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AN INNOVATIVE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE (AI) IN THE FIELD OF DRUG DEALING – A REVIEW

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ABSTRACT
The Pharmaceutical sector in India has emerged as a global leader, contributing significantly to the production of affordable generic drugs and vaccines. Despite its success, the industry faces challenges from early research and development stages to market demand. The evaluation of Artificial Intelligence into the Pharmacy has better annual growth rate and it has the potential to address longstanding issues, enhance operational efficiency and reduce costs associated with drug discovery and development. The incorporation of Artificial Intelligence presents a transformative opportunity for the Indian Pharmaceutical sector and offering advancements in drug development, manufacturing and quality controls. The Pharmaceutical sciences have the potential to benefit significantly from the advancements of Artificial Intelligence (AI). This review paper explores the use of AI in the field of drug manufacturing and drug development and its future prospect in the field of pharmacy.

KEYWORDS: Artificial intelligence, Pharmacy, Drug research and manufacture, Drug development.

INTRODUCTION
Various industries put forward their efforts to enhance the satisfaction of their customer needs and their expectation by inventing and developing various methodologies. The Pharmaceutical field plays a very important role on protecting the life of individuals. The Pharmaceutical industry has to be worked based upon the persistent discovery and the development of new methodologies to overcome the worldwide healthcare challenges and to response for the pandemic emergency situations.[1] The discovery of a new drug is to be ranges from a small drug molecule with a greater stability and better potency to overcome the need of treating disease.[2] On account to that, the lower level of drug toxicity is also to be maintained which is the major challenge on the drug discovery.[3] The main aim of the Pharmaceutical industry is to produce a drug with better advantages and ease for utilization among patients. Although, the Pharmaceutical industry faces many obstacles for the future advancement of modern technology.[4] To fulfil the demands of the society and the physicians in the current era, the process of drug discovery has to be innovated more rapidly. The enormous development of artificial intelligence in the field of Pharmacy plays a significant role in the early stages of drug development and drug analysis and validation.[5]

AI is a sub-branch of computer science which creates machines that act as a human intelligence and perform several tasks that definitely requires human intelligence. The several tasks include learning, decision making, problem solving etc. AI has analysed more data and predicts the results based on the information and produces much faster with accurate and precised results.[6] The phrase "Artificial Intelligence" (AI) is a term which involves the lesser amounts of human intermediations by using computers to imitate human intelligent behaviour.[7] It involves an intelligent computer program to provide outputs in the similar way that of the human by gathering a data, developing efficient system from that data and analyse to produce an appropriate conclusion with self-corrections.[8] It is used to perform more accurate analyses as well as to attain useful interpretations.[9] AI helps for determining human cognitive science reading, observation, preparation, interpretation, reasoning, correction, speech recognition, linguistics, and other sources by learning from the previous experiences, identifying the errors and make them to correct, adjusted to new input values and able to perform a human like activities and analysis.[10]

World Health Organization clears that the Artificial Intelligence (AI) refers to the ability of the algorithems encoded in technology to learn from data so that they can

perform automated tasks without explicit programming of every step by a human.[11] The implementation of AI is poised to bring about a significant transformation in the way the Pharmaceutical industry handles supply chain operations.[12] It also consolidates numerous AI research endeavors from recent decades to create effective solutions for diverse supply chain issues. Additionally, the study suggests potential research areas that could enhance decision-making tools for supply chain management in the future.[13] The progress and innovation of AI applications are often associated to the fear of unemployment threat. However, almost all advancements in the applications of AI technology are being celebrated on account of the confidence, which enormously contributes its efficacy to the industry.[9] Artificial intelligence in Pharmaceutical Industry has the potential to promote innovation, while at the same time increasing productivity and providing better results. In addition, Artificial Intelligence in Pharma Industry offers a value proposition to the companies by creating new and latest business models.[14] This article gives a detailed ideological data about the growth and advancement of AI in the field of Pharmaceutical science from the discovery of drug molecule to that of the formulation development and analysis.

Figure 1 shows AI in Pharmacy

MILESTONES OF AI[14,25]

OBJECTIVES OF AI[26-27]

- Creation of Expert Systems: It involves the creation of automated systems that exhibit intelligent behaviour and advice humans on the right course of action.
- Implementation of Human Intelligence in Computers: It will help create identical cognitive patterns in computers which will help them behave like humans and take appropriate actions to solve complex problems. This will enable automated processes and reduced human workload through the application of algorithms.
- Multi-Domain Application: AI will help in multiple domains of implementation like Computer Science, Cognitive Science, Statistics, Psychology, Medical Science, Engineering, Ethics, Natural Sciences, Healthcare, Space Technology, Logic, Linguistics, E-commerce, and more.
- Applications in Computer Science: AI helps in developing a number of mechanisms to solve many difficult problems in the field of computer science like Search and Optimization, Logic, Control Theory, Language Analysis, Neural Networks, Classifiers, and Statistical Learning Methods, and Probabilistic Methods for uncertain reasoning.

