Review Article

A Review on Artificial Intelligence in Pharma

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Received: 15-10-2023; **Revised:** 22-12-2023; **Accepted:** 29-12-2023; **Published on:** 15-01-2024.

ABSTRACT

Artificial intelligence, a field within computer science, enables machines to operate effectively. Its application in pharmaceutical technology has expanded, enhancing workflow efficiency, cutting operational expenses, and fostering safety, precision, and productivity by tackling intricate data processing tasks. In addition to helping us better understand the relationships between different formulations and process parameters, it might also help save time and money. The amount of research on artificial intelligence (AI) has skyrocketed, and AI technology has been found to be capable of both analyzing and interpreting some crucial pharmacy domains, such as dosage form design, hospital pharmacy, and drug discovery. Artificial intelligence has made remarkable progress in the healthcare sector, with its substantial contributions in the storage and organization of data and information.

Keywords: AI, Telepsychology, MEDi Robot, Innovative peptides & Drug screening.

INTRODUCTION

A subfield of computer science called artificial intelligence (AI) is concerned with problem-solving with the help of programming in symbols. AI has significantly improved disease diagnosis. Now, disease analysis is essential to creating thoughtful treatments and ensuring patients well-being. AI is rapidly making its way into the healthcare sector. AI is seen as playing "a key supporting role in the fight to treat and Stop" the virus and perhaps will "contribute to a solution coming faster than we would have otherwise" in the biotech field. AI is recognized as having a crucial supporting role in the efforts to combat and control the virus, potentially accelerating the discovery of solutions in the biotech sector.[1]

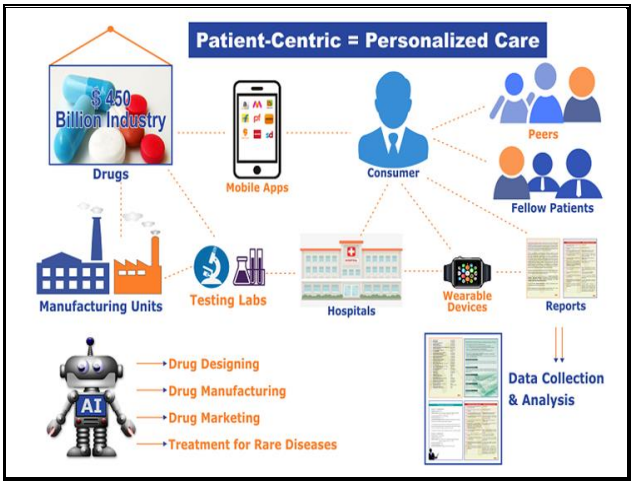

Figure 1: Benefits of using Artificial Intelligence in drug development

Source: https://www.proxzar.ai/wp-content/uploads/2020/05/Is-AI-the-answer-to-patient-centric pharmaceutical-strategy.png

Drug discovery, drug delivery formulation, development, and other healthcare applications are among the emerging initiatives embracing AI technology in pharmacy. This movement has already moved past hype to hope. Predicting in vivo responses, the pharmacokinetic parameters of the therapeutics, appropriate dosage, etc., is also made possible by the use of AI models.[2] As per the significance of pharmacokinetic prediction in drug research, the utilization of in silico models aids in the drug's effectiveness and affordability. The advancements in AI technology fall into two main categories. The first one is made up of traditional computing approaches, such as expert systems, which can mimic human experiences and provide conclusions. From the fundamental ideas, such as expert systems.[3] The second one consists of systems that use artificial neural networks (ANNs) to simulate how the brain functions.

Type of Artificial Intelligence:

A. Based on the caliber and their presence

1. Artificial narrow intelligence or weak AI
2. Artificial general intelligence or strong AI
3. Artificial super intelligence[4]

B. Based on presence (Four Primary Artificial Intelligence Type)

1. Reactive machine
2. Limited memory system
3. Theory of mind
4. Self-awareness

A. Based on the calibre and their presence:

A1. Artificial Narrow Intelligence (ANI) or Weak AI: It specializes in specific tasks, such as facial recognition, driving a vehicle, practising chess, and managing traffic signals, among others.[5]

A2. Artificial General Intelligence (AGI) or Strong AI: It can mimic human capabilities and is often referred to as human-level AI. This type of AI can streamline human cognitive functions and handle unfamiliar tasks.

