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REVIEW

AI in the healthcare system: Current viewpoint developments

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Abstract

AI is increasingly fueling routine transformation in healthcare, computational pathology and diagnostics, but there are still challenges with its clinical integration. Artificial intelligence (AI) is simply mathematics, and to understand how it works, we must be good with our calculations. The major problem is how AI can be developed in such a manner without marginalizing the global population. AI needs to be reliable, as without trust it is impossible for it to drive adoption. In the next few years, many aspects of pharmaceutical manufacturing will be changed by AI through analysis of complex datasets, identification of subtle patterns, and precise predictions, leading to process optimization, quality assurance and operational efficiency. This review is focused on developments regarding current viewpoints on AI applications in healthcare, as well as the challenges, limitations, and concerns surrounding its use in replacing the human workforce.

Keywords: Artificial intelligence, national health programs, natural language processing, machine learning, deep learning

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Introduction

Artificial intelligence (AI) involves the use of digital technology to carry out tasks that usually require the intelligence of human beings [1]. Typical everyday examples are facial recognition and navigation systems [2]. Most AI systems consist of computer algorithms that examine extensive data, find common patterns, learn lessons from the data, and improve a function over time [3]. In today's world, one major type of AI is generative AI, like ChatGPT, which is associated with inclusivity, and new content are created in the form of text, images, and music based on learned patterns [4]. The second one is predictive AI, which can make accurate predictions and estimations about future events based on large amounts of historical data [5].

Most of the healthcare applications are predictive AI systems that utilize data carefully selected from hospitals and research trials [6]. These applications can facilitate the identification of people at high risk of developing certain conditions, diagnose diseases, and personalize treatments [7]. The use of AI in healthcare has the potential to benefit patients, professionals, as well as health and social care (Figure 1) [8].

Large quantities of complex information can be analyzed through AI. It could result in quicker, more accurate diagnoses to predict disease progression, support doctors in making treatment decisions, and help manage the demand for hospital beds [9]. However, the risks to privacy and distortions in decision-making are raising concerns about its use [10-12].

The rich source of data from the NHS in the UK is ideal for AI, but the major problem lies with the data's safety, transparency, and fairness [13-15]. In a world where the speed of technological advancement is outpacing the regulatory policies from bureaucracies, the overall benefit of AI is

Figure 1. AI healthcare (designed by macrovector / Freepik).

Table 1. Characteristic benefits and role of AI (partly modified from Lee & Yoon, 2021) [16].

Role of AI in Diagnosis	Benefits of AI in Healthcare	Challenges	AI in Practice
Enhanced accuracy	Data analysis	Integration	Telemedicine
Early detection	Imaging	Data privacy	Predictive modeling
Personalized medicine	Predictive analytics	Regulation	Diabetic foot ulcers
Efficiency	Clinical decision support	Cybersecurity for privacy and safety	Medication management
Research support	Predict readmission in hospitals	Loss of managerial control	Screening and early diagnosis
Drug discovery and vaccine development	Healthcare cost reduction	Potential ethical issues	Device therapy optimization

still called into question (Table 1) [16].

The claim that AI will transform medicine paves the way to doctorless screening, personalized prevention and enhanced productivity, which are some of the advantages outlined [8]. With the growing demand for the NHS, staff shortages, and a squeeze in healthcare budgets, is AI a solution to the prevailing situation [17,18]?

The future of AI could lead to the democratization and standardization of healthcare systems in achieving a quadruple goal through precision diagnostics, therapeutics, and medicine [8,19,20]. The demonstration of AI has been made in physical [21] and mental [22] health where drug discovery [23], virtual consultation [24], disease diagnosis [25], prognosis [25], medication management [26] as well as health monitoring [27] that have been accelerated.

In building an effective and credible augmented intelligence system in the healthcare sector, it is paramount to ensure that the essential elements do not replace human interactions [28]. The major processes involve design/development, evaluation/validation, diffusion/scale up, and the last but not the least being monitoring/maintenance.

According to a report commissioned by Google, the greater use of AI could provide 3.7M more GP appointments each week within 10 years. AI could revolutionize the sector and generate cost savings of £38BN a year by 2030 across the UK's public service, including the NHS [29].