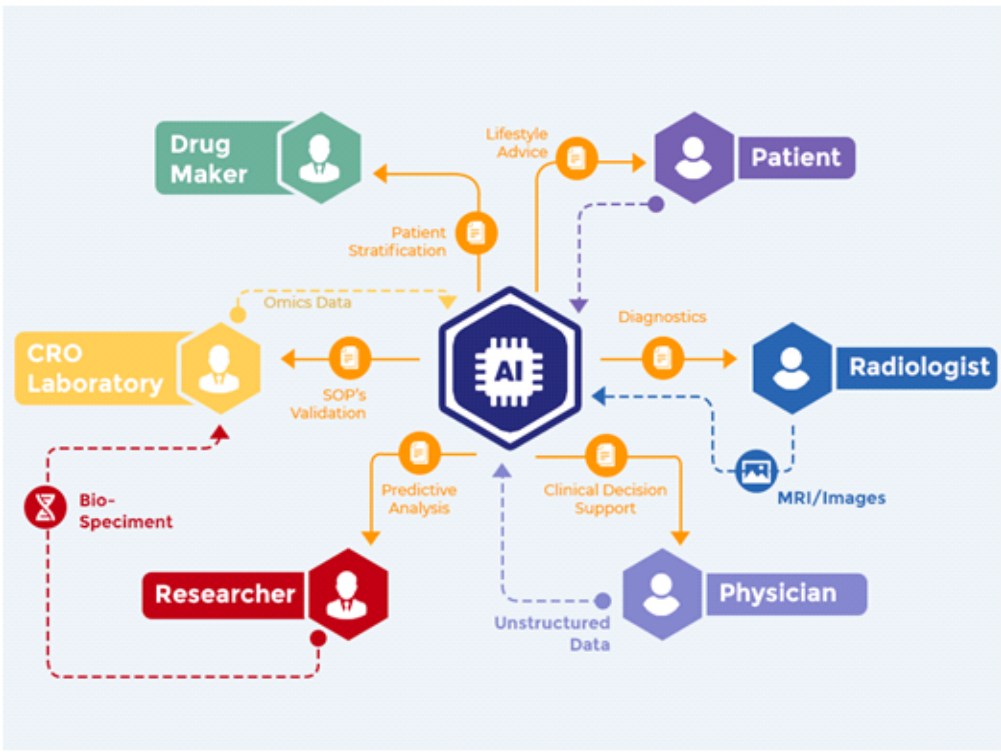

Figure 2 shows the objective of Artificial Intelligence in the field of Pharmacy practice

CLASSIFICATION OF AI[28-29]

1. Based on the calibre and their presence AI can be classified into,

I. Artificial Narrow Intelligence (ANI) or Weak AI: It performs a narrow range task, i.e., facial identification, steering a car, practicing chess, traffic signalling, etc.

II. Artificial General Intelligence (AGI) or Strong AI: It performs all the things as humans and also known as human level AI. It can simplify human intellectual abilities and able to do unfamiliar task.

III. Artificial Super Intelligence (ASI): It is smarter than humans and has much more activity than humans drawing, mathematics, space, etc.

2. Based on the presence and absence of AI:

I. Type 1: It is used for narrow purpose applications, which cannot use past experiences as it has no memory system. It is known as reactive machine. There are some examples of this memory, such as an IBM chess program, which can recognize the checkers on the chess playing board and capable of making predictions.

II. Type 2: It has limited memory system, which can apply the previous experiences for solving different problems. In automatic vehicles, this system is capable of making decisions there are some recorded observations, which are used to record further actions, but these records are not stored permanently.

III. Type 3: It is based upon "Theory of Mind". It means that the decisions that human beings make are impinged

by their individual thinking, intentions and desires. This system is non-existing AI.

