APPLICATION AND IMPACT OF ARTIFICIAL INTELLIGENCE IN MEDICAL CARE: A SYSTEMATIC REVIEW OF THE LITERATURE

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ABSTRACT

Until recently, the application of artificial intelligence (AI) in healthcare was a source of much speculation but little action. Defining AI as "a set of technologies that allow machines and computers to simulate human intelligence," clinical researchers often compare AI to human performance as a means of validation. The present study aims to analyze the application and impact of artificial intelligence in medical care. This systematic review was used to evaluate the applications and impacts of artificial intelligence in medical care. The

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guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA) were followed. In addition, the PubMed, ACM Digital Library, IEEE Xplore, Web of Sciene, and ScienceDirect databases were used for literature review. The literature review revealed 7,415 articles in total. Of these, 11 articles were selected, 5 (45.46%) investigated the impact of AI in medicine, and 6 publications (54.54%) evaluated AI education in medicine. The current application of AI in medical education is focused on clinical specialized training and continuing education, with the main areas of application being radiology, diagnostics, surgery, cardiology, and dentistry. The primary role is to help doctors improve their efficiency and accuracy. The potential benefits of AI for diagnosis, treatment, and drug discovery generate optimism and hope for new knowledge and improved patient outcomes.

Keywords: Artificial Intelligence. Medical education. Teaching. Machine learning.

INTRODUCTION

Until recently, the application of artificial intelligence (AI) in healthcare was a source of much speculation but little action. Defining AI as "a set of technologies that allow machines and computers to simulate human intelligence," clinical researchers often compare AI to human performance as a means of validation. AI is improving rapidly, and its application in the field of medicine is increasing. It is becoming increasingly popular in many medical fields; including ophthalmology, dermatology, and pathology (Al Saad *et al.*, 2022; Ru *et al.*, 2023).

Machine learning (ML) is a division of AI that is involved in teaching machines to classify different medical diseases based on images, sounds, or any data source. AM can also help with diagnosis, finding treatment options, smart health records, and many other applications. AI and ML would play an essential role in improving medicine in the future and support the future needs of medicine by analyzing the enormous amounts and diverse forms of data that patients and healthcare institutions record at any given time (Egert *et al.*, 2020; Ostherr, 2022).

So AI could change more than the way medicine is practiced; it could change the way medicine is taught. Specifically, AI chatbots, such as OpenAI's ChatGPT, have the potential to improve medical education. Equipped with fast efficiency and memory, remarkable accuracy, and a personal interactive style, ChatGPT can perform complex tasks. ChatGPT has already entered the field of medical education, having passed selected and publicly available versions of the questions in Step 1, Step 2 of Clinical Knowledge, and Step 3 of the United States Medical Licensing Examination (USMLE) at the beginning of the year 2023. Its applications in medical education are just beginning to be discovered with emerging research and increased use by medical students; in addition to having the potential to improve patient care and streamline healthcare processes (Sherr *et al.*, 2023).

However, without proper oversight and regulation, the integration of large language models into the healthcare system could introduce a range of risks and unintended consequences. It is essential to explore these potential risks and address them effectively to ensure that AI serves as a beneficial aid in the medical field. One of the main concerns regarding AGI in healthcare is the risk of providing inaccurate medical advice. Since AI-generated content is based on large amounts of data from the internet, there is a possibility that the information provided may be misleading or outright incorrect. For example, ChatGPT may offer treatment suggestions that are outdated or inappropriate for a patient's specific condition. Such inaccuracies can cause patients to receive inadequate treatment or even aggravate their health problems (Liu *et al.*, 2023).

The objective of this research is to analyze the application and impact of artificial intelligence in medical care.

METHODOLOGY

STUDY DESIGN

Systematic review (SR) based on the flowchart of the "Preferred Reporting Items for Systematic Reviews and Meta-Analyses" (PRISMA), comprising experimental or quasi-experimental primary quantitative articles. Interventions in randomized controlled trials were evaluated according to efficacy.

