

Artificial Intelligence in Healthcare: A Review of Its Applications and Challenges

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ABSTRACT

Artificial intelligence (AI) has been revolutionizing healthcare by increasing the diagnostic accuracy, expediting clinical processes and enabling personalized care. AI is being woven into various medical procedures and systems, from improving early disease detection to optimizing treatment strategies. This general overview is dedicated to the different applications, innovations and major challenges of uses of AI for healthcare. The study examines the use of core AI tools and methods such as machine or deep learning and language processing in critical fields such as drug discovery, virtual health assistants, clinical decision support systems, predictive analytics, and imaging. Besides improving operational efficiency, these technologies enable clinicians to intervene more accurately and timely.

Besides the evaluation of technology advancement, this review also discusses practical, ethical and legal challenges that may hinder the broader utilization of artificial intelligence in the clinical setting. It explains how standard artificial intelligence can help improve access to healthcare, support more accurate and timely diagnosis and help healthcare systems make more efficient use of their existing resources. At the same time, the review also touches upon some of the major concerns regarding the use of AI such as patient data privacy, potential bias in AI models, lack of transparency in some algorithms, and rapidly changing regulatory landscape. Overall, this review gives a better understanding of opportunities as well as challenges of AI in healthcare.

KEYWORDS: Artificial Intelligence (AI), Digital Health, Data Privacy, Healthcare Technology, Machine Learning.

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INTRODUCTION

Artificial Intelligence (AI) has emerged as a major revolution in medical world, affecting the practice of medicine and the management of health systems.¹ AI is a revolutionary technology that has the potential to support the health systems around the world to address a range of urgent challenges such as the need for more personalized, evidence-based care, rising costs, labour shortages and the demand for services.² AI can exploit large, complex and heterogeneous data, enabling a more proactive and personalized approach to patient care, revealing hidden patterns and generating predictive insights.³ Many healthcare applications have shown tremendous promise for core AI approaches, in particular machine learning (ML), deep learning (DL), and natural language processing (NLP).⁴ These include enhanced capabilities in drug development and discovery, disease outbreak forecasting, automation in administration, intelligent virtual assistants for patient engagement and improved diagnostics and accuracy using advanced imaging analysis.

The use of AI in healthcare is transforming the world stage at a fast pace. It is expected to grow at a compound annual growth rate (CAGR) of nearly 37% to reach USD 187 billion by 2030.⁵ The fast acceleration comes as AI is increasingly

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important in fields like drug discovery, medical imaging and workflow optimisation, where AI's ability to process huge amounts of data and extract patterns is a significant advantage over traditional approaches. With the rising costs, scarcity of workforce, and the need for value-based care, AI provides a good opportunity for the healthcare sector to fill gaps and promote long term growth. In some high-stake medical applications, artificial intelligence systems have succeeded in competing or even outperforming human experts in critical medical fields such as radiology, pathology, oncology, and genomics.⁶ It is essential to point out that these resources are not substitutes for clinical judgement but rather are increasingly being viewed as tools to augment clinical judgement. But despite these advances, there's a lot of tough hurdles to overcome before standard

artificial intelligence can find its way into the healthcare industry. Concerns do exist about algorithmic bias, data representativeness, patient privacy and the extent to which AI models are used, but it is unclear on its actual impact.⁷

In addition, the opaque or “black-box” nature of many artificial intelligence (AI) systems poses significant challenges in terms of accountability, explainability and transparency,⁸ which are crucial attributes in clinical applications where decisions can have deep ramifications for patients’ lives. In addition, policies regulating the use of AI in medicine are slow to develop and often fall behind the pace of AI innovation and adoption.⁹ Nevertheless, there are still a number of hurdles that must be overcome to implement and fairly adopt, but there are significant barriers to the integration of real-world data such as algorithmic bias, privacy issues, interoperability issues and fragmented regulations.¹⁰ It is important to have trustworthy, transparent and ethical artificial intelligence systems in an effort to avoid widening health disparities and loss of trust among patients. The increased focus on these challenges and the need to establish common governance structures to ensure that AI is used safely, responsibly and sustainably in healthcare has resulted in recent initiatives, such as the EU AI Act (2024)¹¹ and new national health AI policies.