Historical Journey of AI

AI has evolved over the years (Table 2) [9] since the first program by Christopher Strachey began in 1951 [30]. The term "artificial intelligence" was coined in 1956 by John McCarthy during the Dartmouth Conference [31]. The research involving AI, conducted during the 1980s and 1990s, delved into machine learning (ML) and neural networks [32], where IBM developed Deep Blue, which defeated the renowned world chess champion Garry Kasparov in 1997 [33].

AI first came into the limelight during the Second World War, and it took over 70 years for its development to reach the current level of advancement. Alan Turing, the mathematician who was developing an electro-mechanical computer known as the Bombe, broke the Enigma code, which was very difficult for humans to resolve back then [34]. The AI flowchart is shown in Figure 2.

Table 2. Historical stages of AI (modified from Alowais et al., 2023) [9].

Year	Stage
1942	Enigma broken with AI
1950	Alan Turing's test for machine intelligence
1955	John McArthy, the father of AI
1964	First chatbot Eliza
1995	Chatbot Alice
1997	Man vs. machine (Deep Blue beats chess legend)
1998	Emotionally equipped robot Kismet
2008	Voice recognized feature
2011	QA computer system IBM Watson
2020	GPT models in automated conversations
2025	DeepSeek for solving mathematical and scientific issues

In today's world, AI is growing in various fields such as healthcare, finance, transportation, information technology, drones, military, academia, data analysis, computer programming, drug discovery, genomics, and a host of others. AI is also being exploited by fraudsters. For instance, Ms X from the UK, who lost £17K through AI-generated videos, is a victim of deepfake scams. This was in Good Morning Britain news from January 14, 2025.

As the application of AI is increasing, so are the concerns or burning questions about its effect on our way of life, socio-economic impact, and psychological and emotional trauma of individuals affected by job loss. How can the benefits be balanced against the ethical issues surrounding the situation? Will the tech giants exploit it to the detriment of their workforce and consumers? Social media have pros and cons, and so does every system like AI. Will the benefits of AI outweigh its cons? What are the implications for mankind's future? Are we transforming the world into a robotic one, or will humans still be in control? Or is it the other way around? How will dictators, autocrats, warlords, terrorists, tyrants, or members of the underworld embrace this technology? Will they to use it positively or negatively? How will the corresponding impact on vulnerable individuals be felt?

The UK has a large healthcare dataset through the NHS, which makes it ideal for AI tools, but this information must be regulated and secured [13]. The NHS long-term plan promotes the use of AI in helping clinicians and supporting patients. The onus of responsibility and the credibility in using it rest with the innovators,