INCLUSION AND EXCLUSION CRITERIA

Research articles, peer-reviewed, review articles, case reports, with open access or full text, written in English, between 2019 and 2024. A total of 7,415 articles were searched from June 2024 to July 2024, through the National Center for Biotechnology Information (NCBI/PUBMED), ACM Digital Library, IEEE Xplore, Web of Sciene, and ScienceDirect databases, as shown in Table 1. The articles include information of great importance about the applications and impacts of artificial intelligence in medical care.

Table 1. Bibliographic sources and keywords.

RESEARCH QUERY AND LITERATURE SOURCES ("Medical Education" OR "Medical Training") AND ("Artificial Intelligence" OR "Teaching" OR "Deep Learning")	**SEARCH ON**	**SEARCH RESULT**
PUBMED	Full text, English, between 2019 and 2024, research article, essays, review articles, case report	1.194
ACM Digital Library	English, between 2019 and 2024, essays	34
IEEE Xplore	Open access, English, between 2019 and 2024,	30
Web of Science	Open access, English, from 2019 to 2024, research article, review articles, case report	3.266
ScienceDirect	Full text, English, between 2019 and 2024, research article, review articles, case report	2.891

TOTAL		7.415

Source: Prepared by the authors

Articles that did not answer the guiding question of this research were excluded, as well as studies with incomplete abstracts or that do not have well-defined methods and conclusions, which did not present a well-defined guiding question of the research, as well as duplicate articles, not available in full, dissertations or theses, book chapters, news and expanded abstracts published before 2019 in languages other than English.

STUDY PROTOCOL

The PICO strategy (P – population; I – intervention; C – comparison; The – outcomes) guided the elaboration of the SR guiding question and served as a basis for the development of search strategies using the descriptors of Medical Subject Headings (MeSH) and with the Boolean operators AND and OR, as shown in Chart 1. Thus, the research question was: What are the applications and impacts of artificial intelligence in medical care? For this study, the PICO strategy was used, formulated as follows:

Table 1. Stratification of the research problem following PICO strategy for research formulation.

Component	Definition	Descriptors	Keywords
P: Population of Interest	Medical professionals	Medical Education OR Medical Training	Medical Education, Medical Training
I: intervention	How Artificial Intelligence Affects Care	Artificial Intelligence OR Teaching OR Deep Learning	Artificial Intelligence, Teaching, Deep Learning
C: Comparison	Conventional clinical care	-	-
O: result/outcome	identify the impact of AI on healthcare	-	-

Source: Prepared by the authors.

In it, the first element of the strategy (P) Medical professionals; the second element (I) How artificial intelligence affects care C) Conventional clinical care (O) Identify the impact of AI on medical care. The searches were performed using the following search strategy: ("Medical Education" OR "Medical Training") AND ("Artificial Intelligence" OR "Teaching" OR "Deep Learning").

SELECTION OF ARTICLES

The "StArt" Systematic Review Manager was used for the purpose of deleting duplicate articles in an automated manner. Soon after, the analysis of the titles was carried out, followed by the reading of the abstracts to identify which would be evaluated completely, independently (blinded) by two evaluators, in case of disagreements a third evaluator was necessary for final consensus. The final necessary data were extracted using an instrument with identification data (authors and year).

ASSESSMENT OF METHODOLOGICAL QUALITY AND RISK OF BIAS OF STUDIES

To assess the methodological quality of the studies, the Critical Appraisal Skills Programme (CASP) instrument was used.This tool makes it possible to judge the methodological quality, through the classification of the information present in each study through scores. Each item in the table represents one point, and the final sum ranges from 0 to 10 points. The scores were defined as follows: sum of 6 - 10 points good methodological quality and reduced bias and 0 - 5 points satisfactory methodological quality AND increased potential bias. Two researchers independently evaluated each article according to quality criteria, conflicts of interest surrounding the evaluation were resolved through discussions. Below are the quality criteria used.

Table 2. Quality criteria used.

