

Artificial Intelligence in Healthcare: Opportunities, Applications, and Challenges

Atika Saifullah^{1*}, Muhammad Kaleem Gillani², Momina Waheed¹, Iram Shabbir³ and Areeba Iqbal¹

1. Department of Pharmacy, University of Agriculture, Faisalabad
2. Department of Pharmacy Practice, The Islamia University of Bahawalpur (IUB), Pakistan
3. Center of Agriculture Biotechnology and Biochemistry, University of Agriculture, Faisalabad

*Corresponding Author: atikasaifullah450@gmail.com

ABSTRACT

Artificial intelligence (AI) has become a transformative technology that is changing modern healthcare by improving the accuracy and efficiency of medical services. This article discusses the major applications, opportunities, challenges, and future prospects of AI in healthcare. AI-driven technologies such as machine learning, deep learning, natural language processing, and computer-based tools have significantly enhanced the diagnosis of disease, medical imaging, drug discovery, precision medicine, telemedicine, and clinical decision-making. This revolution has the potential to improve patient outcomes, enhance healthcare resources, and reduce healthcare costs. However, the widespread use of AI also faces some challenges such as data privacy concerns, algorithmic bias, lack of transparency, ethical and legal issues, and infrastructure limitations. Overall, AI is expected to accompany healthcare professionals rather than replace them, making it more efficient, personalized, and patient-centered healthcare systems in the future.

Keywords: Artificial Intelligence, Healthcare, Machine Learning, Precision Medicine, Clinical Decision Support

To cite this article: Saifullah A, MK Gillani, M Waheed, I Shabbir & A Iqbal. Artificial Intelligence in Healthcare: Opportunities, Applications, and Challenges. Biological Times. 2026. July 5(7): 16-17.

Introduction

Artificial intelligence (AI) has emerged as one of the most significant technological advancements of the twenty-first century, which has transformed healthcare due to its ability to manage complex medical data, and provide evidence-based clinical decision-making. The healthcare systems are getting a lot of data from things like electronic health records and medical imaging. They are also getting data from databases, wearable devices, and digital health platforms. We need to use intelligent technologies to get useful information from this data. Artificial intelligence technologies can help us understand the data better, make diagnoses more accurate, and create treatment plans that're specific to each patient. This makes healthcare better for everyone. Healthcare becomes more efficient, easier to get to, and focused on the patient. The healthcare systems and artificial intelligence technologies are working together to make this happen. Artificial intelligence technologies are really helping healthcare^{1,2}. The use of AI in healthcare has increased significantly over the past decade due to advances in computational power, cloud computing, and the availability of large-scale biomedical datasets. AI-powered systems are being used in medical imaging, diagnosis of disease, drug discovery, robotic-assisted surgery, telemedicine, and clinical decision support. Diabetic retinopathy, breast cancer and skin cancer, cardiovascular disorders and neurological diseases can be detected by intelligence with an accuracy that is similar to that of experienced healthcare professionals. Artificial intelligence helps doctors by reducing mistakes when they are diagnosing patients, making their work easier and faster, and finding patients who're at high risk early on. This helps people get better. It also helps hospitals use their resources in a smarter way. Artificial intelligence is really good at helping doctors with retinopathy, breast cancer, skin cancer, cardiovascular disorders, and neurological diseases. Therefore, the successful integration of AI into healthcare requires robust regulatory frameworks, ethical governance, interdisciplinary collaboration, and continuous validation in real-world clinical settings. Understanding both the opportunities and limitations of AI is essential for ensuring its responsible and effective application in improving patient care, advancing medical research, and strengthening global healthcare systems.³

