Journal of Institute of Medicine Nepal
Institute of Medicine, Kathmandu, Nepal

OPEN ACCESS

Review Article

JIOM Nepal. 2024 Dec;46(3):1-5.

Applications of Generative Artificial Intelligence in Medicine: Opportunities and Ethical Considerations

Mohan Raj Sharma

Author(s) affiliation

Department of Neurosurgery, Maharajgunj Medical Campus, Tribhuvan University Teaching Hospital, Institute of Medicine, Kathmandu, Nepal

Corresponding author

Mohan Raj Sharma, MBBS, MS
mohanrajsharma@iom.edu.np

ABSTRACT

Introduction

Generative Artificial Intelligence (AI) has emerged as a transformative tool in various domains, including medical sector. Generative AI models like ChatGPT offer unparalleled potential in diagnostics, prognostications, and research assistance. However, their integration necessitates careful scrutiny of risks, including privacy violations and the propagation of inaccuracies. Establishing clear guidelines for their use in academic medicine and research is imperative for the responsible use of these tools. This article explores the foundational concepts of generative AI, highlights its applications in medicine, research, and academia, and addresses ethical and practical concerns.

Keywords

Academic medicine; chatGPT; generative AI; research

INTRODUCTION

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that help to execute tasks that require human intelligence such as problem-solving, learning, language comprehension, recognizing patterns, and decision-making. Generative AI, a subset of AI, creates new data by analyzing patterns in existing datasets. The models are broadly of two types (a) Generative adversarial networks (GANs) and (b) Large language models (LLMs).

GANs are a type of neural network architecture composed of two models - a generator and a discriminator - that work together in a competitive process to generate realistic data. The generator creates fake data, while the discriminator evaluates its authenticity, pushing the generator to improve until the generated data closely resembles the real data. The LLMs can generate synthetic natural language text, code, etc. within seconds based on preexisting data. They use neural networks to identify patterns and trends. The commonest and the most popular one is ChatGPT (Chat Generative Pretrained Transformer), developed by

DOI
10.59779/jiomnepal.1344

Submitted
Nov 15, 2024

Accepted
Dec 11, 2024

OpenAI in November 2022. In just 5 days, ChatGPT surpassed one million users. It reached 57 million users within the first month and 100 million users in three months.[1] Although the exact parameters are not disclosed by the company, it is believed that they are trained on approximately 300 billion words with the capability to converse on a broad range of topics.[1] The current version (ChatGPT4) can process both text and images. The size of the existing data directly corresponds to a more humanlike generation of data. ChatGPT, for instance, is believed to employ 1.76 trillion parameters to facilitate nuanced conversations and comprehensive analysis.[1,2] As of DECEMBER 2024, ChatGPT has 200 million weekly active users worldwide.[1] BioGPT, an another generative AI model gives more specific information on the biomedical field as it is pre-trained on large-scale biomedical literature.[3] Advanced LLMs, including OpenAI GPT-4 Vision, Meta's ImageBind, and DeepMind's Gemini, process diverse inputs such as text, images, and audio. These models amplify the capabilities of AI in multimodal data interpretation and integration.

Generative AI models are transforming and revolutionizing fields like healthcare by offering innovative solutions in diagnostics, prognostication, treatment planning, and research, and medical education. This article examines the applications, benefits, and challenges of the use of generative AI in medical field and discusses guidelines for its ethical utilization in academic and clinical settings. As opposed to search engines like Google, LLMs are not 'search engines.' Responses are not retrieved from a database but synthesized word by word based on previous data

APPLICATIONS IN HEALTHCARE

Generative AI tools are already in use in healthcare. They are being used for aiding in drug discovery, enhancing medical imaging, creating personalized treatment plans, and assisting in patient communication through conversational AI. These tools enable the detection of signs, patterns, diseases, anomalies, and risks and are applied extensively in medical diagnostics, treatment planning, and patient care.[4] They lower the costs of treatment as the number of tests required and humans to do the work is substantially reduced. Generative AI aids in detecting anomalies, diagnosing diseases, and personalizing treatment plans by leveraging advanced algorithms to process and analyze medical data. For example, in radiology, AI models can generate synthetic medical images to improve training datasets, enhancing the accuracy of detecting anomalies such as tumors in MRI or CT scans.[5] In pathology, tools like PathAI utilize generative models to identify subtle patterns in tissue samples, aiding in early cancer detection.[6] Moreover, generative AI can analyze patient-specific data, such as genetic profiles and medical history, to create personalized treatment plans, as seen in applications like DeepMind's AlphaFold2, which predicts protein structures for tailored drug discovery.[7] Generative AI significantly enhances document processing and billing in hospital settings by automating repetitive tasks and improving accuracy. For example, AI tools can streamline medical coding by efficiently assigning ICD codes to patient charts, reducing errors, and speeding up workflows. These systems also help validate insurance claims, detect fraud, and predict payment patterns, enabling smoother and faster revenue cycle management. Additionally, natural language processing (NLP) capabilities assist in extracting and organizing unstructured data, such as patient conversations and handwritten notes, into structured formats, facilitating compliance and billing operations.[8] In addition, they can be used in public health by supporting individuals and communities to make informed decisions regarding their lifestyle and health.[9]

