



Artificial Intelligence in the Pharmacy Profession

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ABSTRACT

The scientist named 'John McCarthy' used the term "Artificial Intelligence" for the very first time in 1956. Previously, it is only limited to engineering field, but in the recent years, it is briefly introduced into the other fields like pharma, healthcare, business, public sector etc. This review article presented to help as a short presentation of AI for the doctors and pharmacists. Here we describe the AI in various field of medical care, its advantage as well as disadvantages in pharmacy, and its tools. It is greatly advanced into the decision-making, problem solving and critical thinking and having applications in various fields like business, pharmacy, health care, and engineering as well. Now the robots are using in the various medical procedures as they are more trustworthy for doctors, as they are more advanced in their work, as they can do any task within the short time period and effectively than humans. This is concluded that AI is the new evolving field in every sector, even in pharmacy, and it need more development for updating the current scenario as well as for new researches.



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INTRODUCTION

The most evolving field "Artificial intelligence (AI)" which is known to impart a revolution change in the field of drug development as well as in the field of healthcare. This happens because of its prospective to handle the big data and awareness for clinical decision-making as well as accomplishing value-based care. It is difficult to know the strategy of AI expertise plus the way of working as well as improving the safety, efficiency, capability of working and supporting to the digital transformation of healthcare (Chen et al., 2019). AI might

affect the healthcare arrangements as well as the outcomes from the production and market in a huge advanced marketplace which is able to generate \$100 billion annually (Cattell et al., 2013). There is no world widely acceptable definition of Artificial intelligence, it is regarding as a general principle or procedure-formula, used in the all pharmaceutical industry with the general goals of making advance the technologies and increasing product yield. AI has incorporate in most of the all procedures, methods, calibration & validation and in other techniques (Faggella, 2019b). All these strategies are collectively known as AI: Artificial Intelligence. AI is continuously affecting and improving every aspect of healthcare system making it more and more advance for future generation. It involve clinical decision support to the patient care, as well as from self-management of many diseases to drug discovery (McKinsey and Company, 2018). It almost comprises all field of technologies. Employing AI in every field is costly and challenging because there are many challenges which resist the development of AI in the field of healthcare. Some of them challenges as follows:

1. Lack of knowledge;

2. Lack of planning strategy for employing AI into existing system to solve problems more efficiently that are currently evolving;
3. Lack of personnel's which are trained in AI field;
4. Lack of organization which give financial support to develop AI strategies;
5. And a lack of medical data for the training and examining the algorithms (Chen *et al.*, 2019; Gulshan *et al.*, 2016).

Many reports and experts in industry believed that the development of new techniques using AI is important and should be launched. Machines which are working under the influence of AI or ML, are more advance in the field of decision making and automation. It can be labelled as the system or whole system that is capable to take inputs from environment, enhance that input as well as acquire the inputs and take actions in respect to that input and help or modify work for achieving particular goal (Faggella, 2019b). A team of researchers and institutions at Google Inc. are working on developing an AI system that could be worked like a physician so that it can predict the sensitivity at the human level and can diagnose, operate the particular condition as well as identifying the chances of risk in the implementation in healthcare so that those can be minimized (Poplin *et al.*, 2018). Machine learning recognized as a tool of AI. It is somewhat that makes the whole system automatic. In other words, it gives the capability of automation to the system so that they can learn and improve the mistakes from experiences without changing in the programme. The goal of Machine learning is to develop a system that can admit and use or acquire the data to learn the improvement itself (Bahl *et al.*, 2018). In other terms, Machine learning is the algorithms that is planned to examine or evaluate and make decisions and predictions according to new and experience work. Currently, machine learning has evolved in almost all fields of health care like diagnosis of diseases, recognition of general symptoms, as well as in the research field, radiology, oncology etc. and epidemic outbreak prediction (Faggella, 2019a).

Advantages of AI in the Medical Field

There are following the reasons which make the more benefits of AI in the healthcare system:

Improving Face to Face and Online Consultations Clinical Help and Medication Management

"Molly" is a virtual nurse that was designed through a Sense.ly start-up with pleased face express plus a charming voice and work on the principle of ML.

The general purpose of developing molly was to provide the immediate help and disease management to the patients in the middle of physicians 'visit'. The AiCure also uses the same concept that work by using phone's camera and AI to have an eye on patient so that he/she is taking prescription at time. This concept could be helpful in the case of clinical trial and patient having chronic condition (Meskó and Görög, 2020).

