The War Between Data Privacy and Cost Efficiency: Opportunities and Challenges of Artificial Intelligence in Healthcare

Gizem Ilayda Öztürk
Lake Forest College
Lake Forest, Illinois 60045

Artificial Intelligence (AI) within healthcare is rapidly evolving, improving drug development, early diagnoses of diseases, data automation, medical chatbots, and more. The implementation of AI has revealed novel biomarkers, increased database, and refined research in medical work. These AI models, which register vast amounts of personal data, must stick to strong regulations and accountability while ensuring patient transparency.

AI, along with Machine Learning (ML), and Deep Learning (DL), has decreased the workload of healthcare providers by automating administrative work and analyzing large datasets and images within research. AI is the simulation of human intelligence, whereas ML ingests large data points and analyses its algorithms. DL processes inputs through artificial neural networks allowing for image pixelation which aids diagnosis and treatment. This article reviews current approaches, strengths, limitations, and future scopes of AI in healthcare.

AI Application in Healthcare

AI has achieved great success in healthcare. Robot-assisted surgery has become less invasive, while reducing error and hospital stay. In anesthesiology, a study showed 4.2% greater accuracy using a ML method analyzing electroencephalography signals. The University of Iowa has started using an FDA approved AI device, with the specificity of 89.5%, that classifies patients by their retinopathy level. With radiological images and neural networks, dental examinations show finer precision and time-efficiency. Image pixelation is widely used in cancer research and treatment as AI provides direct feedback and disease progression. AI has engineered small-molecules features that are used in broad physiological and biophysical research methods. A 2019 study made an AI model that could predict the correct sarcoma subtype (cancer) with an accuracy of over 95%. The widespread implementation of AI has improved many aspects of the healthcare system, revealing more potential possibilities for AI in the future.

Advantage of AI

AI's ability to optimize resources has been a crucial benefit for healthcare providers. Well-implemented AI sources are time and cost efficient due to the clinical burden that alleviates off administrative providers. Diagnostic accuracy and predictive analysis aid treatment and reduce treatment costs. Stanford Medicine made algorithm CheXNeXt, which scans for 14 different diseases allowing providers to focus on other tasks.

Algorithms can predict disease with high precision in identifying borders and relationships in data. Through DL models, images can be processed with pixelation. Pixelation changes each bit of an image to a color gradient and labels it based on the tone of the bit, enabling comparison between healthy and unhealthy patient pictures.

AI's ability to make better and earlier predictions has made it a valuable tool in clinical decision-making. Virtual assistance helps healthcare providers understand language and semantics and can be used as guidance in decision making. Having AI technologies to administer data or take vitals can speed the miscellaneous tasks of healthcare providers.

Challenges of AI

Despite the many opportunities with AI, some risks and limitations have emerged. Healthcare data contains sensitive patient information, so it must be stored and regulated confidentially. Data security and privacy must comply with FDA and HIPPA regulations to be protected from data breaches, misuse of data, and unauthorized access. Hospitals are using sepsis devices that are not regulated by the FDA, posing a threat on patient privacy due to the minimal algorithmic and data transparency.

ML algorithms can sustain biases introduced in training data, which can lead to unfair outcomes with certain individuals. These datasets reflect bias of collectors. In 2022, a gap existed between individuals with different skin tones in a ML cancer algorithm. The algorithm performed better accuracy for those with light skin compared to those with dark skin. Biases also occur within gender-related data, hindering support needed for gender-specific procedures.

High quality and sufficient data are needed in the training of a ML model. Data that lacks in volume, diversity, and annotations result in meager generalized outcomes. The foundation of ML development lays in complete, accurate, and bias-free datasets available for clinicians and developers, yet few of these datasets exist and are accessible. Good quality volume data will prevent overfitting and improve ML models. However, ML models work best on their own data because they are fine-tuned to the specific features, distribution, and context of that data. When exposed to different datasets, these models often fail to generalize well due to variations in data structure, distribution, and other factors.

Future Directions of AI

AI aids research but can compromise patient privacy. Therefore, for AI to remain within healthcare, strict regulations must be implemented and used. Patients need to consent to the use of AI, with healthcare providers offering transparency and accountability along with a thorough risk assessment to ensure patient well-being. To prevent discriminatory outcomes, we must reduce bias and include diverse testing data. Encouraging healthcare providers to collect data together and work towards similar datasets to make AI more generalizable and applicable within different providers allows for AI models to be reused in different settings. Whether data privacy is a priority or cost-efficiency is not clear within the world of AI, yet. Whichever it is, without access to the healthcare system in an affordable way, most individuals will not be able to experience these products as they are not widespread yet.

References

Gupta, R., Srivastava, D., Sahu, M., Tiwari, S., Ambasta, R. K., & Kumar, P. (2021). Artificial intelligence to deep learning: machine intelligence approach for drug discovery. Molecular diversity, 25, 1315-1360.