APPLICATIONS IN MEDICAL EDUCATION

Generative AI has potential applications in medical education.[10,11,11,12] Generative AI is increasingly being integrated into medical education to enhance learning experiences, streamline instruction, and support personalized development. Applications include:

1. Personalized Learning: AI systems analyze students' learning histories to recommend tailored educational resources, such as study guides, self-assessment questions, and flashcards.[11,13]
2. Simulated Training: AI enables virtual simulations for diagnosing and treating patients, including virtual patient interviews and surgical practices. These tools allow students to practice clinical skills, such as empathy and diagnostic reasoning, in a risk-free environment.[11,13]
3. Automated Assessment and Feedback: AI assists in grading assignments and analyzing performance data, freeing educators to focus on curriculum development and mentoring. It also provides insights into student progress, enabling targeted interventions to improve understanding and performance. [11,13,14]
4. Remote and Flexible Learning: AI-powered platforms offer virtual labs, case studies, and surgical simulations accessible remotely, ensuring continuity of education during disruptions like pandemics. Technologies like augmented reality (AR) further enhance these experiences.[15]

Generative AI not only improves access and efficiency in medical education but also provides

continuous learning and adaptation. However, there is a need to train medical educators to develop new skills and competencies related to AI.

APPLICATIONS IN MEDICAL RESEARCH

The application of Generative AI especially LLMs has a huge potential in medical research. The following are the general applications:[16,17]

- Generation of novel hypotheses by combining concepts just like humans. Generative AI systems, such as DeepMind's AlphaFold analyze biological data and propose unconventional uses for existing drugs by combining known molecular interactions with newly identified protein structures. For instance, AI has suggested new therapeutic roles for drugs initially developed for one condition, like re-purposing anti-viral drugs for cancer therapy.[14,18] Similarly AI-generated models propose innovative ways to enhance the effectiveness of immunotherapy by predicting unique biomarkers that could be targeted for specific cancer types.[12]
- Reviewing research papers and proposing unexplored directions worth investigating
- Data simulation by GAN models enabling research in scenarios where real-world data is scarce or sensitive
- Helping find the right journal based on the content of your manuscript.
- Acceleration of medical discoveries. For example, GAN models can generate novel drug-like molecules with desired properties, shortening the time needed to identify viable candidates. [16] AI models simulate the interaction of compounds with biological targets, reducing the need for expensive and time-intensive lab experiments (high-throughput screening).
- Smooth execution of research projects by acting as a research assistant. These tools facilitate hypothesis generation, literature review, critical appraisal, and grant writing.
- AI-augmented writing helps create a polished manuscript increasing its readability. However, it often lacks the 'human touch' such as research details, and personal input from authors.[17,19,20]

ETHICAL AND PRACTICAL CHALLENGES

Although the use of generative AI is quite recent, some risks and challenges have already surfaced.[4,16,20,20]

Privacy and Security

Generative AI models are trained on large datasets that often include sensitive patient information. This creates vulnerabilities to data breaches and misuse. For example, there have been incidents where sensitive data inadvertently exposed during AI training sessions led to potential violations of privacy laws. Additionally, unauthorized access to medical imaging datasets used in AI training has raised concerns about data security and compliance with regulations.[21]

Accuracy and Reliability

While AI generates content with remarkable fluency, its outputs can sometimes be inaccurate or biased. Human oversight remains critical in high-stakes domains such as healthcare.[22]

Misuse in Academia

Generative AI has a potential for misuse in academia. Students and researchers may use these tools to produce entire essays, research papers, or assignments, passing them off as their original work. This not only breaches academic honesty policies but also affects genuine learning and skill development. Misuse also extends to fabricating data or generating non-existent sources.[23,24] (academic tech solutions, misuse). Also using AI to reproduce or mimic the intellectual property of others is increasingly problematic.[24]

Over-reliance on AI for academic tasks (e.g., generating ideas, summarizing, or structuring assignments) can inhibit critical thinking and writing skills, making students less prepared for future challenges.