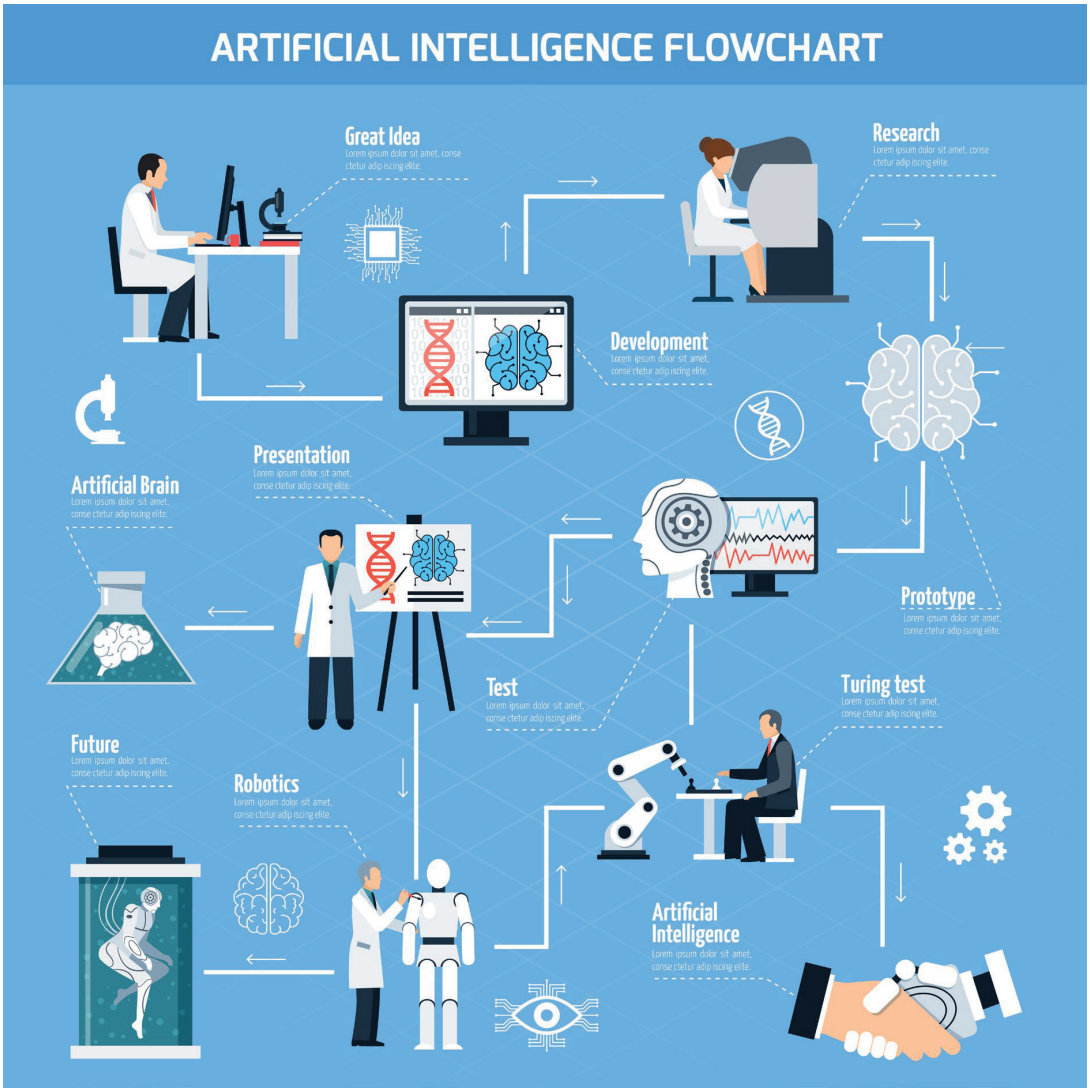

Figure 2. AI Flowchart (designed by macrovector / Freepik).

in their adherence to regulatory and safety standards, ensuring compliance.

The National Institute for Health and Care Research (NIHR) has directed their research in addressing the following issues:

a) AI could help doctors detect heart disease;

b) AI could diagnose lung cancer more accurately;

c) AI could predict the disease's progression;

d) AI could personalize cancer and surgical treatment;

e) AI predictions could minimize pressure on Accident and Emergency departments (A&E) [35].

AI integrated in healthcare systems must not be used in the same way as Facebook, X, Instagram, TikTok, and other social media accounts that have been hijacked for ulterior motives. On the contrary, patient stratification [36] and triage [37] are improving with AI risk calculators while AI surveillance models [38] have been applied to identify and monitor disease outbreaks using X data. It is dangerous for global peace and concord to consider the power of money and the influence of global technology gurus, like Elon Musk, who try to use their social media platforms to meddle in the affairs of governments of their choice. There are numerous billionaires in the world who respect and operate within national and international laws, wherever they are, and do not cross frontiers to cause problems. Invariably, this method of usurping monetary power will undermine laws and regulations binding states, and the democratic will of the people be affected. Thus, it could be a negative aspect of AI regulation in which innovators must not be above the law or immune from punishable consequences. A typical example is the disappointment in the UK, France and Germany with the inference of X through social media.

The French President Emmanuel Macron expressed discontent by warning the tech billionaire, accusing him of meddling in foreign politics to support a "new international reactionary movement." Concerns were also raised in Germany and Norway over the Tesla CEO interfering in the domestic policies of other countries, particularly in Europe. The Norwegian Prime Minister found it disturbing that a man with enormous access to social media and huge economic resources would be directly involved in other countries' internal affairs, causing unnecessary divisions as well as political uproar.

Present and future clinicians should be trained to cope with the proliferation of AI technologies in medical care (Table 3) [9]. As AI develops into varying specialist fields, the skills of the workforce and healthcare professionals will also increase in adaptability, improving the quality of delivery and allocation of resources.

Materials and Methods

Index searches are carried out through PubMed/Medline (National Library of Medicine), Scopus, and EMBASE without language restrictions; however, the databases are purely focusing on articles in English and their relevance to AI. The publications are thoroughly reviewed based on their titles, abstracts, and results.

