

# An Overview on Importance of Artificial Intelligence in the Maintenance of Human Health

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**Abstract**—Artificial intelligence (AI) is a powerful and disruptive area of computer science, with the potential of fundamentally transforms the practice of medicine and delivery of health care. Advancements in research show an increasing interest in creating AI solutions in the healthcare sector. This interest is driven by the broad spectrum and extensive nature of easily accessible patient data including medical imaging, digitized data collection and electronic health records and by the ability to analyze and interpret complex data, facilitating more accurate and timely diagnosis. This review goal is to provide comprehensive over view of the advancements achieved by AI in health care, improving the quality and efficiency of health care decision making, reliable and safe AI systems and current application of AI in healthcare including machine learning, natural language processing and robotics. The paper also explores the future possibilities of AI in healthcare such as personalized medicines, diseases prediction, prevention and drug discovery.

**Index Terms**—Artificial intelligence, health care, diagnostic assistance, data privacy, ethical considerations.

## I. INTRODUCTION

Artificial intelligence (AI) has become increasingly significant in the realm of innovation in the healthcare industry in the last few years (1). AI, in its broadest sense, is a branch of computer science that aims to replace human intelligence using computer systems (2). AI may improve the diagnosis of health conditions, treatment choices and health outcomes, notably in genomics and precision medicine (PM); the review also highlights how AI may save healthcare

costs, boost efficiency and improve patient care, but it also raises data privacy and clinical validation issues (3). The implementation of AI in healthcare systems represents a complex integration of multimodal systems that necessitates fundamental advancements in areas such as privacy, large-scale machine learning, optimization and model performance (4). To successfully incorporate AI into healthcare, two key concepts must be addressed: Data with security and analytics with insights. Regarding data and security, complete transparency and trust are essential for effective integration. Similarly, the role of data analytics and insight is crucial. AI has the capability to synthesize inputs from diverse unstructured and structured sources to aid in making more informed decisions, finding better solutions and fostering reasoned discussions in multimodal applications - for instance, enabling clinicians to make more accurate diagnoses and nurses to develop sensible care and follow-up plans (5). The healthcare ecosystem is beginning to recognize the critical role that AI-powered tools will play in next generation healthcare technologies. AI can enhance almost every aspect of healthcare applications and delivery (6). Ageing populations, growing burden of chronic diseases and rising costs of healthcare globally are challenging governments, payers, regulators and providers to innovate and transform models of healthcare delivery (7). AI involves the development of computer systems capable of performing tasks that typically require human intelligence, such as understanding natural language, recognizing patterns and making decisions.

## II. ARTIFICIAL INTELLIGENCE



It is widely agreed that the term AI indicates the execution by computer of activities that are typically associated with intelligent humans (8). ML algorithms are at the heart of AI. Algorithms are converted to code, which contains instructions for fast analysis and translation of input into conclusions, information or other outputs. AI is fueled by massive amounts of data and has the ability to analyze that data in a short period of time. An AI system is a machine based system that, given a set of human defined goals, can make a prediction, suggestion or choice that may have an impact on real or virtual surroundings. When it comes to data definition and analysis, ML is a subset of AI methods that is based on the application of statistical and mathematical modeling techniques (9). ML may be divided into three types of learning based on how it learns from data: Supervised learning, unsupervised learning and reinforced learning.

Supervised learning leverages labeled data (annotated information); for example, using labeled X-ray images of known tumors to detect tumors in new images (10).

Unsupervised learning attempts to extract information from data without labels; for example, categorizing groups of patients with similar symptoms to identify a common cause(11).

In Reinforced learning (RL) computational agents learn by trial and error, or by expert demonstration.

The algorithm learns by developing a strategy to maximize rewards. Of note, major breakthroughs in AI in recent years have been based on RL.

Deep learning (DL) is a class of algorithms that learns by using a large, many-layered collection of connected processes and exposing these processors to a vast set of examples. DL has emerged as the predominant method in AI today driving improvements in areas such as image and speech recognition (12,13). DL, also known as ‘deep structured learning’, is a subset of machine learning that utilizes multi-layered neural networks to extract features from data in a hierarchical fashion manner. DL can be conducted under supervised, unsupervised or semi supervised settings. It is commonly associated with the need for large volumes of data to effectively train models.

