A Review of Artificial Intelligence Application in Healthcare Sectors

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Abstract

Artificial Intelligence (AI) is no longer an experimental method for computation, but has become a game-changer in the present day medical field. In the past decade, machine learning (ML), deep learning (DL), and now large language models (LLMs) have found their way into most medical specialties, ranging from radiology and oncology to cardiology, neurology, and hepatology. A literature review was conducted to collate peer-reviewed research articles, published from 2020 to 2025, on the evolution, application fields, methodological trends, ethical issues, and unanswered questions about the use of AI in medicine. Using more than hundred primary studies and umbrella reviews, the review reveals that the primary data sources are diagnostic imaging, electronic health records (EHRs), and biomarker analytics, with the rapid growth of multimodal foundation models and agentic clinical workflows emerging in the landscape.

Keywords: *Artificial Intelligence, healthcare, healthcare system, literature review.*

Introduction

Base on the previous researches there are three main elements that make the applying of artificial intelligence in healthcare possible to achieve such as most of clinical data and information are digitized, the development of deep learning architectures, and the last is the availability of the massive biomedical datasets (Kitsios, et al., 2023; Ali, et al., 2023). In the last decade the rule based in expert systems were the first field of AI applications, therefore, it has seen a rapid development of data-driven models that can recognize patterns, predict outcomes and understand natural language (Bortolotto et al., 2025). Kitsios et al. noted that AI is "driving significant" change in the delivery of healthcare, and that it has improved diagnostic accuracy, operational efficiency and, ultimately, the quality of human existence (Kitsios, et al., 2023). The presentation is about pros and cons of the AI capabilities that people, doctors, companies and health-related entities can leverage. Furthermore, the social and ethical aspects of AI are discussed regarding its output in terms of value-added medical services in decision-making processes, privacy and security of patient information, and health monitoring (Kitsios, et al., 2023).

Recent syntheses have further highlighted that AI is not just restricted to academic prototypes, but is now being integrated into actual clinical practice in areas such as radiology, pathology, cardiology, and primary care (Pacurari et al., 2025). Based on Ali, et al., (2023) AI technologies, such as machine learning, IoT, algorithms, and robots, are used to track, identify, cure and gauge risks and benefits, especially in the healthcare segment. Therefore, there are three AI benefits are in healthcare sector. The benefits to individuals are primarily derived from their collected medical data that are often heterogeneous, complex and not normalized. AI provides a convenient solution to overcome this challenge, as it has great potential in generating automatic inferences with limited or no human intervention (Sarker, 2021). The companies leverage AI applications and IT tools on the organizations benefits to cut costs, identify fraud, enhance performance, and offer workflow assistance (Vuković, Dekpo-Adza & Matović, 2025). AI technologies as a whole bring benefits to the sector as well as the entire healthcare sector, including hospitals, insurance providers and government agencies. Because of IT's ability to gather, process, share and store the patient's information, AI can assist in professional training based on this data and applications such as this can save time and resources. But there are problems like privacy/legal problems, data integration problems and patient safety problems (Cacciamani et al., 2025).

There are different levels of computational methods that form the basis of modern medical AI. While classical machine learning is based on feature engineering and statistical inference, deep learning uses multilayer artificial neural networks to learn hierarchical representations directly from raw data, and foundation models, like LLMs and multimodal LLMs (MLLMs), have integrated text, image, and structured data into a single architecture (Bortolotto et al., 2025; Wang et al., 2025). In clinical use, explain ability, model validation and training rigor are now deemed requirements, and not optional enhancements (Pacurari et al., 2025). Likewise, Cacciamani et al. (2025) state that there is no standard reporting tool that has made cross-study comparison and reproducibility difficult (Cacciamani et al., 2025). The objectives of this review study are to identify the key milestones in the field of artificial intelligence in healthcare over the last decade. This research is a first step in order to understand the use of AI in healthcare sector. Therefore, there are more studies will be done in this area.

Literature Review

Literature search was performed on Scopus as the main source of literature which was also cross-referenced in PubMed, IEEE Xplore and Web of Science. The search window was January 2020 to November 2025, with Boolean combination of keywords: "artificial intelligence" AND "machine learning" OR "deep learning" OR "large language model" OR "healthcare" OR "medicine" OR "clinical". All articles were required to be published in English, and they were peer-reviewed. This review focuses on the literature synthesis, not methodological procedure, as it is more important to the user's preferences. The most dynamic area for possible AI use is radiology. The combined contribution of umbrella reviews, diagnostic imaging, EHR data, and laboratory biomarkers is about 70% of training data sources in medical AI, across these reviews. Recently, convolutional neural networks (CNNs) and vision transformers (VTs) have demonstrated their ability to perform at expert level for tasks like lesion detection and organ segmentation and disease classification (Ali, et al., 2025; Pacurari et al., 2025). Radiology stands to benefit especially well from AI, as radiology data comes in structured, intensive, and with labels (Ali, et al., 2025).