This review offers an in-depth and critical review of the state of the art of AI applications in healthcare.¹ It deals with the underlying technologies that enable AI applications, points out the major areas of application in clinical and operational settings and discusses potential advantages in the areas of effectiveness, precision and usability.²

Methods: Literature Search

A focused narrative search was conducted in PubMed, Google Scholar, ProQuest and MEDLINE. Search terms included “artificial intelligence,” “machine learning,” “deep learning,” “clinical decision support,” “clinical validation,” “precision medicine,” “drug discovery,” “generative AI,” “large language models,” “ethics,” “regulation,” and “India.” English language publications from 2016 to 2026 were considered, along with earlier studies when relevant. Titles and abstracts were screened for relevance, and full texts of relevant publications were reviewed. Priority was given to clinical studies, external or prospective validation studies, reporting guidance, and official policy or regulatory documents. This was a focused narrative search rather than a systematic review; no registered protocol, formal risk-of-bias assessment, or meta-analysis was conducted.

Overview of Artificial Intelligence

Artificial Intelligence is the design and development of computational systems that can accomplish tasks requiring human intelligence such as learning, reasoning, perception or decision making. (1) It is a large, interdisciplinary space, which includes subdomains such as computer vision, which

allows machines to process and analyse visual information, natural language processing, or NLP, which makes it easier to interpret and generate human language,¹² deep learning, a specific type of machine learning that uses multi-layer neural networks to model complex and non-linear relationships,¹³ and machine learning, which allows systems to learn from their experiences using data.

The increased use of AI in healthcare is driven by the proliferation of complex, diverse and high-dimensional healthcare-related data generated by various healthcare systems.⁴ These include structured data, such as genomic data, laboratory findings and electronic health records (EHRs) and unstructured data, such as clinical notes, imaging and patient-generated data.¹⁴ Such data sets often have complex characteristics, which are difficult to capture with traditional statistical tools. However, AI techniques especially ML and DL based techniques are great in making inferences from huge and complex databases of clinical importance. AI tools are emerging as useful tools in healthcare to help doctors in clinical decisions, to detect trends in diagnosis, to predict disease progression and to recommend individualized treatment regimens. AI is already showing value in a range of healthcare applications from clinical decision support and diagnostic pattern analysis to disease progression prediction and personalized treatment regimens. Artificial intelligence can improve patient engagement, operational efficiency, public health surveillance, diagnostics and decision support. Predictive models are used to identify high risk individuals, allocate funds and to predict patient re-admission events. With the correct application, artificial intelligence can help transition from a reactive to a proactive and preventative care model.

Importance of AI in Healthcare

The healthcare sector produces and uses huge amounts of complex, diverse data. Clinicians are being asked to combine different types of data including genomic data, laboratory results, electronic health records (EHRs), diagnostic imaging, and patient-reported outcomes to guide clinical decision-making.¹⁴ But when patterns are less obvious or nonlinear, conventional data analysis methods often fail to reveal valuable patterns and trends in this volume and complexity.⁴ In this context, Artificial Intelligence appears as an innovative technology that can enhance different aspects of the healthcare delivery system, including operational management and diagnostics.

AI's biggest impact is better accuracy of diagnostics.¹⁵ AI-powered tools, particularly those based on the machine learning (ML) and deep learning (DL) have shown exceptional capabilities in analysing complex information such as medical imaging including X-ray, CT, and MRI, and pathological slides in tissue diagnostic.¹⁶ Artificial intelligence systems have been demonstrated to have a level of sensitivity and specificity comparable to that of

expert clinicians in radiology and pathology, and in some cases superior. These technologies may help in detecting anomalies, categorizing disease subtypes and ranking critical cases resulting in accurate and timely diagnosis.¹⁷ AI is also used for predictive analytics which allows healthcare providers to move from reactive to proactive models of care. AI can trawl through a patient's data over time to identify those who might suffer bad outcomes such as complications, progression of disease or returning to hospital. Predictive algorithms are used to stratify cardiovascular risk, predict the onset of sepsis and predict deterioration in the critically ill patient so that interventions can be made earlier and outcomes improved.¹⁸ AI facilitates the amalgamation of multimodal data for personalized healthcare, including genetic, phenotypic, environmental and lifestyle factors to formulate personalized treatment regimens for each patient. Doctors use AI-powered models to suggest treatments that are more likely to be successful for specific subgroups of patients. This makes the treatment work better and cut down on side effects. Such levels of accuracy are of value in management of chronic disease, pharmacogenomics and oncology.

