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ARTIFICIAL INTELLIGENCE IN MEDICAL DEVICE AND HEALTH CARE SECTOR

G. RAMYA BALAPRABHA[1], G. JHANSIRANI[2], A. MEENAKSHI[2], AV RAJEEZ[2] AND T. RAMARAO[3]

1: CMR College of Pharmacy, Hyderabad, India

2: Department of Pharm D, CMR College of Pharmacy, Hyderabad, India

3: CMR College of Pharmacy, Hyderabad, India

*Corresponding Author: Dr. G. Ramya Balaprabha: E Mail: ramyapharmd66@gmail.com

ABSTRACT

Medical technology based on artificial intelligence (AI) is growing quickly. The creation of deep neural networks, machine learning, natural language processing, robotics and medical imaging was a major artificial intelligence project in the new year. In the upcoming ears, it is anticipated that artificial intelligence will replace a large number of the health services currently rendered by administrators and clinicians. Almost every aspect of behaviour and healthcare, including clinical decision-making, healthcare administration, interventions, patient monitoring, research and more, benefits from the application of artificial intelligence (AI) technology and strategies. The importance of artificial intelligence to the healthcare and medical device industries will be discussed in this review.

Keywords: Artificial intelligence, Digital health, Medical imaging

INTRODUCTION

For many years, society has been enthralled by artificial intelligence (AI) and its promise to enhance our quality of life. Artificial intelligence already permeates every aspect of

our everyday lives, including our interactions with media, transit, and communications. The use of AI in healthcare to enhance illness detection, treatment, and the creation of potent medications is gaining traction.

Artificial intelligence refers to computer programs that mimic or display particular traits of human intelligence or intelligent behavior, like thinking, problem-solving, and learning [1]. Artificial intelligence also refers to scenarios in which machines may replicate human minds in learning and analysis, allowing them to solve problems [2]. The potential of AI in healthcare is vast, with applications ranging from medical imaging to predictive analytics to patient interaction and clinical decision support systems [3]. This method is increasingly being used in pharmaceutical, medical device, and healthcare industries to assist with different stages of research and development as well as patient treatment [4]. AI's predictive powers enable early disease identification and personalized treatment, leading to better patient outcomes. As AI integrates with human expertise, a new era of intelligent healthcare systems is expected, promoting a healthier world population.

ARTIFICIAL INTELLIGENCE:

AI is not a single technology but a range of computational models and algorithms which are directly concerned with health care. Machine learning, Deep learning, Neural networks are subsets of Artificial intelligence.

1.**Machine learning: The Powerhouse Behind Artificial Intelligence**

Machine learning is a statistical technique for fitting models to data and to 'learn' by training models with data [5]. In healthcare, the most common application of traditional machine learning is precision medicine – predicting what treatment protocols are likely to succeed on a patient based on various patient attributes and the treatment context [6]. Neural network, a more advanced form of machine learning, was developed in the 1960s to predict disease development in patients, resembling neurons in processing signals but with less functionality [7].

ML itself may be categorised as 'supervised', 'unsupervised', 'semi-supervised' and 'reinforcement learning' (RL), and there is ongoing research in various sub-fields including 'semi-supervised', 'self-supervised' and 'multi-instance' ML.

Supervised learning is a machine learning technique that applies prior learning to a new data set by labeling the training data with correct answers. It improves efficiency by learning from mistakes. Unsupervised

learning uses data without labels for independent learning, allowing complex tasks and erratic learning. Semi-supervised learning combines supervised and unsupervised learning, using labeled and unlabelled data. Reinforcement learning, a widely used type of AI, involves computational agents learning through trial and error or expert demonstration, maximizing rewards [8-11].

2.Deep learning (DL): It is a subset of machine learning. Artificial neural networks, which are algorithms inspired by the human brain, learn from large amounts of data. The term 'deep learning' comes from the fact that neural networks have multiple layers that facilitate learning [12].

3.Neural Networks: Artificial neural networks, also known as neural networks, are machine learning algorithms that mimic the human brain's functions to identify data links. They consist of layers of nodes activated by sufficient stimuli, which mix input with weights, influencing the learning method [13].

Areas where AI is used in health care:[14]

1.For Disease Predictive Analysis

•Learns from prior patterns to predict human health., Early illness detection and diagnosis, Detection of morbidity to anticipate disease

2.To enhance the therapy options

•Treating patients by matching their care to medical recommendations, Look for unanticipated patterns in treatments, Estimate a drug's effectiveness.

3. For Medical Care and Drugs

•Clinical Tests, Health Imaging, Digital medical records, Managing medical data and records, In order to develop and supply

4.To monitor patients in real time

•Automatic data capture and input, Regular patient surveillance, Customisable early warning scores

APPLICATIONS OF AI IN HEALTHCARE:

Al is utilized in key medical fields like treatment design, medication development, skin cancer categorization, MRI scans, and aided surgery, with strong data management being crucial for transforming healthcare [15].

