Review Article

Artificial Intelligence in Drug Discovery

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ABSTRACT

Artificial Intelligence (AI) has recently developed as a trending, interesting topic in the field of health care industry, the biopharmaceutical organizations are making so much of efforts to approach AI to ameliorate drug discovery process and to scale down the research and development expenses, to reduce the failure rate in clinical trials, and bring out new medicines. The medical care industries, recognizes the need and support the increasing amount of data received from case safety reports. AI provides good opportunity for the discovery and development of drug. AI can be applied to different health care data (structured and unstructured). Different machine learning has approached and recently re-emerged, few of them may be considered as examples of domain specific AI, which have successfully used for drug discovery and design. Mostly used AI techniques are machine learning methods for structured data, such as the neural network and the classic support vector machine and for the unstructured data they are modern deep learning and natural language processing. This review gives a clear picture of this machine learning techniques and their application in health care.

Keywords: Artificial intelligence (AI), Drug discovery, Clinical trials, Machine learning (ML), Natural learning process (NLP), Deep Learning (DL).

INTRODUCTION

Artificial Intelligence (AI) is gradually growing in the health care practice, with the recent evolution in digital data acquistation, machine learning, and computing infrastructure, AI application is growing in those fields, where it was thought that there is only responsibilities of human experts. The use of immense statistics in the health care and rapid development in machines learning algorithm leads to development of AI based startup companies in health care and drug discovery process.

Artificial intelligence came into sustenance in 1956 at Dartmouth College summer workshop, "The Dartmouth Summer Research Project on Artificial Intelligence'', which was generative event for the artificial intelligence as a field. The field of AI was developed not on the agreement or methodology or choice of problem or general theory of learning, but by the visual understanding that the computers can be designed t perform inventive task[1]. In the early 1990's the AI had expanded in terms of rapid growth in high performance (Moore's law), data communication (internet), cloud technologies (sales force, AWS, EC cloud app, etc..) and big data storage[2].

Encouragement

AI is sophisticated electronic devices which help us to learn features from large number of health data, and use them to acquire information and assist the clinical trial. it can also help to assist the clinical practitioner by providing up to date information from various sources such as journals, textbooks, articles for the better patient care. Additionally, to it AI systems help in easy diagnosis and reduce diagnostics and therapeutic errors in human clinical practice. Furthermore, AI system draw out useful information from a huge patient population to aid real time conclusion for health risk alert and health outcome prediction.

Before the application of AI system in the health care, they need to be trained through data that are generated from the clinical activities, such as screening, diagnosis, treatment assignment and so on (3), specifically, in the diagnosis stage, a substantial proportion of the AI literature analyses data from diagnosis imaging, genetic testing and electro diagnosis

(Figure 1) (4), for example, Jha and Topol urged radiologists to adopt AI technologies when analyzing diagnostic images that contain vast data information (5)

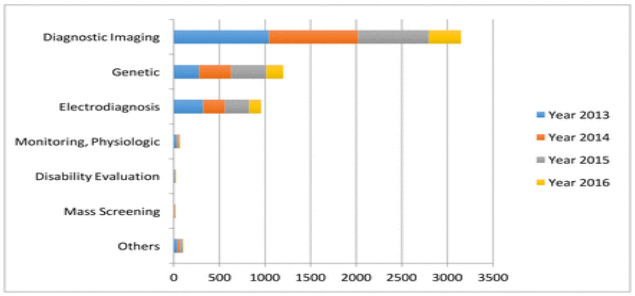

Figure 1: The data types considered in the artificial intelligence artificial (AI) literature. The comparison is obtained through searching the diagnosis techniques in the AI literature on the Pub Med database[4]