Critical Appraisal Skills Programme (CASP)
1) Is the objective clear and justified?
2) Is there adequacy of the methodological design?
3) Are the theoretical-methodological procedures presented and discussed?
4) Was the study sample appropriately selected?
5) Is the data collection detailed?
6) Was the relationship between researcher and researched considered?
7) Were the ethical aspects of a research respected?
8) Is the data analysis rigorous and reasoned? Do you specify the statistical tests?
9) Are results presented and discussed properly?
10) What is the value of the research?

Fonte: CASP UK, 2024.

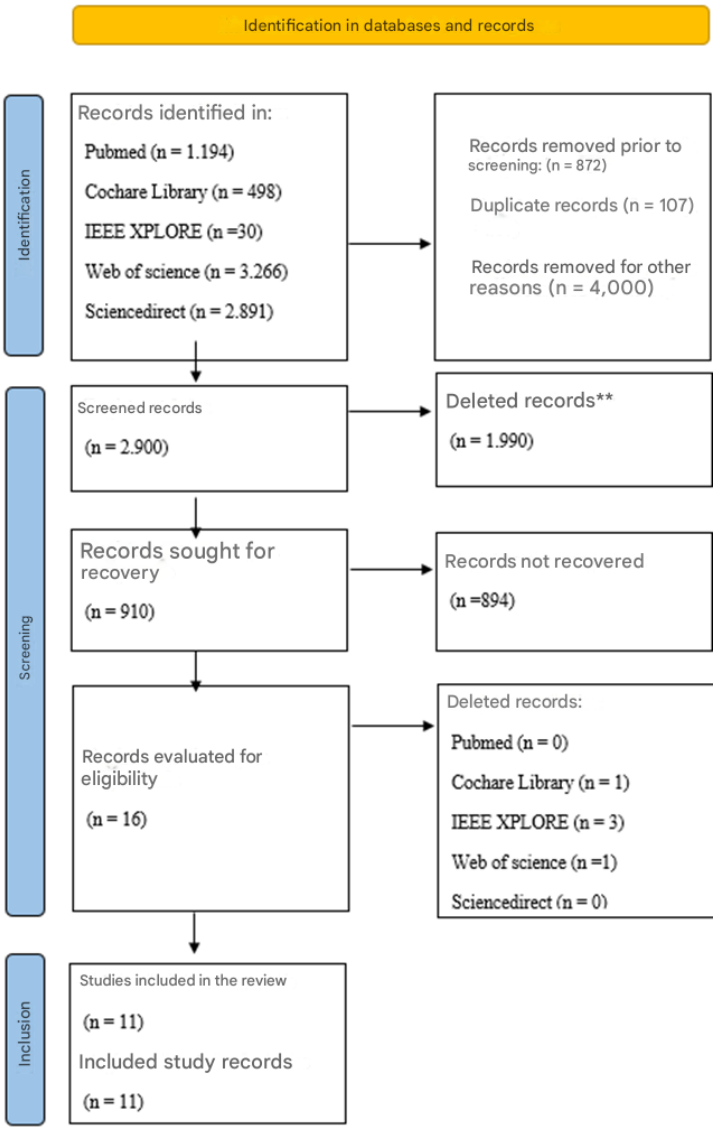
ANALYSIS OF THE RESULTS

The extraction of data from the chosen studies occurred independently by two researchers. The researchers performed a complete reading of the selected articles to extract relevant information that would help them synthesize and characterize the studies. The data from the studies included in this SR were analyzed and presented descriptively in a table (Chart 3) containing the identification of the study (authors and year), type of study, population, objectives, results, and quality evaluation score of the articles.

RESULTS AND DISCUSSIONS

The diagram of the selection process is shown in Figure 1. The literature review revealed 7,415 articles in total. After the first analysis, 872 articles were excluded before screening, 107 duplicate articles, and 4,000 for other reasons (insufficient data, inconsistency with the theme). Of the 2,436 related studies, 16 were listed as potentially relevant, keeping the focus on the object of this research. Of these, 5 were excluded in the second phase and 11 were selected for the study. Of 11 selected articles, 5 (45.46%) investigated the impact of AI on medicine and 6 publications (54.54%) evaluated AI education in medicine.