Diagnosis Based on AI

The Food and Drug Administration endorsed a software programme which lets medical experts to accomplish cardiovascular ultrasound imaging without any special training. It works on the concept of AI and give constant direction and furthermore the capacity to save pictures of diagnostic area. It gives the general instructions for user including their procedure of working and automatically gives response in the form of picture. It may be called "co-pilot" because who don't have such knowledge about ultrasound, can do ultrasound without an expert (Staines, 2020).

Mining Clinical Records

The collection; storage; as well as tracking of medical records is a serious work for the purpose of future investigation or researches. This work is initially handled by AI platforms effectively like Google Deepmind Health is work in the collaboration of Moorfields Eye Hospital NHS Foundation Trust to give the assist in the eye treatment through investigation in the scan of retina. This algorithm can recognize the many eyes 'problems and give results in the detailed determinations within 30s (NHS, 2016).

Precision Medicine

In the many cases, doctors are using software which recognizes the change in the mutation of gene in the normal genes and cancerous genes. This advanced work results in the more focused therapies for the different types of cancers. E.g. Deep Genomics Company which works to recognize the patterns in the genetic data of patients and try to connect mutation to ailments and the A.I. - based algorithm named Oncompass Medicine differentiate the gene in the patient having cancer with the ongoing clinical trials (Meskó and Görög, 2020).

Planning Treatment Strategies for Patients

The most popular AI based concept that is IBM Watson which is useful for the oncologists designed to analyse the data of patient whether it is correctly structured or not, thereby turned into decision-making for the treatment. The software predict the way of treatment by comparing the data of patient with the clinical researches (Zauderer *et al.*, 2014).

There are several examples in other fields of medical like in radiology, making an enhanced radiation therapy requires days. With the help of AI, this process can be speed up to couples of minutes ([Meskó and Görög, 2020](#)).

Drug Creation

The process of drug development requires several years as it go through many clinical trials and huge cost as well. By speeding up this trials while making it more costly, would be show a great impact on healthcare. Many companies are using AI based technologies to speeding up this process e.g. company Atomwise uses supercomputers from which they find out best treatment form a database of molecular structure. They have also been launched a search engine for the existing as well as unknown combination of drugs for the treatment of many infective diseases. This AI platform reduces the time taken by drug development process ([Atomwise, 2015](#)).

Disadvantage

Quality and Quantity of Data

AI benefits from information as it can access more data and it can dominate at undertakings. Advanced algorithms need explained information to ensure those are expert in their work and intended to use in particular assignment. There are clinical experts who go about as information annotators which is a tedious and repetitive undertaking. Clinical algorithms could be beneficial in only enhancing the large annotated data. So that the role of annotators to assist executing AI in the medical care system. So here we conclude that the data annotators are play a vital role in the AI revolution in medical field ([Meskó and Görög, 2020](#)).

Privacy or Security Issues

AI in medical sector needs to access more and more data to learn new aspects of medical state timely, whether this learn data from medical algorithms, biosensors, applications or from institutions or whatever basis of information, it get. This data may access from an institution or an application or from any people. It was demonstrated much of the time that individual's profile can be tracked back easily if foundations makes information anonymized.

Legal Issues and Responsibility

There is a possibility that deep learning can skip or miss a report during diagnosis of a patient, it predict the any treatment to the doctor, and the doctor accepts that judgment as it given by software and the patient is suffering from its medical condition

continuously. Another problem during the surgeries which are done by automatic robots, what if automatic robots hurts a patient. There is a continuous discussion about who will be the responsible for the any harm or any problem when automatic robots and AI both are operating human together.

Current agreement expresses that the expert is responsible in the event that the person utilized the instrument in a circumstance or use besides its agreement, or abused it, or use it notwithstanding huge expert questions of the legal issues of the proof encompassing the tools. The responsibility such work is depend on the inventors and the organizations follow them.

Trust

The medical profession is all about trust on the medical expert that they are treating the patient in a correct way of monitoring. We need a lot of to make trust on the automated operating machines e.g. how an automatic car react in the circumstances we know or whether it settles on comparable choices in a crisis. Thus it takes even more to believe on it for patients and for medical experts too as it highly involve in the drug design, and decision making in the IBM Watson case. Trust issue point should be considered whenever we choose any technology in the medical profession.

Patient Design

The designing algorithms are involved in the clinical trial at a high level of thinking and decision making so that they met to the patents problems and changes are adapted as per the patients convenient. E.g. there was a start-up in Canada which comprised of an algorithm that was able to identify the Alzheimer in the phone calls of patients and showed various outcomes of patients who were not from the origin of Canada, whether they are from French or other country. This problem can be minimized by involving the people at the beginning of the improvement. So there are many researches that are being held for developing these algorithms in some way that they can address them all humans whether they belong to any part of the world. It can comprises all human beings ([Chen and Decary, 2020](#)).