It was reported by the bloomerg technology that the Microsoft had developed an artificial machine to aid doctors in finding proper cure for cancer.[2,6] Microsoft is working on a project to launch a machine called Hanover. This machine aims to collect, store and memorize the available information to the data base which is required to treat the cancer, which will predict the combination of drug that will be more effective in treating cancer. Different study shows that researchers at Stanford university have recently introduced an AI based algorithm which can identify the skin cancer as same as professional physicians, the technique used by program is known as Deep learning for recognizing 130,000 of images of rashes, moles and lesions.[7]

Artificial intelligence falls into two main category, the first category includes machine learning (ML) techniques that analyze structured data such as imaging, genetics, and EP data. In medical application, the ML method strive to collect patient's characteristics or conclude the possibility of the disease outcome. the second category include Natural language processing(NLP) that extract information from unstructured data such as clinical notes/medical journals and add as a supplement and make more informative to the structural medical data(4)

The figure 2 shows the better presentation of clinical data generated shows the mapping of natural learning processing to machine learning data analysis

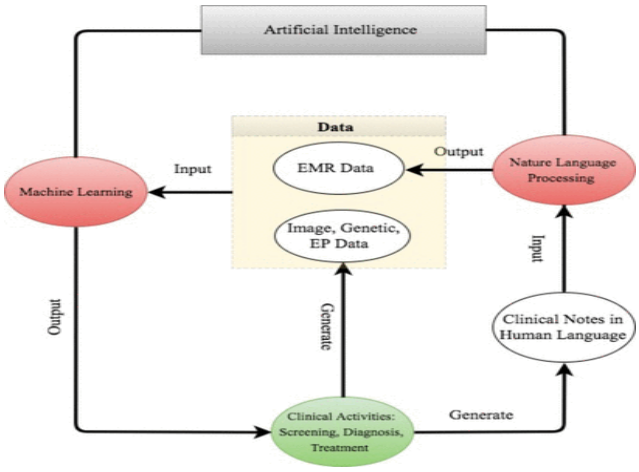

Figure 2: The road map from clinical data generation to natural language processing data enrichment, to machine learning data analysis, to clinical decision making. EMR, electronic medical record; EP, electrophysiological.[4]

ARTIFICAL INTELLIGENCE IN CLINICAL TRIALS

Matching the right trial with right patient is a time consuming and challenging process for both the patient and clinical study team. Majority of drugs take years to come into market, which cost billions and might even fail in the late stage of trial, having so much into consideration the attempt of use of Artificial intelligence (A)I was put forward, an idea which is necessary in tending this issues and which will help in a successful drug development.

Dr. Niven Narayana, Co-founder, president and chief technology officer of biopharma company Berg, discussed his company's interrogative biology AI platform that has identified several drug targets that are in development and at least 25 more are in pipeline. Berg's platform gives data on the individual patients from demographic information and environment condition to genetic mutations, in order to collect all the new treatments. He said berg's method has cut the time and money required to develop drugs more than half. "It's not only that we're reducing the time to produce the drug; the drug that's produced is going to have more of an impact," Narain said. "That's also a metric that needs to be intangibly appreciated, because you could get things done faster [using current drug development methods], but it's only going to help 10,000 people. But if you get it done faster [with AI] and you're helping 10 million people that are a big difference."[8]

To recruit the right patient into clinical trial is a huge investment in time and funding, better patient monitoring and methods used during ongoing clinical trial can reduce the burden and can make the end point detection more efficient. Artificial intelligence techniques with the combination of wearable technology, like mobile usage, face time, and individual patient monitoring system.

To act accordance with the adherence criteria, patients need to keep detailed records of their medication history and other different data points which include their body functions, medication response, and daily activities. Which will be overburden and complicated task, which can lead to 40% of patients to neglect after certain days into clinical trial.[9] So as to keep and collect the record automatically of the patient data, wearable sensors and video monitoring are used. Machine learning and deep learning can be used to analyze the real time data for assessing, detecting and logging for the events of pertinent. This will help to collected data points for data point detection more efficiently and in a valid way, rather than patient driven self monitoring methods, this is called 'cognective sensing' Figure 3. AI plays crucial role in image end point detection; centers where the manually reading was done started using AI. Machine earning has been put forward and is been approved[10, 11], for the rapid detecting of the disease from the medical image along the algorithms that assess the pathological conditions, will help to save time and cost with image studies rather than manual processing.