Beyond what doctors do every day, Artificial Intelligence has really changed how we do research to make medicines. It helps us find drugs, figure out how they work, and make sure they are safe for people to take. Usually, making a new drug takes a long time and a lot of money. We are talking more than ten years from when we first think of an idea to when it is available in stores. Artificial Intelligence can look at millions of chemicals, pick the best ones, and even find new uses for old drugs, which makes the whole process faster and cheaper. Also, Artificial Intelligence can look at lots of kinds of information, like what the doctor sees, pictures of the inside of the body, genes, and lab results, to get a complete picture of what is going on and how to treat each person. With all the good things Artificial Intelligence can do, there are still many problems to solve before

we can use it everywhere in healthcare. We need to make sure people's private information is safe and that the computers we use are secure. We also need to make sure the Artificial Intelligence is fair and that we can understand how it makes decisions. There are also rules and laws that we need to follow. We need to make sure everyone has equal access to these new tools. Furthermore, Artificial Intelligence needs information to work properly, and that is a big challenge. Artificial Intelligence relies heavily on having good data to learn from.^{4,5}

Applications and Opportunities for Artificial Intelligence in Healthcare

Artificial intelligence (AI) has transformed healthcare by increasing the accuracy and efficiency of medical services. Through advanced machine learning algorithms and deep learning models, AI can analyze large volumes of structured and unstructured medical data within seconds, assisting healthcare professionals in making timely and evidence-based decisions. Rather than replacing clinicians, AI serves as a powerful decision-support tool that improves patient care safety while it also reduces workload and healthcare costs. Recent technological advancements have expanded AI applications across nearly every aspect of healthcare, from disease diagnosis to pharmaceutical research and hospital management⁶

Disease diagnosis and medical imaging:

One of the most important applications of AI is disease diagnosis and medical imaging. Deep learning algorithms can really help us understand what is going on in images like X-rays, computed tomography, magnetic resonance imaging, and retinal scans. These systems are a help to radiologists when they are trying to find diseases like breast cancer, diabetic retinopathy, pneumonia, stroke, and lung cancer. They can even find these diseases at a stage that is just as good as what experienced specialists can do. When we can find diseases early and correctly, we can start treating patients early, reduce mistakes, and more patients can survive. Deep learning algorithms can also help us keep an eye on patients when they are in the hospital. AI-based computer vision systems can watch patients all the time, find out if they are getting worse and help doctors jump in and do something about it quickly.⁷

Personalized medicine:

Personalized medicine is a deal. It is an opportunity. Personalized medicine and clinical decision support are closely related to this opportunity. Artificial Intelligence, or AI for short, looks at the information that's specific to each patient. This information includes the patients' profiles, laboratory findings, imaging data, lifestyle factors and electronic health records. AI uses this information to recommend treatment strategies that are tailored to each patient. This approach is good because it makes the treatment more effective. It also helps to minimize reactions to drugs and unnecessary interventions. AI is also used in decision support systems. These systems help doctors in ways. They can predict how a disease will progress. They can identify patients who're, at high risk. They can recommend management plans that are based on evidence. All of this helps to improve the quality of care. It also helps to make patient care safer.

Personalized medicine, clinical decision support, and AI all work together to make this happen.⁸

Telemedicine and Healthcare Administration:

Artificial intelligence has really helped telemedicine and healthcare administration. People can wear devices that have intelligence to track things like heart rate and blood pressure. This helps doctors find out if someone is getting sick before it gets really bad. It can also keep people from going to the hospital when they do not need to. There are also assistants and chatbots that use artificial intelligence to teach people about health and remind them to take their medicine. They can even help people figure out if they need to see a doctor. This makes it easier for people to get healthcare in places where it is hard to find doctors. In hospitals, artificial intelligence helps with things like paperwork and scheduling. This means doctors and nurses can spend time taking care of patients. Artificial intelligence can do a lot to make healthcare better. It can help doctors diagnose people correctly and find treatments. As artificial intelligence gets better, it will help doctors give people the care they need. However, we need to make sure we use intelligence in a responsible way so that everyone gets good healthcare. We need to test it and make sure it is fair for everyone.^{9,10}

Challenges of Artificial Intelligence in Healthcare

Artificial intelligence (AI) has the potential to transform healthcare. Its implementation is accompanied by many challenges. AI has shown capabilities in disease diagnosis, clinical decision support, and healthcare management. However, several barriers limit its effective use in routine clinical practice.

