Next Generation Healthcare

Next Generation Healthcare:

Deep Learning and Blockchain for Precision Clinical Decision-Making

Edited by

Jyotir Moy Chatterjee
and Shubham Mahajan

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Dr. Shubham Mahajan, a distinguished member of prestigious organizations such as IEEE, ACM, and IAENG, boasts an impressive academic and professional background. He earned his B.Tech. degree from Baba Ghulam Shah Badshah University, his M.Tech. degree from Chandigarh University, his Ph.D. degree from Shri Mata Vaishno Devi University (SMVDU) in Katra, India. Currently, he serves as an Assistant Professor at Amity University, Haryana.

Dr. Mahajan has a remarkable track record in the field of artificial intelligence and image processing, holding an impressive portfolio of eighteen Indian patents, as well as one Australian and one German patent. His contributions to the field are further evidenced by his extensive publication record, which includes over 94 articles published in peer-reviewed journals and conferences and 8 edited books. His research interests span a wide array of topics,

encompassing image processing, video compression, image segmentation, fuzzy entropy, nature-inspired computing methods, optimization, data mining, machine learning, robotics, and optical communication. Notably, his dedication and expertise have earned him the 'Best Research Paper Award' from ICRIC 2019, published by Springer in the LNEE series.

In recognition of his exceptional achievements, Dr. Mahajan has received numerous accolades and honors throughout his career. These include the Best Student Award in 2019, the IEEE Region-10 Travel Grant Award in 2019, the 2nd runner-up prize in the IEEE RAS HACKATHON in 2019 (held in Bangladesh), the IEEE Student Early Researcher Conference Fund (SERCF) in 2020, the Emerging Scientist Award in 2021, and the IEEE Signal Processing Society Professional Development Grant in 2021. His commitment to excellence in research was further underscored by his receipt of the Excellence in Research Award in 2023.

Dr. Mahajan's influence extends well beyond academia. He has served as a Campus Ambassador for IEEE, representing prestigious institutions such as IIT Bombay, IIT Kanpur, IIT Varanasi, and IIT Delhi, as well as various multinational corporations. His active participation in fostering international research collaborations highlights his passion for advancing the frontiers of knowledge and innovation on a global scale. Additionally, Dr. Mahajan is a dedicated member of the Technical Program Committee and serves on the Editorial Board for several international conferences and journals.

PREFACE

Healthcare today faces challenges like siloed and fragmented data, delayed clinical insights, and disparate workflow tools due to vendor-locked systems, lack of trust among data holders, and concerns over security and privacy. This book aims to explore the potential of health information and technology, focusing on enabling personalized healthcare through deep learning frameworks. By applying artificial intelligence (AI) to healthcare data, the industry can make incremental progress. However, the main challenge lies in effectively learning from unstructured clinical data without producing erroneous outputs. The book will cover deep learning applications in healthcare, including clinical trials, telemedicine, and health records management, with an emphasis on accurate and reliable algorithms to improve patient outcomes. It invites contributions at the intersection of deep learning, healthcare, and computer engineering.

Chapter 1 set out to demonstrate the possibilities, significant worries, and hazards of AI in healthcare by using real-world examples to back up its claims and to offer policymakers direction on how to create, evaluate, and implement AI systems to achieve policy goals

Chapter 2 explained in detail about how the deep learning (DL), a segment of AI that have tremendous potential to revolutionize the healthcare sector.

Chapter 3 presented an overview of the blockchain process and explores its usage in the healthcare while focusing on its ability to enhance data integrity, data management, and operational efficiency, it also highlights several successful blockchain implementations in healthcare, including pilot projects and commercial solutions, and identifies key areas for future research.

Chapter 4 intended to delve deeper into the available datasets as well as the DL approaches for Parkinson disease (PD) detection for different modalities and also the performance parameters are mentioned that assist in validating the potential of the DL approaches in performing the early diagnosis.

Chapter 5 concentrated on the application of advanced DL for analyzing the results for accuracy and increasing the ability to predict patient outcomes using a large dataset of electronic health records (EHR) and medical imaging from heterogeneous patient populations.

Chapter 6 aimed to investigate the potential of leveraging natural language processing (NLP) techniques on unstructured EHR data to aid in the early detection and management of Alzheimer's disease.