Tools of AI

There are enormous tools of AI which has been complied with the present issues of industries and continuously improving it. Some of the AI tools that are popular in the pharmaceutical industry are shown in Figure 1 and described below:

IBM Watson for Oncology

A supercomputer has developed by IBM (International Business Machines) for the oncologist to

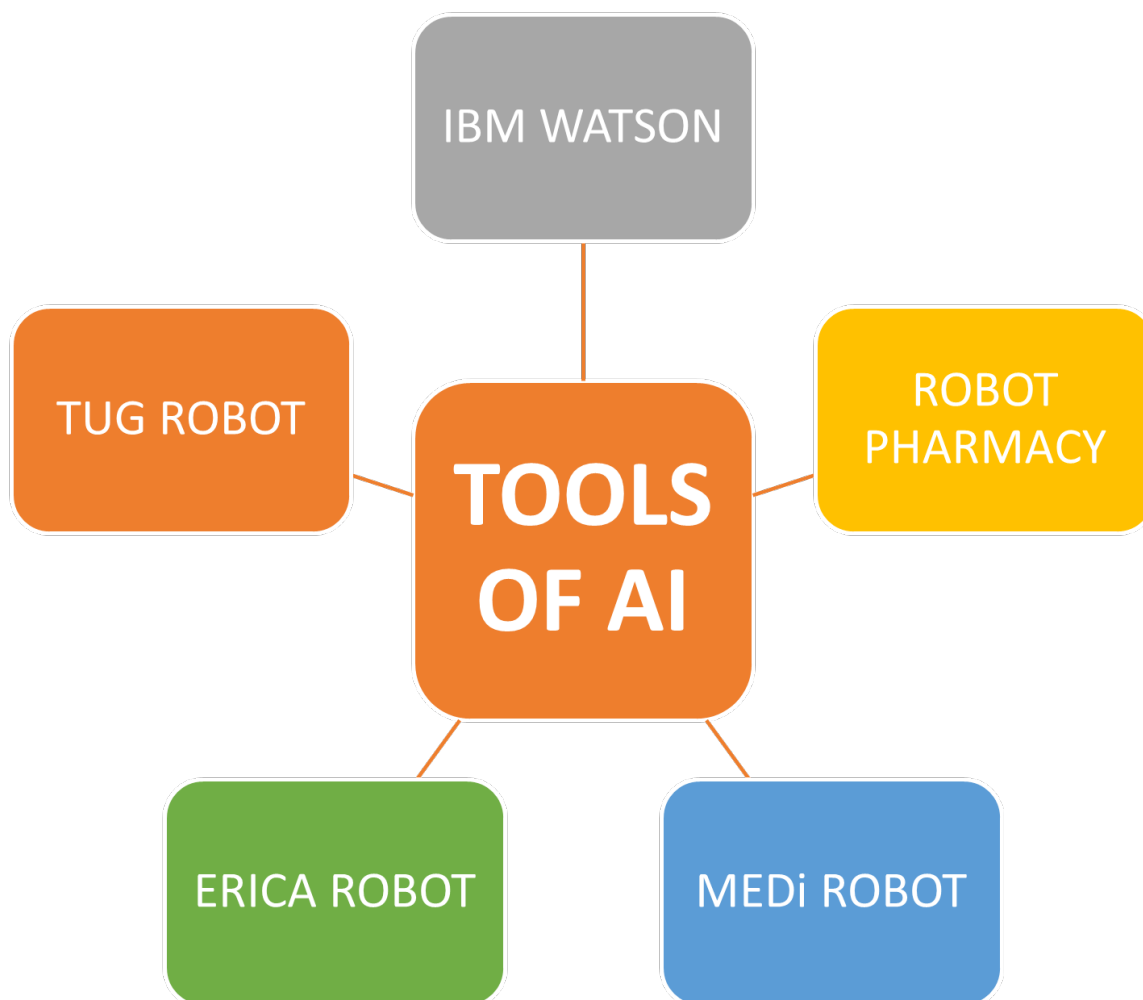


Figure 1: Tools of Artificial Intelligence

response to basic questions. It is a combination of AI plus modern diagnostic software technique, this supercomputer is known as Watson. It helps to oncologist to take better treatment plans for cancer by providing an appropriate therapy based on the evidence obtained. This supercomputer works by checking the clinical data of a patient and then aptitude, afterward gives the best options for the treatment of patient. This supercomputer has capacity to collect clinical data of patient easily, rewrite in the simple language and compares the data of patient with the research, and clinical researches then provide the suitable and best treatment plan according to the report of patient and then gives the best treatment plan for the patient (Vyas *et al.*, 2018; IBM, 2021).

