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A REVIEW ON THE ROLE OF ARTIFICIAL INTELLIGENCE (AI) IN THE FUTURE OF PHARMACY EDUCATION

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ABSTRACT

Artificial Intelligence (AI) focuses in producing intelligent modelling, which helps in imagining knowledge, cracking problems and decision making. Recently, AI plays an important role in various fields of pharmacy like drug discovery, drug delivery formulation development, polypharmacology, hospital pharmacy, etc. In drug discovery and drug delivery formulation development, various Artificial Neural Networks (ANNs) like Deep Neural Networks (DNNs) or Recurrent Neural Networks (RNNs) are being employed. Several implementations of drug discovery have currently been analysed and supported the power of the technology in quantitative structure-property relationship (QSPR) or quantitative structure-activity relationship (QSAR). In addition, de novo design promotes the invention of significantly newer drug molecules with regard to desired/optimal qualities. In the current review article, the uses of AI in pharmacy, especially in drug discovery, drug delivery formulation development, polypharmacology and hospital pharmacy are discussed. Key words: Artificial intelligence, Artificial neural network, Drug discovery, Drug delivery research, Hospital pharmacy.

KEYWORDS: *Artificial Intelligence, AI Technology, ANNs, Roles of AI.*

1. INTRODUCTION

Artificial Intelligence (AI) is a stream of science related to intelligent machine learning, mainly intelligent computer programs, which provides results in the similar way to human attention process.1 This process generally comprises obtaining data, developing efficient systems for the uses of obtained data, illustrating definite or approximate conclusions and selfcorrections adjustments.

In general, AI is used for analyzing the machine learning to imitate the cognitive tasks of individuals.2,3 AI technology is exercised to perform more accurate analyses as well as to attain useful interpretation.3 In this perspective, various useful statistical models as well as computational intelligence are combined in the AI technology.4 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.

Recently, AI technology becomes a very fundamental part of industry for the useful applications in many technical and research fields.3,4 The emergent initiative of accepting the applications of AI technology in pharmacy including drug discovery, drug delivery formulation development and other healthcare applications have already been shifted from hype to hope.5,6 The uses of AI models also make possible to predict the in vivo responses, pharmacokinetic parameters of the therapeutics, suitable dosing, etc.

According to the importance of pharmacokinetic prediction of drugs, the uses of in silico models facilitate their effectiveness and inexpensiveness in the drug research.8 There are two key classes of AI technology developments.9 The first one comprises the conventional computing methodologies including expert systems, which are capable of simulating the human experiences. Many sectors use clinical trial data analysis approaches to improve their success in meeting client requests and expectations. There is no more critical sector when saving lives than the pharmaceutical business. Reacting to medical crises like the current pandemic and other worldwide healthcare issues relies on constant innovation and the use of new technology.

Extensive research and development across several areas, including production technology, packaging concerns, and customer-oriented marketing techniques, is usually the foundation of innovation in the pharmaceutical sector . New pharmaceutical developments span the gamut from small molecule drugs to biologics, emphasizing improved stability and high potency to address unfulfilled demands for disease treatment. An area of great worry that will need future study and inquiry is the evaluation of the substantial toxicity levels linked

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to new medications. Finding the most beneficial and appropriate pharmacological molecules for use in healthcare is one of the main goals. Nevertheless, to meet the medical and healthcare needs of people throughout the globe, the pharmacy business must continue to innovate by using technology- driven approaches.

Training healthcare workers to enhance their participation in everyday responsibilities is an ongoing need due to the industry's continued demand for competent workers.The pharmaceutical sector places a premium on identifying workplace skill shortages. Recognizing that providing sufficient training may be a substantial problem, it is critical to address the identified gaps successfully via suitable corrective actions. Some authorities have reported that June 2022 was the month in which 41% of supply chain disruptions occurred. The research goes on to say that the second most challenging obstacle to overcome is disruptions in the supply chain. Several pharmaceutical sectors are looking forward to more supply chain innovations and new models to tackle these problems, which may make their businesses more resilient. Clinical trials are among the several activities severely impacted by the 2019 coronavirus illness (COVID-19) pandemic.

The pandemics, natural disasters, price fluctuations, cyberattacks, logistical problems, and faulty products. The epidemic's transportation effects have devastated the world's supply chain and sectors. Disputes about whether to use the current or new pricing for commodities or resources cause decision-induced delays in receiving price updates from suppliers, which in turn cause price fluctuations.