Dhabliya, D., Kulkarni, S. V., Jadhav, N., Ubale, S. A., Sharma, P., Gavali, A. B., ... & Gaidhane, A. (2024). Strategic integration of artificial intelligence in public health: Policy recommendations for improved healthcare delivery. Journal of Krishna Institute of Medical Sciences (JKIMSU), 13(1).

Aung, Y. Y., Wong, D. C., & Ting, D. S. (2021).The promise of artificial intelligence: a review of the opportunities and challenges of artificial intelligence in healthcare. British medical bulletin, 139(1), 4-15

Chen, M., & Decary, M. (2020, January). Artificial intelligence in healthcare: An essential guide for health leaders. In Healthcare management forum (Vol. 33, No. 1, pp. 10-18). Sage CA: Los Angeles, CA: SAGE Publications.

van IJzendoorn, D. G., Szuhai, K., Briaire-de Bruijn, I. H., Kostine, M., Kuijjer, M. L., & Bovée, J. V. (2019). Machine learning analysis of gene expression data reveals novel diagnostic and prognostic biomarkers and biology, 15(2), e1006826.

Keskinbora, K., & Güven, F. (2020). Artificial intelligence and ophthalmology. Turkish journal of ophthalmology, 50(1), 37.

Lai, T. (2024). Interpretable Medical Imagery Diagnosis with Self-Attentive Transformers: A Review of Explainable AI for Health Care. BioMedInformatics, 4(1), 113-126.

Arefin, S. (2024). AI Revolutionizing Healthcare: Innovations, Challenges, and Ethical Considerations. MZ Journal of Artificial Intelligence, 1(2), 1-17.

Hashimoto, D. A., Witkowski, E., Gao, L., Meireles, O., & Rosman, G. (2020). Artificial intelligence in anesthesiology: current techniques, clinical applications, and limitations. Anesthesiology, 132(2), 379-394.

Mirsadeghi M, Behnam H, Shalbaf R, Jelveh Moghadam H: Characterizing awake and anesthetized states using a dimensionality reduction method. J Med Syst 2016; 40:13 [PubMed: 26573650]

Ossowska, A., Kusiak, A., & Świetlik, D. (2022). Artificial intelligence in dentistry—Narrative review. International journal of environmental research and public health, 19(6), 3449.

Rasool, S., Ali, M., Shahroz, H. M., Hussain, H. K., & Gill, A. Y. (2024). Innovations in AI-Powered Healthcare: Transforming Cancer Treatment with Innovative Methods. BULLET: Jurnal Multidisiplin Ilmu, 3(1), 118-128.

Duran-Frigola, M., Cigler, M., & Winter, G. E. (2023). Advancing targeted protein degradation via multiomics profiling and artificial intelligence. Journal of the American Chemical Society, 145(5), 2711-2732.

https://med.stanford.edu/news/all-news/2018/11/ai-outperformed-radiologists-in-screening-x-rays-for-certain-diseases.html

Li, Y. H., Li, Y. L., Wei, M. Y., & Li, G. Y. (2024). Innovation and challenges of artificial intelligence technology in personalized healthcare. Scientific Reports, 14(1), 18994.

Secinaro, S., Calandra, D., Secinaro, A., Muthurangu, V., & Biancone, P. (2021). The role of artificial intelligence in healthcare: a structured literature review. BMC medical informatics and decision making, 21, 1-23.

Gonçalves Costa, G., JD Nascimento Júnior, W., Mombelli, M. N., & Girotto Júnior, G. (2024). Revisiting a Teaching Sequence on the Topic of Electrolysis: A Comparative Study with the Use of Artificial Intelligence. Journal of Chemical Education, 101(8), 3255-3263.

Zhang, J., Mattie, H., Shuaib, H., Hensman, T., Teo, J. T., & Celi, L. A. (2022). Addressing the "elephant in the room" of AI clinical decision support through organisation-level regulation. PLOS Digital Health, 1(9), e0000111.

Daneshjou, R., Vodrahalli, K., Novoa, R. A., Jenkins, M., Liang, W., Rotemberg, V., ... & Chiou, A. S. (2022). Disparities in dermatology AI performance on a diverse, curated clinical image set. Science advances, 8(31), eabq6147

Panch, T., Duralde, E., Mattie, H., Kotecha, G., Celi, L. A., Wright, M., & Greaves, F. (2022). A distributed approach to the regulation of clinical AI. PLOS Digital Health, 1(5), e0000040.

Kaushik, S., Choudhury, A., Sheron, P. K., Dasgupta, N., Natarajan, S., Pickett, L. A., & Dutt, V. (2020). AI in healthcare: time-series forecasting using statistical, neural, and ensemble architectures. Frontiers in big data, 3, 4.

Amann, J., Blasimme, A., Vayena, E., Frey, D., Madai, V. I., & Precise4Q Consortium. (2020). Explainability for artificial intelligence in healthcare: a multidisciplinary perspective. BMC medical informatics and decision making, 20, 1-9.