Robot Pharmacy

University of California San Francisco (UCSF) uses the robote pharmacies for the production and stalking of drugs with the general goal of enhancing the safety and efficacy of the drugs for the patients. This technology has made almost 350,000 drug doses

with increase yield and without any error, this is because of their size as well as capability of delivering accurate drugs and these two qualities makes them better than human in the handling of drug as there are many chances of mistake which may turn to be a great loss of company or may lead to dangerous to the life of patient. The robotic technology has capable to prepare oral and sterile injectable preparations of toxic substances in the case of chemotherapy drugs. The robotic technology has reduced the work load of pharmacists as well as nurses of UCSF and this results in better patient care because they can directly and fully available to the patient care and helping to the doctors.

The robotic technology is the fully automatic system that first receive the prescription electronically from the pharmacists and pick the individual doses of drug then packed and dispensed. There is an advantage of the automatic system that it is helpful in the handling of sterile preparations as it can fill the syringes with the right medications. These all facilities are fully automatic (Patient Care, 2011).

MEDi Robot

“Medicine and Engineering Designing Intelligence” is the full form of MEDi. This robot was developed by Tanya Beran, she is the professor of Community Health Sciences at the University of Calgary in Alberta. She got the thought of designing MEDi robot while working in a hospital where children were shout during the medical treatment. These robots are designed to make a bond with children to make them comfort and afterwards tell them about the medical treatment and what is expected during the procurement. It directs those general things that should done during the medical procedure like how to inhale during the procedure, and how to handle. It can be designed with the AI in such way that they can think, plan, or reason.

MEDi made by company Aldebaran Robotics and having intrinsic facial acknowledgment technology. These are capable to communicate in 20 different languages and versatile in their work as per different situations. They have retailer price of \$9000, however, this cost can be increased with the implementation of new application up to \$30000. The main purpose of the development of robot was the pain management of kids during medical procedures, but it has expanded their work as they are now capable to involve in medical procedures (Vyas *et al.*, 2018).

Erica Robot

Erica is a new robot that has been developed by Hiroshi Ishiguro, a professor at Osaka University, in the collaboration with the Japan Science and Technology Agency, Kyoto University, and the Advanced Telecommunications Research Institute International (ATR). It can able to speak Japanese and has facial expression of European and Asian. It has desired to visit south-east Asia, want a life partner with whom it can talk and enjoys animated movies. Erica is the “most excellent and smart” as android. The robot could not walk properly; yet it has developed the ability of understanding and human like facial expressions (Vyas *et al.*, 2018).

TUG Robots

These are designed for help in emergencies and delivering drugs, food as well as can convey the weight loads in the hospital. There are the two configurations of TUG robots that is fixed carts and exchange base platform. The fixed card can be used to convey the drugs, laboratory specimens whereas, the exchange base platform can be used to convey the material which are loaded in the different racks. TUG can convey a few kinds of trucks or racks subsequently making it a truly adaptable and utilizable

asset. Monitoring TUG is a very simple task with the help of the touchscreen which allows clients to figure out where the TUG need to deliver and supply material. The TUG automatically decide the best way in the case of multiple destinations. The advantage of using TUG are the enhanced efficacy, patient safety, employee fulfilment as well (TUG, 2018).

Application of AI

There are several applications of AI in the pharmacy shown in Figure 2 and these are the masters in their work:

Artificial Intelligence in Drug Discovery

The drug discovery process is limited or resisted due to the lack of advanced technologies. Drug discovery process is the costly and time-consuming process (Vyas *et al.*, 2018). With the implementation of AI in this field, it will eliminate the some additional steps like it can easily and quickly shows the drug target as well as predict the drug structure (Sellwood, 2018). It also faces some problems in the growth, variety, and doubtful or incomplete data, it is unable to deal with such data whereas such data can be handled in the industry.

QSAR-based computer model (Quantitative structure-activity relationship) can be helpful in the quick prediction of physicochemical properties of unknown compound as well as their stability, efficacy and ADR of compound in the biological environment but this model has some problems such as experimental errors in the handling of small training sets, lack of validations etc. To solve this problem, there are DL (deep learning) and relevant modelling studies, new AI innovations, which is devised for the predictions of safety and efficacy evaluation parameters of drug compounds in the researches.

There are many tool which act as virtual chemical space and predict the environmental distribution of the molecules by illuminating the properties of drug molecules. Examples of such virtual chemical space are: PubChem, ChemDBChemBank, etc. the reason behind the virtual chemical space is the illumination the distribution of compound and the collection of data to explore the bioactive compounds (Paul *et al.*, 2021).