Figure 1 - Flowchart for selecting studies in the PRISMA 2020 format, developing RCT selection phrases from this systematic review.



Source: Prepared by the authors.

Chart 3 describes the distribution of articles used according to author/year, title, theme, objective, results, and quality evaluation grade.

Chart 3 - Distribution of articles according to author/year, title, theme, objective, results and grade for quality evaluation.

AUTHOR/YEAR	TITLE	THEME	OBJECTIVE	RESULTS	GRADE FOR QUALITY EVALUATION
Scherr *et al.*, 2023	*ChatGPT Interactive Medical Simulations for Early Clinical Education: Case Study*	Medical education	This paper models ChatGPT 3.5's ability to perform interactive clinical simulations and shows the benefits of this tool for medical education.	Two initial prompts were chosen. Prompt 1 was developed through 3 test simulations and successfully used in 2 simulations. Prompt 2 was developed through 10 additional test simulations and successfully used in 1 simulation.	10
Hu *et al.*, 2023	*An Artificial Intelligence Training Workshop for Diagnostic Radiology Residents*	Artificial intelligence in medicine	Develop, implement, and evaluate feedback for an artificial intelligence (AI) workshop for radiology residents that was designed as a condensed introduction of AI fundamentals suitable for integration into an existing residency curriculum.	Twelve residents participated in the workshop, with 11 completing the survey. An average score of 4.0 ± 0.7 (SD), indicating agreement, was observed when asking residents whether the workshop improved AI knowledge. Confidence in understanding AI concepts increased after the workshop to 16 out of 18 (89%) comprehension questions (P-value range : 0.001 to 0.04 for questions with higher confidence).	10
Ostherr *et al.*, 2022	*Artificial Intelligence and Medical Humanities*	Medical education	This article explains four main areas of concern related to AI and the role that medical/health humanities research can play in addressing it:	The potential benefits of AI for diagnosis, treatment, and drug discovery generate optimism and hope for new insights and better patient outcomes. The	9

			definition and regulation of "medical" versus "health" data and applications; social determinants of health; narrative medicine; and technological mediation of care	potential harms of algorithmic bias and further dehumanization of healthcare prompt calls for transparency and accountability in how these systems are deployed.	
Egert *et al.*, 2020	*Machine Learning and Artificial Intelligence in Surgical Fields*	Artificial intelligence in medicine	Explore how artificial intelligence is being used to assess and improve surgical skills, diagnose various surgical pathologies using images and tissue specimens, and how surgeons can utilize these technologies in the field of telemedicine to improve access to care and resources.	Machine learning and artificial intelligence are rapidly being incorporated into multiple aspects of medicine related to surgical fields. This technology can benefit surgeons in assessing surgical skills, as well as teaching trainees the best methods during the operation, especially during robotic procedures.	9
Saad *et al.*, 2022	*Medical Students' Knowledge and Attitude Towards Artificial Intelligence: An Online Survey*	Medical education	To investigate the attitudes of Jordanian medical students towards Artificial Intelligence (AI) and Machine Learning (ML). Also, estimate the level of knowledge and understanding of the effects of AI on medical students.	89% of students believed in the importance of AI in the medical field, and 71.4% believed in the benefit of teaching AI in a medical career. 47% of students had an understanding of the basic principles of AI, 68.4% of students believed that it is mandatory for medical students to receive knowledge of AI. Statistically, students who received AI teaching/training were more likely to consider radiology as a career given the	10