Chapter 7 presented an analysis of virtual reality (VR) and augmented reality (AR) technologies, examining their characteristics, applications, and potential impact across various domains including healthcare.

Chapter 8 provided a transformative trajectory towards smart urban ecosystems, even as urban centers struggle with growing populations and tremendous infrastructure, resource management, and service delivery issues and the healthcare infrastructure.

Chapter 9 aimed to employ both machine learning (ML) and DL approaches to classify the subjects into PD and healthy controls by utilizing a trustworthy dataset from the UCI repository to evaluate the performance of each approach.

Chapter 10 aimed to decode how novel technologies can offer a quicker and effective solution to identifying and preventing billing fraud in the Indian healthcare system by using DL.

Chapter 11 focused on the revolutionary changes AI is bringing to telemedicine in patient registration, appointment scheduling, medical billing, and more.

Chapter 12 investigated the emergence of blockchain and DL technologies through healthcare social enterprise.

Chapter 13 examined the usage of the YOLOv8 Nano model in polyp segmentation on medical images, specifically within the context of a colonoscopy.

Chapter 14 introduced a DL framework that uses the popular U-Net architecture for polyp segmentation in colonoscopy images.

Chapter 15 discussed the feasibility of applying the YOLOv8 DL model to the segmentation of brain tumors from MRI scans.

Chapter 16 discussed how AI helps construct diversity in the healthcare sector, which is critical to the provision of health services aligned to cultural requirements of the patient.

Jyotir Moy Chatterjee, India & Nepal
Dr. Shubham Mahajan, India

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I would like to acknowledge the most important people in my life, that is, my Grandfather late Shri. Gopal Chatterjee, Grandmother late Smt. Subhankori Chatterjee, Father Shri. Aloke Moy Chatterjee, Mother late Ms. Nomita Chatterjee, and Uncle Shri. Moni Moy Chatterjee. This book has been my long-cherished dream which would not have been turned into reality without the support and love of these amazing people. They have continuously encouraged me despite my failure to give them proper time and attention. I am also grateful to my friends, who have encouraged and blessed this work with their unconditional love and patience.

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Editing this book has been a journey of collaboration, dedication, and discovery, and I am deeply grateful to everyone who has supported and inspired me along the way.

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Thank you all for being part of this endeavor.

Dr. Shubham Mahajan
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CHAPTER 1

ARTIFICIAL INTELLIGENCE: IS THIS THE FUTURE OF THE HEALTH CARE INDUSTRY?

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Abstract: This study set out to demonstrate the possibilities, significant worries, and hazards of AI in healthcare by using real-world examples to back up its claims and to offer policymakers direction on how to create, evaluate, and implement AI systems to achieve policy goals. An unsystematic examination and evaluation of peer-reviewed and gray literature on artificial intelligence in the health sector, explicitly emphasizing significant findings for policy and governance. The application of artificial intelligence in the healthcare sector is now in its early stages. Most applications have not been extended beyond the research setting. The utilization of this technology in practical clinical environments is now in its nascent phase, with a more significant body of evidence accessible in the domains of public health, biomedical research, and administrative duties that do not directly pertain to patient care. Integrating artificial intelligence into healthcare involves inherent risks and hazards that need meticulous deliberation. They are efficiently managed by policymakers employing proactive strategies. To optimize the production of beneficial health and policy outcomes using AI, it is

advisable to concentrate on five fundamental policy domains. These topics encompass the management of health data, the application of AI principles, flexible laws, improving the expertise of healthcare workers and patients, and creating intelligent public investments. Artificial Intelligence is not a panacea but a specialized tool for addressing specific problems. Effective development and implementation of AI require data governance that ensures the accessibility and protection of superior-quality data. Additionally, it necessitates that those significant stakeholders possess the means to utilize technical infrastructure and resources, legal frameworks that endorse reliable AI solutions, and the empowerment of healthcare workers and patients. Ability to effectively and efficiently use AI products and services while ensuring safety. Substantial financial commitment and international cooperation are essential for all these undertakings.