IV. Type 4: It has self-awareness, i.e., the sense of self and consciousness. This system is also non-existing AI.

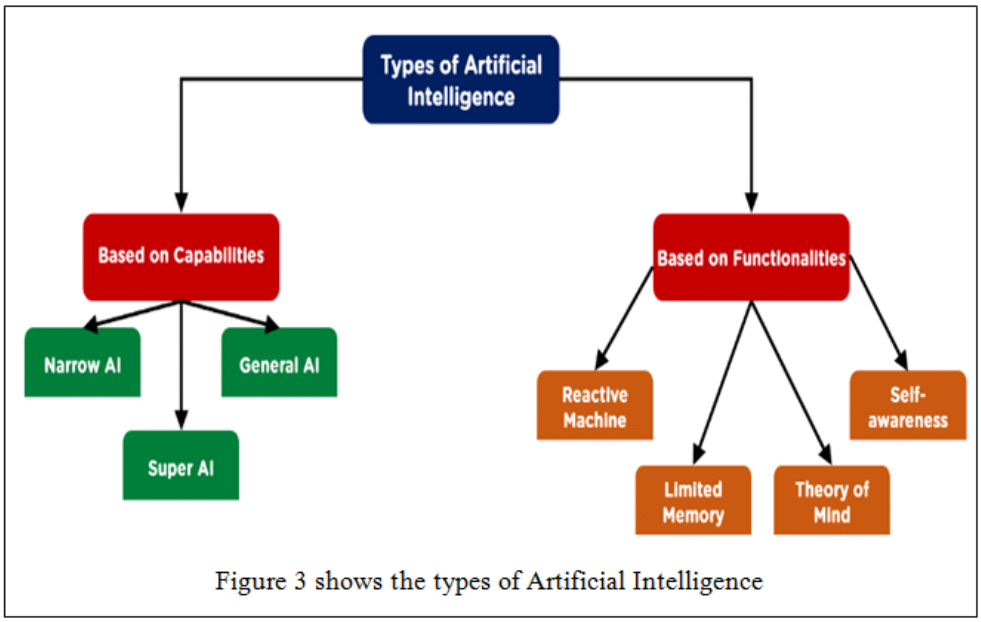

Figure 3 shows the types of Artificial Intelligence

THE IMPACTFUL ROLE OF ARTIFICIAL INTELLIGENCE IN PHARMACY

Recently, AI technology becomes a very fundamental part of industry for the useful applications in many technical and research fields.[15] The traditional drug discovery process is time-consuming and expensive. An enormous amount of estimated US$ 2.6 billion over more than 10 years is spent on developing a drug. In spite of this spending nine out of ten candidate therapies fail between phase I trials and regulatory approval.[16] However, AI has revolutionized this process by creating intelligent machines that can perform tasks requiring human like intelligence.[17] The need for examination and trustworthy knowledge to address issues related to its acquisition and application in the field may be one of the hurdles that change always bring, nevertheless. These difficulties drive the inclusion of AI since it can manage massive data sets with improved automation. A modern technology-based system called artificial intelligence (AI) uses advanced tools, networking, and technologies to simulate human intelligence.[18] A fast-growing use of AI has been in the lifecycle of discovery, clinical development and delivery of Pharmaceutical products (medicines and vaccines). WHO has published guidance on training, validation and evaluation of AI for cervical cancer screening.[19] 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.[20]

Over the last five years, the use of artificial intelligence in the Pharma and biotech industry has redefined how scientists develop new drugs, tackle disease, and more.[21] Machine learning and other technologies are expected to make the hunt for new Pharmaceuticals quicker, cheaper and more effective. Leading Pharma companies are progressing towards using AI for certain strategic applications. AI will help the Pharma companies to increase the success rates of new drug discovery meanwhile decreasing operational costs.[22] The term "machine learning" refers to the capacity to continuously statistically understand data without any explicit programming.[23] The use of AI could significantly change the speed and scope of drug discovery today. In general, the incorporation of AI in the Pharmaceutical area can bring advancements such as:

❖ AI-based drug development doesn't rely on preestablished targets. As a result, during the medication development process, personal biases and previous experience are not taken into account.

❖ AI develops innovative algorithms for drug discovery by combining the most recent advances in biology and computation. Due to the rapid increase in processing power and decrease in processing costs, AI is having all what it takes to level up the levels of competition in drug research. AI has a higher capacity for defining pertinent interactions in Pharmaceutical screens. Therefore, the likelihood of false/positives can be reduced by carefully selecting the aforementioned test parameters.

❖ The capacity of AI to transform drug screening into a virtual lab, where promising targets can be reduced without demanding a lot of experimental input or manpower hours, is perhaps its most important capability.

❖ The collection and storage of large amounts of digital patient data have become easier because of recent technological advancements. To help speed up the

creation of novel medications and improve their chances of success in the early stages of development, AI platforms may mine the massive libraries of genomic information, health records, medical imaging, and other patient data.[24]