AI has shown promising potential to enhance operational efficiency of healthcare systems with applications extending beyond clinical domain.⁵ Automation intelligence tools are being deployed to streamline administrative functions such as clinical documentation, medical billing and appointment scheduling.¹⁹ AI has shown great promise to enhance operational efficiency of healthcare systems with applications outside clinical domain. Automation intelligence tools are being used to make administrative functions more efficient, such as clinical recording, medical billing, and scheduling appointments.

AI also improves staffing models, minimizes redundancy in care delivery and improves supply chain and inventory management.¹⁹ AI cuts down on administrative tasks and enables healthcare staff to spend more time with patients.⁴

Standard artificial intelligence can also be applied to scale up and enhance health systems, particularly in low resource settings.²⁰ Artificial intelligence is vital in contact tracing, resource planning and epidemiological modeling in the case of public health emergencies like the COVID-19 pandemic.¹ The features show how standard artificial intelligence can assist in population health efforts and provide care to people in need in hard-to-reach places. AI in healthcare is expected to bring a raft of benefits such as better diagnostics, personalised treatment, proactive risk assessment and system optimisation. However, there will be a variety of data governance, clinical integration and regulatory oversight to think about to realise these benefits at scale.

Evolution and Milestones of AI in Medicine

The healthcare sector generates and utilises large amounts

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AI in personalized healthcare helps in the fusion of multimodal data like genetic, phenotypic, environmental and lifestyle factors for the development of personalized treatment regimens for each patient.² Models based on AI help to make clinical decisions by suggesting treatments with the higher chance of success for specific subgroups of patients.¹⁴ This helps in improving the effectiveness of the treatment and reduces the side effects. This level of precision is especially useful in managing chronic diseases, in pharmacogenomics and in oncology.²¹ AI is being used beyond the clinical setting to improve the efficiency of healthcare system. Automation intelligence tools assist with clinical documentation, billing and scheduling. Artificial intelligence can assist with staffing, reduce duplicated care, and improve supply chain and inventory management. AI is freeing healthcare workers from administrative tasks, so they can spend more time with patients. Standard artificial intelligence can help scale and strengthen health systems, particularly in resource-poor settings. During the COVID-19 pandemic AI aided in contact tracing, resource planning and epidemiological modelling. The features show how standard artificial intelligence can assist in population health efforts and provide care to people in need in hard-

to-reach places.

Overall, the use of AI in health care is set to bring many benefits including improved diagnostics, personalised care, forward-looking risk assessment and system optimisation.⁵ However, there will be a range of data governance, model interpretability, clinical integration, and regulatory oversight considerations²² to realise these benefits at scale.

Artificial intelligence (AI) in medicine has developed over the last few decades with both conceptual and technological progress.¹ The first attempts to encode clinical knowledge in computational frameworks were made in the early 1970s with the development of computer-based rules-based expert systems.² Some of these were notable, such as INTERNIST-I, intended to aid in the differential diagnosis of complex internal medicine cases, and MYCIN, intended to diagnose bacterial infections and prescribe antibiotics. They were based on logical inference trees and manually selected rules. They were inflexible and unable to generalise beyond the specified conditions to adapt to the new clinical data, thus hampering their innovative approach.

Despite the limited advances made in expert systems in the 1980s and 1990s, AI has remained limited in its wider application in clinical medicine due to limitations in system interoperability, data access and computer power. The landscape began to change with the introduction of machine learning (ML), a method that emerged in the early 2000's and allowed systems to learn relationships and patterns directly from data rather than being programmed.¹⁴ This was a basic paradigm shift from knowledge-based AI to data driven AI which led to a more adaptive and scalable method for medical applications. The rapid development of AI in recent years is mainly due to deep learning (DL) techniques and the availability of large-scale annotated datasets. Deep learning (DL) is a type of machine learning using multilayer artificial neural networks which have achieved great results for example in medical imaging, natural language processing and speech recognition.¹³ These technologies have resulted in artificial intelligence (AI) systems that could match or exceed the capabilities of human clinicians in certain diagnostic areas such as diagnosis of skin lesions, diagnosis of diabetic retinopathy, and lung nodule detection on chest computed tomography scans.