Keywords: Artificial Intelligence, Health Care, Governance Policy, Technology, Legal Framework

1 Introduction

Artificial intelligence (AI) refers to computer systems that can learn and make decisions in some ways similar to humans but with significantly different overall behavior. Taken together, artificial intelligence has been a goldmine of ideas for sci-fi writers and futurists for almost a century. Modern computing and massive data have made this a reality, and machines are seeing heavy use across many industries. The broad usage of AI technology benefits personal, corporate, and national success. Artificial intelligence has started to outperform humans in several cognitively demanding activities.

The artificial intelligence (AI) ecosystem includes robotics, ANNs, and ML. Machine learning aims to train computers to recognize patterns in new data or extrapolate patterns from existing data. Robotics is the science and art of designing, building and programming artificial intelligence systems. Predicting how a robot would behave around people and other objects is usually straightforward.

Nevertheless, there are continuing efforts to train robots to be more self-aware and situationally aware by utilizing deep learning [45] and developing ANNs to create a system that could mimic brain activity. Natural language processing (NLP) is concerned with the computational analysis and manipulation of human language.

In recent decades, improving AI's capacity for language, mathematics, and logic has been a primary focus of research and development. Emotional intelligence, however, is the focus of the next generation of AI research and development intelligence. Simultaneously, Google's DeepMind's sequential learning capability lets Ais pick up various abilities. Deep learning has become more prevalent in recent years, and for good reason: it helps robots understand the physical world, which is helpful for a wide range of activities in many different sectors.

China's recent investments in artificial intelligence (AI) have been substantial among the world's top economies. Venture capitalists' (VCs') keen interest in investing in AI start-ups is one of the leading forces propelling the present surge of AI growth. Quickly improving computer power is driving the sector to the next level in terms of technology.

There is a correlation between the rise of AI and the prevalence of open-source platforms that facilitate and promote collaborative learning. The ubiquitous availability of big data drives the current wave of growth in the AI business almost as much as software and technology. There will be 163 trillion gigabytes of big data produced by today's increasingly digital economy by 2025, an increase of 40% annually.

Using statistical and mathematical modeling approaches to a set of human-defined objectives, AI systems may influence actual or virtual environments through forecasts, suggestions, or judgments [1]. These systems can be partly or fully autonomous. Healthcare increasingly uses health and welfare technologies based on artificial intelligence for screening and early detection, health tracking, and precise treatment. There is mounting evidence that public health agencies' disease surveillance and response systems can benefit from AI applications based on machine learning [2]. Improvements in patient health and well-being and communication among patients, caregivers, and healthcare professionals can be achieved via intelligent technologies, such as sensors and wearable textiles, to track individuals with chronic conditions [3].

Facilities and home-based care can all benefit from medical AI technology, especially in rural areas or areas with limited resources [4,5]. Incorporating or utilizing the reasoning and analytics capabilities of AI technology into current patient information databases can aid in

better decision-making, which in turn can lessen the likelihood of incorrect diagnoses and mismanagement of health resources, improve healthcare worker-patient collaboration, and provide more personalized treatment to patients [6, 7]. This is similar to how enhanced business analytics, device-level process automation, and patient-centered care delivery are all improved by embedded AI technology.

2 How AI Stimulates the Human Brain

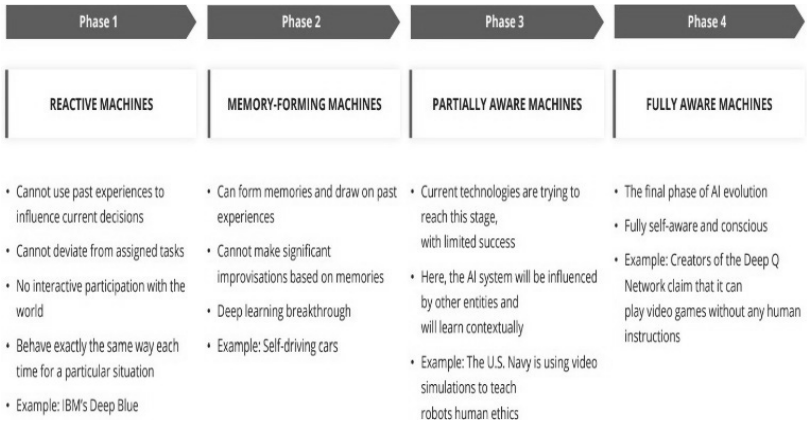

Fig. 1-1 Current Artificial Intelligence Ecosystem
Source: McKinsey; Stanford; Next Move Strategy Consulting