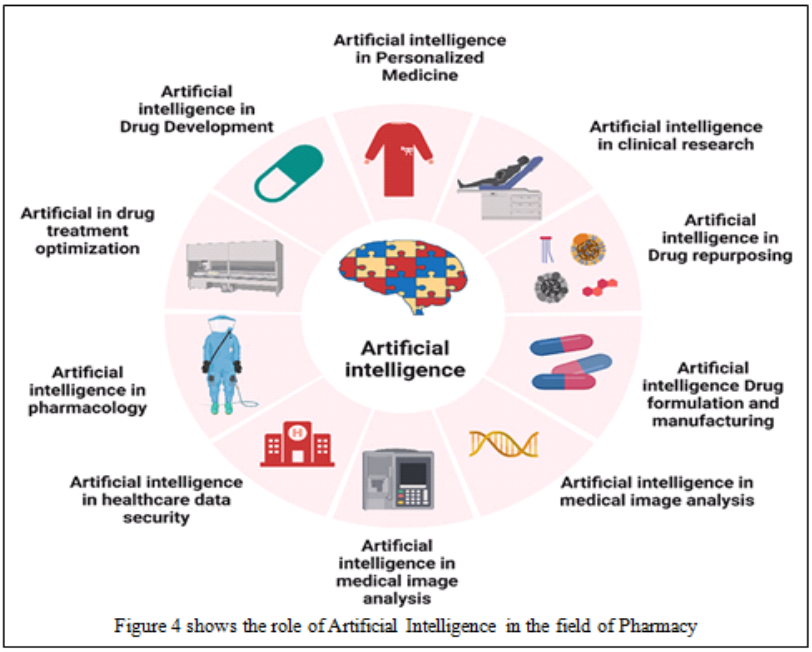

Figure 4 shows the role of Artificial Intelligence in the field of Pharmacy

The role of AI in drug discovery[30-33]

- Drug discovery is one of the Pharmaceutical industry's most significant applications of AI. Discovering a new drug can take years and cost billions of dollars. AI can help streamline this process by analysing vast amounts of data and predicting which compounds will likely be effective. This can help researchers narrow their focus and identify potential drug candidates more quickly.
- AI can also significantly contribute to drug discovery by identifying new drug targets. AI algorithms can analyse vast amounts of biological data, such as genomic and proteomic data, to identify potential targets for drug intervention. By understanding the underlying molecular mechanisms of diseases, AI can help researchers identify novel targets that were previously unknown or overlooked. This opens up new avenues for drug development and allows researchers to explore innovative therapeutic approaches.
- There are several uses of AI in drug discovery, and they can be categorized as follows.

a) Target validation and choice - AI evaluates the Drug Information Bank to ascertain the beneficial effects of drug candidates, genetic expressions, interactions between proteins, and clinical data records from a public library. To ascertain a drug's efficacy target, it is required to understand the function of potential molecular targets and their significance in illness.

b) Screening of compounds and lead optimization - To build the chemical database for AI-based virtual screening, significant amounts of compounds are retrieved from openly accessible chemogenomics libraries, which include millions of compounds with structural information.

c) Preclinical research - To quickly collect relevant huge amounts of biological data, clustering-based ML methods assess RNA sequencing technologies to discover a molecular mechanism of action. It also exposes several previously unknown relationships between different stimuli and the cytokines they affect.

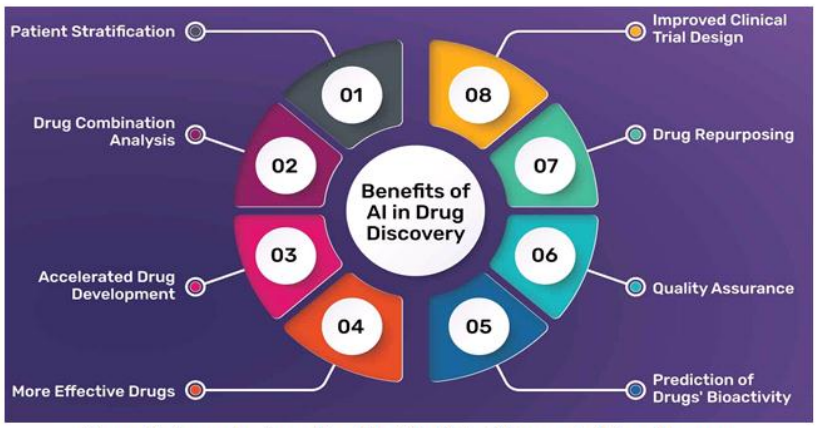

Figure 5 shows the benefits of Artificial Intelligence in Drug discovery

The role of AI in drug screening[33]

The use of AI in drug screening includes target identification; molecular simulations; drug property predictions; de novo drug creation, synthesis of route generation, and candidate drug prioritization.

AI-based drug discovery tools and resources[34-35]

Data resources are one of the fundamental elements of using AI for drug discovery and evaluation. Examples of data resources are ChEMBL, ChemDB, COCONUT, DGIdb, DrugBank, DTC, INPUT, PubChem, and SIDER or STITCH. Common AI methods include Delta Vina, neural graph fingerprint, alpha fold, and computer and additional techniques include clustering, classification, and regression analysis techniques.

AI in drug molecule design[36-37]

Traditionally, designing a drug molecule requires a lot of effort and entails multiple failed attempts. For example, a synthesis plan can have hundreds of distinct steps, many of which would produce unfavourable byproducts or side effects or will just not work. AI, on the other hand, is now starting to enhance the efficiency of design, and synthesis, speeding up, streamlining, and lowering the cost of company operations while also reducing chemical waste. AI is being used to develop new Pharmaceutical products, including the following.