				advancement in AI.	
Liu *et al.*, 2023	*Surviving ChatGPT in healthcare*	Artificial intelligence in medicine	Provide a comprehensive yet succinct summary of this subject to stimulate broader discussion and insights into the future of medicine in the age of Artificial General Intelligence (AGI).	By recognizing and mitigating these challenges, AGI can be leveraged to enhance patient care, medical knowledge, and healthcare processes, ultimately benefiting society as a whole.	9
Von Ende *et al.*, 2023	*Artificial Intelligence, Augmented Reality, and Virtual Reality Advances and Applications in Interventional Radiology*	Artificial intelligence in medicine	Describe the current and possible future applications of artificial intelligence, radiogenomics, and augmented and virtual reality in interventional radiology, while describing the challenges and limitations that must be addressed before these applications can be fully implemented in common clinical practice.	Integrating these techniques would not only benefit procedure planning and performance, as well as treatment follow-up, but is also poised to improve the patient experience, decrease radiation exposure for both the patient and operators, and potentially decrease hospital costs and adverse events. The benefits of AI in IR are far-reaching and can help at an individual patient level, improving the scheduling and effectiveness of minimally invasive procedures, but also at an international level, optimizing global radiology education.	10
Hamilton *et al.*, 2024	*Artificial Intelligence and Healthcare Simulation: The Shifting*	Medical education	Deepen the current impact of AI on healthcare-related training	Artificial intelligence will not put trained doctors out of business, but it will change the	9

	Landscape of Medical Education.		and education (HCS).	way they do business. Trained doctors are here to stay, but not necessarily in the current numbers in all specialties. Some will be more pressured by AI than others and, in this sense, AI may start to affect the career choices that our students and trainees will make in the coming years. Artificial intelligence will continue to be a disruptive agent in health education.	
Ali *et al.*, 2023	*A systematic literature review of artificial intelligence in the healthcare sector: Benefits, challenges, methodologies, and functionalities*	Artificial intelligence in medicine	Describe the application of AI in healthcare.	It has been identified that AI continues to significantly outperform humans in terms of accuracy, efficiency, and timely execution of related medical and administrative processes. The benefits for patients are mapped directly into the relevant AI functionalities in the categories of diagnosis, treatment, consultation, and health monitoring for self-management of chronic conditions.	10
Shoja *et al.*, 2023	*The Emerging Role of Generative Artificial Intelligence in Medical Education, Research, and Practice*	Artificial intelligence in medicine	It examines current trends in the use of GAI models in medicine, outlining their strengths and limitations.	Medical education seems to focus on the role of GAI models in assessments and essay writing, as well as their	10

				interaction with students in the classroom and with assignments. Other applications, such as automatic scoring of student essays, creating content for quizzes, and assisting in facilitating learning, should be explored. More consensus-based guidelines are needed to govern the appropriate use of GAI, not only in medical education, but also in research, scholarship, and clinical practice.	
Leng, 2024	*Challenge, integration, and change: ChatGPT and future anatomical education*	Artificial intelligence in medicine	Discuss the application of ChatGPT in anatomy teaching and its various levels of application based on our own teaching experiences, and discuss the advantages and disadvantages of ChatGPT in anatomy education.	ChatGPT increases student engagement and strengthens students' ability to learn independently. At the same time, ChatGPT faces many challenges and limitations in medical education. Medical educators must keep up with the rapid changes in technology, taking into account the impact of ChatGPT on curriculum design, assessment strategies, and teaching methods.	9

Source: Prepared by the authors.

Artificial intelligence plays a crucial role in enhancing training, planning, and treatment strategies in areas already well-established in healthcare simulation. AI enhances one-on-one training and bedside skills and decision-making with individual patients. In addition, they are also applied in the training of tasks or procedures. To the extent that practice with a task trainer generates familiarity and sufficient handling of the instruments imparts practical experience to the healthcare professional, simulation is commonly used to assess surgical or technical proficiency. Because healthcare simulation is intertwined with computer technology, it offers opportunities for rapid scalability with AI and will therefore be the most practical place to test new AI applications (Ostherr, 2020; Hamilton, 2024).

The maturation of AI technologies has changed the roles of physicians, and new decision-making processes in medical settings and innovative AI-based protocols have the potential to provide diagnostic and treatment decisions through the analysis of complex data sets. It also includes benefits for people that consist of automated decision-making; patient monitoring, especially monitoring of elderly patients; and simplification of processes. It also includes benefits to organizations consisting of workflow aid, performance improvement, cost reduction, and fraud detection. In addition to bringing benefits to the sector that consist of saving time, reducing resource consumption, and providing professional training, data sharing, and availability (Sapci & Sapci, 2020; Ali *et al.*, 2023).