The second most important area of AI research is oncology, which is estimated to have 13.9% of the total number of systematic reviews across the entire field (Cacciamani et al., 2025). Bortolotto et al. report the use of AI for the design of nanocarriers, prediction of biodistribution, modelling drug response and the application of nanoparticles for imaging (Bortolotto et al., 2025). Radiomics models have been shown to stratify patients, predict adverse drug reactions, and tailor chemotherapy treatments (Bortolotto et al., et al., 2025; Pacurari et al., 2025). Artificial Intelligence algorithms are currently used to assist in the interpretation of the ECG, coronary calcium scoring, automated image segmentation, and estimation of noninvasive fractional flow reserve (FFR) (Zhong, et al., 2025; Bortolotto et al., 2025). These tools are changing the paradigm from rule-based decision support to continuous monitoring with sensors in cardiology. The development of multimodal AI models that combine MRI, PET, genomic, and behavioral information, have enhanced early detection and patient stratification in Alzheimer's and Parkinson's disease (Bortolotto et al., 2025; Christodoulou, et al., 2025; Jasodanand et al., 2025). These strategies are part of a larger shift in the learning paradigm from single-modality classifiers to integrated, patient-specific classifiers.

AI is utilized in hepatology for histopathological grading, for robotic assistance during surgery and for prioritizing patients on the transplant waiting list (Bortolotto et al., 2025). One area of particular concern is how AI might be used in transplant allocation, where fairness and explainability are important ethical issues. Therefore, it is important to know them before application them in clinical practice. LLMs and MLLMs have been a unique research direction since 2022 (Zhang, et al., 2024; Yin, et al., 2024). Wang et al. outline the shift from traditional NLP to transformer-based models that engage in clinical reasoning, summarization, and decision-making (Wang et al., et al., 2025). Their review of 90 studies identified three paradigms that have influenced their work: Prompt engineering, in-context learning for low-resource clinical adaptation. Retrieval-Augmented Generation (RAG): To anchor LLM outputs to trusted medical knowledge bases. Multi-agent (agentic) workflows of orchestrating LLMs as collaborating clinical assistants. However, there are inherent risks associated with LLMs in medicine such as hallucination, exacerbation of bias, and targeted misinformation attack, cautions (Omiye et al., 2024; Han et al., 2024). The subtle symptom patterns in primary care records can be picked up by ML methods that would not be discernible by manual reading, and these can help to identify cancer earlier (Jones et al., 2021). This is a departure from the hospital-centric approach of AI to a community level screening. 4.8 Explainable AI (XAI) in Healthcare Loh et al. do a review of XAI methods in health care over 10 years (2011–2022), revealing that explainability has turned from a niche research interest to a regulatory requirement (Loh, et al., 2022). The percentage of reviews with ethical concerns increased consistently from 2021 to 2024 where privacy, bias, and explainability were themes that frequently arose (Pacurari et al., 2025).

Table 1 AI in Healthcare

Trend	Description	Representative Sources
Multimodal integration	Fusion of imaging, genomics, and clinical text	(Bortolotto et al., 2025; Wang et al., 2025).
Explainability mandates	Shift from black-box to interpretable models	(Loh, et al., 2022; Cacciamani et al., 2025).
Generative AI adoption	LLMs and RAG-based clinical assistants	(Omiye, et al., 2024; Wang et al., 2025).
Ethical governance	Privacy, bias, and accountability frameworks	(Han et al., 2024; Pacurari et al., 2025; Poojari, 2026).
Real-world validation	Demand for prospective multicentre trials	(Sarker, 2021; Bortolotto et al., 2025; Cacciamani et al., 2025).
Federated learning	Federated learning approaches	(Poojari, 2026).
AI algorithmic	AI-driven	(Haider, et al., 2026).