Several key projects and platforms demonstrate the potential of AI in the healthcare sector.²³ Many healthcare AI projects and platforms demonstrate its power. DeepMind, a Google subsidiary, can accurately identify over 50 eye diseases using optical coherence tomography (OCT) scans. Some data scientists have been criticised for not delivering on expectations, but IBM Watson Health was one of the first to commercialise AI for oncology decision support and achieved a great deal with the bulk of clinical literature and patient data. Today, AI-enabled computer-aided detection (CAD) systems are widely used in radiology to help analyse

MRI, interpret CT and perform mammography. AI has been leveraged for predictive analytics, robotic surgery, genomics and virtual health assistants making it more useful across the continuum of healthcare. The FDA has also marked regulatory milestones with the approval of increasing AI-powered medical devices such as IDx-DR for DR screening.²⁴

To summarise, AI in medicine has evolved from rule-based systems to data-driven complex and intelligent models that can learn patterns and reason.² As AI continues to evolve, it is expected that its acceptance by regulators and clinical end users, real-world validation, and increasing computational capabilities will further drive its adoption into regular clinical practice. As AI continues to evolve, acceptance is expected to grow by regulators and clinical end users, and real-world validation will support its adoption,²⁵ with growth in computational capacity.

AI Applications in Healthcare

An Innovation in Multiple Domains of Health Care Artificial intelligence (AI) is proving to be a revolutionising force in many different areas of health care.¹ The integration provides tools that enhance productivity, accuracy and accessibility in clinical diagnostics, patient management, hospital operations and medical research.²³ The main fields of application can be categorised as:

Clinical Diagnosis and Guidance AI for Clinical Diagnostics

The application of standard artificial intelligence (AI) tools, especially machine learning (ML) and deep learning (DL), is revolutionising disease detection, management and therapy.¹⁵

Medical Imaging: AI programs are more accurate at reading radiological images such as MRIs, x-rays, CT scans and mammograms.^{6,16} These systems are particularly useful for detecting retinal diseases, brain abnormalities, fractures and cancers (breast, lung and prostate).^{26,17}

Pathology: AI tools can analyse histopathology slides (16) to identify cellular abnormalities faster and more accurately than manual techniques.²³

Laboratory Diagnostics: Artificial intelligence can help analyse large amounts of laboratory data such as biomarkers and blood work so that it can help detect unusual patterns and help in early diagnosis.¹⁴

AI in Clinical Decision Support: AI-based clinical decision support systems (CDSS) combine large datasets to help medical professionals with: Patient history and symptoms imaging and laboratory results Genetic data Current recommendations for treatment.¹⁴ These tools support timely and personalised decision-making by physicians by predicting disease evolution, detecting potential

complications and offering evidence-based treatment recommendations⁴ with positive impacts such as increasing the accuracy of diagnosis, decreasing human error, enabling personalised, evidence-based care and improving treatment outcomes and patient safety.²

Artificial Intelligence in Patient Monitoring and Telemedicine

As wearable medical technology like smartwatches, becomes more popular, artificial intelligence can analyse real-time patient data such as pulse, saturation of oxygen, sleep habits and exercise.²⁰ Artificial intelligence algorithms can identify changes in health metrics from a baseline that can prompt early intervention by alerting patients or health care professionals.²⁷ This is especially so for those with long term illnesses, AI enhances telemedicine systems in the following ways:

Chatbots and virtual assistants: Assist in directing patients to appropriate levels of care and initial symptom evaluation.¹²

Voice and Video Analytics: Evaluating respiratory distress, stress and mood in virtual visits, scheduling and follow-up. Automate repetitive tasks to enhance the patient experience.⁴

Remote and Underserved Care: AI-powered remote monitoring allows patients to get timely care without in-person visits, improving access to healthcare in rural, underserved or low-resource areas.²⁷

These tools enable preventative and proactive care, reduction in hospital admissions, improved access to healthcare and increased patient engagement and adherence.²⁷

Health Care Operations and Drug Development

A. Healthcare management and operations are being automated to take care of the administrative and logistical work and artificial intelligence is streamlining the core operations of healthcare organizations.¹⁹ Drug Development and Healthcare Operations NLP (Natural Language Processing) tools are used to extract relevant information from clinical notes and apply billing and coding standards to automatically generate billing codes.¹² AI anticipates appointment length, patient flow and provider availability to optimize schedules and minimize wait times. Doctors use voice to text transcription tools to document and organize clinical notes instantly and this is how clinical documentation is done. AI optimises inventory between departments and forecasts supply needs⁵ (such as prescription drugs and personal protective equipment). AI tools help to reduce workload on clinicians, administrative errors and improve hospital effectiveness and resource allocation.