We conducted a comprehensive literature search using the following databases in order to cover interdisciplinary research spanning artificial intelligence, biomedical, and healthcare. Studies were included in: (a) if they targeted healthcare professionals; (b) if they explored their experiences in using AI tools in their domain as barriers and facilitators to work with AI in real-world scenarios; (c) if their understanding in these tools relevant in healthcare delivery; (d) if they focused on issues relating to healthcare provision, health outcomes, and health services were considered for inclusion. We excluded

Table 3. The relationships between AI, ML, DL and NLP (modified from Alowais et al., 2023) [9].

Name	Feature
AI	A broad field that includes anything related to making machines smart
NLP (Natural Language Processing)	The branch of AI that focuses on teaching machines to understand, interpret and generate human language
ML (Machine Learning)	A subset of AI that involves systems that can learn by themselves
DL (Deep Learning)	A subset of ML that uses models built on deep neural networks to detect patterns with minimal human involvement

studies that focused on a hypothetical situation rather than their actual use, as well as those not involved in healthcare settings.

- **PubMed:** For peer-reviewed articles on biomedical applications of AI, biomaterials development, and clinical healthcare innovation.
- **Scopus:** For a broad spectrum of research literature in materials science, biomedical, and AI applications.
- **Web of Science:** For studies where AI technologies are integrated in healthcare and biomedical research.
- **IEEE Xplore:** For technical research on AI algorithms such as convolutional neural networks, recurrent neural networks, and their applications in biomedicine.

Various academic databases including Google Scholar were systemically searched using keywords such as "AI in healthcare", "machine learning" and related terms. Studies and articles focusing on AI applications in healthcare, specifically in diagnostics, personalized treatments, decision support systems (DSSs), and patient monitoring thoroughly reviewed. Selection criteria included the relevance to AI techniques (e.g. machine learning and deep learning) in healthcare, emphasis on advancements in diagnostics, personalized care and clinical DSSs. The search was limited to studies published within the last decade to ensure relevance and current advancements with no language limit.

The quality and credibility of included studies were evaluated based on design, methodology, sample size, statistical analysis, and relevance to the manuscript's focus. The narrative strategy allowed for exploration of wider implications and potential future directions of AI integration in healthcare, beyond mere aggregation of findings.

Limitations of the review process included the reliance on available literature, potential publication biases, and varying methodologies among included studies. Furthermore, rapidly evolving AI technologies in healthcare may introduce limitations and pose difficulty in capturing all the latest developments.

The application of AI is galvanizing interest in disease diagnosis, clinical pathology testing, pharmaceutical manufacturing, drug delivery, treatment selection and healthcare in general. Though AI offers cost reduction, dosage optimization of drugs, medical imaging, time savings in minimizing man-made errors and improved accuracy, nonetheless the integration of AI in healthcare settings poses a challenge despite the associated benefits. *It lacks the intuition and critical thinking needed for groundbreaking discoveries*. The fear expressed by radiologists and doctors that AI will replace physicians' role in the future is a significant worry, which must be taken seriously. Also, face-to-face treatment of patients as well as doctor-patient relationships must not be undermined by AI. There are no emotional and psychological connections of humans with AI.

More bone fractures can be spotted using AI than humans. Its initial use in scanning potentially can avoid both unnecessary X-rays and missed fractures. Britain's National Institute for Health and Care Excellence says the technology is safe, reliable and could reduce the need for follow-up appointments.

The AI industry is growing at astronomical pace with a projected increase in value by 5× over the next five years. As many as 97 million people will work in the AI space as of 2025 while 83% of companies will make it a top priority in their business plans.

Results

Many studies have reported that healthcare professionals are concerned about not understanding the outputs of AI nor the rationale behind them [39,40]. There are also issues with confidence in the accuracy of AI applications and their corresponding recommendations.

There is a belief among some healthcare professionals that AI provide added value and enhance decision-making, some pointed out that it only served as a confirmation of their clinical judgment whereas others did not find it useful in any way.

This review highlights applications of AI such as improving healthcare delivery through the

provision of accurate diagnoses, challenges and concerns associated with AI in replacing human workforce. However, persistent issues still remain, including biases linked with AI algorithms, inadequacies of transparency in decision-making, potential pitfalls of patient data privacy and safety risks associated with AI implementation in clinical healthcare settings.