- ✓ Disease Identification/Diagnosis
- ✓ Personalized treatment with digital therapeutics and behavioural modification.
- ✓ Drug Development and Production
- ✓ Prognostic forecasting
- ✓ Medical Tests.

AI for quality assurance and control[38]

Pharmaceutical quality assurance and control systems are expected to benefit from the use of AI technologies. Bands are frequently used in the Pharmaceutical industry to ensure that product quality requirements can be satisfied, although they aren't always as precise as they may be. The applications of AI in the Pharmaceutical industry can predict even little variations that could have an impact on the functionality and safety of the products. Pharmaceutical quality control and assurance using AI can improve product quality and process accuracy.

AI in Pharmaceutical marketing[39]

E-commerce and other marketing strategies are already utilizing AI in their successful marketing campaigns. Pharmaceutical companies can utilize comparable tools and techniques to expand and effectively serve their market. The tactics of AI in Pharmaceutical marketing can greatly increase overall earnings.

AI in clinical trials

In recent years, the healthcare industry has been undergoing a revolution due to AI. Clinical trials are one of the areas where AI can have a significant impact. These trials are vital for testing the safety and effective ness of new drugs and treatments.

A. Patient recruitment: One of the most significant challenges in clinical trials is patient recruitment. Identifying suitable patients who meet specific criteria for a problem can be difficult. AI-powered tools can help identify potential patients by analysing electronic health records, social media, and other data sources. This can significantly reduce the time and cost involved in patient recruitment.[40]

B. Protocol design: AI can also help in designing clinical trial protocols. AI algorithms can identify the most effective study designs and endpoints by analysing data from previous trials. This can help researchers develop more efficient and effective practices that produce better results.[41]

C. Predictive analytics: AI algorithms can analyse data from clinical trials to identify patterns and predict outcomes. This can help re searchers decide which treatments to pursue and which to abandon. Predictive analytics can also help identify potential safety issues before they become significant problems.[42]

D. Real-time monitoring: Real-time monitoring during clinical trials using AI powered tools can help

researchers identify potential safety issues early on and take appropriate action. It can also help researchers adjust treatment protocols based on patient responses.[43]

E. Data analysis AI algorithms can analyse vast amounts of data from clinical trials to identify patterns and trends. This can help researchers gain new insights into disease mechanisms and treatment efficacy. Data analysis can also help identify subgroups of patients who may respond better to specific treatments.[44]

F. Regulatory compliance AI-powered tools can ensure regulatory compliance during clinical trials by automating data collection and reporting tasks. This can reduce the risk of errors and ensure that practices meet regulatory requirements.[41]

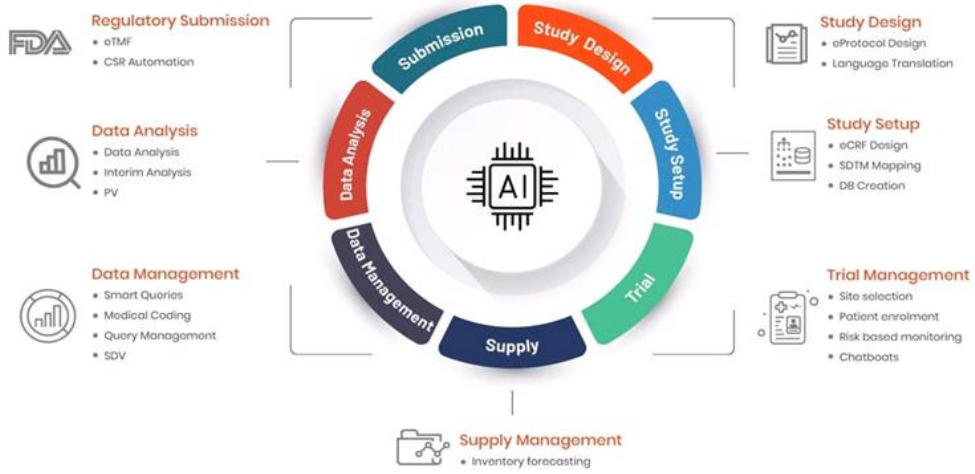

Figure 6 shows the role of Artificial Intelligence in Clinical trials

Ethical considerations

The use of AI in the Pharmaceutical industry brings up several ethical considerations. Transparency and explainability are among the significant concerns. AI algorithms can be intricate and opaque, making comprehend in how they arrive at their conclusions challenging. This lack of transparency can raise questions about the fairness and accountability of decisions made by AI algorithms. To address this issue, laws may require Pharmaceutical companies to provide justifications or explanations for decisions made by AI algorithms.[45-46]

Safety and efficacy

Ensuring the safety and efficacy of Pharmaceuticals powered by artificial intelligence is a crucial concern. AI algorithms have the potential to generate new drug candidates and predict patient responses to existing drugs. However, these predictions must undergo rigorous testing and clinical trials to validate their accuracy. In addition, Pharmaceutical companies may be required by law to demonstrate the safety and efficacy of AI-driven treatments before they are approved for use.[47-48]

