Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 44 No. 3 (2023)

Connected Health: Revolutionizing Patient Care Through Artificial Intelligence Innovations

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Abstract: The pharmaceutical sector is not immune to the radical changes brought about by the widespread adoption of AI. Automation, optimisation, and individualization are just some of the ways that artificial intelligence is being applied in the pharmaceutical business, from drug research to dispensing. This article examines how AI is already being used and where it has the potential to go in the pharmaceutical sector. We'll take a look at how AI is being used in the pharmaceutical industry, from R&D to personalised medicine to quality assurance to supply chain management to patient counselling. Data privacy, ethical concerns, and legal impediments are just a few of the difficulties we'll cover in relation to the use of AI in the pharmaceutical industry. This article will highlight studies that demonstrate how AI has the potential to drastically revolutionise the pharmaceutical industry through accelerating medicine development, improving patient outcomes, lowering costs, and increasing efficiency and accuracy across the board. This has led many to predict that AI will revolutionise every aspect of healthcare, from diagnosis to treatment to follow-up care. In most people's minds, AI techniques will supplement and improve upon existing human efforts rather than supplant them. Artificial intelligence is prepared to assist the healthcare business with administrative work, clinical documentation, patient outreach, and specialised aid in areas such as image analysis, medical device automation, and patient monitoring.

1. Introduction

The pharmaceutical industry will also be significantly altered by the broad implementation of AI. Throughout the pharmaceutical industry, from discovery to distribution, AI is being used to automate, optimise, and personalise processes. In this post, we'll take a look at the current applications of AI in the pharmaceutical industry, as well as its future prospects. In this presentation, we will examine the many applications of AI in the pharmaceutical business, including research and development, personalised medicine, quality assurance, supply chain management, and patient counselling [1]. When exploring the application of AI to the pharmaceutical industry, we will address such topics as data protection, ethical considerations, and legal barriers. As will be highlighted in this article [2], artificial intelligence (AI) has the potential to radically alter the pharmacy sector for the better in a variety of ways. Faster drug discovery, better patient outcomes, lower costs, and higher rates of efficiency and accuracy in a wide range of pharmacy activities are just a few of the many benefits. AI has the potential to enhance the entire healthcare delivery process, from diagnosis to treatment to post-treatment follow-up. Conventional wisdom holds that AI methods will enhance rather than replace human labour [3]. Artificial intelligence (AI) has numerous potential applications in the healthcare industry, ranging from mundane administrative chores to cutting-edge areas like image analysis, medical device automation, and patient monitoring.

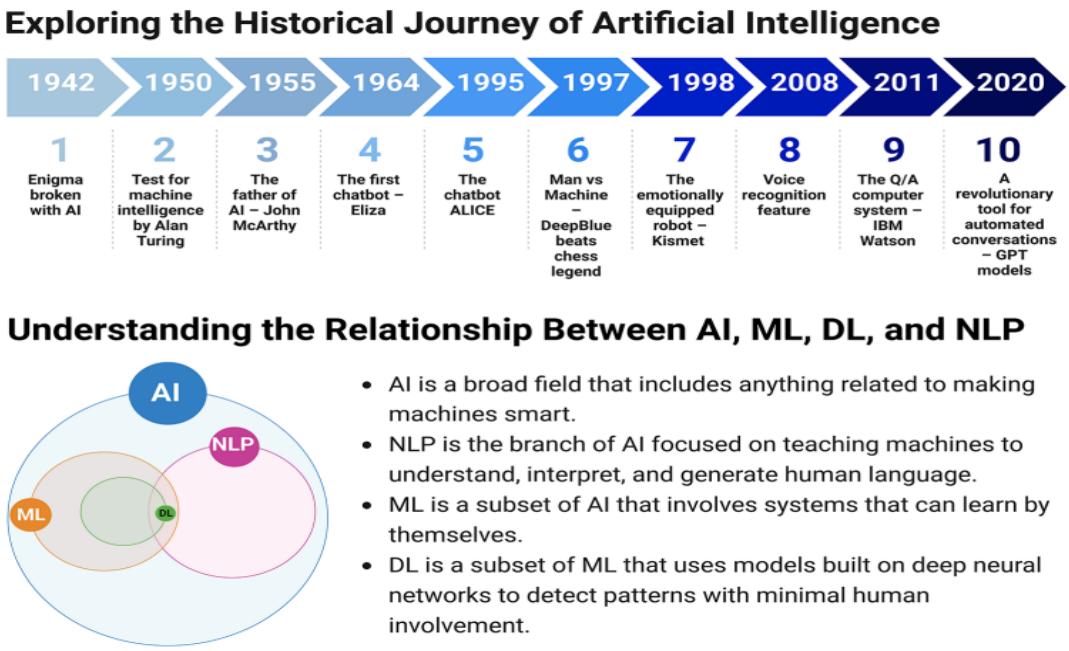

Fig 1: Understanding the Interactions Among AI, ML, DL, and NLP to Reconstruct Its Developmental Path.

Since Christopher Strachey built the first AI programme in 1951, the field of artificial intelligence (AI) has advanced significantly. Artificial intelligence (AI) was in its infancy at the time and was predominantly a topic of research in academic institutions [4]. John McCarthy organised the Dartmouth Conference in 1956, which is where he came up with the term "artificial intelligence." This event is considered to be the beginning of the current era of artificial intelligence. Research on artificial intelligence (AI) concentrated on rule-based and expert systems in the 1960s and 1970s. Nevertheless, this strategy has limitations because to the requirement for additional computational power and data [4]. In the 1980s and 1990s, researchers in the field of artificial intelligence (AI) shifted their attention to machine learning (ML) and neural networks, which enabled computers to learn from data and gradually improve their performance. IBM's Deep Blue, which in 1997 defeated Garry Kasparov to become world chess champion, exemplifies the advancements made in technology during this time. Natural language processing (NLP) and computer vision were two promising areas for future AI development that received a lot of attention from academics in the 2000s. This has led to the development of voice-activated digital assistants (like Apple's Siri and Amazon's Alexa; see Fig. 1).