B. AI is advancing personalised medicine and drug discovery by:

Genomic Analysis: Standard artificial intelligence algorithms can evaluate large genomic data sets to identify mutations, understand disease mechanisms, and predict individual patient responses to therapies.^{28,21}

Screening candidates for drugs: Machine learning algorithms screen thousands of compounds to find promising candidates with the desired biological activity.²¹

Optimising clinical trials: AI is able to monitor adverse events in real time, predict trial outcomes and identify patient populations.²¹

AI in Precision Medicine: AI brings together genetic, environmental and lifestyle data to create personalised treatment regimens.²⁸ that are unique to each patient's individual profile.²¹

Effect: Faster drug discovery, lower research and development costs, increased likelihood of successful clinical trials, safer and more effective treatments.²¹

Generative AI and Large Language Models

Generative Artificial Intelligence (GenAI), particularly large language models (LLMs), can draft and summarize clinical text, answer questions, and support conversational interactions. Med-PaLM 2 has been evaluated on medical question-answering benchmarks, while AMIE has been assessed in simulated text-based consultations with patient actors. These studies report promising results under controlled evaluation conditions, but they do not establish that these systems improve patient outcomes in routine care.^{29,30}

A 2026 exploratory study evaluated a multimodal version of AMIE in 105 simulated telehealth consultations involving clinical image and clinical documents. Although specialist ratings favoured the system on several assessed measures, the consultations were simulated; the findings therefore do not demonstrate safety or benefit in routine clinical practice. LLMs can also produce inaccurate or unsupported statements, omit relevant context, or reproduce biases. Their outputs should be checked by qualified clinicians, and their use requires further evaluation in real clinical workflows.³¹



Figure 1: Recent Use of AI in Healthcare. (32)

Challenges of AI Adoption in Healthcare

Adoption of AI in Healthcare is a challenge. Adoption of AI in Healthcare is not an easy task. While AI holds the promise to revolutionise healthcare, many barriers to AI adoption exist.³³ These issues need to be addressed across a range of technical, ethical, regulatory and human-centric areas to ensure that AI improves healthcare outcomes.²⁵ Let's look at the key challenges in detail:

Data security and privacy information

A. An explanation of data security and privacy: AI systems require large number of patients data, including genomic data, electronic health record (EHR) data, wearable sensor data and diagnostic imaging data.¹⁰ This is personal information and is governed by strict privacy laws.²²

Key concerns: Consequences of hacking or data leaks: Healthcare providers and AI developers are penalised and see reputational damages for failure to protect patient data, and this erodes the trust of the public in the system.¹⁰

B. Algorithmic Bias Justification: The impartiality of an AI model is dependent on the quality of data that has been utilised to train the AI model.⁷ If the training data sets are not diversified and tend to be skewed to specific groups (i.e., mostly White or urban groups) Lack of information on minority groups. This may exacerbate or entrench existing health inequalities.³³ Such examples include misdiagnosis of under-represented individuals, recommendations for unfair treatment and incorrect predictions for people with rare diseases.

Implication: Data sets need to be diverse, inclusive and balanced for justice and equity and AI models need to be bias audited and corrected.⁷

Explainability and Regulatory Barriers

A. Explainability and Transparency: Justification: Many of the best AI models, particularly those based on deep learning (neural networks), are "black boxes": they produce results, but don't explain what decisions they made.⁸ Clinicians may not understand or misinterpret AI decisions, and they may not want to blindly follow AI recommendations.³³ It is important for informed consent and collaborative decision-making that patients understand how decisions are made with AI, which they have difficulty in.²²

The following solutions are being investigated:

Explainable AI (XAI) techniques that visualise the attributes influencing a decision.⁸ Heatmaps in Medical Imaging. Heatmaps are a tool for medical imaging applications.¹⁵ Simpler model architectures with performance compromises.

Implication: It is hard to be adopted in the clinic if the model is not explained and patient safety might be put at risk.

