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Review Article

ARTIFICIAL INTELLIGENCE: APPLICATIONS IN HEALTHCARE INDUSTRY

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ABSTRACT

Artificial intelligence (AI) is becoming a core part of the digital health systems to shape and support modern medicine. The situations such as pandemic COVID-19 pressing health systems to consider technology, such as artificial intelligence powered clinical decision support for faster and more informed decisions. AI utilises machine learning models to search medical data and uncover insights to improve health outcomes and patient experiences. AI is mainly used for clinical decision support and imaging analysis. Clinical decision support tools help the physician to take decisions about treatments, medications, physical and psychological health and other patient needs by providing quick access to information or research that's relevant to their patient. In medical imaging, AI tools are used to analyze CT scans, X-rays, MRIs and other images/ findings that a human radiologist might miss. Many healthcare organizations around the world started field-testing new AI-supported technologies to overcome the challenges like COVID-19 pandemic created. Various healthcare applications with AI are presented in this article.

INTRODUCTION

The pandemic crisis such as COVID-19 stressed the need to develop effective drugs and drug delivery systems within short period of time. The traditional healthcare system approach involves lot of time, huge investment with limited success rate. Artificial intelligence is defined as a branch of computer science that enables computer systems to perform various tasks with intelligence similar to humans^[1]. AI is mainly dealing with the design and application of algorithms for analyzing, learning and interpreting data^[2]. The process of AI involves obtaining information, developing rules for using information, approximate or accurate conclusions, and self-correction^[3].

With the implementation of AI, the computers or machines exhibit the characteristics of humans such as reasoning, generalizing and learning from past experience, etc. The use of AI in diverse sectors of the pharmaceutical industry includes drug discovery and development, drug repurposing, improving pharmaceutical productivity and clinical trials^[4]. AI allows the rapid discovery and development of drugs. Different AI tools are being applied to support the drug development process^[5]. The response towards the administered drug is different from individual to individual and hence therapeutic drug monitoring is required. The monitoring of patient response and the dispensing of personalised medicine is possible with the help of AI. AI has inspired computer-aided drug discovery^[6]. The pros of AI are improved diagnosis, better clinical decisions, streamlining of process and opportunity to serve rural community. The cons include complications of learning, difficulties to adapt, need of human assistance and problems involved in selection of correct AI platform. Several programmes of AI are reported along with their applications. AI appears to be transforming the future of healthcare field but still it has to make an impactful

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outcome [7]. The ethical concerns and the healthcare industries availing AI are included here.

AI TECHNOLOGIES IN HEALTHCARE

Various technologies or algorithms of AI utilised in healthcare industries [8] is furnished in Figure 1. These technologies are summarised briefly here.

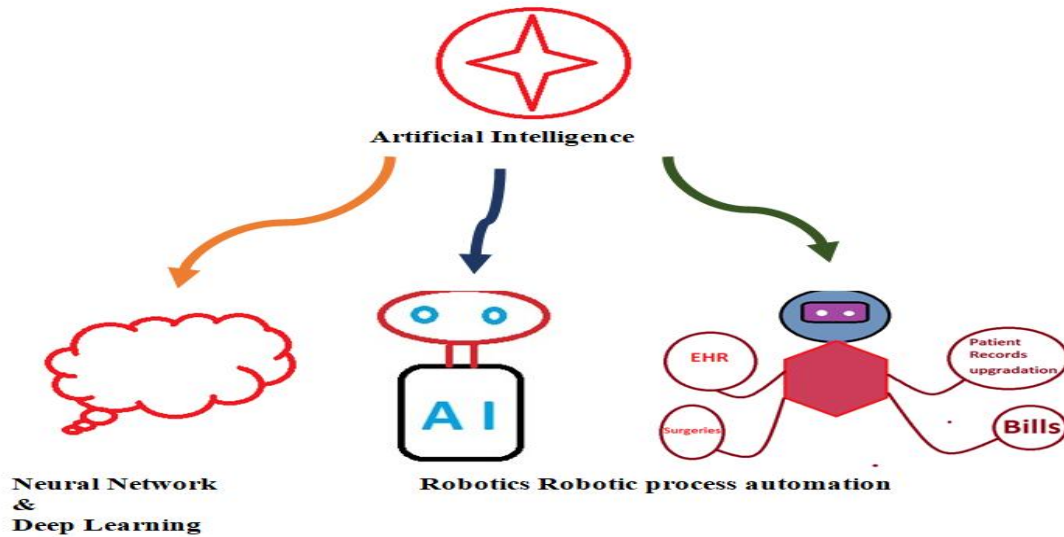


Fig. 1: Various technologies or algorithms of AI

Machine Learning (Neural Network and Deep Learning)

