**ROLE OF ARTIFICIAL INTELLIGENCE IN HEALTHCARE AND PHARMACEUTICALS**

A. Karpagama, Lavanya.Eb, Sarojini.Pb, Uttam Kumawath.Ob, Rohith Madhavan.Kb, Anitha.Kb

a School of Pharmaceutical Sciences, VISTAS, Chennai -600117.

b SRM College of Pharmacy, SRMIST, Kattankulathur, Tamilnadu 603203.

**Corresponding author:**

Dr. Nirenjen. S

Department of Pharmacology,

SRM College of Pharmacy, SRMIST,

Kattankulathur, Tamilnadu 603203.

Phone: +91 7695890174

Mail: nirenjen1999@gmail.com

**ABSTRACT:**

Artificial intelligence (AI) techniques and their applications in medical and pharmaceuticals are evolving rapidly. Artificial Intelligence deals with increasing amounts of data that are provided by health trackers like watches, smartphones, and other monitoring sensors in the field of medicine. Artificial intelligence focuses on how computers learn from algorithms, data and mimics the human thought and behavior process. The key categories of AI applications in healthcare involve early detection of diseases, diagnosis, prognosis, precision medicine, drug development, clinical trials, and providing patient quality care. It improves and increases clinical decision support systems that are used in transforming the future of pharmaceuticals. AI can play an important role in developing personalized medicine and the implementation of new personalized products in healthcare. There are many techniques that AI uses in health care sector.

**Keywords**: Artificial Intelligence, Deep Learning, Healthcare, personalized medicine.

**I. INTRODUCTION:**

Artificial intelligence (AI) is one of the emerging fields in various sectors. AI is defined as it is the combination of science and technology to produce intelligent machines. It is not a single technology but a range of intelligent processes and behaviours generated by computational models [1]. AI is not a new concept; it has been around for more than 50 years. The two main concepts of artificial intelligence used in healthcare informatics are deep learning and machine learning [2]. Deep learning is one of the machine learning techniques which trains the models using artificial neural networks. It was used both in health care and non-health care sectors using computer vision and natural language processing [3]. Machine intelligence is termed as the behavior of machines that are indistinguishable from humans. The concept of artificial intelligence and machine learning in the health care sector is to provide a set of tools that augment and extend the effectiveness in the healthcare industry and to bring an increased quality of life to patients. The goal of implementing AI in healthcare is to improve the safety and quality of treatment decisions. Nowadays, AI has been included successfully in decision support systems (DSS’s) for diagnosing the data in specialties like radiology, pathology and, ophthalmology [4]

**II. HISTORY OF ARTIFICIAL INTELLIGENCE:**

AI in healthcare is not a new concept as well as its evolution. The concept was there from 1990. The British mathematician Alan Turing (1950) was one of the founders of modern computer science and AI [6]. The application of AI technology in the field of surgery was first consecutively investigated by Gunn in 1976 when he explored the chance of diagnosing acute abdominal pain with computer analysis. AI was collectively used for their established technologies like decision support making, knowledge-based response systems, and expert systems during the early days [7].

The early versions of AI in healthcare used rules and knowledge methods; at present, AI uses various statistical methods along with the symbolic representation of diseases. In 1960 the PROLOG language was developed to manage reasoning and decision making processes. During 1970’s first generation of AI was developed for making individualised clinical decision making processes [3]. De Dombal’s computer aided diagnosis was developed for diagnosing acute abdominal pain. This incorporates newer statistical technologies like probabilistic reasoning and neural networks. Over some period AI technologies were successfully incorporated within medical devices such as ECG machines, insulin pens and ICU pumps [8]. After a few decades AI was established into clinical studies focused on reviewing the impacts of AI on patient outcomes in inpatient settings, in psychiatry and in medication safety [9].

The challenges in the early days of AI were legal and ethical issues, complexity of medical information which are not documented, and transferability of one algorithm setting to another in patient care, brittleness, and dynamic nature of professional healthcare knowledge development by AI [11]. Nowadays these are replaced by powerful computing tools like big data. Big data offers a connection between molecular and cellular biology to the clinical real world [4, 11, 12].