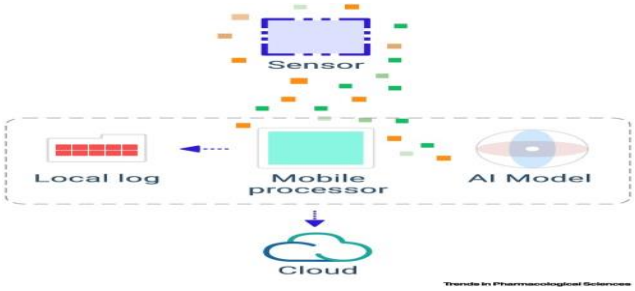

Figure 4: Data are collected by wearable sensor and analyzed in real time at the point of sensing by a mobile

processor that runs AI model, results are recorded in local log, in cloud or in combination of both.[9]

Artificial intelligence and machine learning methods quickly identify the risk of developing any issues in the patient behavior that might be a dropout with regards to study protocol, one such example, as the lack of detection of stroke in early stages, only some patient survives and get the timely treatment, use of-genetic fuzzy finite state machine and PCA by vilae et al developed a moment detecting device for early stroke prediction[12], human activity recognizing stage and stroke onset recognizant stage are the process included in the detection of stroke, as soon as the movement is notably different from the normal pattern, a stroke alert is been activated and assess for treatment as soon as possible. One more study done by et al.,[13] came up with wearable device for the collecting of data about normal and pathological gaits to predict the stroke. The data is been drawn out and modeled by hidden Markov models and SVM, and 90% of data is been correctly classified to the right groups with the algorithm.

Table 1: Cognetive Sensor for Incorporation in Candidates

Types of Sensor	Components	Application	Reference
Neural implant	Retinal stimulation electrode	Bionic eye	(14)
	EEG and ECoG electrodes	Brain activity monitoring, deep brain-stimulation, controlling prostheses with thought	
	Artificial skin sensors	Tactile prostheses	
Molecular sensors	Nano- and Micro fluidic sensors, portable DNA sequencer	DNA sequencing	(15)
	Smart pills, nanobiosensors, functionalized nanoparticles	Biomarker detection	(16)

A drug molecule which is entirely prepared by Artificial intelligence is all set to enter into the clinical trial for the first time, indicating a critical discovery for the role of machine learning in medicine.

Oxford based AI start up **exscientia** in collaboration with Japanese pharmaceutical firm Sumitoma Dainippon pharma, has designed a new compound to treat patient with obsessive-compulsive disorder.[17] On the stroke to speed up the standard path of drug development which will take four and half year, AI technique designed compounds outstretched the point of entering clinical trial in just 12 months. The AI perhaps makes the drug discovery faster, cost effective and more effective or patients.

''The design and development of molecule thr0ugh medicinal chemistry has always been slow and laborious process, Exscientia can do this in many fewer steps which is very really impressive, and it comes from very sound scientific principle, I think they are real assets to have in the UK'' said by sir john bell, the regius professor of medicine at Oxford university. Exscientia's AI platform used a suitable algorithms decide and select the best chemical structure for the chemical compound, which is known as DSP-1181, and target at the specific vector in the brain involved in obsessive compulsive disorder (OCD). All together Ten million of potential molecules were able to generate with the algorithm, screen through the candidates and make a decision about which one to synthesis and test.