AI in drug formulation

Pharmaceutical sciences hav0e seen various formulations, for example solid dispersions, extrudates, pellets, nanoparticles, and liposomes, arise in addition to standard dosage forms. The name "formulation techniques" is given to these techniques because they empower the development of formulations or incorporate functionality into common dosage forms such as tablets. AI applications in formulation techniques are even more worthwhile to investigate in order to create next-generation drug products with desired efficacy and health out come because these methods can successfully address a variety of API issues, such as low solubility, stability, bio availability, and production capability.[49]

Strengthening Pharmacovigilance

AI could be used to improve detection of safety signals (information about a potential adverse event due to a Pharmaceutical product) both during a clinical trial and after approval of a medicine. With increasing reports of adverse reactions, AI could be used to detect safety signals that are difficult to identify with current methods, including drug–drug interactions, drug–disease interactions, medication errors, secondary malignancies,

and changes in the frequency and severity of known events, patterns of use of medications, and misuse.[50] AI could be used in identifying adverse events for case reports, such as to assess whether the report is valid and meets minimum reporting requirements.[51]

AI and its potential in transforming HPLC processes

Artificial Intelligence (AI) has emerged as a transformative technology with the potential to revolutionize various industries, including analytical chemistry and High-Performance Liquid Chromatography (HPLC). AI encompasses a range of computational techniques that enable machines to mimic human intelligence, learn from data, and make autonomous decisions.[52] In the context of HPLC, AI holds promise for enhancing analytical performance, streamlining workflows, and unlocking new capabilities for data analysis and interpretation. One of the primary applications of AI in HPLC is in data analysis and interpretation.[53] AI algorithms, such as machine learning and deep learning, can automate the process of peak detection, integration, and identification in chromatograms, enabling faster and more accurate analysis of complex datasets.[54]

AI in Vibrational Spectroscopy

Vibrational spectroscopy techniques, such as Fourier transform infrared (FT-IR) and Raman spectroscopy, have been demonstrated to be highly successful analytical methods and have proven to be low cost, require minimum sample preparation, be non-destructive, and yield highly valuable chemical information. There is a requirement for improvement and automation in data processing for classification and visualization of spectrochemical data measured from biological and medical samples.[55]

AI in Raman Spectroscopy

ML, as a subfield of AI, is being used to extract, connect, and summarize information from large and complex analytical datasets for separation science, mass spectrometry, NMR, and atomic and molecular spectroscopy. The advancing of applications of AI technology is certainly the case in Raman and surface-enhanced Raman spectroscopy (SERS) techniques, which involve large databases of complex vibrational spectra.[56]

AI in UV-vis Spectroscopy

Ultraviolet-visible (UV-vis) spectroscopy is widely recognized as a workhorse for general analytical laboratory, process, and field measurements. Water quality monitoring is just one of the many applications where UV-vis exhibits its beneficial features, such as speed, environmental friendliness, non-destructive sample handling, and high analytical sensitivity. Water quality measurements using UV-vis for process or field applications have been quite common over the years. The application of ML to UV-vis spectroscopy provides an automated and "smart" platform for routine water analysis and screening.[57]

Other applications of AI in Pharma and Healthcare[58]

- Conducting repetitive tasks such as data entry and laboratory testing, thus clearing time for working on more important or complicated tasks and communicating with patients.
- Management of data, including medical records.
- Healthcare systems analysis to determine errors or inefficiencies.
- Natural language processing. This AI division lets computers understand human speech and writing and interpret it. It can review thousands of detailed electronic medical records and then detail the appropriate steps to identify and treat multi-illness patients.
- Consultations with the medical profession. AI-based systems like Babylon are developed to provide database-based medical advice.

BENEFITS OF ARTIFICIAL INTELLIGENCE INTEGRATION

The integration of Artificial Intelligence (AI) into laboratory environments brings forth a multitude of benefits, revolutionizing traditional chemical analysis methods and enhancing overall efficiency, accuracy, and productivity. Some of the key benefits include.

I. Improved Analytical Accuracy: AI algorithms excel at pattern recognition and data analysis, leading to more accurate and reliable results in chemical analysis. By leveraging machine learning techniques, AI can identify subtle trends and correlations within complex datasets that may go unnoticed by human analysts, thereby enhancing the precision of analytical measurements.

II. Enhanced Efficiency and Productivity: AI driven automation streamlines laboratory workflows, reducing the time and resources required for sample preparation, analysis, and data processing. Tasks that were once performed manually, such as data entry, instrument calibration, and routine maintenance, can now be automated, freeing up researchers' time for more intellectually demanding activities.