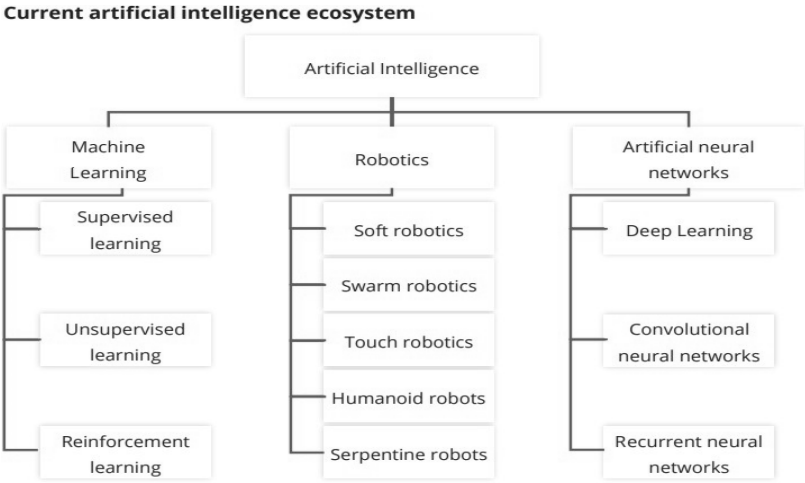

Fig. 1-2 Evolution of AI: A Reactive State to an Aware State
Source: PwC; McKinsey

1.1 Deployment of AI Across Industries

Artificial intelligence is improving people's lives, businesses, and society. Artificial intelligence (AI) provides the automation that many nations are missing to sustain their economies in the face of dwindling labor force participation while increasing productivity on an extensive and local scale.

Using various forms of AI technology is helping small businesses in many ways, including reducing labor expenditures, increasing throughput, improving quality, and decreasing downtimes. We may expect widespread productivity gains as a result of automation. Despite a mere 1% increase in robot density in 2019, productivity rose by 0.8% across all industries, according to a government-sponsored report by the 2020 trade summit Select USA. The most significant gains were in sectors that had only recently begun to use robots.

Although this growth is anticipated for every nation, some are expected to witness significantly greater activity than others. Based on their World Robot Report for 2021, the International Federation of Robotics (IFR) determined the top five nations based on robot density in production. The nations in question are Germany, Sweden, South Korea, Singapore, and Japan. Regarding market share, Asia ranks first, followed by North America and Europe.

The critical healthcare business is only one of several that have benefited from the rapid development and widespread use of artificial intelligence in recent years [8]–[10]. There are already numerous areas where AI has automated the manual health system; in some cases, humans are only needed for the most basic tasks related to patient and resource management [11]–[13], while AI components take care of more complex procedures. [14],[15],[12], and [16] are among the publications that discuss the fast development of AI-based healthcare systems, especially for diagnostic and early detection purposes.

Thanks to these advancements, AI can now do hitherto human-only jobs with more ease, speed, dependability, and efficiency—all at a lower cost—than humans can [17], [18]. The digitalization of healthcare can help technological progress overcome extra difficulties when IS developers can successfully construct AI systems to carry out specific activities [19]. For instance, according to research [15], [20], [21]. AI has the potential to save healthcare costs while improving patient care. The demand for healthcare services is expected to rise in response to the expanding human population. Consequently, the healthcare industry needs cutting-edge AI solutions to boost efficiency and effectiveness without increasing prices [22]. In this regard, AI remains at the forefront of offering ground-breaking solutions. Recent developments in artificial

intelligence (AI) and other areas of fast technology have helped with healthcare sector growth management [11], [23].