**III. AI: THE BOOMING FIELD IN MEDICINE:**

Nowadays, artificial intelligence has a refined influence on nearly every aspect of life and human conditions starting from research and discovery to diagnosis and selection of therapy. Machine learning is a set of techniques or technical skills that enables AI[1,13]. Implementing AI in health care can bring faster and more personalised care in patients.

3.1 AI USE IN MONITORING FITNESS:

Technology, applications and apps encourage healthy behavior in individuals and help with the positive management of a healthy lifestyle. Additionally, AI increases the ability for healthcare professionals to better understand the day to day patterns and need of the people they care, for better feedback, guidance and support. Wearable health trackers like FitBit, Apple, Garmin and others monitors heart rate, blood pressure, oxygen saturation and other activity levels. They can send alerts to the user about their health status and this help the healthcare professionals to monitor the condition of patients.

3.2 AI USE IN EARLY DETECTION OF DISEASES:

AI is already being used to detect diseases, such as cancer, chronic obstructive pulmonary disorder more precisely and in their early stages. The use of AI is enabling review and conversion of mammograms 30 times faster with 99% accuracy, dropping the need for unnecessary biopsies. Google’s Deep Mind Health is working in partnership with clinicians, researchers and patients to solving and detecting real-world healthcare problem. AI can help in making decisions in clinical diagnostics and therapeutics. AI can identify patient populations who are at risk. AI can reduce the health inequalities by surfacing most vulnerable patients [4,5].

3.3 AI USE IN DIAGNOSIS:

Machine learning algorithms can process inconceivable amounts of information in the fraction of second and provide more accurate than humans in spotting even the smallest detail in medical imaging. Machine learning can predict the short term and long term risk of patient safety [2]. Deep learning techniques are used for detecting diabetic retinopathy in primary health centres in the US. The company Zebra Medical Vision developed a new platform called profound, which analyze of all types of medical imaging reports that is able to find every sigh of potential conditions such as Lung cancer, osteoporosis, breast cancer, aortic aneurysms, dementia and many more with almost 90 percent accuracy rate. The outputs of machine learning can predict the image whether it shows a malignant or benign tumour. IBM’s Watson for health is helping healthcare organizations to review and store the patient’s medical information safely.

3.4 AI USE IN TREATMENT DECISION MAKING:

Improving the quality of care requires the association of big health data with proper and timely decisions, with predictive analytics which can support clinical decision-making and actions as well as prioritise administrative tasks. The clinical introduction of genome sequencing, biometrics and data visualising is used to interpret and operationalise data from various fields of biomedicine. Health care is experiencing the informational boom as the rapid expansion of scientific knowledge and pace of technological development have resulted in overwhelming data with sophisticated interpretation. Here the AI promises that it promotes the clinical decision making process by uncovering the clinical information hidden in the massive amount of data.

3.5 AI USE IN DIGITAL CONSULTATION:

The digitizing of healthcare data as well as advancements in computer processing data and storage has also enabled the development of algorithms in artificial intelligence [5,15]. The digital health firm ‘Health Tap’ developed “DR.A.I.,” and apps like ‘babylon’ in the UK use Artificial Intelligence to give medical consultation to patients based on their personal medical history, chief complaints, and common medical knowledge. Users report their symptoms into the app, which uses speech recognition to compare against a database of illness and asks patient to specify symptoms to triage whether they should go to the Emergency Department, Urgent care or a primary care doctor. For maximizing the benefit of AI in healthcare and to build trust among the people and healthcare professionals it will therefore be essential to govern the risks that AI possesses and to minimize them to improve patient safety [2,14]. In short, where physicians are overloaded with data which requires sophisticated interpretation it is expected that with AI it will become more efficient. There is always a high demand in healthcare services to use optimal resources to improve patient care without compromising the patient's safety [15].