Artificial Intelligence in the Lifecycle of Pharmaceutical Products

The pharmaceutical product can be developed with the implementation of AI in the sector of advance decision making, advanced drug design techniques which provides basis for the future researches, and it is helpful in generating clinical data for the proposed researches. There is an AI platform, devel-

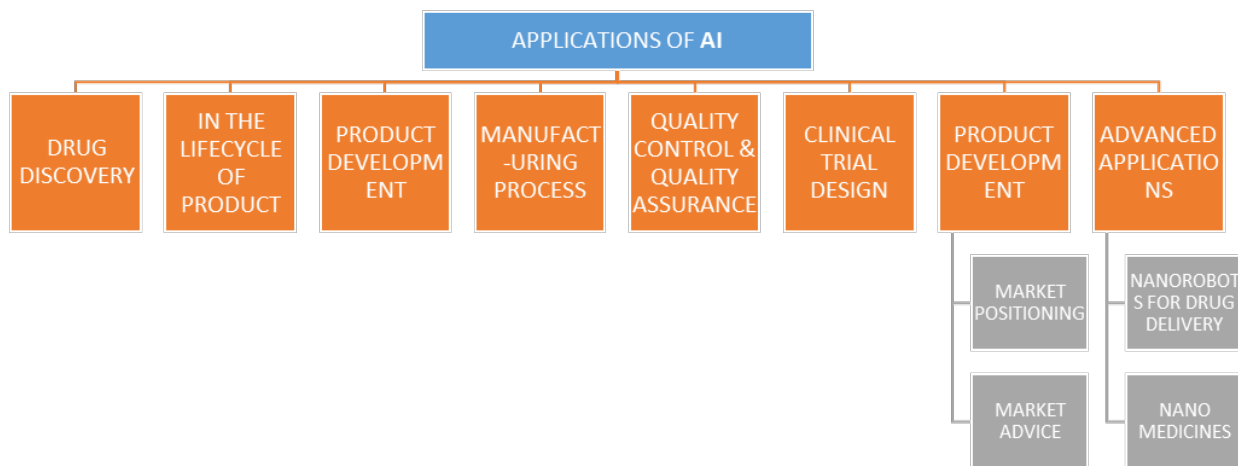


Figure 2: Applications of Artificial Intelligence

oped by Eularis, worked on the principle of ML algorithms named E-VAI which is used as a decision making platform that help to predict the better way of marketing. E. g. it generates analytical data of a pharmaceutical product which helps to gain competition in market and it tells about the correct strategy for the maximum sale of pharmaceutical product, thus help the marketing executives to locate the exact location for marketing as well as increase the interest of investors to make more investments (Paul *et al.*, 2021).

Artificial Intelligence in Advance Pharmaceutical Product Development

There is the step of formulating the suitable dosage form of new discovered drug molecule after the discovery of a new drug molecule and before the marketing the product, which retain the property of drug molecule and deliver the desired effect with minimum adverse effects. This step can be done with the aid of AI that replaces the older trial system and minimize the errors (Paul *et al.*, 2021). With the QSPR model of AI, this step can be helpful in minimizing the errors such as instability, disintegration, dissolution, and so on and the decision-making AI platforms helps to decide the nature, quantity as well as type of pharmaceutical excipient, it works as a feedback mechanism for entire process which monitor and modify it occasionally (Zhao *et al.*, 2006).

Various mathematical tools which works in the AI, e.g. computational fluid dynamics (CFD), discrete element modelling (DEM) etc. used to analyse the flow properties of power in the tablet manufacturing process and its dissolution rate profile in the case of computational fluid dynamics (CFD). With the help of these all models of AI, production of pharmaceutical products has been very easy and quick

process (Paul *et al.*, 2021).

Artificial Intelligence in Pharmaceutical Manufacturing

The involvement of AI in manufacturing is like power boost for the pharmaceutical industry. The AI is continuously changing the manufacturing process, as now modern manufacturing systems with AI are trying to give human knowledge to machines with expanding interest of efficiency and better product quality along with reducing the complexities in the manufacturing processes (Paul *et al.*, 2021).

AI platforms are making the manufacturing process so easy with the advanced tools like CFD, Reynolds-Averaged Navier-Stokes solvers technology that use to review the stress level in machine and misusing the automation in the many pharmaceutical process. In the similar way, mathematical simulations are also producing a progressed ways to deal with complex flow problems in manufacturing (Chen *et al.*, 2016).

It has been used in the manufacturing of many compounds like sildenafil, diphenhydramine hydrochloride with the maximum yield and purity as similar as convectional method of manufacturing. The working capacities of granulation has increased up to 600L with the aid of AI technologies and correlated neuro-fuzzy logic.