The current application of AI in medical education is focused on clinical specialized training and continuing education, with the main areas of application being radiology, diagnostics, surgery, cardiology, and dentistry. The primary role is to help doctors improve their efficiency and accuracy. In addition, the field of combining AI with medicine/medical education is constantly expanding, and the most urgent need is for policymakers, experts in the medical field, AI and education, and experts in other fields to come together to reach consensus on ethical issues and develop regulatory standards (Sun *et al.*, 2023).

AI has the ability to further revolutionize healthcare, specifically for the field of interventional radiology (IR), not only to improve image processing, but also to guide and predict the outcomes of your minimally invasive procedures, through accurate diagnoses, personalized treatment plans, and real-time procedural support. In addition, while not a direct form of AI, similar fields such as augmented reality (AR) and virtual reality can improve physician education and training, improve patient understanding, and improve procedural guidance, as well as reduce procedural risks and complications (Ru *et al.*, 2023; Von Edde *et al.*, 2023).

ChatGPT is rapidly developing and has a profound impact on medical education. More and more studies are beginning to explore the possibility of applying ChatGPT in

medical education. The integration of ChatGPT with medical education is a continuous and gradual process, its emergence offers exciting new opportunities for educational innovation (Sherr, 2023; Leng, 2024).

One of the main concerns regarding AI in healthcare is the risk of providing inaccurate medical advice. Since AI-generated content (AIGC) is based on large amounts of data from the internet, there is a possibility that the information provided may be misleading or outright incorrect. For example, ChatGPT may offer treatment suggestions that are outdated or inappropriate for a patient's specific condition. Such inaccuracies can cause patients to receive inadequate treatment or even aggravate their health problems (Liu *et al.*, 2022; Leng, 2024).

In addition, there is the potential for the violation of patients' privacy, such data can be compromised, leading to unauthorized access, collection, and sharing of sensitive personal information. They also include challenges related to legal/privacy issues, which consist of privacy issues, legal issues, and government regulations. This risk highlights the importance of ensuring that AI technologies (such as: ChatGPT) meet stringent privacy standards before their widespread adoption in healthcare (All Saad *et al.*, 2022; Ali *et al.*, 2023).

Medical education must evolve because future doctors will encounter patients in health contexts that are quite different from the present. Ubiquitous and digitized healthcare systems allow doctors and patients to access biomedical information easily. The exponential expansion of medical knowledge requires physicians not to remember, but to update, what they know and select the right information from a surplus of options. Artificial intelligence will reduce the efforts needed by physicians to interpret digital data and improve their ability to establish a diagnosis and prognosis (Liu *et al.*, 2024).

Therefore, the non-analytical, humanistic aspect of medicine will be more emphasized because it is difficult to replace it with technology. Moreover, advanced medical technology leads doctors to encounter an increasing number of elderly and latent patients with chronic conditions and comorbidities due to their extended life. Globalization has led physicians to face unknown disease profiles or contexts that were not common in regional communities. Future medical education must be restructured to align with these inexorable changes, considering students who will work in digitized health systems (Hah *et al.*, 2019).

CONCLUSION

The potential benefits of AI for diagnosis, treatment, and drug discovery generate optimism and hope for new insights and better outcomes for professionals and patients. It

should be noted that AI also plays an important role in the training of medical professionals by allowing a more autonomous, independent and targeted study, so it is essential that strict criteria are established for adequate filtering of the information obtained through these technologies and whether they come from totally reliable and evidence-based scientific sources. In view of the above, more studies are needed on the subject, for a better understanding of the use of AI and to determine the feasibility, effectiveness and cost of the use of AI, since it is an emerging topic with wide and rapid dissemination of its use even in the face of opportunities for improvement and maturation that allow ensuring the rationality and sustainability of its implementation.

REFERENCES

1. Ali, S., Abdelbaki, W., Shrestha, A., Elbasi, E., Alryalat, M. A. A., & Dwivedi, Y. K. (2023). A systematic literature review of artificial intelligence in the healthcare sector: Benefits, challenges, methodologies, and functionalities. Journal of Innovation & Knowledge, 8, 100354. https://doi.org/10.1016/j.jik.2023.100354 (accessed January 28, 2025).