B. Regulation Reasoning Validation and Approval regulatory agencies: Central Drugs Standard Control Organization (CDSCO), European Medicines Agency (EMA), United States Food and Drug Administration (FDA) in India.¹¹ What these companies want proof that they are accurate, reliable and safe. Continuous post-marketing surveillance. Compliance to software as a medical device (SaMD) regulation. Challenges include longer approval periods, expensive validation and uncertainty in the development of regulatory structures for AI for adaptive and continuously learning models.²⁵

The problem: The complex and time-consuming journey to clinical use delays and adds cost to the benefits of AI.

The issue: The high and long road to clinical use discourages innovation in AI.⁹

In India, CDSCO oversees medical-device software under the Medical Devices Rules, 2017, when the software meets the definition of a medical device. In the United States, the FDA regulates AI-enabled software functions that qualify as medical devices through applicable device pathways. The EMA's reflection paper addresses AI use across the medicinal-product lifecycle; it is not a general approval framework for medical devices. These agencies therefore have distinct roles, and requirements depend on the product's intended use and jurisdiction.

Adopt and integrate

A. Clinical Workflow Compatibility

Justification: Healthcare settings are complex because of time constraints, heavy cognitive loads and pre-existing IT systems (e.g., electronic health records).¹⁴ The best AI tools should not disrupt the clinician's workflow, but should be integrated into existing workflows, and provide insights in real-time without requiring additional steps or training.⁸

Poorly integrated systems can: Add to the administrative burden, Cause alert fatigue (too many alerts), Cause alerts to be ignored or not used even when technically correct.⁸

Implication: AI should improve clinical practice, not complicate it.³³ The end users' feedback should be taken into account in terms of usability and relevance and be incorporated in the solution design process. The reality is that medical professionals would not be able to use the best artificial intelligence systems if they do not understand how the AI works, or if they consider it as a threat to their independence in practice or knowledge, or if they are worried about legal and medical implications of the use of AI.⁹

B. To build trust you need: open discussion of limitations and a transparent design.⁸ The involvement of clinicians in the development process and their training.² Showing progress in practical, real-world results, not theory.

Implication: Technology will not be the sole determinant of success in the use of AI. People and process will be equally important. The Ethical Dimensions of artificial intelligence (AI) in health care has raised several important ethical issues that should be carefully addressed to allow the responsible and equitable use of AI.²²

The Ethical Dimension of AI in Medicine

The potential of Artificial Intelligence (AI) in medical healthcare has raised some important ethical questions that need to be addressed, like its potential for responsible and equitable use.

Patient Independence and Transparency: Patients need to be fully informed about the collection, use and security of health data to be able to give their informed consent.²² Further, AI decisions must be transparent and interpretable to allow physicians and patients to understand and trust the AI recommendations.⁸

Responsibility and accountability: It is important to determine who is responsible for errors and negative consequences caused by artificial intelligence systems.²² Patient safety and legal clarity necessitate well-defined accountability frameworks that outline the responsibilities of AI developers, healthcare providers and institutions.²⁵

Fairness and Equity: AI should foster equitable access, benefits and outcomes in healthcare and should not be biased against marginalised and vulnerable groups. (34) But as the deployment of AI becomes more advanced, there is a need for conscious efforts to ensure equity and inclusiveness of data and application.²²

These privacy, security and ethical concerns point to the necessity of developing ethically and technically responsible artificial intelligence systems governed by strong processes and cross-disciplinary collaboration.⁷

Indian Healthcare Perspective

India's linguistic diversity and differences in healthcare access, infrastructure, and clinical practice make local evaluation essential. AI tools should be validated across representative populations, languages, and care settings, with attention to privacy, data governance, and interoperability. Their implementation should align with national digital-health initiatives, including NITI Aayog's National Strategy for Artificial Intelligence and the Ayushman Bharat Digital Mission.

DISCUSSION

The article highlights the revolutionary effect of artificial intelligence (AI) on healthcare systems, with far-reaching implications for multiple stakeholders such as patients, doctors, researchers, and policymakers.¹

Artificial Intelligence (AI) is a game changer in healthcare:

Artificial intelligence is one of the significant developments in the history of medicine, and it is transforming how health care is delivered and practiced.¹ AI employs complex algorithms that can extract information from huge and varied data sets. (2) It can learn from large data sets to enable the new paradigm of health, P4 medicine - predictive, personalised, preventive and participatory medicine.⁴

AI tools are more accurate and efficient than human experts and can augment clinician capabilities through tools such as risk prediction models, personalised treatment recommendation systems and diagnostic imaging classifiers.⁴