''AI can learn faster than conventional approach, so we had to made and test only 350 compounds, a fifth of the Normal compound candidates, which is record braking productivity,'' said by Andrew Hopkins, chief executive of the startup and a molecular biophysicist. ''the algorithm can be applied to any drug targets, against the huge range of disease in cardiology, oncology and many other rare condition.[17]

Another area in which Artificial intelligence is been practiced is in designing of clinical trial, every clinical trial follows a protocol, which is used to describe how a study will be conducted, any trial related problems that need amendments to the protocol can lead months of months delay and cost a huge amount to it. ''when protocol is right, the drug development is faster and cheaper,'' lipset said. When clinical trial is designed, researchers depend on information from various sources, which include comparable studies, clinical data and regulatory information. Application of Artificial intelligence –powered software can not only proceed faster, but also can gather more data than a person could just read.

Trials.ai, a startup company in San Diego, California, represents its Artificial intelligence tool as a data driven guide. To collect and analyze data that is publicly available such as journals papers, drug labels and as well as private data that is owned by medical device companies with which Trial.ai works Natural learning process along with Artificial intelligence is used.

Continues monitoring of patient condition becomes necessary to assure timely intervention by physician to start right medical procedure and administration of required medication in appropriate time. Patients with high risk area like cardiology, neurology, oncology, psychology where patient monitoring and dispensing of drug on time is necessary. As much disease condition strike us in life, medication are used to controlled and cure the disease. As most of the re-admission of hospital is due to medicating errors and non adherence and these accounts for the growing number of deaths every year. The need of improved patient monitoring systems which include methods and apparatus and should be patient friendly and doctor friendly and should increase the patient care quality without unnecessarily increase. In the patient clinical visit, and such system should be accurate and reliable.

Present inventions provide health monitoring system which includes the methods and equipments for broader range of patient care service without patient intervention by using remote monitoring with the artificial intelligence. Remote located patient's medical condition can be generated by the means of monitored-generated signals with the help of telephone lines reaching interface to the medical expert system application. The patient is asked questions in the physician's own voice, the pattern of the questions asked would be prerecorded by the physician, who is interpret and presented to the patients and depending upon the patient response to each question with the help of natural language interface.

Combination of artificial intelligence along with the voice technology appropriate clinical questions is asked by a physician, by forward and backward chaining in artificial intelligence. Additionally the artificial technology along with the voice technology allow it to simultaneously carry on multiple conversation (approximately 48), monitoring the results include features like call monitoring and call recording and call forwarding at any time when physician direct rules that there is an indication and alarming situation to the patient.

The patient monitoring device might use AT&T'S, Dua tone matrix frequency (DTMF) for touch tone telephones, which DECvoice hardware (the voice synthesis/reorganization technology) can recognize.[18]Figure 5

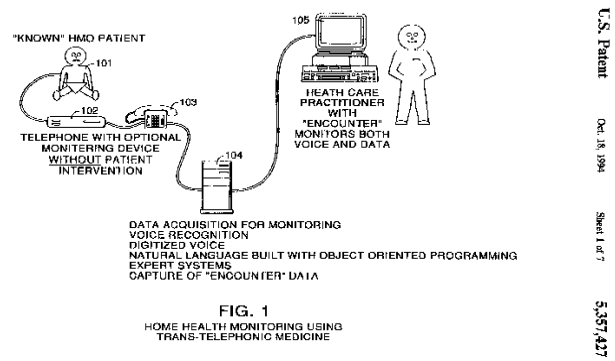

Figure 5: Home health monitoring using Trans-Telephonic medicine

One more example of remote monitoring is RxPense®. Users of RxPense® pill dispenser have their medication controlled 24*7. At the time of dose, the patient is notify with the sequence of audible and visual reminders. The patient verifies by voice, pin or password and receive their medications, instrustin will be presented and the patient confirm that he has taken the medication, the consumption of medication is been captured by the RxPense®, patients vital is also been captured by Bluetooth connected sensors. The data is collected and uploaded t the audit trail to the cloud, which provides consolidated patient view. instantly Artificial intelligence begin processing the live data by analyzing, diagnosing and preparing intelligence report to the decision making and take acting.[19] Figure 6

Figure 6: RxPense® pill dispenser

AI startups are going a step ahead and started visual detection and confirmation, New York based mobile SaaS platform AiCure uses image and facial reorganization algorithm to track the adherence. Patient uses their phone to take video of themselves of swallowing pills, the AiCure make sure that the right pill is taken by the right person.