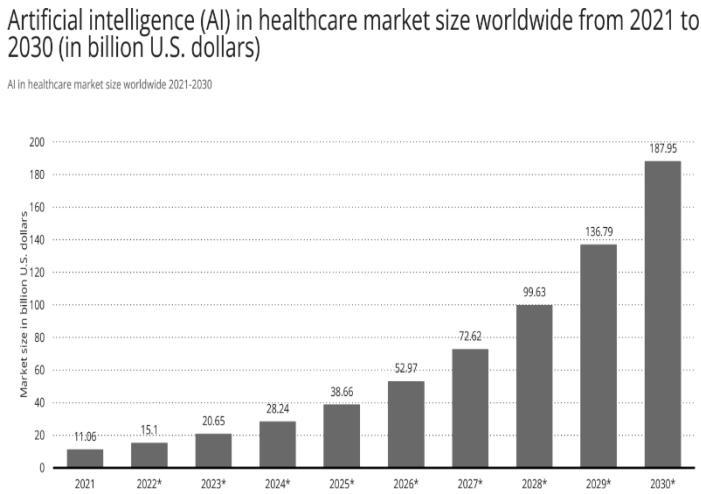

Fig.1-3 AI & Health Sector Future Trend:
Source: Precedence Research

1.2 Adoption of AI in the Health Sector

[24], [25] and [26] note that thanks to recent AI breakthroughs, robots, machine learning systems, and big data may be used to monitor, detect, and measure healthcare-related risks and benefits. Because they facilitate process improvement and medical service management, medical data and analytics play an essential role in healthcare. There has been a meteoric rise in the amount and type of medical data gathered in the last several years. Patients, researchers, and medical professionals create vast quantities of data every day. This data comes from various sources, including electronic health records (EHRs), medical imaging, and different monitoring devices, including health-tracking applications and gadgets. More and more people use these gadgets daily, even when they do not need medical treatment [18], [27], [28]. In this context, AI has the potential to gather data, process it, undertake dynamic analyses, and offer healthcare organizations valuable insights [11]. According to [29] and [30], machine learning algorithms often rely on data storage and processing power to accomplish this task. For example, reliable predictions may be attainable by the regular observation of medical data,

which may reveal trends in patient behavior. Therefore, AI may be able to prevent patients' illnesses from worsening and suggest medical actions, therapeutic insights, and ways to minimize health deterioration. This can enhance patient outcomes, including diagnosis, treatment, and drug utilization. [17], [18] and [31] are only a few examples of recent studies that have looked at the possibility of artificial intelligence (AI) helping modern medical institutions cut operational expenses and improve practice accuracy.

By offering thorough information about available solutions, artificial intelligence aids clinicians and patients in making knowledgeable treatment decisions [32]. There is reason to be hopeful about AI's future. However, we also cannot disregard its challenges, such as the difficulties of incorporating AI solutions relying only on machine learning into healthcare settings. According to several recent studies [33]–[36], potential patient injury due to system faults is a significant new concern. AI in healthcare decision-making raises additional problems related to ethics, law, and medicine.

Even though AI has many drawbacks, it also has a lot of good purposes. One of the biggest is helping with healthcare preventative care, essential for individuals of all ages to get and remain healthy. [27], [37], [38] all found that people with preventive health disorders, such as type 2 diabetes and high blood pressure, could use apps to make evidence-based decisions. However, early health data identification and diagnosis require several AI applications [39]– [41]. When it comes to making reliable diagnoses quickly and accurately, medical practitioners depend on these AI apps [9], [42], [43]. By comparing a patient's information with digital photographs and data from massive databases that hold information about other patients in similar and comparable circumstances, AI may do comprehensive comparison analysis using Big Data. This is the most basic kind of AI. [29], [30] state that this self-learning process can detect patterns and provide physicians with evidence to support their diagnoses and treatment strategies. In addition to facilitating these complex processes, artificial intelligence (AI) technology can improve medical care administration [32].

This extensive research [44] covers the methodology, characteristics, benefits, and downsides of artificial intelligence (AI) in healthcare. We need further study in AI theory and practice to fully understand these aspects of AI. Several intriguing new findings regarding artificial intelligence are cropping up, including how AI can regulate doctors' rights and duties, privacy issues related to AI, and the optimal approach for AI to manage patients' and ethics committees' approval when storing,

processing, editing, and sharing their medical records. Governments should enact legislation to guarantee the security of patients' medical records. Although there are ethical considerations to bear in mind, machine learning and expert systems also utilize raw patient and hospital data. Standards for technology development and health applications are necessary for the optimal use of artificial intelligence (AI) in healthcare. This review article aims to accomplish just that by outlining the latest AI healthcare applications and proposing a taxonomy to classify AI's benefits, drawbacks, approaches, and characteristics in healthcare.