3.6 AI USE IN PRECISION MEDICINE:

AI technology is necessary to achieve the goal of “precision medicine” [5,13]. Precision medicine is a budding medical model where medical decisions and treatments are personalized to the patient based on their disease stage and condition. “Precision medicine requires the availability of massive computing power and data algorithms that can learn by themselves at an exceptional rate [13]. AI systems have been created to analyze data-notes and reports from a patient’s file, external research, and clinical experience to help in creating the correct, individually customized treatment plan, instead of developing treatments for peoples and building the same clinical treatment decisions based on a few similar physical characteristics among patients. Genetics and genomics look for mutations and link to disease from the information in DNA. With the help of AI, body scans, spot cancer and vascular diseases early and predict the health issues people might face based on their genetics.

3.7 AI USE IN PALLIATIVE CARE:

Our lifespan has been increased more than previous generations, and as we approach to the end of life or older, we are dying in a different way as when it comes with diseases we die from conditions like dementia, heart failure and cancer. Becoming older is also a phase of life that is often overwhelmed by loneliness. AI has ‘conversations’ and other social interactions with people to keep aging minds sharp. The National Institutes of Health have created the ‘AiCure’ app to monitor the use of medication by a geriatric patient. A Smartphone’s camera is partnered with Artificial Intelligence enabled software to autonomously confirm that patients are taking their prescriptions and helps them manage their conditions. This will help the elder patients from medication adherence.

3.8 AI USE IN MAINTAINING HEALTH RECORDS:

To improve patient care, health care workers need to identify, quantify and interpret relationships among variables, to do this artificial intelligence and machine learning helps by using computers which allows the learning of data algorithmically [3]. To decide the predictive modelling in patient care artificial intelligence and machine learning are used by means of electronic health records (EHR) considering the variables such as medication prescription, patient clinical history, laboratory values, physiological imaging and drug notes etc., that fit into the datasets [4]. Adoption of AI in healthcare management will ensure that the right information is provided to the right people to enable the quality patient care. Some of the examples are automated medical coding by AI, AI based diagnosis specificity, AI based early detection information [5,7]. Usage of electronic medical record systems in the last few decades has proved that there are large numbers of data available for AI applications [4,5].

3.9 AI USE IN DRUG DISCOVERY AND DEVELOPMENT:

Clinically one drug may interact significantly with the other drug in any other conditions. These quantitative or qualitative interactions are not possible to explain with the other methods but with machine learning and AI it is possible to capture these and explain the complex relationships. AI is useful from research and development to clinical practice to population health. Starting from the novel therapeutic agent discovery, precision disease stratification, integration of more number of data, extension of physician efficiency and efficacy, continuous remote monitoring diagnostics and till optimized resource allocation, Artificial Intelligence plays a crucial role [1,13,14]. Some of the future innovations of AI includesdesigning of new drugs with new drug combinations**,** delivering clinical trials, Testing the Modelling of drugs to mimic the physiology of organ**,** Robots involved in manufacturing units and in distributions**,** 3D printing of personalised drugs in any shape and desired dosage**,** Better understanding of human biology and pathophysiology of diseases and in Providing safe health care data.

**IV. AI TECHNIQUES IN HEALTHCARE SECTOR:**

There exist many artificial intelligence and machine learning techniques which are useful in medicine (table2). Artificial neural networks (ANNs), fuzzy expert systems, evolutionary computation and hybrid intelligent systems are the AI technologies that are popularly involved in medicine.

4.1 ARTIFICIAL NEURAL NETWORKS:

 ANNs are the computational techniques that are inspired by the biological nervous systems. They consist of networks that are highly interconnected computer processors called neurons which are capable of performing parallel computations for data processing and knowledge representation [12,14]. These ANNs are used in the clinical diagnosis, image analysis in radiology and histopathology, data interpretation in intensive care settings and waveform analysis [6,17].