Figure 7: Facial reorganization software with several security features.[20]

HIPPA, a law that protect the patient information like medical data and privacy, allow the sharing of data with personal recognizable information like name and SSN numbers and pull down information, generally after signing of general inform consent form. This make it manageable for artificial indigence startup to analyze medical data base and can select eligible patient within minutes, otherwise this will take months.

DISCUSSION

How things work for the development process of new drugs have put many pharmacy and sponsors in a critical situation. where the period of blockbuster drug was coming to a tail end but the R&D process of introducing and adding of drug to the portfolio is too slow going and too expensive to recompense for this change. Essential transformation of the underlying business and innovation model for the whole industry was needed for an ideal shift to a new sustainable route of growth and progress.

Over past few years Modern AI techniques have make head way to a level of full growth that allow them to engage in real life set ups to assist human decision makers in computer versions, some cases in medical and health care environment, navigation. Simultaneously the pharmacy and heath care are still in development

Even though, the artificial technology is captivating considerable attentions in medical research, the actual-life execution is still facing barrier. The very first obstacle comes from regulations, present regulations lack of standards to assess the safety and efficacy of artificial intelligence system. To get over this, the US FDA endeavourer to provide guidance for assessing artificial intelligence systems.(4). The first classification of the guidance states about the general wellness product which are not strictly regulated as long as device intended to be only for the general wellness and avail low risk to patient. The second guidance explains the use of real world evidence to access the artificial intelligence. Lastly the guidance classifies the rules for the adaptive design in clinical trial, which will be broadly used in the evaluation for the operating characteristic of artificial intelligence. After the disclosure of these guidance, medical imaging platform was the first to get FDA approved deep learning clinical program that will help the cardiologist to diagnose the cardiac disease.[17]

We expect that the fields that will see the prompt translation of artificial intelligence based technologies are those with the strong image based or visual integrant that is flexible to automate analysis or diagnosis which includes many departments like radiology, optholmogy, pathology and dermatology. In spite of the act that fields requiring integration of many different types of data that have well known procedural component such as surgical specialties, may require prolong time before realizing the initiating of AI technology, AI in research related application over all the field of medicine is rapidly advancing.

The application of AI based technologies in clinical research will provide no shortage of work for the future. Ongoing research will be required to develop new AI algorithm for medical application and to ameliorate existing drugs. AI abilities incorporated detailed thinking models to answer unpredictable inquiries and take care of complex issues in clinical research

Firstly, it needs to be tested alongside the preexisting technology it aims to replace and the value that are added should be demonstrate and evaluate in an explainable, ethical way, not only to the users but ales to the regulatory bodies. Following this al steps AI will be adaptable in the use of clinical trial, and making trials faster, lowering the failures rates and less recherché and development cost effective. Many companies together exploring this avenue. Regulators are approved many AI technology or the healthcare.

The AI technologies reviewed and mentioned in this article are real life practicability.

AI is developing rapidly in this decay. With the help of pc's, gadgets, wearable we get all the information of the patient, complete errand, get answer and settling on choice and robotizing dull and slow activities.

AI had thought provoking opportunities to thrive in the health care arena. Currently the top most used AI in biopharmaceutical companies include,

1. The mobile platform to ameliorate the health outcome, the ability to recommend patients by the means of real time data and thus improve the health of patient.

2. Individual personalized medicine- ability to develop individual personalized medicine by evaluating big data base so as to identify cure option using cloud base system.

3. Acquisition galore- combination of artificial intelligence and health care are been used by new startup companies to foster the innovative requirements of large bi tech firms

4. Drug discovery- pharmacy companies in concomitance with software companies are implementing the latest technologies in the ultra expensive and expansive process of drug discovery.[2]

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