3 Conclusion

Machine learning, the Internet of Things (IoT), algorithms, and robots are all examples of artificial intelligence (AI) techniques utilized in the healthcare industry. These tools help monitor, diagnose, treat, and assess risks and rewards.

Healthcare companies rely heavily on medical data and analytics to streamline operations and improve medication delivery. This review covers all aspects of artificial intelligence (AI) in healthcare, including its benefits, drawbacks, methods, and characteristics. As this assessment shows, people, companies, and the healthcare sector all benefit from artificial intelligence and related areas. This category includes issues about patient safety, privacy, data integration, and legal requirements. This extensive study found that several different types of artificial intelligence (AI) are often used in the health business. These include data mining, expert systems, machine learning, data science, computer vision, virtual reality, and image processing. Among the many uses of AI in healthcare are remote surgery, consultations, security, data collection, treatment, and diagnostics. This literature analysis provides valuable insight into the current landscape of AI research and its potential healthcare applications.

This review study had practical consequences for practice in guiding future research and healthcare policymakers. The importance of determining whether the benefits of AI outweigh the risks in healthcare cannot be overstated. The results of this literature review indicate that AI may significantly enhance healthcare.

Strict regulations govern the healthcare business. Therefore, analyzing the dangers of actual and perceived data integrity breaches, privacy issues, and safety concerns related to AI in healthcare is crucial. As a result, several businesses are attempting to secure patient data by enacting stricter rules.

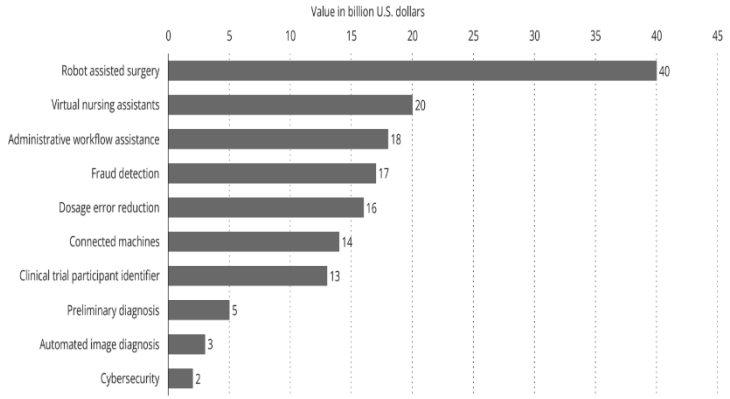

Fig. 1-4 Future Trends of AI Applications in 2026
Source: Precedence Research

Artificial intelligence (AI) can revolutionize many facets of health and social care, including clinical practice, public health, biological research, and administration. With the intelligent use of AI and other digital technologies, there are chances to make existing administrative and healthcare systems more effective, efficient, and equitable. Since almost 20% of healthcare spending is either needless or harmful, there is a tremendous opportunity to make a change.

Unfortunately, reliable data about the ROI of AI in healthcare is still lacking. Furthermore, funding should be set aside to conduct thorough evaluations of AI goods and services' financial and health benefits in contrast to the existing healthcare models.

In decision-making and recommendation-making, most applications these days are not highly feature-rich. We are still in the early stages of development, so features like frequent use and scalability will be added later. Many AI training efforts fail due to a combination of factors, including the complexity of medicine, a shortage of high-quality, freely available personal health data, and barriers to integrating general-purpose technology in the health sector. Sometimes, AI techniques seem to make things worse rather than better.

Although artificial intelligence (AI) is not a panacea, it may solve some problems. Thus, governments should proceed with care regarding its appeal. If lawmakers are serious about facilitating the health industry's AI development and implementation, they must address the fundamental challenges. In the long run, this will benefit human health and advancement. To make this happen, we need to ensure that the right

people have access to the right technology and that consistent data governance is in place to ensure that high-quality data is available and secure. Appropriate legislative frameworks and promoting trust in the technology among all stakeholders, including healthcare providers, patients, and the broader public, are prerequisites for implementing consensus-based global AI standards, such as the OECD Principles on AI. Being well-versed in the proper implementation and effective utilization of AI is essential for healthcare practitioners and patients since they will be the principal end users of AI in healthcare. We must invest heavily in AI and collaborate across borders to ensure its benefits outweigh its drawbacks.

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The authors have no competing interests to declare relevant to this article's content.

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