III. Real-time Monitoring and Analysis: AI-enabled systems offer real-time monitoring and analysis capabilities, allowing researchers to track experimental progress and make informed decisions on-the-fly. By continuously analyzing incoming data streams, AI algorithms can detect anomalies, identify trends, and trigger alerts or adjustments to experimental parameters, facilitating proactive intervention and optimization.

IV. Optimization of Resource Utilization: AI algorithms optimize resource utilization by dynamically adjusting experimental parameters based on real-time feedback and historical data analysis. This enables researchers to maximize the efficiency of laboratory equipment, minimize reagent consumption, and reduce experimental

turnaround times, ultimately leading to cost savings and improved productivity.

V. Facilitation of Interdisciplinary Collaboration: AI integration fosters interdisciplinary collaboration by facilitating the integration and sharing of data across different research domains and laboratory environments. By standardizing data formats and enabling seamless data exchange, AI-powered platforms promote knowledge sharing, collaboration, and innovation among researchers from diverse backgrounds.

VI. Predictive Modelling and Decision Support: AI algorithms enable predictive modelling and decision support in chemical analysis, allowing researchers to anticipate experimental outcomes, optimize experimental designs, and prioritize research efforts effectively. By leveraging historical data and computational modelling techniques, AI can generate insights and recommendations that guide researchers towards the most promising avenues of inquiry.

VII. Scalability and Adaptability: AI-driven solutions are inherently scalable and adaptable, capable of accommodating changes in experimental protocols, sample types, and analytical techniques. Whether analysing small-scale research samples or conducting high-throughput screening in industrial settings, AI powered systems can seamlessly scale to meet the evolving needs of researchers and industries.[59]

ADOPTION OF ARTIFICIAL INTELLIGENCE BY PHARMA INDUSTRY[61]

Despite today's high standard of care, drug advancement is becoming increasingly difficult. Overall revenues are therefore generally down and many businesses are looking for innovative treatment solutions to combat this. More effective and automated processes, data-driven decisions, and better predictive analytics tools are needed to boost R & D performance and develop new drugs in order to get out of this situation. It's here that AI comes in. Nonetheless, due to a lack of AI expertise among many healthcare and Pharmaceutical practitioners, it may be difficult to fully embrace AI. There are several approaches to facilitate adoption.

- Collaboration with, or acquisition of, AI startups and tech companies. Many Pharmaceutical companies reach out to specialist firms and startups that concentrate on drug discovery powered by AI. This enables their expertise and tools to be tapped to create promising drug candidates based on existing hypotheses and experience. Notable examples include collaborations with Bergand companies such as AstraZeneca, Roche, and Sanofi Pasteur, the above-mentioned bioPharmaceutical company. In addition, when they recently partnered with IBM Watson for Drug Discovery, Pfizer made headlines, and both Novartis and Johnson and Johnson partnered with IBM Watson Health.
- Collaboration with academia. Industry-academia partnerships are expected to keep growing as Pharma is starting to embrace AI.
- Developing internal expertise and granting employees with the needed resources.
- Open Science Projects and R & D challenges. This is a valuable tactic of AI adoption for drug discovery, with less financial risk involved compared to other tactics.

Top 10 Pharmaceutical industries using artificial intelligence (AI)[14]

This is forth industrial revolution where AIs have taken over the world. And Pharmaceutical and healthcare sector are most affected industries by AI. Today, we shall see top 10 (2019) highest grossing Pharmaceutical companies which are using AI or machine learning for drug discovery, clinical research, disease diagnosis, novel medication, predictions, data analysis etc.

1. Pfizer

Pfizer promoted a drug discovery partnership with IBM Watson. In December 2016, Pfizer and IBM announced a partnership to accelerate drug discovery in immuno-oncology. In May 2018, Pfizer had fastened AI collaboration. Massachusetts Institute of Technology announced Pfizer as a member of its Machine Learning for Pharmaceutical Discovery and Synthesis Consortium. Pfizer also announced a partnership with Chinese tech start up X talPi for molecular stability of an organic compound and advanced their work in drug designing.

2. Roche

Roche has developed a machine learning diagnostic techniques for diabetic macular edema, a complication of diabetes that causes a thickening of the retina and lead to blindness. Roche can utilise its vast clinical trial database to develop AI algorithms to predict the presence of disease, risk of disease progression, and response to treatment; all of which could be supplied to ophthalmologists to deliver higher quality personalised healthcare.

3. Novartis

After becoming CEO of Novartis, Vasant Narasimhan took revolutionary steps towards implementation of Artificial intelligence in Novartis which proven to be global footprints for others. Novartis was able to decode cancer pathology images through AI. Novartis joined with Tech startup PathAI and created a system through which they are able to diagnose cancer.

