji G, Shahmoradi L, Safdari R, Nilashi M, Alizadeh M. The application of internet of things in healthcare: a systematic literature review and classification. Universal Access in the Information Society. 2019;18:837-69.

[30]. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nature medicine. 2019;25(1):44-56.

[31]. Fiske A, Henningsen P, Buyx A. Your robot therapist will see you now: ethical implications of embodied artificial intelligence in psychiatry, psychology, and psychotherapy. Journal of medical Internet research. 2019;21(5):e13216.

[32]. Patel S, Park H, Bonato P, Chan L, Rodgers M. A review of wearable sensors and systems with application in rehabilitation. Journal of neuroengineering and rehabilitation. 2012;9(1):1-17.

[33]. Hassenzahl M. Experience design: Technology for all the right reasons. Morgan & Claypool Publishers. 2010.

[34]. Katsanis SH, Katsanis N. Molecular genetic testing and the future of clinical genomics. Nature Reviews Genetics. 2013;14(6):415-26.

[35]. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nature medicine. 2019;25(1):44-56.

[36]. Li F, Xin H, Zhang J, Fu M, Zhou J, Lian Z. Prediction model of in-hospital mortality in intensive care unit patients with heart failure: machine learning-based, retrospective analysis of the MIMIC-III database. BMJ open. 2021;11(7):e044779.

[37]. Rajkomar A, Dean J, Kohane I. Machine learning in medicine. New England Journal of Medicine. 2019;380(14):1347-58.

[38]. Gagnon MP, Ngangue P, Payne-Gagnon J, Desmartis M. m-Health adoption by healthcare professionals: a systematic review. Journal of the American Medical Informatics Association. 2016;23(1):212-20.

[39]. Saranya G, Pravin A. A comprehensive study on disease risk predictions in machine learning. International Journal of Electrical and Computer Engineering. 2020;10(4):4217.

[40]. Pudjihartono N, Fadason T, Kempa-Liehr AW, O'Sullivan JM. A review of feature selection methods for machine learning-based disease risk prediction. Frontiers in Bioinformatics. 2022;2:927312.