4.2 FUZZY EXPERT SYSTEMS:

Fuzzy expert systems involve the scientific logical reasoning, thinking and inference that recognises and uses the real world phenomenon where everything is a matter of degree. The fuzzy logic technique has been used in diagnosing various types of cancer using tumour markers and it also predicts the survival rate in patients with cancer.

4.3 EVOLUTIONARY COMPUTATION:

Evolutionary computation is the general term for several computational techniques which is primarily based on the natural evolution process that imitates the mechanism of natural selection and survival of the fittest in solving real world problems [4, 6, 10]. They have been largely used in diagnosis, prognosis, signal processing and medical imaging of genetic algorithms to predict the outcome of the disease. Each AI technique has its own advantages and disadvantages. Neural networks are mainly concerned with learning, fuzzy logic with imprecision and evolutionary computation with search and optimisation, when these techniques are combined together or with one another to produce hybrid intelligent systems to work in a complementary manner [7,9].

**TABLE 1 : AI TECHNIQUES AND APPLICATIONS**

| AI TECHNIQUES  | APPLICATIONS IN HEALTHCARE |
| --- | --- |
| Machine learning/ Deep learning | Precision medicineElectronic health record managementData retrieval Patient quality careDrug developmentSupporting clinical decision makingUnderstanding immunology sequence |
| Natural Language Processing | Virtual health assistantsChat bots for appointmentsNote taking and transcriptionOnline appointmentsScheduling data |
| Artificial Neural network | Clinical decision support systemDiagnosis and prognosisClinical interpretation of medical condition |
| Fuzzy logic | Clinical decision makingPrediction of outcomesPredicting survival rates |
| Computer vision  | Radiological and histopathological image analysisInterpretation of MRI,CT,USG |
| Robots | Chat bots providing health-related informationGeriatric careRobotic assisted surgeryPalliative careEmergency medicine |

**V. CHALLENGES IN IMPLEMENTING AI IN HEALTHCARE:**

Integrating AI in healthcare can bring few risks over their benefits. For example, failure in the software can affect a large number of patients. Critical assumptions in AI systems can lead to dangerous recommendations that are insensitive to local data and models [16]. Due to opaque AI technologies such as deep learning makes the explaining part difficult in case of failure. To reduce these risks and increase patient safety, regular governing of AI systems and their risks will bring trust among the healthcare and patients [14,16].

Implementing this is critiqued due to their “black box” paradigm. There are more ethical issues in adapting AI in healthcare, some of them are introducing bias to minimise the risk and dependence on AI among clinicians may decrease the patient-clinician relationship. Based on survey results, to minimise the risks it was believed that input data, output data and the protocols should be kept within a secure infrastructure for safe processing of patient data, data protection regulations such as general data protection regulation [11,17]. There are limitations in accepting the biochemical results that are generated from an auto-analyser or images produced by magnetic resonance imaging. To overcome this, the need to undertake more randomised controlled studies to prove the efficacy of AI systems in medicine [15].

**VI. CONCLUSION:**

Technology is shifting fast, and the world is changing and adapting the technology. Concepts like AI that was mere science fiction only a couple decades ago. Now they are quickly becoming common. There are more than 300 Artificial intelligence enabled medical devices that are approved by FDA. Rapid advances in AI research and their approval make it that AI is extensively used in the healthcare sector and there is a high development in the upcoming future. Advancements in AI in healthcare can assist the human thoughts, human power, and human resources effectively and efficiently. As every advancements has both the pros and cons. AI can be used in improving healthcare under the supervision of physicians to reduce their risks in healthcare. AI can be used in business analytics of healthcare. Advances in AI implementation in the healthcare sector will lead to improvement of better clinical decision making, risk assessment, care process, continuity of care, coordination of care, safety of care, management process in healthcare. As we accepted the computers, digitalization and dependency upon the internet through time, eventually AI will be employed to bring about another revolution in health sector. The future of Artificial Intelligence holds the pledge of a more effective and efficient healthcare system built on a strong foundation of dependable and precise data.

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