Discussion

The automation of AI in healthcare could help in easing the burden of burned-out clinicians and reduce projected work shortages [17]. Some could leave the profession earlier due to burnout from an increased workload [41], administrative stress [42] and lack of organizational support [43]. Patients' attitudes and perceptions toward AI technology are based on trust, which is crucial when used in healthcare. If AI is hijacked in the same way that it is currently applied to generate disinformation and be on social media platforms, it will be a disaster for everyone especially in the healthcare sector and pose a significant concern.

The implementation of AI for automating medical history-taking and triage in a primary care setting as experienced by healthcare leaders has been reported by Siira et al. 2024 [44]. The barriers encountered in the process by healthcare professionals, organizations and in technology include scepticism and resistance in practice, adapting conventional units for digital care and inadequacies associated with AI. In challenging these obstacles, those who have responsibility for the healthcare found their approaches and knowledge scarce with AI.

There are major influencing factors that may affect the use of AI in healthcare [45]. Such factors include socio-cultural/religious differences, lack of government commitments, proliferation of AI interest groups with malicious intent, unstable power supplies, regulatory/ethical issues, wars, inefficiencies of global institutions, natural disasters, political upheavals, erosion of international laws/orders by dictatorial/ autocratic/oppressive regimes, emergence of worldwide trade wars triggered by recent tariffs and nations impoverished by corrupt leaders. The safeguarding privacy of patients and avoidance of bias with AI must be taken with utmost consideration under ethical guidelines.

A successful AI adoption relies on where it delivers with immediate value, like improving diagnostics and reducing administrative procedures. To ensure smooth operations and build AI literacy with training for staff, it is better to choose an AI provider with expert knowledge for reliability and long-term support. Ultimately, AI technology can assist in clarifying disease diagnoses [46] and shortening the route in developing innovative treatment solutions [47].

The use of AI and machine learning algorithms could improve daily lives, in particular people suffering from respiratory, cardiovascular, oncology, diabetes, urology, ophthalmology and a host of other diseases.

As there is a growing interest in AI technology, the ethical, legal and cultural issues must be addressed before it is given a wholesome integration in the healthcare sector [9].

Through many mechanisms, biases in AI-based healthcare technology can arise. Their presence within datasets as artifacts can give insights into drivers of inequities and targeted socio-technical interventions that could be helpful in mitigating them and their corresponding impacts on these technologies.

Nurses are indispensable in the healthcare system and their welfare is crucial to nurse-to-patient ratios as well as their workloads. With the considerable obligations entrusted on them in caring for patients, administering medications, monitoring of potential symptoms, assisting in varying medical procedures and emotional attachments to patients, AI could help in alerting nurses in advance of a patient's deteriorating condition and provide them with earlier interventions.

The global healthcare landscape is changing with AI applications. The potential drivers of AI in the market are increasing healthcare data, rising demand for personalized medicine, cost reduction and efficiency gains, and enhanced patient outcomes.

The EU AI Act came into force on August 1, 2024, with the aim of fostering responsible AI development and deployment in the European

Union. The EU emphasized that all high-risk AI systems must adhere to compliance relative to mitigation measures, high-quality datasets, clear information about users and human oversight. Furthermore, a European AI office has been created as the central point of contact for experts EU-wide. The European Health Data Space Regulation (EHDSR), which took effect in 2025, is empowered to ensure training, testing, evaluation of algorithms that include medical devices, in vitro diagnostics, clinical AI support systems, and digital health applications must comply with data protection and meet ethical standards. These are exemplary strategies taken by the EU to alleviate fears, concerns and unforeseen risks that AI might pose in healthcare.

Interestingly, there are international AI collaborations in healthcare:

a) the Directorate-General for Health and Food Safety cooperates with WHO Europe to support the improvement of health outcomes in the WHO European Region;

b) the DG Health and Food Safety works closely with OECD by encouraging expansion of AI in healthcare;

c) the European Commission engages with G7 and G20 partners on diverse activities related to IA in the healthcare sector.

AI in healthcare reveals its growing potential to revolutionize various facets of the field, from diagnosis, treatment to administration and research. While AI offers encouraging advancements, it also presents challenges that need to be addressed for a responsible and effective implementation. The possible benefits of AI involve the following:

Personalized treatment

Patients' data can be analyzed to tailor treatment plans, predict patient outcomes, and personalize medication regimens. AI can detect subtle patterns in data that might be missed by human clinicians, leading to earlier diagnosis and intervention. The AI algorithms can recommend optimal treatment strategies based on a patient's unique profile, lifestyle, genetic makeup and response to previous therapies.