Problems like rising crime rates and unpredictability in the supply of vital operating and manufacturing resources are new developments stemming from nations' tactics of crossborder economic cooperation. To meet the demands of patients and ensure their compliance, it is necessary to manufacture footprint changes. According to the pharmaceutical industry, the difficulty with maintaining the cold supply chain rendered many COVID-19 vaccinations useless during the pandemic. Inadequate innovation and inaccurate forecasting in business and industrial operations are the main reasons for the interruption in the supply chain due to the delayed reaction. Customer happiness, business image, and potential revenues are all severely affected when there are interruptions in the pharmaceutical industry's supply chain.

Figure 1 shows that the pharmaceutical industry's supply chain activities will undergo a radical upheaval due to the introduction of AI. Furthermore, it synthesizes a great deal of artificial intelligence research for a few decades to address many supply chain problems. Furthermore, the paper proposes future research directions to improve supply chain management decision-making tools.

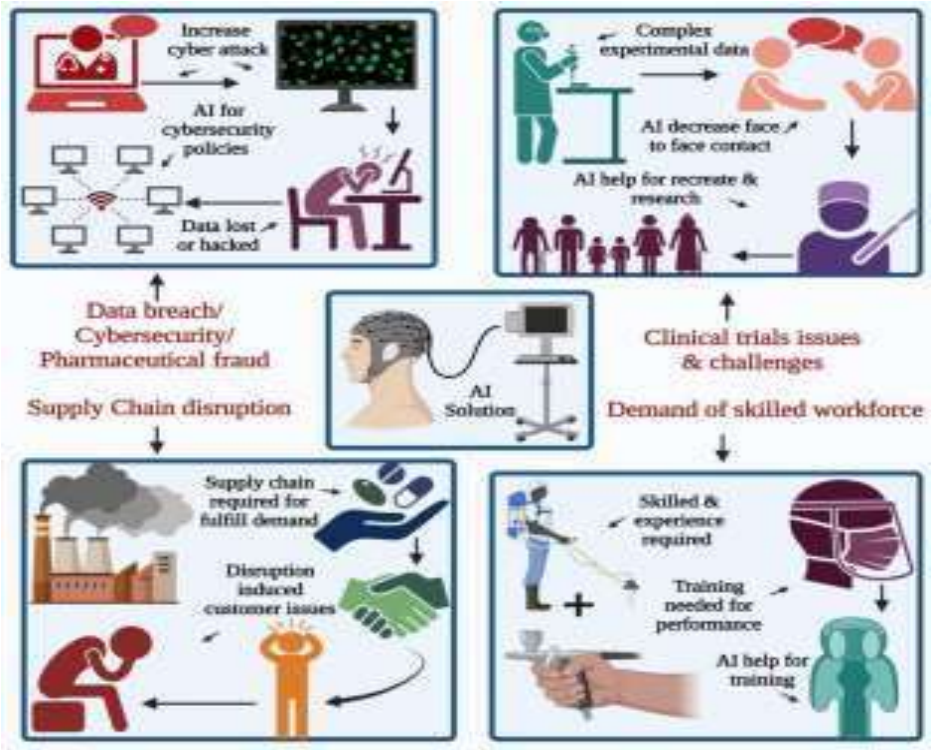


Fig: Potential AI solution to the problems faced by the pharmaceutical business

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2. CLASSIFICATION OF AI

AI can be classified into two different ways: according to calibre and their presence According to their ability, AI can be categorized as: 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.

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.

According to their presence and not yet present, AI can be classified as follows

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 a 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.

3. NEURAL NETWORKS AND ANNS

The learning algorithm of neural networks (from input data) takes two different forms mainly. The classes of neural networks are as follows (Figure 2):9,17 i) Unsupervised learning: Here the neural network is submitted with input data having recognised pattern. It is used for organizational purpose

The unsupervised learning algorithm uses „Self Organizing Map" or „Kohonen".9 This is known as very useful modeling for the searching of relationships amongst the complex data sets. ii) Supervised learning: This kind of neural network is illustrated with the sequences of harmonizing inputs and outputs. It is used for learning relationshipconnection between the inputs and the outputs. It shows its usefulness in formulation to measure the cause and effects linking between input-output. It is the most frequently employed ANNs and is entirely linked with the back propagation learning rule. This learning algorithm is known as the outstanding methodology.