In healthcare, the machine learning technology is used for precision medicine. This technology allows predicting the best treatment protocols which are likely to be more successful on a patient based on different patient characteristics and treatment context [9]. In supervised learning, machine learning and precision medicine applications require a training dataset for which the outcome variable (e.g. onset of disease) is known. Neural network technology has been used for categorisation applications like determining whether a patient will acquire a particular disease. Deep learning is applied to radiomics in imaging data beyond what can be perceived by the human eye [10].

Natural Language Processing

Natural language processing includes applications such as speech recognition, text analysis, translation and other goals related to language. It is used to create, understand and classify clinical documents and other reported research data. It is useful in analysing unstructured clinical notes and preparing reports from such data.

Robotics

Physical robots enabled with AI perform several tasks in the healthcare sector. Surgical robots are being used to improve the surgeon's ability to see, stitch wounds etc and beneficial in gynaecologic surgery, prostate surgery and head and neck surgery.

Rule-based Expert System

Rule-based expert system is used in Electronic Healthcare (EHR) with some set of rules. A set of rules are created by human experts and knowledge

engineers and then an easy to understand rule based expert system will be implemented. These rules are directly proportional to the knowledge domain. Most of the cases, the knowledge is changing with time due to the advances in health sciences, then the rules can be complex and time taking. Artificial intelligence is being used to overcome this drawback of a rule-based expert system.

Robotic Process Automation

Robotic process automation (RPA) is used to perform repetitive tasks like updating patient records or billing. It can also be used to extract the specific data when combined with other data.

APPLICATIONS OF AI IN HEALTHCARE

Artificial intelligence (AI) in the healthcare sector is receiving attention from researchers and health professionals [11]. In the last, five to ten years, AI becoming more advantageous for the healthcare industry and going to have a significant impact on this industry. Healthcare Industries are applying AI to make a better and faster diagnosis than humans. AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach to the patient before hospitalization. Artificial Intelligence finds diverse applications in the healthcare sector. AI applications are used in healthcare to build sophisticated machines that can detect diseases and identify cancer cells. Artificial Intelligence can help analyze chronic conditions with lab and other medical data to ensure early diagnosis. AI uses the combination of historical data and medical intelligence for the discovery of new drugs [12].

Artificial intelligence is proving to be a game-changer in healthcare, improving virtually every aspect of the industry from robot-assisted surgeries to safeguarding private records against cyber criminals. Artificial intelligence is used to analyze the treatment techniques of various diseases and disorders. AI is

used in various areas of healthcare such as diagnosis processes, drug research sector, medicine, patient monitoring care centre, digital health monitoring, patient data & risk analysis, surgery, hospital management, drug discovery etc. Various applications are summarized in Figure 2.