A3. Artificial Super Intelligence (ASI): It surpasses human intelligence and exhibits significantly greater activity in areas like drawing, mathematics, and space-related tasks, both in what's currently available and what's still in development.[6]

B. Based on presence (Four Primary Artificial Intelligence Type)

B1. Reactive Machine: It serves specific, single-purpose applications and lacks the ability to draw from past experiences due to the absence of a memory system. This category is referred to as reactive machines. Notable instances of these systems include IBM's chess program, which can identify chessboard pieces and make predictions.

B2. Limited memory system: It possesses a constrained memory system that leverages past experiences to address various issues. In the context of autonomous vehicles, this system is adept at making decisions based on recorded observations, which are used for subsequent actions, but these records are not retained permanently.

B3. Theory of mind: It relies on the concept of "Theory of Mind," which implies that human decision-making is influenced by their unique thoughts, intentions, and desires. This kind of AI system does not currently exist.

B4. Self-awareness: It possesses self-awareness, including a sense of self consciousness. However, this type of AI system does not exist at this time.

The role of artificial intelligence (AI) in the following areas:

1. Disease diagnosis
2. Digital therapy/personalized treatment
3. Radiation therapy
4. Retina
5. Carcinoma
6. Other chronic disorders
7. Drug discovery
8. Prediction of bioactivity and toxicity
9. Clinical trials
10. Designing clinical trials, identifying patients, recruiting, and enrolling them;
11. Monitoring trial, patient adherence and end point detection.
12. Forecasting of an epidemic/pandemic.[7]

● The Past [Historical Event]

Progression of Artificial Intelligence:

• Year 1943: Warren Mcculloch and Walter Pits completed the first research that is currently known as artificial intelligence in 1943. They put forth an artificial intelligence model.

Birth of Artificial Intelligence:

• In 1955, Herbert A. Simon and Allen Newell developed the first artificial intelligence program, dubbed "Logic theorist." This program found new and more elegant proofs for some theorems and had proven 38 out of 52 theorems in mathematics.

The golden years-early enthusiasm (1956-1974)

• In 1966, researchers focused on creating algorithms capable of solving mathematical problems. Joseph Weizenbaum introduced the initial chatbot, named ELIZA, during the same year.

• In 1972, Japan constructed the first intelligent humanoid robot, known as WABOT-1.

Since the 1950s, artificial intelligence has had a difficult past. It was long considered a field for dreamers, but that began to change in 1997 after chess champion Garry Kasparov was defeated by IBM's Deep blue computer. The history of AI has been turbulent since the 1950s. The idea that IBM's deep blue computer was only for dreamers started to change in 1997 when it defeated chess champion Garry Kasparov. The $1 million Jeopardy prize was successfully won by IBM's brand-new Watson supercomputer in the US in 2011. Since then, Watson has expanded into the pharmaceutical and healthcare sectors. In 2016, the company partnered with pfizer to expedite the creation of novel immuno-oncology medications.[8]

Artificial Intelligence in telepsychology [E-therapy]

From the raw datasheets, AI may be able to extract a meaningful relationship. This can also be applied to the disease's diagnosis, course of treatment, and mitigation. Many of the more recent methods utilized in this emerging field of computational understanding have the potential to be applied in nearly all branches of medical science. The challenge of learning, analysing and applying a wealth of knowledge must be overcome in order to solve the complex clinical problems. The advancement of AI in medicine has aided clinicians in resolving challenging clinical issues. Systems like artificial neural networks (ANNs), evolutionary computational models, fuzzy expert systems, and hybrid intelligent systems can help healthcare workers with data manipulation. The biological nervous system serves as the foundation for the artificial neural network (ANN). A network of linked computer processors, resembling neurons, conducts concurrent data processing. The initial artificial neuron employed a binary threshold function. The multilayer feed-forward perceptron, with distinct layers including input, middle, and output layers, became a prominent model. Each

neuron is linked through connections with assigned numerical weights.[9]