The potential misuse of AI-generated content in research papers, coupled with a lack of transparency regarding its application, raises concerns about authorship and originality.[19,20,25]

Guidelines for Responsible Use

Currently, there is no clear consensus on the standards for using LLMs such as ChatGPT in academic medicine to generate text or images. However, some guidelines are proposed and are widely used based on a scoping review by Kim et al (2023) and the recommendation by the International Committee of Medical Journal Editors (ICMJE): [26,27]

- ChatGPT/LLM should not be cited as an author
- Author(s) should have at least a basic understanding of what a LLM is before they use these tools
- LLMs should not be used to produce the entire text
- The contents should be verified by humans
- LLMs may be used for editing and refining text
- Any use of ChatGPT/LLM should be transparent and duly acknowledged at the end of the manuscript
- The authors should take legal responsibility for the generated contents

Confusion among Peer Reviewers

Generative AI use in research writing is indisputably growing fast and cannot be stopped. However, there is still confusion regarding how the reviewers should act especially how they recognize or interpret AI-augmented/generated manuscripts.[19] There is a clear need for reviewer guidelines that promote impartial evaluations of submissions based on the quality of the research, regardless of any personal biases towards LLMs. Also, whether a reviewer can use the LLMS to review a manuscript is another area that needs further discussion and clarification.[28] AI can handle time-consuming tasks such as checking formatting, grammar, and reference consistency. It can also match manuscripts with appropriate reviewers based on topic and expertise, helping to streamline the process There are currently six AI tools to assist the reviewers for manuscript evaluation.[29,30] Journal Article Peer Review Assistant (JAPRA) is one such model which is free to use. Most of them are user-friendly and help in summarizing the manuscript and identifying key areas of improvement including ethical issues, biases, etc. However, AI struggles with the more complex aspects of peer review, such as evaluating the novelty and significance of research.[30]

CONCLUSION

Generative AI represents a paradigm shift in patient care, medical education, and research offering tools that enhance efficiency, innovation, and accessibility. However, the ethical and practical challenges necessitate a balanced approach, with robust regulations and human oversight to mitigate risks. Continued discussions among stakeholders is essential to fully realize the potential of generative AI in medicine and its responsible use in academia and research.

ACKNOWLEDGEMENT

The contributions of ChatGPT to this study are acknowledged while adhering to transparency guidelines.

FINANCIAL SUPPORT

The author(s) did not receive any financial support for the research and/or publication of this article.

CONFLICT OF INTEREST

The author(s) declare that they do not have any conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

1. ChatGPT Statistics 2024: How Many People Use ChatGPT? Backlinko. June 4, 2024. Accessed August 10, 2024. https://backlinko.com/chatgpt-stats
2. The Future of ChatGPT: Predictions and Opportunities. AIContentfy. March 5, 2023. Accessed October 28, 2024. https://aicontentfy.com/en/blog/future-of-chatgpt-predictions-and-opportunities-1
3. Luo R, Sun L, Xia Y, et al. BioGPT: generative pre-trained transformer for biomedical text generation and mining. Brief Bioinform. 2022;23(6):bbac409. doi:10.1093/bib/bbac409
4. Tan S, Xin X, Wu D. ChatGPT in medicine: prospects and challenges: a review article. Int J Surg Lond Engl. 2024;110(6):3701-3706. doi:10.1097/JS9.0000000000001312
5. Zhong Z, Xie X. Clinical applications of generative artificial intelligence in radiology: image translation, synthesis, and text generation. BJRArtificial Intell. 2024;1(1):ubae012. doi:10.1093/bjrai/ubae012
6. Waqas A, Bui MM, Glassy EF, et al. Revolutionizing Digital Pathology With the Power of Generative Artificial Intelligence and Foundation Models. Lab Invest. 2023;103(11):100255. doi:10.1016/j.labinv.2023.100255
7. Yang Z, Zeng X, Zhao Y, Chen R. AlphaFold2 and its applications in the fields of biology and medicine. Signal Transduct Target Ther. 2023;8(1):1-14. doi:10.1038/s41392-023-01381-z
8. Reddy S. Generative AI in healthcare: an implementation science informed translational path on application, integration and governance. Implement Sci. 2024;19(1):27. doi:10.1186/s13012-024-01357-9
9. Biswas SS. Role of Chat GPT in Public Health. Ann Biomed Eng. 2023;51(5):868-869. doi:10.1007/s10439-023-03172-7
10. Preiksaitis C, Rose C. Opportunities, Challenges, and Future Directions of Generative Artificial Intelligence in Medical Education: Scoping Review. JMIR Med Educ. 2023;9:e48785. doi:10.2196/48785
11. Hale J, Alexander S, Wright ST, Gilliland K. Generative AI in Undergraduate Medical Education: A Rapid Review. J Med Educ Curric Dev. 2024;11:23821205241266697. doi:10.1177/23821205241266697
12. Alowais SA, Alghamdi SS, Alsuhebany N, et al. Revolutionizing healthcare: the role of artificial intelligence in clinical practice. BMC Med Educ. 2023;23(1):689. doi:10.1186/s12909-023-04698-z
13. Sridharan K, Sequeira RP. Artificial intelligence and medical education: application in classroom instruction and student assessment using a pharmacology & therapeutics case study. BMC Med Educ. 2024;24(1):431. doi:10.1186/s12909-024-05365-7
14. ChatGPT in medical education: Generative AI and the future of artificial intelligence in health care | AMA Update Video | AMA. Accessed October 12, 2024. https://www.ama-assn.org/practice-management/digital/chatgpt-medical-education-generative-ai-and-future-artificial
15. Artificial Intelligence & Online Education: AI Innovations in Online Learning. Accessed October 22, 2024. https://www.onlineeducation.com/features/ai-in-distance-learning
16. Ruksakulpiwat S, Kumar A, Ajibade A. Using ChatGPT in Medical Research: Current Status and Future Directions. J Multidiscip Healthc. 2023;16:1513-1520. doi:10.2147/