### III. HOW TO BUILD EFFECTIVE AND TRUSTED AI-AUGMENTED HEALTHCARE SYSTEMS?

Despite more than a decade of significant focus, the use and adoption of AI in clinical practice remains limited, with many AI products for healthcare still at the design and develop stage. While there are different ways to build AI systems for healthcare, far too often there are attempts to force square pegs into round holes i.e. find healthcare problems to apply AI solutions to without due consideration to local context (such as clinical workflows, user needs, trust, safety and ethical

implications). We hold the view that AI amplifies and augments, rather than replaces, human intelligence. Hence, when building AI systems in healthcare, it is key to not replace the important elements of the human interaction in medicine but to focus it, and improve the efficiency and effectiveness of that interaction. Moreover, AI innovations in healthcare will come through an in-depth, human-centered understanding of the complexity of patient journeys and care pathways (7).

#### Design and develop

The first stage is to design and develop AI solutions for the right problems using a human-centered AI and experimentation approach and engaging appropriate stakeholders, especially the healthcare users themselves (7).

#### Stakeholder engagement and co-creation

Build a multidisciplinary team including computer and social scientists, operational and research leadership, and clinical stakeholders (physician, caregivers and patients) and subject experts (e.g. for biomedical scientists) that would include authorizers, motivators, financiers, conveners, connectors, implementers and champions. A multi-stakeholder team brings the technical, strategic, operational expertise to define problems, goals, success metrics and intermediate milestones (7).

#### Human-centered AI

A human-centered AI approach combines an ethnographic understanding of health systems, with AI. Through user-designed research, first understand the key problems (we suggest using a qualitative study design to understand ‘what is the problem’, ‘why is it a problem’, ‘to whom does it matter’, ‘why has it not been addressed before’ and ‘why is it not getting attention’) including the needs, constraints and workflows in healthcare organizations, and the facilitators and barriers to the integration of AI within the clinical context. After defining key problems, the next step is to identify which problems are appropriate for AI to solve, whether there is availability of applicable datasets to build and later evaluate AI. By contextualizing algorithms in an existing workflow, AI systems would operate within existing norms and practice to ensure adoption, providing appropriate solutions to existing problems for the end user (7).

#### Experimentation

The focus should be on piloting of new stepwise experiments to build AI tools, using tight feedback

loops from stakeholders to facilitate rapid experiential learning and incremental changes. The experiments would allow the trying out of new ideas simultaneously, exploring to see which one works, learn what works and what doesn’t, and why. Experimentation and feedback will help to elucidate the purpose and intended uses for the AI system: the likely end users and the potential harm and ethical implications of AI system to them (for instance, data privacy, security, equity and safety) (7).

#### Evaluate and validate

Next, we must iteratively evaluate and validate the predictions made by the AI tool to test how well it is functioning. This is critical, and evaluation is based on three dimensions: statistical validity, clinical utility and economic utility. Statistical validity understands the performance of AI on metrics of accuracy, reliability, robustness, stability and calibration. High model performance on retrospective, in silico settings is not sufficient to demonstrate clinical utility or impact. To determine clinical utility, evaluate the algorithm in a real-time environment on a hold-out and temporal validation set (e.g. longitudinal and external geographic datasets) to demonstrate clinical effectiveness and generalisability. Economic utility quantifies the net benefit relative to the cost from the investment in the AI system (7).

#### Scale and diffuse

Many AI systems are initially designed to solve a problem at one healthcare system based on the patient population specific to that location and context. Scale up of AI systems requires special attention to deployment modalities, model updates, the regulatory system, variation between systems (7).

#### Monitor and maintain

Even after an AI system has been deployed clinically, it must be continually monitored and maintained to monitor for risks and adverse events using effective post-market surveillance. Healthcare organizations, regulatory bodies and AI developers should cooperate to collate and analyze the relevant datasets for AI performance, clinical and safety-related risks, and adverse events (7).

## IV. MEDICAL APPLICATIONS OF AI

AI is rapidly becoming an important component of contemporary healthcare, due to recent advancements in computer science and informatics, among other

factors. AI algorithms and applications powered by AI are being utilized to assist medical practitioners in clinical settings and ongoing research (Table I). Currently, clinical decision support and image analysis are the most commonly encountered applications of AI in medical contexts (9). Treatment, medication and

other patient requirements are all addressed through clinical decision support systems, which provide clinicians with fast access to up-to-date information and research that is relevant to the patient's situation.