They provide prediction with the help of an equations which determines the quantity of fluid to be added, and necessary speed for the granulating machine, as well as the diameter of granules. Meta-classifier and tablet-classifier are the apparatuses which assist in the administration the quality of the final product, marking the possible error in the process of tablet manufacturing (Paul *et al.*, 2021).

Artificial Intelligence in Quality Control (QC) and Quality Assurance (QA)

The equilibrium of various factors should be maintained in the manufacturing of the product from the crude material (Aksu *et al.*, 2013). The batch-to-batch consistency and Quality control tests on the products are required to maintain for the desired product. This methods probably won't be the best methodology for each situation, so that there is a requirement of AI implementation. The Current Good Manufacturing Practices (cGMP) was amended by Food & Drug Administration (FDA) with the involvement of 'Quality by Design' (QbD) methodology for the better understanding the critical operations and the specific quality of the pharmaceutical product.

Goh *et al.* considered the dissolution rate profile as an indicator of consistency for batch to batch operations with the help of artificial neural network (ANN), that predict an error of <8% in the dissolution rate of various batch to batch operations (Paul *et al.*, 2021). AI can be executed for the guidelines of processes manufacturing to accomplish the product. Gams *et al.* used an AI system which is a collaboration of both human efforts and AI where the primary or preliminary information were analysed from the various batches and the results from them are kept as prove which were additionally converted into guidelines and examined by various operators to lead the manufacturing set in the future (Aksu *et al.*, 2013). The Freeze-drying process based on ANN-operating system which work as a group of self-adaptive evolution with backpropagation algorithms and used to give appropriate temperature and cake-thickness for the specific arrangement of working condition, hence help to maintain the quality and consistency of final product. There are many computerized platforms which are used to ensure the quality of the product. E.g. Electronic Lab Notebook. With use of data mining and various intelligent techniques in the TQM (Total Quality Management), improves the important methodologies during the complex decision, creating new technologies for the advanced quality product (Paul *et al.*, 2021).

Artificial Intelligence in Clinical Trial Planning

The new drug discovery clinical trials are done for specific disease or infection with the purpose of building or checking safety and efficacy of a particular drug and it requires at least 6 to 10 years with a considerable money investment in completion and the chances of success are less there, which leads to huge loss of industry as well as investor (Paul *et al.*, 2021). There are many reasons of failure including shortage of technical arrangements as well as

unsuitable patient selection. These losses can be minimized with execution of AI in clinical trials which provides a vast digital data for access (Fogel, 2018). The main step in the clinical trials is the appropriate selection of the patients which takes about 33% of total time and the success rate can be ensured by the correct selection of the patients, if this step is taken wrong then leads to 86 % or overall failure of trails (Kalafatis, 2000). AI can help in choosing the patient data on the basis of patient-specific gene-exposome profile examination for the phase II and III of a specific disease clinical trial which will results in the early expectations of drug target in selected patients (Fogel, 2018). There is a problem of patients who give up at the time of clinical trials, this problem makes the selection process more sensitive otherwise it leads to 30% failure of the clinical trials as well as time and money. This failure may be minimize by keeping close eye on the patient nursing and help them to monitor the rules related to clinical trial (Kalafatis, 2000). A mobile application was established by Ai Cure which is responsible for the close monitoring of regular medication consumption in Phase II trials by patients who are suffering from schizophrenia. This application increased the patient loyalty up to 25% towards the clinical trial and ensuring the success of clinical trial (Sellwood, 2018).

Artificial Intelligence in Product Management

Artificial Intelligence in Product Positioning in the Market

Market positioning of product is defined as the mode of building a marketing value or recognition of a product in market where it attracts buyer to buy them. It tries to make a vital element in practical strategies in business for encouraging organizations to make their own matchless personality among all products.

The same methodology was followed by a company in the marketing of pioneer brand Viagra, and they focused on other aspects associated with the men's erectile dysfunction but not specifically on the treatment. It has become easier for companies to market their products and get a unique marketing value of their company using the AI strategy plus e-commerce sites for advertisement.

Companies are using web crawlers as one of the innovative AI platform for getting a marketing value in online market and helps to make a vital element in the market. Companies are trying to make their websites better than their competitors and offering reward system for a short time period which affect their market sale and make them popular (Paul *et al.*, 2021).

Artificial Intelligence in Market Advice and Analysis

The nonstop growth of business results in the success of a company. The results of R&D department with the considerable access to technologies, is facing failure due to the lack of the new marketing strategy (Paul *et al.*, 2021). The advanced digital technologies is helping in the digital marketing by applying multi criteria decision-making approach which help in the collection and examination of the statistical and mathematical data and developing an AI-based decision making models by involving human inference with the general goal of building new advertising strategies (Milgrom and Tadelis, 2018).