Figure 2: Artificial Intelligence in telepsychology

Source: https://www.shutterstock.com/image-vector/artificial-intelligence-healthcare-computer-database-concept-2353878985

In 1974, Paul Werbos introduced a novel method known as "Backpropagation learning" featuring an effective learning algorithm. Artificial neural networks have found applications in fields like image diagnosis, data interpretation, and waveform analysis. Fuzzy logic is a discipline concerned with reasoning, thinking, and inference that can comprehend and apply real-world phenomena. It primarily relies on a continuous membership range from 0 to 1, where 0 represents false and 1 signifies true. Fuzzy controllers have also been employed for the management of vasodilators and anesthetics in surgical settings. This evolutionary computation technique is inspired by the principles of natural evolution, focusing on the survival of the fittest.

● Artificial intelligence in radiooncolgy:

Automated treatment planning, a recent technological advancement, offers significant advantages in radiotherapy treatment planning. It effectively enhances plan quality, consistency, and reduces error rates. The treatment process can be categorized into three segments: automated rule application, modeling of previous clinical knowledge, and multi-criteria optimization. A basic computer program with predefined structures can implement clinical guidelines. The treatment planning system can analyse a patient's anatomy and physiology and replicate the reasoning process typically used in manual treatment planning. Radiomics can be applied to predict outcomes and assess toxicity in individual patients receiving radiation therapy.[10]

● Artificial intelligence in ophthalmology:

Retinal high-resolution imaging has made it possible to assess human health in a remarkable way. An ophthalmologist or retina specialist can create a personalized therapy plan and implement an ever-improving learning healthcare system using just one retinal photograph and high-definition medications.[11]

● Artificial Intelligence in oncology:

AI has become increasingly important in the fields of cancer diagnosis and treatment due to its wide range of applications. A multilayer perceptron neural network was trained with gene expression data to predict the lymphoma subtypes of non-Hodgkin lymphoma.[12]

Lymphoma subtypes make up the output layer of the neural network, while 20,863 genes make up the input layer. Burkitt, diffuse large B-cell lymphoma (DLBCL), follicular lymphoma, marginal zone lymphoma and mantle cell lymphoma (MCL) are among the subtypes of lymphoma. Using gene expression data, an artificial neural network was trained to find new prognostic markers for MCL. The results showed that 58 genes had high accuracy survival predictions, 10 of which were linked to poor survival, and 5 of which were favorable.

According to a multivariate analysis of gene expressions using the multilayer perceptron (MLP), three genes are correlated with poor survival and four genes with favorable survival in DLBCL patients. RNA-Seq provided the genetic and transcriptional data used in the Cell-of-Origin (COO), Classification of DLBCL using an AI deep learning technique in the next-generation sequencing (NGS) platform. Artificial intelligence has made assays for classification and further clinical application more economical, efficient and repeatable. AI reduces time while maintaining high accuracy in the diagnosis of cancer.[13]

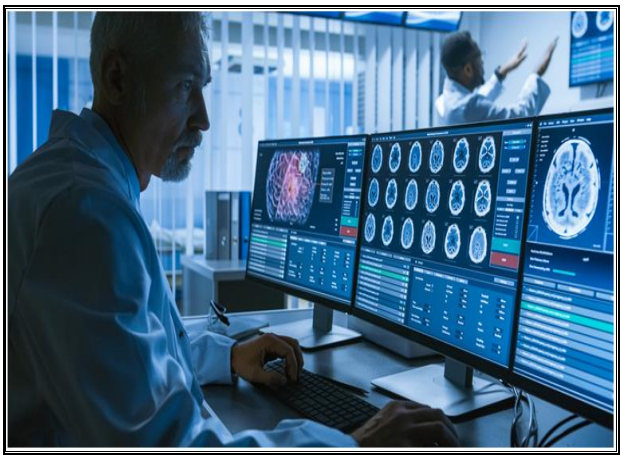

Figure 3: Artificial Intelligence in oncology

Source: https://pharmaphorum.com/views-analysis-digital/ai-cancer-care-3-ways-artificial-intelligence-transform-cancer-outcomes