Challenges and Limitations

According to Abdelwanis, et al., (2026), the AI researches in healthcare situations is limited. Publication bias could disturb the findings of each review study, “as studies demonstrating positive results are more likely to be published than those showing neutral or negative findings” (Olawade, et al., 2026). In the reviews that follow, four challenges emerge:

- Heterogeneity in data and standards for data acquisition protocols (Bortolotto et al., 2025).
- 2) Limited prospective multicentre validation, limiting generalizability (Bortolotto et al., 2025; Cacciamani et al., 2025).
- 3. Algorithmic bias and gaps in algorithmic fairness, especially across demographic sub-groups (Han et al., 2024; Cacciamani et al., 2025).
- 4. Lack of regulatory and reporting standards, with only 39.2% of reviews conducted with AI specific bias assessment tools (Cacciamani et al., 2025).

Vithanage et al., (2025) also note that adapting generative LLMs to unstructured EHR extraction is still challenging, context-sensitive, and requires significant computational resources, especially in specialized contexts like residential aged care (Vithanage, et al., 2025). Moreover, there are huge needs to do more researchers about AI in medical sector. In addition, according to Wang et al., (2025), there is a need for cooperation among AI researchers, clinicians, and policy makers in order to be sure that the framework that build is based on regulatory requirements and clinical standards. "Studies on the use of AI in the healthcare sector should adopt cross-theory approach covering the individual (patient and medical staff perspective), organizational (hospital & teams) and industry (healthcare sector) level units of analyses" (Ali, et al., 2025).

Discussion

The process of development of AI in medicine over the last five years has been improved very well. The researches have started with narrow, task-specific classifiers (2020-2022), followed by diagnostic AI systems based on deep learning (2022-2024), and progressed to now multimodal foundation models and agentic LLM ecosystems (2024-2026). It describes this convergence as "Human-AI-Human paradigm," which means that computational precision is not replacing the clinical expertise, but more like it connects with it (Pacurari et al., 2025). But as is the case in literature, it is clear that technological capability is not enough. In order to ensure safe, equitable deployment, there is a need for harmonised data standards, external validation of data and transparent governance (Han et al., 2024; Bortolotto et al., 2025; Bortolotto et al., 2025). Many studies have been illustrating the benefits and challenges artificial intelligence in medicine sector. The AI shows fast development and huge assistances in healthcare sector.

In last few years there is limited researchers about AI technologies and tools in healthcare systems. Specially in using Chatbot with doctors and patients. AI can improve the medical sector and increase the advantage of these technologies. Therefore, it is the key factor of sustainability, patient-centric and competitive developments (Kimar, A., & Kumar, 2026). The Moreover, the Federated Learning has the significant effect in order to enhance the AI performance and reservation the data privacy in the same time (Poojari, 2026). Therefore, it is important to considered about Federated learning in AI in healthcare sector. In AI tools, it is important that the doctors have to give an active supervision in order to reducing the bias in healthcare outcomes (Haider et al., 2026). Therefore, it is also important that the doctors follow up and give active direction with their patients when they use AI tools such as ChatGPT, in order to get answers of their questions.

Conclusion

Literature search was performed on Scopus as the main source of literature which was also cross-referenced in PubMed, IEEE Xplore and Web of Science. Artificial intelligence in medicine went from promising future support to reality between 2020 and 2025. Recently AI is possible to be applied in healthcare because most of clinical data and information are digitized, the development of deep learning, and availability of the massive biomedical datasets. The expert systems were the first that applied AI, therefore, it has seen a rapid development of data-driven models that can recognize patterns, predict outcomes and understand natural language. AI technologies, such as machine learning, IoT, algorithms, and robots, are used to track, identify, cure and gauge risks and benefits, especially in the healthcare segment. Therefore, there are three AI benefits are in healthcare sector such as the individuals, organizations and sector benefits. However, there are challenges such as privacy/legal, data integration and patient safety problems.

In the previous researches were using the AI in several systems such as AI in diagnostic imaging and radiology. Moreover, artificial intelligence in oncology, Nano medicine and cardiology. AI applied in neurology and neurodegenerative disease also with hepatology. Also Large Language Models and Generative AI in Clinical Practice. It is also use in Primary Care and Early Cancer Detection. Finally, explainable AI (XAI) in Healthcare. However, this research is illustrating and understanding the use of AI in healthcare sector. The next study will demonstration the uses the AI such as ChatGPT in Medical sector. Moreover, it will answer the patients questions and compare it with doctors' answers in order to show if it is useful to the patients to follow the AI's answers. Furthermore, another study will be done to compare the answers of patients question base on three AI models such as ChatGPT, DeepSeek and Gemini in order to understand which AI tool has the best answer among them.

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