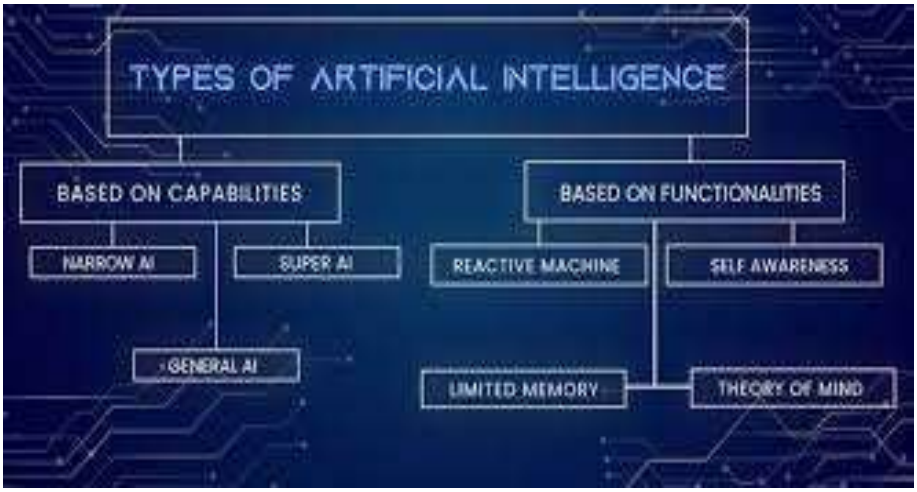


Fig: Types Of Artificial Intelligence (AI)

4. THE FUTURE ROLE OF (AI).

In Addressing Current Pharmaceutical Challenges Research on nano molecules is underway in the pharmaceutical sector to improve goods and ensure consumer satisfaction. These molecules have various Alanazi: Role of Artificial Intelligence in Pharmacy Practice: A Systematic Review Archives of Pharmacy Practice ¦ Volume 15 ¦ Issue 2 ¦ April – June 2024 37 benefits. Preparing synthetic derivatives is cheap and requires little effort in the chemical synthesis process.

Therefore, a wide variety of stable and effective formulations including tiny molecules, are available in the pharmaceutical industry. Innovative small molecules confront competition from generic molecules, complicated data is necessary for their introduction, and clinical studies are also necessary, except for uncommon illness therapy.

As a result of these procedures, businesses are under increasing financial pressure to innovate. Amidst the dilemma caused by molecules being too tiny and advances not being widely disseminated, the biomolecular drug business continues to expand quickly. The shape and reactivity of small molecules constitute the foundation of their effects.

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The building blocks of proteins, known as amino acids, and the building blocks of nucleic acids, known as nucleotides or ribonucleotides, make up biomolecules. The spatial conformation and supramolecular sequence also impact their stability and function.
Products from biomolecules, like insulin and adalimumab, have succeeded wildly. Because infusion is the most practical and preferred method of administering these biomolecules, their pharmacokinetics are intricate. Research based on nucleic acids places a premium on pharmacokinetic regulation and molecular stability .

Applying AI to Advancements in Drug Delivery and Discovery
Essential objectives include improving the pharmacokinetic exposure of these molecular forms. New technology advancements might be helpful in tackli these obstacles and similar ones. While artificial intelligence (AI) has great promise for the future of medication administration and discovery, it is not without significant limits that human intervention or intellectuals will be needed to decipher the complicated outcomes.

Artificial intelligence (AI) relies heavily on datasets for its predictions. However, human intervention is necessary to interpret the findings correctly due to the gray area. When it comes to making predictions and evaluating hypotheses, AI might run into problems with algorithm bias. In addition, the identification of inactive molecules is a typical outcome of docking simulationsHuman intervention is still necessary for a rigorous review of these parameters to make successful decisions and conduct cross-verifications to eliminate system bias. Still, AI has a lot of room to grow in practical applications; with enough effort, we should be able to address its shortcomings and make it more trustworthy and effective .

5. APPLICATIONS OF ARTIFICIAL INTELLIGENCE

When it comes to artificial intelligence, the approach uses machine learning or portions of it, including deep learning and NLP. Supervised and unsupervised learning are possible, with the algorithm used playing an essential role in both cases. Machine learning approaches may be either supervised or unsupervised.