In gastrointestinal cancer, colorectal cancer (CRC) screening technology is used to assess the patients' level of malignancy and visual nocturnal imaging plays a critical role in predicting the progression of gastric cancer by detecting Helicobacter pylori infection. AI is a flexible clinical tool for screening and early lung cancer detection. Because deep learning and machine learning AI techniques can accurately characterize pulmonary nodules and maintain large amounts of data, they provide a supportive measure in lung cancer screening. At the moment, AI helps pathologists with their tasks and helps distant institutes

that are facing a pathologist shortage. The development of this technology in pharmaceutical and healthcare research depends on the availability of user-friendly tools that do not require a background in computational science, as these will help overcome the limitations of AI in translational research. AI has shown great promise in the last ten years for the diagnosis of breast cancer. Utilizing a combination of quantitative and qualitative MRI features, assisted techniques can be used to predict treatment response in patients with breast cancer, even prior to the initiation of neoadjuvant chemotherapy (NAC). AI-based software can assist radiologists in their clinical work by helping them differentiate between benign and malignant breast lesions and by lowering the likelihood that false-negative mammograms will be interpreted.[14]

● Artificial intelligence in chronic pain management:

Based on computer programming techniques, various computerized therapies are available. The behavioral and cognitive approach, which uses joysticks or multiple-choice questions, is the main focus of the therapies. A brand-new method of computer interaction has just been created. The patient may follow recommendations for one medication and perform their own biopsy. Regular monitoring is necessary for chronic diseases and artificial intelligence (AI) can be used to create virtual medical assistants to help with this monitoring. One can forecast the occurrence of arterial fibrillation using an integrated system using a single-lead ECG sensor with deep learning and physical activity using a smart watch and accelerometer data.[15]

The automated system recognizes issues and retains the most efficient fix for each patient. Insulin therapy optimization is already being done with it. In patients with type 2 diabetes mellitus, machine learning based technologies such as clinical decision support can also predict the short and long term HbA1c response following the initiation of insulin. Patients can now control their diabetes with more advanced methods, such as web-based apps for smartphones and tablets.[16]

▪Artificial intelligence – enhanced Drug Screening:

Testing compounds against samples of diseased cells is a common step in the lengthy drug discovery process. Further analysis is needed to identify compounds that are biologically active and worthy of further investigation. Novartis research teams use images from machine learning algorithms to predict which untested compounds might be worth investigating further in order to expedite this screening process. New and efficient medications can be made available sooner thanks to computers' significantly faster discovery of new data sets than traditional human analysis and laboratory experiments. This also lowers the operational costs related to the labor-intensive manual investigation of each compound.[17]

The current AI initiative by the top biopharmaceutical companies include:

1. Utilizing real-time data collection, a mobile platform can enhance patient outcomes by making recommendations for patients.

2. Drug discovery- Pharma firms and software companies are collaborating to integrate state-of-the-art technologies in the expensive and time consuming drug discovery process.