Table 1. Applications of artificial intelligence that have the greatest potential in the healthcare industry (22)

Application	Description	AI techniques used	Benefits
Medical imaging and diagnostics	AI algorithms can analyze medical images to detect diseases (e.g., cancer, fractures)	DL (CNNs) and computer vision	Improved accuracy and faster diagnosis
Drug discovery and development	Accelerates identification of potential drug candidates and purposing existing drugs	ML and predictive analytics	Reduced time and cost in drug development
Personalized medicine	Tailoring treatment plans based on individual genetics and health data	DM, genomic analysis and ML	More effective treatments and better outcomes
Predictive analytics	Predicts patient outcomes and disease risks based on data patterns	ML and statistical modeling	Proactive care and risk reduction
Patient monitoring and care	Real-time monitoring of patient vital signs with alert systems	IoT devices and ML algorithms	Early issue detection and improved safety
Robotic surgery	AI-assisted robots enhance precision in surgical procedures	Robotics, computer vision and ML	Minimally invasive surgery and better outcomes
Disease outbreak prediction	Uses data analysis to predict and track disease outbreaks	Big data analytics and epidemiological modeling	Early intervention and public health planning
EHR management	Organizes and analyzes EHR data for clinical insights	NLP, DM	Improved data accessibility and decision-making
Telemedicine and remote care	Delivers medical care remotely via AI platforms	Video Analytics, ML and NLP	Increased access and patient convenience
Clinical decision support	Aids clinicians with evidence-based recommendations	Expert systems, ML and NLP	Improved patient outcomes and care quality
Health chatbots	Offers patients information and symptom checking	NLP, ML and conversational AI	24/7 engagement and reduced healthcare workload

AI, artificial intelligence; CNN, convolutional neural network; DL, deep learning; DM, data mining; EHR, electronic health records; ML, machine learning; NLP, natural language processing.

AI opens up an array of possibilities for the development of intelligent medical products, innovative services and new business models. There are numerous different types of AI technologies in medicine, spanning from virtual to physical. The ability of AI technologies to identify complex patterns and hidden structures has allowed image based detection and diagnostic systems in healthcare to perform similarly or at times even better than a clinician in certain instances, according to recent research (14). Furthermore, clinical decision support systems that are powered by AI have the potential to minimize human diagnostic errors, enhance decision-making support, increase reproducibility and assist physicians in making better use of data and documentation (15).

#### V. ROBOTICS IS ANOTHER AREA OF AI THAT HAS THE POTENTIAL TO TRANSFORM HEALTHCARE (16)

Robots can be used for a wide range of tasks in healthcare, including surgery, rehabilitation and patient care. For example, surgical robots can be used to perform minimally invasive procedures, which can reduce recovery time and improve outcomes. Robots can also be used for telemedicine, allowing healthcare providers to remotely monitor patients and provide care in real-time. Robotics, as a field of artificial intelligence (AI), holds great promise for transforming healthcare. Robotics combines AI algorithms with mechanical devices to create intelligent machines that can perform physical tasks and interact with the environment. In healthcare, robotic systems have the potential to revolutionize various aspects of patient care, medical procedures, and healthcare operations. One of the key applications of robotics in healthcare is in *surgical procedures*. Robotic surgical systems, such as the da Vinci Surgical System, enable surgeons to perform minimally invasive surgeries with enhanced precision and control. These systems consist of robotic arms with specialized instruments controlled by the surgeon, offering increased dexterity, 3D visualization, and reduced invasiveness. Robotic surgery can lead to shorter hospital stays, faster recovery times, and improved surgical outcomes for patients. In accumulation to surgical applications, robots can also assist healthcare providers in tasks such as patient care and rehabilitation. Robots can be

used to perform repetitive tasks, such as lifting and transferring patients, reducing the physical strain on healthcare professionals and minimizing the risk of injuries. Robotic exoskeletons can aid in rehabilitation by providing support and assistance to patients recovering from injuries or impairments, helping them regain mobility and strength.