AI also work like a decision-maker which gives the new marketing strategy for a product depending on the customer's perspective and understanding the need of the market and ultimately results in the huge marketing of product. AI-based software's with the executive of ML observe the customers' history based on the last experience, and show the advertisements of products on different sites or platforms which will directly address to the commercial site of product by just a click. This method works on the natural language-processing tools that examines the words entered by you and relate them to the different probable products in the market (Paul *et al.*, 2021).

Several companies are allowing the searching of products in the web by using product's characteristic, specification and their brand name, this makes the market of a product by its work. In the similar way, many Pharmaceutical companies are launching their apps and making sites for the digitalization e.g. 1 mg, pharmacy etc. (Milgrom and Tadelis, 2018). AI can predict the market situation for various essential pharmaceutical product which helps companies to keep their price, stock as per the market consuming capacity and reducing the loss. Example of AI platform for such work: Smart Sales Prediction Analysis.

Advanced applications of Artificial Intelligence

The implementation of Artificial Intelligence in Nanorobots for drug delivery

Nanorobots are involved for the most part of coordinated routes, biosensors, control, these all things are maintained and modified timely by AI system. Nanorobots are developed and modified to stay away from crash, detect and attach, target identification. Nano/microrobots with advanced techniques are able to explore more focus on the physiological condition at the target site such as pH, temperature and results in the improved efficacy with maximum

bioavailability as well as reducing adverse reactions of drug in body (Fu and Yan, 2012). For the delivery of genes and drugs within the parameters required, implantable nanorobots are developed. The drug release from the implantable nanorobots are influenced by AI tools like fuzzy logic etc. (Paul *et al.*, 2021).

Artificial Intelligence based nanomedicine

Nanotechnology based nanomedicines are become a novel field of drug delivery system for the treatment, detection, and nursing of complicated disease states Nanogel particle drug delivery system has become the novel and most important in the diagnostics and treatment as they show improved efficacy as well as bioavailability of many drugs. The working capacity can be advanced and modified by the implementation of AI (Sacha and Varona, 2013).

Methotrexate nanosuspension was prepared computationally which was prepared on the basis of energy released by drug molecules reactions and providing the suitable circumstances that that could result in the accumulation of drug particles (Zhao *et al.*, 2006).

Artificial Intelligence in Various Fields of Healthcare

AI has developed in the almost all of the fields of healthcare, making it automatic, and advance as well as up to date. Some of them fields are described below:

AI in Radiology

AI in the radiology has gained more acceptance because of it vital applications in this field. The main reason for this acceptance is the gradual progress in the image-identifying tasks which is a critical step in the diagnostic and AI makes it easy by the accumulation of digital data. Its increased data accessibility in the radiological tests results in the expanded responsibilities of radiologists as well as a lack of professionals. For fastening the diagnosis process, many techniques has been developed which are based on computer vision and AI algorithms, and improving perception of pathogens (Gulshan *et al.*, 2016), help in the basic labour issues as well as make them advance for emergency situations. However, this development is not intended to replace humans with robots, not for augmenting with human, the intention behind this development is to assist the application which underline the information that may not be possible to access by humans and providing information in a couples of minutes. There is a platform which was developed by MaxQ-AI Ltd and it is CE approved, used for highlighting the intracranial bleeding area. This start-up is highly bene-

ficial in the radiology and providing at time decision support to the professional and making results more precise in the current intense medical state. They involve the process of 3D CT scan (Computed tomography), which detect the intracranial bleeding area and highlight it. A spinoff company from San Francisco named Viz.ai Inc, is making this technique more advance and one step forward for better diagnosis, they focus on decreasing time consumed in the treatment after the CT scan. This platform is capable to identify the large vessel occlusion (LVO) in the brain which is a common reason for strokes. The platform analyse the images and send an alert to the radiologist where it detect LVO (Mintz and Brodie, 2019). Now the detection of the many diseases has been possible after the implementation of AI like liver, bone, heart problems etc. e.g. the detection of vertebral fractures on the chest and abdomen has been possible with using a set of algorithms (Gulshan *et al.*, 2016). Expending AI and deep learning in the diagnosis has been demonstrated pretty much better than human execution in certain sectors, for example, node hub metastasis identification and mammography threat location (Bejnordi *et al.*, 2017; Mintz and Brodie, 2019).