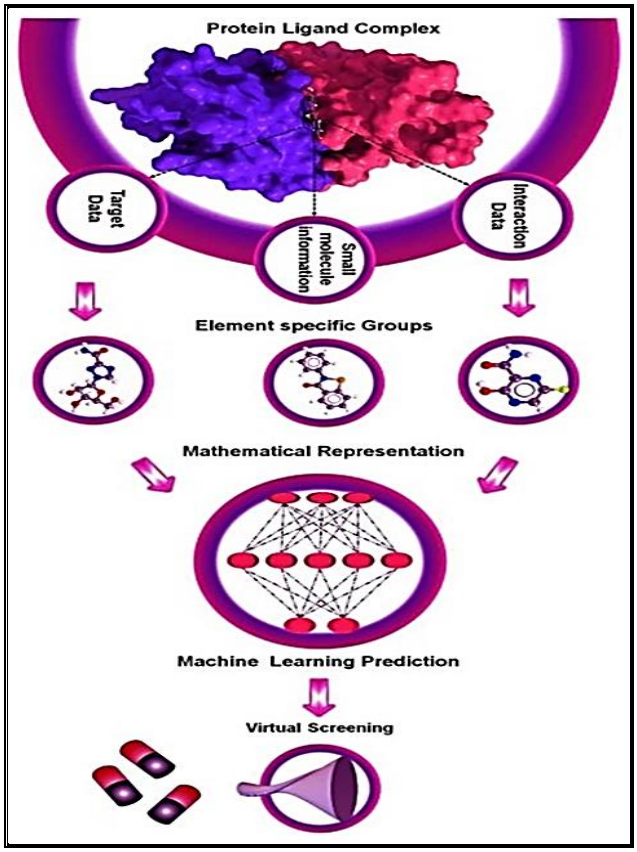

Figure 4: Enhanced Drug screening by Artificial intelligence

Source: https://link.springer.com/article/10.1007/s11030-021-10326-z

Figure 5: Robot Pharmacy

Source: https://healthcarebusinessclub.com/articles/healthcare-provider/technology/the-smart-pharmacy-the-new-future-of-pharmacies/

Artificial Intelligence Frameworks [Machine learning tools]

[ADVANCE TECHNIQUES]

A. Robot pharmacy: Robotic technology is used by UCSF Medical Center to track and prepare medications with the goal of enhancing patient safety. [Figure 5]

They claim that the technology has flawlessly prepared 3,50,000 doses of medication.

The robot has shown itself to be significantly superior to humans in terms of both size and medication delivery accuracy.[18]

B. MEDi Robot: The acronym for medical and engineering designing intelligence is MEDi. AI instruments Tanya Beran, an Albertan professor of community health sciences at the University of Calgary, oversaw the project that resulted in the development of the pain management robot. Her experience working in hospitals where kids scream during treatments gave her the idea. After establishing a rapport with the kids, the robot explains to them what to expect during a medical procedure.[19]

C. TUG robots: Aethon TUG robots are made to move through hospitals on their own and deliver supplies, meals, medications, specimens and heavy items like trash and linen. It comes in two configurations: an exchange baseplatform that can be used to move racks, bins, carts, and fixed and secured carts.

D. Erica robot: Professor Hiroshi Ishiguro of Osaka University in Japan is the creator of the new care robot Erica. It was created in cooperation with Kyoto University, the Advanced Telecommunications Research Institute International (ATR) and the Japan Science and Technology Agency. Its facial features are a mix of European and Asian and it speaks Japanese. It enjoys watching animated movies, wants to travel to Southeast Asia and wants a life partner who can have conversations with it, just like any other regular human.

Propose Emerging Therapeutic Approaches:

Verge is addressing the primary issues in drug discovery through automated data collection and analysis. Stated differently, an algorithmic method is being employed to map out hundreds of genes that are involved in complex ways in brain diseases such as ALS, Parkinson's and Alzheimer's. According to Verge, collecting and evaluating gene data will have a favorable effect on the preclinical trials stage of the drug discovery process. On the human brain, concentrating especially on the preclinical stage.[20]

1. Synthesis of Innovative Peptides:

The Irish start up Nerites uses artificial intelligence (AI) and other cutting-edge technologies to make it easier to find new, healthier ingredients and foods that are more robust. Using this collaboration, BASF (Baden Aniline and Soda Factory) will create innovative functional peptides made from whole foods. Finding and bringing to market peptide-based treatments that can aid in the treatment of diseases like diabetes is BASF's primary objective.[21]

2. Care and Supervision of Uncommon Diseases:

AI developments and a resurgence of interest in treating rare diseases. Over 350 million people worldwide suffer from more than 7,000 rare diseases at the moment. Nevertheless, there is hope for patients suffering from uncommon illnesses as Heal, a biotech company based in the UK, has managed to obtain $10 million in series funding to employ artificial intelligence in creating novel medications for uncommon ailments. $60 million has been invested in Therachon, a different Swiss biotech business that uses AI to create medications for the treatment of uncommon genetic illnesses.[22]