Robots equipped with sensors and AI algorithms can also be employed for remote monitoring and telemedicine. These robots can navigate hospital corridors and patient rooms, capturing vital signs, relaying information to healthcare providers, and allowing for remote consultations. This enables healthcare professionals to monitor patients in real-time and provide timely interventions, especially in remote or underserved areas. Besides, robotics can enhance the efficiency of healthcare operations and logistics. Autonomous robots can be deployed for tasks such as medication delivery, inventory management, and sterilization of hospital environments. This automation reduces the workload on staff, improves accuracy, and allows healthcare professionals to focus more on patient care. While robotics in healthcare offers numerous advantages, there are challenges to be addressed. Ensuring the safety and reliability of robotic systems is crucial, particularly in critical procedures. Robotic systems must undergo rigorous testing and validation to ensure they meet the highest standards of safety and efficacy. Additionally, ethical considerations such as patients consent, privacy, and maintaining the human touch in healthcare interactions need to be carefully considered and addressed.

#### VI. CURRENT AND FUTURE USE CASES OF AI IN HEALTHCARE (7)

Research in the application of AI healthcare continues to accelerate rapidly, with potential use cases being demonstrated across the healthcare sector (both physical and mental health) including drug discovery, virtual clinical consultation, disease diagnosis, prognosis, medication management and health monitoring. We describe a non-exhaustive suite of AI applications in healthcare in the near term, medium term and longer term, for the potential capabilities of AI to augment, automate and transform medicine.

AI today (and in the near future)

Currently, AI systems are not reasoning engines i.e. cannot reason the same way as human physicians, who can draw upon ‘common sense’ or ‘clinical intuition and experience’. Instead, AI resembles a signal translator, translating patterns from datasets. AI systems today are beginning to be adopted by healthcare organizations to automate time consuming, high volume repetitive tasks. Moreover, there is considerable progress in demonstrating the use of AI in precision diagnostics (e.g. diabetic retinopathy and radiotherapy planning).

AI in the medium term (the next 5–10 years)

In the medium term, we propose that there will be significant progress in the development of powerful algorithms that are efficient (e.g. require less data to train), able to use unlabelled data, and can combine disparate structured and unstructured data including imaging, electronic health data, multi-omic, behavioral and pharmacological data. In addition, healthcare organizations and medical practices will evolve from being adopters of AI platforms, to becoming *co-innovators* with technology partners in the development of novel AI systems for precision therapeutics.

AI in the long term (>10 years)

In the long term, AI systems will become more intelligent, enabling AI healthcare systems achieve a state of precision medicine through AI-augmented healthcare and connected care. Healthcare will shift from the traditional one-size-fits-all form of medicine to a preventative, personalised, data-driven disease management model that achieves improved patient outcomes (improved patient and clinical experiences of care) in a more cost-effective delivery system.

Connected/augmented care

AI could significantly reduce inefficiency in healthcare, improve patient flow and experience, and enhance caregiver experience and patient safety through the care pathway; for example, AI could be applied to the remote monitoring of patients (e.g. intelligent tele health through wearables/sensors) to identify and provide timely care of patients at risk of deterioration. In the long term, we expect that healthcare clinics, hospitals, social care services, patients and caregivers to be all connected to a single, interoperable digital infrastructure using passive sensors in combination with ambient intelligence.

Virtual assistants and AI chatbots

AI chatbots (such as those used in Babylon and Ada) are being used by patients to identify symptoms and recommend further actions in community and primary care settings. AI chatbots can be integrated with wearable devices such as smart watches to provide insights to both patients and caregivers in improving their behaviour, sleep and general wellness.

## VII. PRECISION DIAGNOSTICS (7)

Diabetic retinopathy screening

Key to reducing preventable, diabetes-related vision loss worldwide is screening individuals for detection and the prompt treatment of diabetic retinopathy. However, screening is costly given the substantial number of diabetes patients and limited manpower for eye care worldwide (17). Research studies on automated AI algorithms for diabetic retinopathy in the USA, Singapore, Thailand and India have demonstrated robust diagnostic performance and cost effectiveness (18,19,20,21). Moreover, Centers for Medicare & Medicaid Services approved Medicare reimbursement for the use of Food and Drug Administration approved AI algorithm ‘IDx-DR’, which demonstrated 87% sensitivity and 90% specificity for detecting more-than-mild diabetic retinopathy.

AI-driven drug discovery

AI will drive significant improvement in clinical trial design and optimisation of drug manufacturing processes, and, in general, any combinatorial optimisation process in healthcare could be replaced by AI. We have already seen the beginnings of this with the recent announcements by Deep Mind and Alpha Fold, which now sets the stage for better understanding disease processes, predicting protein structures and developing more targeted therapeutics (for both rare and more common diseases).