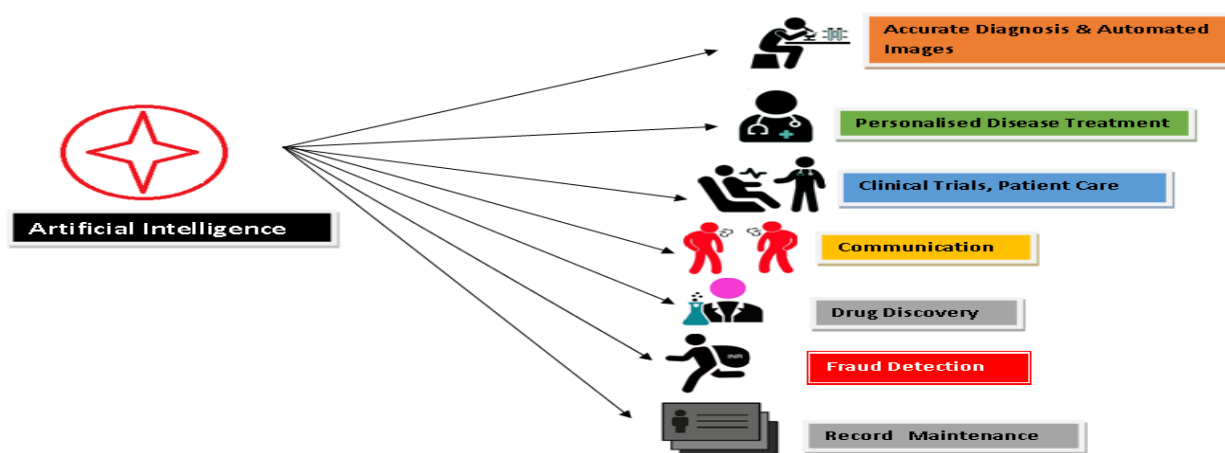


Fig. 2: Applications of AI in healthcare

Accurate Diagnosis

Path AI offers one of the best machine learning and artificial intelligence tools in healthcare that allows pathologists to make accurate diagnosis. AI improves accuracy in the diagnosis of cancer patients so that most of them can be looked after or be cured at a stage where it does not turn fatal and to save numerous lives. Doctors are now able to scan for harmful substances and bacteria in samples of blood, such as *Staphylococcus*, *E. coli*, etc., by using AI-enhanced microscopes at a much faster rate. AI can collect the data from medical devices like heart monitors and look for more complex conditions, such as sepsis. IBM has developed a predictive AI model for premature babies that are 75% accurate in detecting severe sepsis.

Better Customer Service

Chat bots are developed with machine learning technology to communicate with the patients with respect to their illness and symptoms, which reduces the load on medical professionals. It allows patients to raise their queries regarding appointments, bill payments etc, offering the required solutions to the patients and allowing healthcare experts to focus on other important tasks.

Virtual Health Assistants

Virtual assistants are integrating systems with cognitive computing, augmented reality, body and speech gestures to offer a personalized experience to patients in terms of managing their health and getting rid of their queries.

Treatment of Rare Diseases

BERG is an AI-based clinical-stage biotech platform using research and development (R&D), along with interrogative biology that works on mapping diseases. It speeds up the finding and creation of advanced medicines and vaccines. It also allows medical professionals to create robust products for patients fighting rare diseases like Parkinson's disease.

Targeted Treatment

Benevolent AI with the help of deep learning and AI provide the correct treatment to the required patients at the right time, resulting in achieving better target selection by the patients.

Personalized Disease Treatment

A healthcare system could offer patients around-the-clock access to an AI-powered virtual assistant that could answer questions based on the patient's medical history, preferences and personal needs. AI has the potential to provide customized real-time recommendations to patients around the clock.

Automation of Redundant Healthcare Tasks

AI automates reduces time-consuming tasks so that the administrators have some spare time so that they can work with other important and necessary tasks. Olive is an AI-based platform used to automate several processes such as checking the eligibility of un-adjudicated medical claims, transferring the necessary medical data to the respective medical professionals.

Management of Medical Records

The development of proper diagnosis and new medicines and drugs requires the connection of significant, important and necessary data points.

Segregation of the desired data from the bulk data by manual operation may cause loss of significant and valuable data in the huge pile of data, leading to the loss of billions of dollars a year for the industry. AI break down the data and connect the required data that earlier took years for processing.

Reduction of Dosage Errors

With the aid of Artificial Intelligence, the industry will be able to reduce the margin of possible errors in medication so that the patient takes the right amount of prescribed medicine and to prevent repercussions.

Robot Assisted Surgery

Robots integrated with mechanical arms, cameras, required surgical instruments, augment the knowledge; skills and experience of the doctors are able to complete tasks such as open-heart surgery which require precision, control and flexibility. Surgeries assisted by AI-implemented robots causes lesser complications, comparatively lesser pain and a faster recovery rate.

Automated Image Diagnosis

AI systems using deep learning technologies and programs, equip themselves with algorithms that offer a quicker reading of complex images, including CT scans and MRIs and to overcome the shortage of radiologists and other medical professionals in hospitals.

Fraud Detection

AI based tools allow elaborate navigation through the processes, detect fraud cases and to minimise the damage to the medical organizations and patients.

Success of Clinical Trials

Artificial neural networks predict the bioactivity of drugs based on characteristics of each patient and hence researchers can find the right candidates to test developmental drugs for various diseases and disorders. AI allows the collection and organization of the data to get the right theory involved for a particular disease and its treatment. AI in healthcare industry increases the success rate of clinical trials with increased speed and lesser investment.

Development of New Drugs

Artificial intelligence technology allows scanning of pre-existing medicines and uses them to redesign medication and repurposing in a way that allows better treatment of diseases and reduce the cost and time to develop new drugs. AI reduce the costs of developing new medicines primarily two ways: creating better drug design and finding promising new drug combinations. With AI, many of the big data challenges facing the life sciences industry can overcome.