PRECISIONS DIAGNOSIS:

AI in oncology: AI is rapidly being used in clinical oncology to harness the power of the electronic health record (EHR).AI-based natural language processing approaches, in particular, have shown promise in forecasting illness progression across vast healthcare systems. A DL-based AI program modelling EHR developed by a Mount Sinai group was able to predict the development of a arrange of diseases with 93% accuracy overall, including malignancies of the prostate, rectum, and liver [16].

i) Artificial Intelligence in Dermatology: One of the early articles demonstrating the promise of deep learning in cancer imaging was in the diagnosis of skin cancer based on pictures of the skin [17]. A CNN trained on 130,000 skin photos outperformed 21 dermatologists in sensitivity and specificity, demonstrating the evolution of practical applications for detecting skin pathology [18]. CNNs have been used for automatic detection of polyps during colonoscopy, with a 94% sensitivity in detecting clinically significant regions, according to a study trained on 1,290 colonoscopic pictures from 1,290 patients [19].

ii) Artificial Intelligence in Breast cancer: Breast cancer detection and staging are two instances where AI applications may actually outperform human assessments. In research by Bejnordi *et al.*using a training set of 129 slides (49 with metastases to lymph nodes and 80 without), the system actually outperformed 11 diseases in terms of diagnostic performance. Furthermore, the pathologists required 30 hours to examine all 129 slides, despite the algorithm's operating time being assumed to be insignificant [20].There are 30 AI algorithms for breast imaging that have received FDA approval as of this writing, according to the American College of Radiology Data Sciences Institute's (ACRDSI) AI Central, and they are split up as follows: (i) nine for the identification of breast lesions in mammography; (ii) ten for the estimation of breast density in mammography; (iii) one for the enhancement of picture quality in mammography; (iv) three for the identification of breast lesions in ultrasound; and (v) two for the identification of breast lesions in MRI [21].

iii) Artificial intelligence in Lung cancer: AI algorithms have been found to be more accurate than manual diagnosis in identifying lung cancer, according to a study by Yu *et al*., using 2,186 whole-slide image histopathology studies. This could guide oncological treatment choices and improve patient care. Additionally, a CNN technique was used to predict adverse effects of polypharmacy combinations, highlighting the potential of AI in cancer treatment [23]. This study resulted in the identification of at least five unique drug-drug interaction predictions, all of which were later shown to have supporting literature data. The use of artificial intelligence to anticipate radiation harm has sparked considerable interest in recent years [24]. In order to predict urinary and rectal toxicity resulting from prostate radiotherapy [25, 26, 27], hepatobiliary toxicity following liver radiotherapy [28], and rectal toxicity for patients receiving radiation therapy for

cervical cancer **[29]**, basic neural networks, CNNs, and other machine learning techniques have been investigated using clinical and dosimetric data.

AI in cardiology: Machine learning and AI are revolutionizing cardiology by improving diagnosis and interpretation of conditions like myocardial infarction, ventricular arrhythmia, and myopathies. Advanced imaging techniques like echocardiography and SPECT imaging can measure cardiac function. **[30]**. Ortiz *et al*. in 1995 leaded the way to the application of AI tools in the field of heart failure (HF). They used a neural network method, based on echocardiographic data, to assess a one-year prognosis in a HF patient. Their work concluded that neural networks could more accurately predict outcomes than linear discriminant analysis (accuracy of 90% and sensitivity of 71.4% vs 67.4% and 67.5%, resp.) **[31]**.

AI in radiology AI is increasingly being used in medicine, particularly in radiology, due to advancements in image-recognition tasks and increased digital data. This has led to quicker diagnosis, better disease visualization, emergency notifications, and personnel shortage assistance. However, the goal should not be to replace human radiologists, but to complement and provide applications that emphasize information not available through human vision or deliver knowledge in a shorter time **[32]**.

AI in Psychology: AI in psychiatry uses advanced computational techniques like automated language processing and machine learning algorithms to assess patients' mental states beyond self-reports. It has transformed mental healthcare, influencing physicians' diagnoses, predictions, and treatments. Latent semantic analysis (LSA), a natural language processing technique, is beneficial for psychiatrists, supplementing human clinical judgments and minimizing false-negative and false-positive diagnostic rates **[33, 34]**. AI technology is being used to study sadness and anxiety in chatbots, while Right Eye LLC has developed an AI-powered autism experiment to identify early-stage autism spectrum disorder using eye tracking technology **[35]**.

AI IN MEDICAL RESEARCH:

AI can analyze large datasets, identify patterns, and locate relevant scientific literature. It aids in matching patients for clinical investigations, aiding medical research. AI can also aid in early detection of epidemic causes and infectious disease outbreaks, and anticipate negative medication effects **[36]**.

Precision Therapeutics

Researchers worldwide are gathering multimodal datasets to study disease cellular

and molecular causes, developing digital and biological indicators for diagnosis, severity, and progression. AI is being used in drug discovery and immunomics/synthetic biology for crucial applications [37].