AI in Cardiology

The ML and AI brings about quicker understanding and conclusion in numerous spaces of cardiology e.g. the process of an Electrocardiogram has been fully automatic, this automatically predict the results in the 3D imaging mode with the capacities of heart plus the angiography which regulate other functions of coronary vessels like calcification etc. (Slomka *et al.*, 2017). The EMR (electronic medical record) technique with AI has been showed to be beneficial in the decrease number of death by means of early detection of heart attack and this happens because of its ability to do longitudinal assessment of data to find any clue that gives the predictions for heart failure (Choi *et al.*, 2017). Employing AI in the decision making process, it predict the best way of treatment in the case of angina, it uses the EMR of patient, and had a superior results in reducing mortality (Mintz and Brodie, 2019).

AI in Gastroenterology

The treatment in this field is mainly depends on the endoscopic pictures of the affected areas. To improve identification in a clinical test that keeps going a couple of moments just, and is played out various times each day an AI based framework was created. The AI platforms such as CAD system (computer aided diagnosis), showed the abnormal area on the screen by highlighting them, thus helping the professional by saving their time. This system is

capable in both diagnosis as well as in decision making as it can also define the pictures and predict the best treatment plan. This platform has shown 90% of detection capacity with improved outcomes in the colonic polyps. This platform has proofed that the AI based platforms can make the diagnosis process more effective. The CAD system was used with the general goals of the early detection gastric cancers and colonic cancers which was not an easy task to detect these medical conditions in the minimum time. It was illustrated to have a 96.3% accuracy in the detection of gastric diseases with an affectability of 95% (Mintz and Brodie, 2019).

AI in Ophthalmology

A medical condition known as Diabetic retinopathy (DR) which is currently affecting almost 400 million people globally who experience the ill effects of diabetes. This condition results in the vision and blindness as it affect the veins which goes through retina and may cause detachment of retinal (WHO, 2016). The detection of Diabetic retinopathy can be improved and effective by the execution of AI and deep learning. A study was done by Gulshan *et al.* who use two approval arrays of 9963 and 1748 pictures and tracked down at high affectability and explicitness rate and contrasted with ophthalmology specialists (Gulshan *et al.*, 2016). It has concluded that the deep learning is effective in this field in the early detection of eye related problems, and these studies need further more study and more improvement (Mintz and Brodie, 2019).

AI in Oncology

AI application may really demonstrate to give preferred outcomes over human readings. Somashekhar shown that AI is dependable for the finding of breast cancer (Somashekhar *et al.*, 2018). The Watson oncology was found to effective in 90% concordance rate with a specialist tumor board on proposals of best treatments in breast cancer. Bejnordi conducted a study for this. In this study, he contrasted a set of 129 slides, in which 49 slides were with metastases to lymph nodes and 80 slides were without metastases, he done this work with the collaboration of 11 pathologies. For this work, the pathologist need 30hours to compare all slides in actual, whereas these slides can be analysed with the AI algorithm, it requires only couples of minutes. The AI is seen to be more effective than human in the case of lungs cancer detection. A study conducted by KH Yu, C Zhang, they mainly focused on the AI accuracy for pathological diagnosis and they involved the set of 2186 stained slides of lung adenocarcinoma and squamous cell carcinoma.

The conclusions obtained from their study predict that the AI can accurately diagnose the lung cancer as well as giving them appropriate oncological treatment (Yu *et al.*, 2016). There are many studies that are being held and continuously occurring in the field of oncology and these all are studies are aim at making more advanced way of diagnosis as well as treatment in the cancer case.

CONCLUSION

The human is believe to be the most complex and cultured machine, but now, the situation has changed significantly. Human are no longer defined to be the most complex machine, the human brain is doing hard word to develop a system that is more complex and effective than human in working capacity and it has successful in doing so. Now it has become an essential part in the pharmaceutical industry in addition to health care system and the researchers are on the fact of implementing the AI in every field of so that many researches are being carried out globally to enhance the manufacturing process better, and enhancing other activities in industry as well as hospitals. The tools of AI like Watson for oncology, Erica robot, robotic pharmacy, etc. has been reformed the pharmacy professional, making it automatic as well as increasing working capacity at a much great extend and there are the less risks of errors. The aim of implementing AI in pharmaceutical is to decrease challenges which met in companies like increased cost of drug development etc. AI is also speeding up the needed time for the development and design as well quality, efficacy, and safety of product in the cost-effective manner, which is turns in the more start-ups in this field. However, execution of AI in the system is not intended to replace the humans but they are intended to help human and work under the guidance of humans. However, if we look at the unemployment ratio as it is increasing day by day and will increased more after the implementation of AI, then it forced to rethink otherwise all the activities that are done by humans, will be a part of AI executive.

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Conflict of Interest

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