Improved efficiency

Automated administrative tasks can be powered through AI tools, streamline workflows, and optimize resource allocations, leading to enhanced efficiency in patient outcomes.

Drug discovery and development

AI accelerates the process of finding new drugs and therapies by identifying potential targets, predicting efficacy, and designing clinical trials. Large datasets of molecular information can be analyzed with AI.

Virtual assistant and patient support

AI-powered virtual assistants can provide patients with 24/7 support, answer questions, and manage appointments in order to guide them through their healthcare journey, improving engagement and access to care.

Enhanced diagnostics

AI algorithms can analyze medical images such as (X-rays, CT scans, MRIs) with a high degree of accuracy expressed as genetic data, patient histories to identify diseases and predict future health risks with greater outcomes.

Robotics and automation

AI-driven robotics is being used in surgery, rehabilitation, and other areas to boost precision, reduce human error, and improve patient outcomes.

Challenges and considerations

The accuracy and reliability of AI models are mainly dependent on the quality and representativeness of the training data. Biases in this information can lead to unfair or unreliable predictions. Also, understanding how AI algorithms reach conclusions is vital for building trust and ensuring accountability. Explainable AI (XAI) is a part of active research in tackling this challenge.

AI raises ethical concerns associated with data privacy, algorithmic bias, and potential displacement of human healthcare professionals. The exponential growth of AI development in healthcare necessitates the application of correct regulatory frameworks to foster patient safety and credible innovation.

AI application in diagnostics

The use of AI in medical imaging for diagnosis is increasingly being applied. For instance, about 53% of medical devices have been approved or CE marked in Europe, whereas 58% of those in the USA are licensed for radiological diagnoses.

Medical diagnostic errors are associated with human judgment in about 60% of cases, and corresponding deaths could be minimized through AI. In the USA, Mayo Clinic, which is known for its innovation in patient care, employed AI for cervical screening in women to identify pre-cancerous changes in their cervix.

In the UK, Moorfields Eye Hospital London has announced the use of machine-learning-based algorithms as a solution to trace eye diseases using optical coherence tomography. The hospital indicated that the AI-based system provided the correct referral decision for over 50 eye diseases with 94% accuracy, matching world-leading experts.

AI can often outperform traditional methods in accuracy for burn and wound management. AI-powered tools are using advanced machine learning algorithms to analyze images of wounds, providing speedy and precise assessments. These tools assist in identifying infection, determining the depth of burns, and monitoring the healing process with greater accuracy than conventional techniques. The algorithm model uses patient data, demographics, wound characteristics, and comorbidities to predict healing trajectories.

The analysis of large datasets, identifying patterns and insights that tremendously improve diagnosis as well as treatment plans, could be made using advanced machine learning algorithms. Both machine and deep learning techniques provide unprecedented accuracy and speed in medical care.

AI algorithms

The introduction of the assessment tool "Minuteful for Wound" by Healthy.io has helped North Cumbria Integrated Care (NCIC) NHS Foundation Trust in the transformation process [48]. The model uses an AI algorithm to support clinicians at various levels of experience in assessing wounds confidently, consistently and safely. It offers a higher degree of accuracy and precision than conventional standard of care.

Did Not Attends (DNAs) is a common experience among most GP surgeries and hospitals in the UK, which are looking for ways to overcome this problem [49]. The practice of sending out letters, emails, texts and calls to remind patients of their appointments does not account for individual behaviors.

The four types of AI algorithms are supervised, unsupervised, semi-supervised, and reinforcement learning [50]. Unsupervised ML is useful for feature extraction in phenotyping, while supervised ML is for identifying new associations or for creating diagnostic and prognostic models.

In the practice of pathology, AI is increasingly fueling fundamental transformation despite the fact that no AI algorithm is used routinely in typical anatomic pathology laboratories [51]. Currently, ethical concerns raised by data privacy breaches and systemic algorithmic biases pose significant challenges in AI applications [52].

The algorithms associated with AI require large, high-quality datasets for training and validation [53] - a requirement that can be difficult to meet in biopharmaceutical environments where information may be fragmented or partially complete.

Whilst AI can generate code, human professionals are still crucial for the process, as they will help in correcting errors, in refining algorithms, and in boosting AI development.