6. ADVANTAGES OF AI TECHNOLOGY

The potential advantages of AI technology are as follows:6,15,41 Das, et al.: Artificial Intelligence in Pharmacy 308 Indian Journal of Pharmaceutical Education and Research.

i) Error minimization: AI assists to decrease the errors and increase the accuracy with more precision.Intelligent robots are made of resistant metal bodies and capable of tolerating the aggressive atmospheric space, therefore, they are sent to explore space.

ii) Difficult exploration: AI exhibits its usefulness in the mining sector. It is also used in the fuel exploration sector. AI systems are capable of investigating the ocean by defeating the errors caused by humans.

iii) Daily application: AI is very useful for our daily acts and deeds. For examples, GPS system is broadly used in long drives. Installation of AI in Androids helps to predict what an individual is going to type. It also helps in correction of spelling mistakes.

iv) Digital assistants: Now-a-days, the advanced organizations are using AI systems like „avatar" (models of digital assistants) for the reduction of human needs. The „avatar" can follow the right logical decisions as these are totally emotionless. Human emotions and moods disturb the efficiency of judgement and this problem can be overcome by the uses of machine intelligence.

v) Repetitive tasks: In general, human beings can perform single task at a time. In contrast to the human beings, machines are capable of performing multi-tasking jobs and can analyze more rapidly in comparison to the human beings. Various machine parameters, i.e., speed and time can be adjusted according to their requirements.

vi) Medical uses: In general, the physicians can assess the condition of patients and analyze the adverse effects and other health risks associated with the medication with the help of AI program. Trainee surgeons can gather knowledge by the applications of AI programs like various artificial surgery simulators (for examples, gastrointestinal simulation, heart simulation, brain simulation, etc.

vii) No breaks: Unlike human beings who have the capacity of working for 8 h/day with breaks, the machines are programmed in such a way that these are capable of performing the work in a continuous manner for long hours devoid of any kinds of confusions and boredom.

viii) Increase technological growth rate: AI technology is widely used in most of the advanced technological innovations worldwide. It is capable of producing different computational modelling programs and aims for the invention of the newer molecules. AI technology is also being used in the development of drug delivery formulations.

ix) No risk: In case of working at the risky zone like fire stations, there are huge chances of causing harm to the personnel engaged. For the machine learning programs, if some mishap happens then broken parts can be repairable.

x) Acts as aids: AI technology has played a different function by serving children as well as elders on a 24x7 basis. It can perform as teaching and learning sources for all.

xi) Limitless functions: Machines are not restricted to any boundaries. The emotionless machines can do everything more efficiently and, also produce more accurately than the human beings.

7. DISADVANTAGES OF AI TECHNOLOGY

The important disadvantages of AI technology are as follows:

i) **Expensive:** The launch of AI causes huge money consumption. Complex designing of machine, maintenance and repairing are highly cost effective. For the designing of one AI machine, a long period of time is required by the R&D division. AI machine

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needs updating the software programmes, regularly. The reinstallations as well as recovery of the machine consume longer time and huge money.

ii) **No replicating humans**: Robots with the AI technology are associated with the power of thinking like human and being emotionless as these add some advantages to perform the given task more accurately without any judgement. If unfamiliar problems arise, robots cannot take the decision and provide false report.

No improvement with experience: Human resource can be improved with experiences. In contrast, machines with AI technology cannot be enhanced with experience. They are unable to identify which individual is hard working and which one is nonworking.

iii) **No original creativity:** Machines with AI technology have neither sensitivity nor the emotional intelligence. Humans have the ability to hear, see, feel and think. They can use their creativity as well as thoughts. These features are not achievable by the uses of machines.

iv) **Unemployment:** The widespread uses of AI technology in all the sectors may cause large scale unemployment. As because of the undesirable unemployment, human workers may lose their working habits.

8. CONCLUSION

During past few years, a considerable amount of increasing interest towards the uses of AI technology has been identified for analyzing as well as interpreting some important fields of pharmacy like drug discovery, dosage form designing, polypharmacology, hospital pharmacy, etc., as the AI technological approaches believe like human beings imagining knowledge, cracking problems and decision making. The uses of automated workflows and databases for the effective analyses employing AI approaches have been proved useful. As a result of the uses of AI approaches, the designing of the new hypotheses, strategies, prediction and analyses of various associated factors can easily be done with the facility of less time consumption and in expensiveness.This systematic review explores the pivotal role of artificial intelligence (AI) in addressing challenges within the pharmaceutical industry. The integration of AI is depicted as a transformative force in supply chain management, workforce optimization, and clinical trial disruptions, particularly in the aftermath of the COVID-19 pandemic.

The review emphasizes the potential of AI to streamline drug development processes, from target identification to drug discovery, design, and optimization. Furthermore, the application of supervised and unsupervised learning models in various pharmaceutical contexts, such as drug discovery, predictive maintenance, and clinical trial outcomes prediction, is highlighted. The evolving landscape of AI in the pharmaceutical sector promises to revolutionize research and development, offering solutions to longstanding issues and presenting new opportunities for innovation.

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