3. Medication Adherence and Measurements:

To strengthen medication adherence and increase drug trial vigilance, Abbvie teamed up with Acura, a company based in New York. In this partnership, abbvie monitored adherence using the AiCure Mobile SaaS platform's facial and image recognition algorithm. More specifically, the patients use their smartphones to record themselves swallowing a pill and the AI powered platform verifies that the right person did, in fact, swallow the prescribed medication. And the outcomes were outstanding, increasing adherence by as much as 90%. Several clinical trials have employed Genpact's AI solution to adjust the dosage administered to individual patients in order to maximize outcomes. Through this collaboration, Bayer uses Pharmacovigilance Artificial Intelligence (PVAI) from Genpact to monitor medication adherence and identify possible side effects much earlier.[23]

Benefits of Artificial Intelligence Technology's:

The prospect benefits of Artificial Intelligence technology are as follows:

1. **Accuracy Improvement:** Artificial intelligence aids in reducing mistakes and enhancing precision, resulting in increased accuracy. Resilient metallic robotic entities that can withstand harsh space conditions are deployed for space exploration due to their ability to endure challenging atmospheric environments.[24]
2. **Challenging Expedition:** Artificial intelligence demonstrates its practicality in the mining industry, as well as finding application in fuel exploration. AI technologies have the capability to explore the ocean by overcoming human-induced errors.[25]
3. **Routine Implementations:** AI plays a valuable role in our everyday activities and actions. For instance, GPS systems are widely employed during extended journeys and the integration of artificial android devices aids in predicting user input and rectifying spelling errors.[26]
4. **Artificial intelligence Assistants:** AI systems like "avatars" or models of digital assistants, are being used by sophisticated organizations these days to

reduce the need for human labor. The "avatar" can make the correct, logical choices because they are devoid of all emotion. The efficiency of judgment is disrupted by human emotions and moods, but machine intelligence can help solve this issue.[27]

5. **Clinical Applications:** With the aid of an AI program, doctors can generally evaluate their patient's conditions and analyse any side effects or other health risks related to their medications. With the use of AI applications, such as different artificial surgery simulators (such as those that simulate the heart, gastrointestinal tract, brain, etc.), trainee surgeons can learn a lot.[28]

6. **Enhance Technological Progress Rate:** Nearly all of the world's cutting-edge technological advancements use artificial intelligence (AI) technology. It strives to create newer molecules and is capable of generating various computational modeling programs. Additionally, the development of drug delivery formulations makes use of AI technology.[29]

7. **Assistant and Relief:** AI technology serves individuals of all ages, both children and the elderly, round the clock, taking on roles as educational resources for teaching and learning.

8. **Infinite Possibilities:** Machines operate without limitations and devoid of emotions. These emotionless machines can outperform humans in various tasks, executing them with greater efficiency and precision.[30]

Vision of Artificial Intelligence:

When it comes to pharmaceuticals, there are a lot of unmet needs. In healthcare, a revolution is taking place. A Johnson & Johnson representative said in a statement that "artificial intelligence is giving us the ability to discover new treatments and techniques faster than we would have thought possible just a decade ago."

This is an exciting moment to work in this field as well. They went on the market for healthcare AI is expanding quickly and is generating lucrative and fulfilling careers.[31s]

In the pharmaceutical field, efforts are underway to leverage AI to predict the timing and locations of potential epidemic outbreaks with a reasonable level of accuracy. This involves utilizing AI that learns from historical outbreak data and other information sources. Within the healthcare sector, AI is being employed to proactively avoid medical mistakes and lower the frequency of hospital readmissions.

CONCLUSION

When creating and utilizing AI systems for COVID-19 and other pandemics in the future. AI can help with a wide range of pertinent issues, such as social distancing, contact tracing, diagnosis, workplace safety and more. Errors could impede the progress of combating the virus, so many factors need to be taken into account for effective use in real-world application to guarantee the solutions meet the needs of the business. The human being represents the most advanced machine ever designed. The human brain is a highly successful machine that strives to create something that is far more efficient than a human being at any given task. The field has undergone significant change as a result of AI tools like robotic pharmacy, Tug robot and Watson for oncology. The need for more sophisticated and technologically advanced infrastructure will increase as the health care sector grows. The creation and implementation of algorithms for data interpretation and learning analysis is known as artificial intelligence.

Source of Support: The author(s) received no financial support for the research, authorship, and/or publication of this article

Conflict of Interest: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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