Opportunities of AI in medical diagnostics market

Driving market growth of AI in regions such as North America is the radiologist shortage, compounded by an increase in cases of chronic diseases [54]. Consequently, the research into the use of AI in diagnostic tools and a surge in funding for R&D activities related to AI-powered healthcare solutions are expected to be key drivers of the growing market in North America.

By 2029, the European medical diagnostics market is projected to have a 22.5% increment, which could amount to around 4,719.3 million USD. For emerging markets, the increasing interest in developing human-aware AI systems could generate opportunities for growth in the years to come [55]. However, there are influencing factors that may hinder the growing market such as budgetary constraints, political upheaval, global economic turbulence, wars, and reluctance to adopt AI-based systems, data privacy concerns, and interoperability.

The fear expressed by radiologists and doctors that AI will replace physicians' roles in the coming years is a significant worry to be taken seriously [56]. Both consider human skills like empathy and persuasion to be crucial; therefore, technology alone cannot be substituted for a doctor. In addition, there is concern that patients may rely excessively on these technologies, which will undermine face-to-face treatments as well as patient-doctor relationships in the long term. Many doctors are questioning AI's ability to accurately diagnose patients' conditions [46].

Untapped emerging markets like China, India and Brazil could experience exponential growth from companies involved in AI medical diagnosis. This is attributed to the growing patient population of these countries and might replicate in other nations. The improvements in medical technology, especially in better imaging equipment, could culminate in the rapid expansion of healthcare both in India and China.

Fostering effective and ethical health AI solutions requires collaboration among AI engineers, domain experts, data scientists, and other stakeholders, leading to more efficient AI models [57]. The impact of AI on real-life scenarios remains uncertain.

AI is good at diagnosing diseases and analyzing DNA, but it lacks the creativity for biological research and scientific discovery [58].

What the future holds for AI?

AI is generating interest in investment. The UK Prime Minister Sir Keir Starmer has recently announced that he wants the country to be the superpower of AI worldwide. This is encouraging news for business and economic growth.

It is believed that AI will transform our way of life in the future, including chores, booking tickets, shopping, telemarketing, data entering clerks, customer services, legal assistants, and financial advisors, etc. [59]. The productivity of AI may boost our workplaces by enabling people to do more and benefit from it. AI will replace dull or dangerous tasks. The human workforce will be liberated to focus on tasks for which they are more equipped, such as empathy and creativity. However, there are challenges AI will face like increased regulation, data privacy concerns, and worries about job losses [60].

A cheap and powerful AI called DeepSeek designed by the Chinese has sent the US stock market spiraling after its release in the third week of January 2025 [61]. It can solve mathematical and scientific issues that match with those of the o1 model, available in September 2024 by OpenAI in San Francisco, California. Though DeepSeek-R1 has its shortcomings on many tasks in which researchers might want it to perform, it also provides scientists globally with the opportunity to train custom reasoning models adapted to tackle problems in their disciplines [62]. It is expected that DeepSeek-R1 will encourage more scientists to try large language models (LLMs) in their daily research based on its low cost and strong performance.

The clinical pharmaceutical development arising from AI could benefit the industry to the sum of around $25 billion due to smarter trials, better data and speedy results. According to Eli Lilly CEO David Ricks, AI could augment human productivity and automating regulatory processes.

The applications of AI-driven solutions by pharmaceutical companies could lead to significant improvements in productivity, quality, efficiency and innovation [63]. Since AI is increasingly being integrated into industrial biomanufacturing, the maintenance of human oversight and control remains paramount [64]. The continued interest and adoption of AI in biomanufacturing will probably facilitate more efficient and a more cost-effective production of pharmaceuticals, culminating in accessible life-saving treatments to patients on a global scale.

Limitations of AI

There are significant challenges and limitations linked to AI [65]. The complexity of the AI model raises issues that are difficult to interpret, requiring specialized expertise for development and implementation. The nature of AI decisions is associated with concerns about transparency, accountability and regulatory compliance. It is crucial that AI systems meet prescribed standards for pharmaceutical manufacturing, guidelines, and safety.

The sophistication and integration of AI into critical manufacturing processes and healthcare demands that ethical considerations relating to data privacy, algorithmic bias and potential misuse must be addressed in both present and future applications.