Drug Interactions

Improvements in natural language processing allowed the development of algorithms to

identify drug-drug interactions. Machine learning algorithms were created to extract information on interacting drugs and their possible effects from medical literature.

Improved Healthcare Access

AI based medical software offers interactive and customized healthcare services so that the patients have better and improved access to the hospitals.

App drove quick Medical Care

These apps are helpful in appointment management, prescription management, improving fitness and updating about preventive healthcare measures by providing suggestions about how to take care of their health on daily basis in lifestyle diseases like diabetes, heart diseases.

Informed Patient Care

A trained machine learning algorithm can cut down research time by giving clinicians valuable search results with evidence-based insights about treatments and procedures while the patient is still with the clinician.

Reducing the Costs of Care

AI reduce costs across the healthcare industry by reducing medication errors, by providing customized virtual health assistance, fraud prevention and supporting more efficient administrative and clinical facilities.

Providing Contextual Relevance

AI algorithms use context to distinguish different types of information. For example, a well-trained AI algorithm can use natural language processing to identify the medications belong in the patient's medical history from the list of a patient's current medications along with a new medication.

ETHICAL CONCERNS

The following ethical concerns are involved with AI.

Data Collection

Large amount of patient related data should be gathered to train machine learning and effective use of AI in health sector. Most of the cases, the patients are uncomfortable to provide their privacy data and causes the scarcity of real, accessible patient data.

Automation

The jobs most susceptible to automation are those dealing with digital information, radiology and pathology. However, doctors who take advantage of AI in healthcare are expected to provide greater quality healthcare than doctors and medical establishments who do not.

Bias

AI's decisions are based on direct reflection of the input data; the data it receives must have accurate representation of patient demographics. Collecting data from minority communities may lead to medical discrimination. These biases can be eliminated

through careful implementation and collection of representative data.

TOP ARTIFICIAL INTELLIGENCE COMPANIES IN HEALTHCARE

- Google health/ deep mind: Google health provided AI based solution for identifying breast cancer, predicting patient outcomes, averting blindness etc. The life sciences arm of Google's corporation Alphabet done experiments with disease monitoring technologies, including a digital contact lens to observe blood sugar levels.
- IBM Watson health: With the power of cognitive computing, IBM developed Biorasi to bring drugs to the market rapidly and to slash the costs by over 50%.
- Microsoft in association with Oregon health & science university affiliated Knight Cancer institute developed Hanover project to analyse medical research and to predict most effective cancer drug treatment options.
- Chinese based company Tencent is working on AI medical innovation system (AIMIS), an AI-powered diagnostic medical imaging service.
- Intel capital in collaboration with the start up Lumiata to use AI to identify at-risk patients and develop care options.
- Kheiron Medical developed deep learning software to detect breast cancers from mammograms.
- Fractal analytics incubated qure.ai which focuses on deep learning and AI to improve radiology and speed up the analysis.
- iFLYTEK launched an artificial intelligence integrated service robot Xiao Man, to identify the registered customer and provide personalized recommendations.
- Oncora medical: This Philadelphia-based start-up is established to help cancer research and treatment, especially in radiation therapy. Their integrated digital database collects the relevant data and organizes the electronic medical record. The company's software measure quality of care, optimize treatment, provide in-depth oncology outcomes data and imaging to improve operations and patient outcomes.
- CloudMdx Health: This Silicon Valley based organisation utilizes natural language processing (NLP) and deep learning to collect existing data from electronic medical records and to provide clinical insights for healthcare professionals to make data-driven decisions and to improve patient outcomes.
- Babylon Health: This UK based patient-centered remote consultation service is equipped with

free smartphone app's dynamic AI. This app collects complaints from the users and subsequently matches them to a relevant physician. The deep learning Babylon's AI system also provides users with personalised insights desired to stay healthy and better understand their health.

- Corti: This Denmark based AI-powered firm listens patient interviews, analyzing the caller's voice and background noises and taking insights from historical data and artificial neural networks, the AI is able to understand the context especially heart attack.

CONCLUSION

Artificial intelligence drive the emergence of a computational precision medicine, simplifies the lives of patients, doctors and hospital administrators by performing tasks that are typically done by humans, but in less time, more precision and at a fraction of the cost. Proper application of AI in the healthcare system reduces time, resources, cost, risks, provides quick and accurate diagnosis and treatment thus saving more lives. AI has countless applications in the healthcare system. The AI sector is one of the world's highest-growth industries.

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