-Genetic engineering and immunology

AI tools on multimodal datasets could help understand disease cellular basis, clustering, and patient populations, enabling personalized preventive strategies. Immunomics could diagnose and predict care, particularly in cancer, neurological disorders, and uncommon diseases, enhancing patient experience [37].

AI empowered healthcare professionals

Healthcare professionals will use AI to enhance their care, providing safer, standardized, and more effective services. They can use AI digital consults to examine digital twin models of patients, testing the effectiveness, safety, and experience of interventions before delivering them in the real world, such as cancer drugs [37].

Personalized medicine Artificial Intelligence techniques are crucial in personalized medicine for precision in disease discovery, treatment, and administration. They control adverse drug reactions and enzyme metabolism, preventing overdose and preventing drug elimination before it works. [38].

Drug discovery:

AI has transformed drug discovery by significantly accelerating the process of identifying potential drug candidates and optimizing drug development. Here are some key aspects of AI in drug discovery [39]. Target identification, drug design and optimisation, virtual screening, drug-drug interactions, personalised medicine, understanding disease biology adverse events prediction, optimising clinical trial designs, data integration and knowledge sharing.The incorporation of artificial intelligence (AI) in drug discovery has the potential to minimize the time and expense associated in creating new treatments, making the process more efficient and expediting the translation of findings from the lab to the clinic. However, it is critical to acknowledge that AI models require validation and constant modification in order to ensure their dependability and safety.

Patient monitoring

The adoption of electronic health records and proliferation of smartphones and fitness monitoring devices has created unprecedented access to digital data and the potential to exploit AI techniques for monitoring patients [40]. As a result, we have details on patients' sleep patterns, BP, PR and other measures in ways that we never had before. In addition to

these advancements, we have had increases in other settings as well. For example, waveform pattern learning can improve monitoring and analysis of electrocardiographs, electroencephalographs, electromyographs and Doppler ultra-sounds in hospitals **[41]**. AI-enabled software can be used in intensive care units for cardiovascular and respiratory monitoring through the interpretation of vital signs. After a hospital visit, health services can use natural language processing-enabled virtual assistants to communicate appropriate health and medication information and schedule follow-up visits for patients **[42]**. The use of such virtual health assistants has been found to increase medication compliance and reliable follow-up **[43]**.

Advantages of using AI in healthcare:

1. AI will assist in managing hospital records, a laborious task that will become quick and effective with its aid.

2.Diseases will be diagnosed more quickly and accurately than by a doctor, allowing for quicker treatment.

3. Real-time data will make healthcare decision-making considerably simpler with the use of artificial intelligence.

4. AI will make it simple to track specific patient data, aiding in treatment.

5. AI can mitigate human labour requirements and free up their attention for other productive tasks, such as attending to patients' vitally crucial mental health.

6. With the aid of AI, administrative work will be completed much more quickly and effectively, saving money, which accounts for 30% of healthcare costs.

7. Wearable medical gadgets using AI will make it possible to identify issues more quickly than with traditional methods.

8. AI will lower the cost of healthcare, enabling everyone to access basic medical services.

9. The usage of artificial intelligence will shorten the time required for diagnosis and treatment.

10. Artificial intelligence significantly reduces errors and enhances accuracy and precision through data-driven decisions and algorithms, which can be completely eliminated when properly coded.

11. AI can save medical professionals time on administrative tasks like record maintenance, scan analysis, and data entry, allowing them to focus on patient care.

Disadvantages and challenges of using AI in healthcare:

1.AI is excellent at carrying out precise programmed commands, but it still needs medical input. It is not yet able to operate independently which still need human support.

2. AI model training requires extensive input, including health data. Insufficient or incomplete data can lead to unrepresentative results, such as social discrimination and small samples, affecting the target population.

3. Robots are replacing human interference in repetitive tasks, impacting employment standards and replacing skilled workers with AI-powered robots.

4. To fulfil the most recent requirements, hardware and software must be upgraded over time. The cost of maintaining and repairing the machine is also significantly higher.

5. Robots' programming, stored in their internal circuit, allows them to perform tasks but prevents them from acting differently or using their minds. The human intellect's creativity surpasses any machine.

6. Ethical issue with research and biomedical medicine- AI.in healthcare must adhere to biological ethical guidelines like justice, non-violence, benefit, and autonomy, ensuring permission, safety, privacy, voluntary participation, and autonomous decision-making in implementation

CONCLUSION:

AI advancements have the potential to transform healthcare by providing a personalized, precise, predictive, and portable future. These advancements include medical imaging, diagnostics, predictive analytics, patient interaction, and clinical decision support systems. AI-powered diagnostic technologies have shown excellent accuracy in detecting anomalies and speeding up diagnoses, while predictive analytics streamline healthcare workflows and improve patient outcomes through proactive interventions. The influence of these technologies and the digital renaissance prompts health systems to adapt to the changing landscape. The NHS believes that AI can give medical staff more time to focus on patient care, allowing them to focus on what matters most. In the future, AI can be used to provide a common, high standard of care, regardless of who provides it and where. AI may become a vital instrument for enhancing health equity.

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