Limitations and future directions

Our review has several limitations as AI is evolving almost on a daily basis. Further studies are needed to explore more databases, and the incorporation of more keywords to be searched. Future work requires to be carried out as to elucidate a number of issues raised in this study. For example, how might the lack of emotional and psychological connection in AI is to be established between healthcare professionals, patients and the public?

To what degree will AI replace the human workforce in the healthcare system? On the other hand, AI models being accurate and reliable depend heavily on the fact that the training data are of quality and representative. Biases in these are bound to happen, which can lead to unfair or inaccurate predictions, how will they be addressed in the healthcare sector? Additionally, it is significant to evaluate the benefits and pitfalls of incorporating AI-powered virtual health assistants in patient care, taking accessibility, patient engagement and trust into consideration. There are substantial hurdles in the widespread integration of AI technologies in healthcare due to the financial burden posed by it.

Conclusion

As there is a rapidly growing interest in the use and application of AI in healthcare, it must command the confidence of patients, the public and clinical staff. To understand and address the concerns associated with AI, the public and healthcare personnel must be engaged. AI technologies will need to be designed and used in ways that protect or even enhance the human dimension of care. The major demerit of AI is that the health workforce will not question the outcomes of AI systems and so may miss errors. The public will welcome and support the involvement of AI in decision-making, where AI outputs are checked by a human being. This suggests that the public strongly values being informed about many uses of AI in healthcare. In helping the healthcare service personnel to adapt to the rise of AI, the policymakers and leaders need to consider its impact on varying roles and tailor engagement and support accordingly.

As we are shifting from globalization to protectionism or to market hegemony with the recent USA tariffs slapped on the rest of the world, it is a wake-up call for every nation or region in the world today to think about how to deal with it and its impact on AI, along with the looming global recession. It is not a technology to be used for economic bullying or cajoling other nations to cave in regarding their healthcare operations. The globe is in a race for power. However, the question is: on what terms? How long will these wars last, and are there any immediate solutions to them? Where does the world order lie, or is it completely eroded? This situation is a testament to where absolute power corrupts absolutely, and brewed aggression or autocracy becomes an item on the agenda. It raises concern about the direction in which the world is heading and how to resolve these forces created by man's inhumanity to man, as well as natural disasters.

The question for people now is which country or region can rise to the threats or challenges posed to global security and world order. The uncertainty in the markets caused by the tariffs will grossly dampen economic growth, drive costs, including AI, to astronomical levels, which

will undoubtedly affect its usage, and have a tremendous impact on the health-related quality of life and healthcare trust worldwide.

The industries for pharmaceuticals and medical devices in the healthcare sector have expressed distaste for trade policy changes since they were announced. The tariffs could lead to higher healthcare costs, chaos on the supply chains, and make care less affordable. The forthcoming months could see incremental utilization of hospitals and health systems due to elevated costs of imports. There could be potential shortages in care facilities, so there should be a reconsideration of the strategies.

To mitigate disruptions, it will be appropriate for healthcare industries to diversify suppliers and make room for backups. Also, where feasible, less capital-intensive production processes could be applied to optimize yields and reduce unnecessary byproducts.

With current trade wars in place between the USA, China, and the rest of the world, there will be negative consequences for healthcare according to industry executives and drug pricing experts. Trump's tariffs could lead to increased pricing, shortages of essential medicines such as antibiotics, generic drugs, and hindered research and the development of new drugs. Furthermore, healthcare will become less accessible, particularly for low-income earners. Added costs to producers will also impede the availability of new therapies and technologies. The major outcome of all these tariff impositions is the emergence of a New World Order that deviates from the status quo to novel alliances at the national, regional, and continental levels either toward or away from the USA.

In wrapping up, this narrative review focuses on the potential of AI technology in healthcare delivery, the challenges and concerns associated with AI in replacing the human workforce. AI has the potential to boost the quality of the healthcare system, diagnosis, disease prevention, prediction and new therapeutic pathways, thereby improving patient outcomes. Though there are beneficial aspects of AI, these remains ethical, regulatory where data quality and privacy issues that raise concern are to overcome alongside its broad implementation strategies in healthcare. Additionally, the bias in AI data leading to inaccurate predictions needs to be addressed in the future as to reassure patients and healthcare professionals. Where we are going will require a mandatory continuing education for healthcare professionals in the delivery of a robust, trusted and successful implementation of AI without alienating clinicians on the frontline with patients.

Ethics approval and consent to participate

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Conflict of interest

The authors declare no conflict of interest.

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