## VIII. CHALLENGES AND OPPORTUNITIES OF USING AI FOR IMPROVING HEALTHCARE (22)

Although the advantages of implementing AI in the healthcare industry are evident, there are noteworthy obstacles that require resolution. The following challenges are deemed to be of utmost significance: The ethical implications associated with the integration of AI technology, such as potential

breaches of data privacy and confidentiality, informed consent

and patient autonomy, must be addressed. In the realm of PM, AI, ML and BD analysis, establishing robust data protection regulations to effectively safeguard individual confidentiality, particularly for those receiving medical treatment, is crucial. Furthermore, the accurate analysis by AI algorithms heavily depends on the availability of large amounts of high quality data. Healthcare data are often present in a fragmented manner, lacking interoperability and consistency, which leads to potential issues of completeness and accuracy. Ensuring the quality, accessibility and standardization of data poses significant obstacles. The implementation of AI in healthcare decision-making.

The implementation of AI in healthcare decision-making processes raises a range of ethical questions. A conscientious examination of the transparency and accountability of AI algorithms, potential biases inherent in data and algorithms and the attribution of liability for AI-generated decisions is imperative. The dynamic nature of regulatory frameworks and guidelines aims to tackle these challenges. Furthermore, the process of integrating AI into pre-existing healthcare systems and workflows can be challenging. The successful implementation of AI technologies requires overcoming obstacles such as ensuring smooth integration and compatibility with legacy systems. Additional significant challenges to predict include healthcare system regulations that may limit the full potential of AI technology, as well as understanding the best practices for applying knowledge gained from AI in an ethical and optimal manner.

From a clinical perspective, a considerable issue for healthcare providers will be that they are no longer the sole authorities in medical treatment delivery. They must also respond to patients who, in certain cases, may have an understanding of their medical conditions comparable to that of the experts. Furthermore, healthcare providers may find themselves required to consider insights from an AI program that could be more knowledgeable in certain areas. Nonetheless, in both scenarios, it is the healthcare providers' responsibility to assess the information provided and

administer the appropriate care, which may or may not align with the AI technology's recommendations.

## IX. CONCLUSION

AI has the potential to enhance healthcare service delivery in areas such as illness prevention, early diagnosis and treatment. The provision of health services is already undergoing a transformation. AI applications may be categorized based on the specific objectives they serve and the methods they employ to accomplish these goals. The integration of data from multiple sources, such as wearable devices, genetic information from genome sequencing, electronic health records, radiological imaging and even hospital rooms, has resulted in a surge of valuable data in healthcare. The steps health care organization leaders and policymakers take in the coming years, starting with short-term opportunities to develop meaningful AI applications that achieve measurable improvements in outcomes and costs, will be critical in enabling this future that can improve health outcomes, safety, affordability, and equity.

For AI to directly impact and improve clinical care delivery, a corresponding evidence base is required to demonstrate improved outcomes and the absence of unintended consequences. However, when AI applications extend to prediction, diagnosis and treatment, the evidence threshold should increase significantly, so that the wealth of information provides a fertile ground for AI systems to learn complex patterns, predict outcomes, and support decision making processes that were previously beyond human capability. Successful AI implementation requires addressing key issues such as data quality and accessibility, privacy and ethical considerations and seamless integration. Despite the challenges, the use of AI in healthcare can offer significant benefits, including improved diagnostic precision, personalized care, enhanced efficiency and accelerated medical research. As such, AI has become an invaluable asset in healthcare transformation and holds promise for improving patient outcomes. By adeptly navigating the challenges and leveraging the benefits, healthcare stakeholders can fully harness AI's capabilities to revolutionize healthcare services. Ethical considerations and human rights must be at the

forefront of AI health technology design, development and deployment to benefit public health and medicine

For AI to effectively integrate into healthcare systems, it is essential to eliminate existing biases encoded in the data used to train algorithms. Addressing the digital divide or the unequal distribution of access the use of information and communication technologies is necessary. Global technology corporations are making substantial investments in data collection, big data algorithms and AI implementation. When used appropriately, AI has the potential to empower patients and communities to manage their healthcare and better understand their evolving needs. Of note, all of the revolutions seen today in AI are only the beginning.

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