One major concern is data privacy and cybersecurity. AI systems need large amounts of high-quality health data to develop accurate models. This data includes health records, medical images, laboratory reports, and genomic information. The collection, storage, and sharing of this information increase the risk of data breaches and cyberattacks. Healthcare organizations must implement cybersecurity measures to protect patient data.¹¹

Another challenge is bias and health inequity. AI models learn from datasets. If these datasets are incomplete or unrepresentative of populations, the resulting algorithms may produce biased predictions. This bias can affect demographic groups, leading to inaccurate diagnoses and unequal healthcare outcomes. AI systems should be. Validated using diverse datasets to ensure fairness and equitable healthcare delivery.¹²

The lack of transparency and explainability of AI models is also a limitation. These models often function as “boxes,” generating recommendations without clear explanations. This lack of interpretability makes it difficult for healthcare professionals to understand AI-generated recommendations. Explainable AI has become an area of research aimed at improving transparency.¹³

Ethical and legal concerns are also obstacles to AI adoption. Questions remain regarding accountability when AI-assisted clinical decisions result in errors. It is often unclear who is responsible. Healthcare professionals, software developers, or AI manufacturers. Establishing legal frameworks and ethical guidelines is essential for the responsible deployment of AI in healthcare.¹⁴

The successful implementation of AI faces organizational barriers, including high costs, inadequate digital infrastructure, and limited interoperability between healthcare information systems. Many healthcare institutions lack the resources and technical expertise required to adopt and maintain advanced AI technologies. Overcoming these challenges will require collaboration among clinicians, researchers, policymakers, engineers, and regulatory authorities to develop transparent and patient-centered AI solutions.¹⁵

Future Perspectives

Future AI systems are anticipated to become more accurate, transparent, and capable of interpreting multimodal data, including electronic health records, medical imaging, laboratory results, and genomic information, so that they can provide comprehensive clinical insights and individualized treatment recommendations. Due to these advancements, there will be earlier disease detection and improved long-term outcomes for patients.¹⁶

The development of generative AI and large language models (LLMs) is also expected to change healthcare by summarizing patient records and history, supporting education in every field, and helping healthcare professionals in evidence-based decision-making. Furthermore, virtual assistants and computer-generated healthcare platforms may improve

patient safety through personalized health education, reminders of medication, mental health support, and continuous remote monitoring, which particularly benefits elderly individuals and patients with serious diseases.¹⁷

Researchers emphasize the importance of developing trustworthy AI systems that are transparent, unbiased, and safe for use across varied populations. Teamwork among healthcare professionals, researchers, policymakers, and technology developers will be essential to ensure reasonable access and responsible implementation of AI worldwide. Rather than replacing healthcare professionals, AI is expected to work as an intelligent partner that will enhance expertise in clinical settings, improve healthcare quality, and support more efficient healthcare systems in the coming decades.¹⁸

Conclusion

Artificial intelligence (AI) is revolutionizing healthcare by improving diagnostic accuracy, increasing drug discovery, improving clinical decision-making, and enhancing patient-centered care. The addition of AI with technologies such as machine learning, deep learning, and large language models has created extraordinary opportunities to improve healthcare efficiency and reduce medical errors. However, it also has several challenges, including data privacy concerns, algorithmic bias, lack of transparency, ethical problems, and implementation costs. These issues must be addressed to ensure the safe use of AI in clinical practice. Future advancements should focus on developing secure and unbiased AI systems. Rather than replacing healthcare professionals, AI should be viewed as a complementary tool that increases human expertise and improves evidence-based decision-making. With responsible implementation and continuous innovation, AI has the potential to transform global healthcare and improve patient outcomes while promoting more efficient, accessible, and sustainable healthcare systems.