AI's disruptive potential goes well beyond the applications discussed. It allows a paradigm shift in healthcare delivery from episodic, reactive care to continuous health monitoring, from generic care to precision care and from reactive to proactive health management.²⁰ "This systemic change could help build more sustainable healthcare systems and lead to better patient outcomes."²⁷

Dual Role of AI: Augmentation vs. replacement of Human Intelligence

The debate on the use of healthcare AI revolves around whether it should augment or replace human intelligence.² The majority of the literature supports augmentation, which aims to help doctors make better decisions with the help of AI, while reducing the time spent on data processing, minimising diagnostic errors and providing solid structures for decision support.¹ In this collaboration, the focus is on "human-in-the-loop" systems in which medical professionals have the final say on decisions, and AI-powered systems provide evidence-based recommendations. These models ensure clinical responsibility and ethical conduct and thus build trust in AI-based health services.²²

Challenges in adopting and implementing the use of AI in a more equitable way

There are several big challenges:

Wide-spread adoption of AI: Access to a variety of good-quality data is important for reliable AI performance.¹⁰ Many existing health care datasets are fragmented, incomplete, or biased, affecting generalisability of AI and further exacerbating health disparities.³⁴

Ethics: Without careful development and oversight, AI models are capable of generating biased recommendations and misdiagnosing conditions, which can disproportionately amplify existing injustices faced by marginalised groups.⁷

Lack of Regulation: AI is moving faster than the regulatory structures in place.¹¹ This creates uncertainty of regulation, validation requirements, and liability in the event of AI-related mistakes.²⁵ Cooperation among healthcare

professionals, technologists, ethicists and lawmakers will be needed to address these concerns and establish robust governance frameworks for the ethical and fair use of AI.²²

Clinicians and Institutions Adoption and Integration: AI to be effective in the clinical setting, it must be adopted by healthcare organisations and providers.³³ But AI tools must not only be technically accurate, but also easy to use, understand and adopt into current electronic health records systems and clinical practices.¹⁴ Clinicians need to be properly equipped with the understanding of the capabilities and limitations of AI to promote responsible and informed use.⁸ Healthcare organizations also have a key role to play in developing ethical standards for the use of AI, in investing in the digital infrastructure, and in creating an innovative culture.

AI systems should undergo external and prospective validation in their intended clinical settings, while applications in precision medicine and drug discovery require laboratory and clinical confirmation. Responsible use also depends on privacy, fairness, human oversight, and compliance with regulations relevant to the system's intended use.

The potential of healthcare AI is enormous, but require continued collaboration and understanding from data scientists, health-care practitioners, ethicists and policy makers.²² A key focus is also to build transparent AI models that can foster trust between patients and providers.⁸ Diverse and inclusive medical datasets will also help to mitigate bias and improve generalizability which is needed to improve equity in AI use cases.³⁴ Standardised protocols for implementation, validation and ongoing evaluation of artificial intelligence (AI) systems need to be developed to ensure their effectiveness and to guarantee safety in clinical settings. More broadly, to unleash the potential of AI in healthcare, it will be important to build public trust through demonstrated ethical leadership and transparent communication. New technologies like edge computing, explainable AI (XAI) and federated learning are expected to play a crucial role in overcoming the current limitations by enabling scalable, privacy-preserving and interpretable AI solutions that can be successfully integrated into healthcare systems.

CONCLUSION

AI is becoming more and more relevant to the health industry as it can assist with diagnosis, clinical decision making, tailoring treatments and streamlining operations. Driven by increases in computing power, robust institutional backing, and growing access to health data, AI has advanced rapidly since the advent of the first expert systems. There are, however, problems in its use in clinical practice. There are many considerations, including data privacy, algorithmic bias, lack of transparency and how AI tools can be integrated into existing workflows. Ethical issues such as accountability and informed consent are important for responsible use of AI. These challenges require continued collaboration between policy, research, technology and

health care practitioners. The key is clear guidelines on safe and effective use, explainable and clear systems and diverse and representative datasets. Current challenges have to be solved by new technologies like explainable AI (XAI), federated learning and edge computing. AI should be used to supplement human intelligence, not replace it. It needs to be embedded into health systems to make them more efficient. AI has the potential to be the building blocks of our future with more smarter and equitable health care system, if properly planned and governed ethically.

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