International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 30, Issue 9, September 2024 **ijppr.humanjournals.com** ISSN: 2349-7203

Artificial Intelligence (AI) in Healthcare

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Received: 2024-09-07 Revised: 2024-09-15 Accepted: 2024-09-20

ABSTRACT

Artificial intelligence (AI) has been developing rapidly in recent years in terms of software algorithms, hardware implementation, and applications in a vast number of areas. In this review, we summarized the latest developments of applications of AI in biomedicine, including disease diagnostics, living assistance, biomedical information processing, and biomedical research. The aim of this review is to keep track of new scientific accomplishments, to understand the availability of technologies, to appreciate the tremendous potential of AI in biomedicine, and to provide researchers in related fields with inspiration. It can be asserted that, just like AI itself, the application of AI in biomedicine is still in its early stage. New progress and breakthroughs will continue to push the frontier and widen the scope of AI application, and fast developments are envisioned in the near future.

Keywords: Artificial intelligence, Machine learning; Deep learning, Neural network, Biomedical research, Healthcare applications Epileptic seizure, Urinary bladder filling.

INTRODUCTION

Artificial intelligence (AI) is defined as the intelligence of machines, as opposed to the intelligence of humans or other living species [1], [2]. AI can also be defined as the study of "intelligent agents"—that is, any agent or device that can perceive and understand its surroundings and accordingly take appropriate action to maximize its chances of achieving its objectives [3]. AI also refers to situations wherein machines can simulate human minds in learning and analysis, and thus can work in problem solving. This kind of intelligence is also referred to as machine learning (ML) [4].

Typically, AI involves a system that consists of both software and hardware. From a software perspective, AI is particularly concerned with algorithms. An artificial neural network (ANN) is a conceptual framework for executing AI algorithms. [5] It is a mimic of the human brain—an interconnected network of neurons, in which there are weighted communication channels between neurons [6]. One neuron can react to multiple stimuli from neighbouring neurons and the whole network can change its state according to different inputs from the environment [7].

AI is now capable of doing activities that people are often unable to complete with the speed, simplicity, reliability, and diligence that AI can provide at a lower cost [**10**,11]. According to Tobore et al. [**12**], technical progress made possible by the digitization of healthcare can help overcome extra problems if developers of information systems (IS) are able to successfully create AI systems to carry out certain jobs [**13**]. For instance, AI has the potential to greatly improve patient care as well as reducing costs associated with healthcare [**08,14,15**]. The ever-increasing human population is projected to raise the demand for medical services to be given at a rapid pace; hence, innovative AI solutions are required in the medical sector in order to increase both efficacy and effectiveness without a corresponding rise in expenses [16,17]. In this particular domain, AI continues to play a pioneering role in providing novel solutions [18].

Recent rapid technological breakthroughs, in particular in the field of AI, have already aided the management of the growth of the medical sector. Recent AI technologies include big data, algorithms for learning applications, and robots. These technologies are used in the healthcare business to track, identify, and assess hazards as well as advantages [19,20,21] The healthcare industry places a significant emphasis on medical data and analytics as a means to strengthen processes and make the administration of medical services more straightforward. In recent years, the amount of medical data that has been obtained as well as their dimensions have increased at an exponential rate. For instance, healthcare providers, scientists, and healthcare consumers create enormous quantities of data from multiple monitoring devices which people are growing to utilize in ordinary situations aside from the need for medical attention [22, 23,24].

2. Genetics-based solutions

It is believed that within the next decade a large part of the global population will be offered full genome sequencing either at birth or in adult life. Such genome sequencing is estimated to take up 100–150 GB of data and will allow a great tool for precision medicine. Interfacing the genomic and phenotype information is still ongoing. The current clinical system would need a redesign to be able to use such genomics data and the benefits hereof [26].

Deep Genomics, a Healthtech company, is looking at identifying patterns in the vast genetic dataset as well as EMRs, in order to link the two with regard to disease markers. This company uses these correlations to identify therapeutics targets, either existing therapeutic targets or new therapeutic candidates with the purpose of developing individualized genetic medicines. They use AI in every step of their drug discovery and development process including target discovery, lead optimization, toxicity assessment, and innovative trial design.

Many inherited diseases result in symptoms without a specific diagnosis and while interpreting whole genome data is still challenging due to the many genetic profiles. Precision medicine can allow methods to improve identification of genetic mutations based on full genome sequencing and the use of AI.

3. Drug discovery and development

Drug discovery and development is an immensely long, costly, and complex process that can often take more than 10 years from identification of molecular targets until a drug product is approved and marketed. Any failure during this process has a large financial impact, and in fact most drug candidates fail sometime during development and never make it onto the market. On top of that are the ever-increasing regulatory obstacles and the difficulties in continuously discovering drug molecules that are substantially better than what is currently marketed. This makes the drug innovation process both challenging and inefficient with a high price tag on any new drug products that make it onto the market [27].

There has been a substantial increase in the amount of data available assessing drug compound activity and biomedical data in the past few years. This is due to the increasing automation and the introduction of new experimental techniques including hidden Markov model based text to speech synthesis and parallel synthesis. However, mining of the large-scale chemistry data is needed to efficiently classify potential drug compounds and machine learning techniques have shown great potential.

4. Conclusions

AI technologies are being used for a range of healthcare applications. These technologies have been developed to support medical imaging and diagnostic services, fight the pandemic, provide virtual patient care, increase patient engagement and adherence to treatment plans, reduce the administrative burden on healthcare professionals, drive drug and vaccine innovation, monitor the compliance of patients with exercises, and carry out gait analyses used in technology-assisted rehabilitation. However, AI also faces various technical, ethical, and governance challenges as it moves forward in healthcare. It raises data security- and privacy-related issues because it utilizes sensitive and confidential data bound by legal panels. The use of AI in addressing challenges could be limited by the quality of existing health data and AI's failure to reflect certain human characteristics, such as compassion. AI is more beneficial while functioning efficiently; however, it cannot replace the human connections that form teams. Human functions such as teamwork and team management are not possible-to-achieve goals, since machines cannot form a bond with humans. A key challenge to be solved for the future governance of AI technologies will be to confirm that AI can be developed and implemented in a way that aligns with people's interests and takes into account technical, ethical, and social aspects. This study adds to the existing literature compiling the application of AI in medical imaging and diagnostics, virtual patient care, medical research and drug discovery, patient engagement and adherence, rehabilitation, and other administrative applications. Additionally, this is the latest update in the literature to address the ethical, social, governance, and technical challenges that HCPs face in adopting AI in healthcare.

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How to cite this article:
Swarup Rupesh Pingale. Ijppr.Human, 2024; Vol. 30 (9): 239-241.

Conflict of Interest Statement: All authors have nothing else to disclose.