References

- [1] Alhejaily AM. Artificial intelligence in healthcare (Review). *Biomed Rep.* 2024;22(1):11. doi:10.3892/br.2024.1889
- [2] Rajpurkar P, Chen E, Banerjee O, Topol EJ. AI in health and medicine. *Nat Med.* 2022;28(1):31–38. doi:10.1038/s41591-021-01614-0
- [3] Han R, Acosta JN, Shakeri Z, Ioannidis JPA, Topol EJ, Rajpurkar P. Randomised controlled trials evaluating artificial intelligence in clinical practice: a scoping review. *The Lancet Digital Health.* 2024;6(5):e367–e373. doi:10.1016/S2589-7500(24)00047-5
- [4] Ciecierski-Holmes T, Singh R, Axt M, Brenner S, Barteit S. Artificial intelligence for strengthening healthcare systems in low- and middle-income countries: a systematic scoping review. *npj Digit Med.* 2022;5(1):162. doi:10.1038/s41746-022-00700-y
- [5] Acosta JN, Falcone GJ, Rajpurkar P, Topol EJ. Multimodal biomedical AI. *Nat Med.* 2022;28(9):1773–1784. doi:10.1038/s41591-022-01981-2
- [6] Moulai K, Yadegari A, Baharestani M, Farzanbakhs S, Sabet B, Reza Afrash M. Generative artificial intelligence in healthcare: A scoping review on benefits, challenges and applications. *International Journal of Medical Informatics.* 2024;188:105474. doi:10.1016/j.ijmedinf.2024.105474
- [7] Lindroth H, Nalae K, Raghu R, et al. Applied Artificial Intelligence in Healthcare: A Review of Computer Vision Technology Application in Hospital Settings. *J Imaging.* 2024;10(4):81. doi:10.3390/jimaging10040081
- [8] Aminizadeh S, Heidari A, Dehghan M, et al. Opportunities and challenges of artificial intelligence and distributed systems to improve the quality of healthcare service. *Artificial Intelligence in Medicine.* 2024;149:102779. doi:10.1016/j.artmed.2024.102779
- [9] Khan SD, Hoodbhoy Z, Raja MHR, et al. Frameworks for procurement, integration, monitoring, and evaluation of artificial intelligence tools in clinical settings: A systematic review. *Ni Z, ed. PLOS Digit Health.* 2024;3(5):e0000514. doi:10.1371/journal.pdig.0000514
- [10] Wang D, Zhang S. Large language models in medical and healthcare fields: applications, advances, and challenges. *Artif Intell Rev.* 2024;57(11):299. doi:10.1007/s10462-024-10921-0
- [11] Mohsin Khan M, Shah N, Shaikh N, Thabet A, Alrabayah T, Belkhaier S. Towards secure and trusted AI in healthcare: A systematic review of emerging innovations and ethical challenges. *Int J Med Inform.* 2025;195:105780. doi:10.1016/j.ijmedinf.2024.105780
- [12] Freyer N, Groß D, Lipprandt M. The ethical requirement of explainability for AI-DSS in healthcare: a systematic review of reasons. *BMC Med Ethics.* 2024;25(1):104. doi:10.1186/s12910-024-01103-2
- [13] Hofweber T, Walker RL. Machine Learning in Health Care: Ethical Considerations Tied to Privacy, Interpretability, and Bias. *N C Med J.* 2024;85(4):240–245. doi:10.18043/001c.120562
- [14] Harishbhai Tilala M, Kumar Chenchala P, Choppadandi A, et al. Ethical Considerations in the Use of Artificial Intelligence and Machine Learning in Health Care: A Comprehensive Review. *Cureus.* 2024;16(6):e62443. doi:10.7759/cureus.62443
- [15] Grzybowski A, Jin K, Wu H. Challenges of artificial intelligence in medicine and dermatology. *Clin Dermatol.* 2024;42(3):210–215. doi:10.1016/j.clindermatol.2023.12.013
- [16] Alhejaily AM. Artificial intelligence in healthcare (Review). *Biomed Rep.* 2024;22(1):11. doi:10.3892/br.2024.1889
- [17] Mohajer-Bastami A, Moin S, Ahmad S, et al. Artificial intelligence in healthcare: applications, challenges, and future directions. A narrative review informed by international, multidisciplinary expertise. *Front Digit Health.* 7:1644041. doi:10.3389/fgdh.2025.1644041
- [18] Integrating metaheuristics and artificial intelligence for healthcare: basics, challenging and future directions | *Artificial Intelligence Review* | Springer Nature Link. Accessed July 1, 2026. <https://link.springer.com/article/10.1007/s10462-024-10822-2>.