2. All Saad, M. M., Shehadeh, A., Alenezi, S., Alenezi, M., & Alenezia, R. (2022). Medical students' knowledge and attitude towards artificial intelligence: An online survey. The Open Public Health Journal, 14, 70-79. https://doi.org/10.2174/18749445202214010070 (accessed January 28, 2025).

3. Egert, M., Steward, J. E., & Sundaram, C. P. (2020). Machine learning and artificial intelligence in surgical fields. Indian Journal of Surgical Oncology, 11(4), 573-577. https://doi.org/10.1007/s13193-020-00312-0 (accessed January 28, 2025).

4. Hamilton, A. (2024). Artificial intelligence and healthcare simulation: The shifting landscape of medical education. Cureus, 16(5), e25189. https://doi.org/10.7759/cureus.25189 (accessed January 28, 2025).

5. Hah, E. R., Yeo, S., Kim, M. J., Lee, Y. H., Park, K. H., & Roh, H. (2019). Medical education trends for future physicians in the era of advanced technology and artificial intelligence: An integrative review. BMC Medical Education, 19(1), 460. https://doi.org/10.1186/s12909-019-1866-7 (accessed January 28, 2025).

6. Hu, R., Rizwan, A., Hu, Z., Li, T., Chung, A. D., Kwan, K., & B. Y. M. (2023). An artificial intelligence training workshop for diagnostic radiology residents. Radiology Artificial Intelligence, 5(2), e230005. https://doi.org/10.1148/ryai.2023230005 (accessed January 28, 2025).

7. Leng, L. (2024). Challenge, integration, and change: ChatGPT and future anatomical education. Medical Education Online, 29(1), 2161273. https://doi.org/10.1080/10872981.2024.2161273 (accessed January 28, 2025).

8. Liu, P. R., Lu, L., Zhang, J. Y., Huo, T. T., Liu, S. X., & Ye, Z. W. (2022). Application of artificial intelligence in medicine: An overview. Current Medical Science, 41(6), 1105-1115. https://doi.org/10.1007/s11596-022-2583-7 (accessed January 28, 2025).

9. Liu, Z., Zhang, L., Wu, Z., Yu, X., Cao, C., Dai, H., Liu, N., Liu, J., Liu, W., Li, Q., Shen, D., Li, X., Zhu, D., & Liu, T. (2024). Surviving ChatGPT in healthcare. Frontiers in Radiology, 23(3), 1224682. https://doi.org/10.3389/fradi.2024.1224682 (accessed January 28, 2025).

10. Ostherr, K. (2022). Artificial intelligence and medical humanities. Journal of Medical Humanities, 43(2), 211-232. https://doi.org/10.1007/s10912-022-09739-4 (accessed January 28, 2025).

11. Scherr, R., Halaseh, F. F., Spina, A., Andali, S., & Rivera, R. (2023). ChatGPT simulations in medical education for early clinical education: A case study. JMIR Medical Education, 9, e49877. https://doi.org/10.2196/49877 (accessed January 28, 2025).

12. Shoja, M. M., Van de Ridder, J. M. M., & Rajput, V. (2023). The emerging role of generative artificial intelligence in medical education, research, and practice. Cureus, 15(6), e41734. https://doi.org/10.7759/cureus.41734 (accessed January 28, 2025).

13. Sun, L., Yin, C., Xu, Q., & Zhao, W. (2023). Artificial intelligence for healthcare and medical education: A systematic review. American Journal of Translational Research, 15(7), 4820-4828. https://www.ajtr.org/ (accessed January 28, 2025).

14. Von Ende, E., Ryan, S., Crain, M. A., & Makary, M. S. (2023). Artificial intelligence, augmented reality, and virtual reality advances and applications in interventional radiology. Diagnostics (Basel), 13(5), 892. https://doi.org/10.3390/diagnostics13050892 (accessed January 28, 2025).