JMDH.S413470

17. Mu Y, He D. The Potential Applications and Challenges of ChatGPT in the Medical Field. Int J Gen Med. 2024;17:817-826. doi:10.2147/IJGM.S456659
18. Hecht L, Buhse S, Meyer G. Effectiveness of training in evidence-based medicine skills for healthcare professionals: a systematic review. BMC Med Educ. 2016;16:103. doi:10.1186/s12909-016-0616-2
19. Hadan H, Wang DM, Mogavi RH, Tu J, Zhang-Kennedy L, Nacke LE. The great AI witch hunt: Reviewers' perception and (Mis)conception of generative AI in research writing. Comput Hum Behav Artif Hum. 2024;2(2):100095. doi:10.1016/j.chbah.2024.100095
20. Guleria A, Krishan K, Sharma V, Kanchan T. ChatGPT: ethical concerns and challenges in academics and research. J Infect Dev Ctries. 2023;17(9):1292-1299. doi:10.3855/jidc.18738
21. Murdoch B. Privacy and artificial intelligence: challenges for protecting health information in a new era. BMC Med Ethics. 2021;22(1):122. doi:10.1186/s12910-021-00687-3
22. Johnson D, Goodman R, Patrinely J, et al. Assessing the Accuracy and Reliability of AI-Generated Medical Responses: An Evaluation of the Chat-GPT Model. Res Sq. Published online February 28, 2023:rs.3.rs-2566942. doi:10.21203/rs.3.rs-2566942/v1
23. The University of Chicago. Combating Academic Dishonesty, Part 6: ChatGPT, AI, and Academic Integrity | Academic Technology Solutions. Accessed October 12, 2024. https://academictech.uchicago.edu/2023/01/23/combating-academic-dishonesty-part-6-chatgpt-ai-and-academic-integrity/
24. Generative AI Misuse: A Taxonomy of Tactics and Insights from Real-World Data. ar5iv. Accessed October 12, 2024. https://ar5iv.labs.arxiv.org/html/2406.13843
25. Májovský M, Černý M, Kasal M, Komarc M, Netuka D. Artificial Intelligence Can Generate Fraudulent but Authentic-Looking Scientific Medical Articles: Pandora's Box Has Been Opened. J Med Internet Res. 2023;25:e46924. doi:10.2196/46924
26. Kim JK, Chua M, Rickard M, Lorenzo A. ChatGPT and large language model (LLM) chatbots: The current state of acceptability and a proposal for guidelines on utilization in academic medicine. J Pediatr Urol. 2023;19(5):598-604. doi:10.1016/j.jpurol.2023.05.018
27. ICMJE | Recommendations | Defining the Role of Authors and Contributors. Accessed September 28, 2024. https://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html
28. Biswas S, Dobaria D, Cohen HL. ChatGPT and the Future of Journal Reviews: A Feasibility Study. Yale J Biol Med. 2023;96(3):415-420. doi:10.59249/SKDH9286
29. Nair A. 6 Assisted AI Tools for Peer Reviewers. Enago Academy. September 24, 2024. Accessed October 12, 2024. https://www.enago.com/academy/6-ai-tools-peer-review-process/
30. Fiorillo L, Mehta V. Accelerating editorial processes in scientific journals: Leveraging AI for rapid manuscript review. Oral Oncol Rep. 2024;10:100511. doi:10.1016/j.oor.2024.100511