4. Johnson & Johnson

Johnson & Johnson announced results of a new real-world study, which found newly diagnosed patients with nonvalvular atrial fibrillation (NVAF) taking XARELTO® (rivaroxaban) experienced significantly fewer strokes, significantly fewer severe strokes and

fewer stroke-related deaths compared to those taking warfarin using artificial intelligence. The study also found that XARELTO® significantly reduced overall strokes (across all severities) by 18 percent compared to warfarin and reduced the risk of experiencing the most severe strokes.

5. MSD (Merck & Co., Inc., Kenilworth, N.J., USA)
Merck and Wayra UK are working together (part of Spanish telecoms business Telefonica) under the banner of the 'Velocity Health' programme. The Velocity Health programmes focused on prevention in healthcare with an emphasis on diabetes prevention and cancer prevention.

6. Sanofi
Sanofi Genzyme, the specialty care global business unit of Sanofi joined with Recursion Pharmaceuticals to deploy its drug repurposing platform to identify new uses for Sanofi's clinical stage molecules across dozens of genetic diseases.

7. Abbvie
Abbvie is working with AI very silently. But it does have a confidential project listed with atom wise. In September 2016, AbbVie partnered with AiCure to use AI-based patient monitoring platform improved adherence in an AbbVie phase 2 schizophrenia trial.

8. GlaxoSmithKline (GSK)
GSK is very active to utilize artificial intelligence for drug disvocery and they have created an in-house artificial intelligence unit. Initially it was called "Medicines Discovered Using Artificial Intelligence." And then renamed as "In silico Drug Discovery Unit." As of July2019, GSK's AI team reportedly numbered about 50.

9. Amgen
Amgen is an investor in precision medicine startup GNS Healthcare. In May 2018, MIT announced that Amgen was a member of its Machine Learning for Pharmaceutical Discovery and Synthesis Consortium. Amgen is also working with medical research machine learning startup Owkin.

10. Gilead Sciences
Gilead's first publicly announced use of AI in drug discovery was in April 2019. This month, Gilead announced a strategic collaboration with stealthy startup Insitro. The collaboration will focus on nonalcoholic steatohepatitis (NASH).

LIMITATIONS OF ARTIFICIAL INTELLIGENCE AT THE PRESENT MOMENT

Despite all of the uses for AI in the Pharmaceutical industry, there are some restrictions attached to it. To achieve the present standards of standard outcomes, AI must be developed. The demand for thorough training data for AI, which necessitates human labor and hence can have chances of inaccuracy, is one of the factors that indicate its limitations. As a result, AI integration is unavoidable. Another drawback of AI is that it can forecast models or structures via de novo medication creation, which is impossible to produce. A multidisciplinary strategy is needed to prepare healthcare workers for the use of AI because AI and ML are IT-based technologies, which may prove hard for the medical industry.[60]

FUTURE OF ARTIFICIAL INTELLIGENCE

Companies like Google and Uber are already using AI capabilities to power self-driven cars. AI will have a great bearing on the automated transportation field by aiding handicapped drivers and preventing accidents. More evolved AI systems will support in hazardous factory-based jobs and may replace humans as well. Climatic change predictions can be made by AI systems using data sciences and environmental technologies. Around 80 percent of customer service operations will be handled by effective and timely AI systems. Personalized health management will be made easier through AI systems symptom-identification and medical data processing abilities. Cyborg technology can help patients utilize artificial prosthetics for a better living by communicating with a robotic system. In space technology, AI can study orbital paths during successful launches and suggest actions based on its observations.

Coming to Pharma Industry, AI is the future of Pharma but the technology is available now. Artificial Intelligence can cut costs down, create new, effective treatments and above all else, help save lives. So, biotech companies should start making use of the advantages of AI at the earliest. Terms of compound design, scope and increase given to us by AI and machine learning will mean that we can tap into a much wider chemical space, giving us a much wider and more diverse range of chemicals to better enable us to pick the best drug discovery molecules. In terms of the industry's choice of patients for clinical trials, the software will also help companies detect any problems with drugs far earlier in terms of efficacy and safety. The industry therefore has a lot to gain from embracing solutions to AI and machine learning. It can be used to create a strong, sustainable pipeline of new medicines to good effect. Using the power of modern supercomputers and machine learning would make it possible for us to produce medicines faster and at reduced costs.[61]

CONCLUSION

Artificial Intelligence integrating into our daily lives and becoming smarter with each passing day. This ensures its presence in every in every aspect of our existence. The innovative development of Artificial Intelligence in the pharmaceutical science provides a massive opportunity for the world to meet the demand in the drug manufacture and drug development. The field of Aritificial Intelligence bring about a significant transformation throughout the whole life cycle of Pharmaceutical goods development, improved operational effectiveness, precision and advancement. AI will also play a crucial role in reducing periods of inactivity and optimising the allocation of resources. The function of Artificial Intelligence in quality control and assurance is of utmost importance. Continued research and development will undoubtedly enable Artificial Intelligence to play a significant role in shaping the future of healthcare.

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