2. Literature Review

The usage of big data and machine learning is having an effect on practically every element of modern life, including the entertainment sector, the commercial world, and the medical field, to name just a few of these spheres. Amazon is aware of the things that people prefer to buy as well as when and where they want to buy them, and Google is aware of the symptoms and conditions that people are searching for. Netflix knows which films and TV shows are the most popular, just as Amazon knows which products are the most sought after. All of this data might be used for in-depth individual profiling, which could be very useful for understanding and targeting behavioural patterns and could even be used to predict healthcare trends. There are several reasons to believe that artificial intelligence (AI) implementation will lead to important advances in healthcare delivery overall, from diagnosis to treatment. Reasons to have faith that AI will lead to substantial improvements in healthcare are numerous. There is now a mountain of data suggesting that AI systems can match or exceed human performance across a wide range of tasks. Quite a few pursuits fit this description. The analysis of medical imagery is one such example, as is the correlation between EMR symptoms and biomarkers and illness characterisation and prognosis [5]. This is also reflected in the applications of medical imaging.

Over the past decade, there has been an explosion of innovation in the domains of artificial intelligence (AI) and data science. The current wave of hype around AI is distinct from those that came before it, despite the

fact that research on artificial intelligence for a variety of applications has been going on for several decades. Improved computing power, larger data banks, and a large pool of AI expertise have all contributed to the meteoric rise of AI tools and technology, including those employed in the healthcare sector [6]. This has allowed for the rapid development of AI tools and technology, including AI healthcare tools and technology. As a direct consequence of this fact, the level of artificial intelligence technology, in addition to its applications and impacts on society, is going to go through a radical transformation.

This article presents a number of distinct perspectives on how best to put artificial intelligence to work in the medical industry. According to a 2018 Forbes article, "the most significant developments will occur in the areas of administrative workflows, image analysis, robotic surgery, clinical decision support, and virtual assistants" [7]. The same topics were discussed in an article published by Accenture in 2018, which also included the decrease of dosing errors, connected machinery, and cybersecurity [8]. A 2019 research by McKinsey identifies robotic-assisted surgery, electroceuticals, linked and cognitive gadgets, targeted and personalised medicine, and others as major industries [9].

Precision medicine takes into account the individual patient's biology rather than the average biology of a group at every point in the healthcare process. Individual data (genetic information, physiological monitoring data, or EMR data) is collected and then used in conjunction with sophisticated models to determine the best course of treatment for each patient. Both the frequency of adverse medication reactions and the effectiveness of therapeutic activities have been shown to decrease [10]. Other benefits of precision medicine include lower overall healthcare expenses. It is anticipated that innovations in precision medicine will give significant benefits to patients as well as revolutionise the manner in which health services are provided and assessed.

Over the next decade, it is expected that a large percentage of the world's population will have access to having their entire genome sequenced, either at birth or later in life.It is estimated that 100–150 GB of data will be needed to sequence such a genome, but doing so will allow for the creation of a powerful instrument for precision medicine. Connecting genomic data to phenotypic information is an ongoing task. Such genomics data and the benefits that come with it [11] would necessitate a shift to the current healthcare system.

In the recent past, there has been a considerable expansion in the quantity of data that can be accessed for the purpose of evaluating the activity of medicinal compounds and biomedical data. This is because more and more tasks are being automated, as well as because new experimental techniques are being used, such as parallel synthesis and text-to-speech synthesis that are based on hidden Markov models. However, accurate classification of possible medicinal chemicals requires mining of enormous volumes of chemical data, and machine learning techniques have shown a lot of promise in this area [12].

Learning systems require a translation to vector format of the drug compounds and associated attributes employed in the in silico models.. Information such as molecular descriptors (relating to things like physicochemical properties) and molecular fingerprints (relating to things like molecular structure) are typically used. The Simplified Molecular Input Line Entry System (SMILES) grid and string format is also used by convolutional neural networks (CNNs) [13].

There have also been applications of machine learning to evaluate the toxicity of molecules. DeepTox is one such programme; it is a DL-based model that assesses the potentially harmful effects of drugs using a dataset that contains a sizable number of pharmaceutical chemicals. Two-dimensional chemical structures are translated into new characteristics and descriptors using a platform called MoleculeNet, which are then used to estimate the toxicity of the provided molecule. The MoleculeNet platform relies on information gathered from a wide range of public sources, including the results of tests conducted on more than 700,000 molecules for toxicity or other properties [15].

In order to find many bioactive chemicals, developed a recurrent neural network to parse SMILES strings. Agonists of retinoic acid type X and peroxisome proliferator-activated receptors were added to the model afterward. They were able to synthesise the compounds and show considerable modulation of receptor activation in vitro [16].

3. AI Assistance In Population Health Management

Predictive analytics and risk assessment

Predictive analytics are becoming increasingly prevalent in population health management in order to detect and direct various health activities. Predictive analytics is a subfield of data analytics that makes extensive use of modelling, data mining, artificial intelligence, and machine learning. Data from the past as well as the present are analysed by it so that it can predict the future. In order to enhance patient outcomes and cut costs, data is analysed with machine learning algorithms and other technologies. This leads to the development of prediction models. The ability to forecast who may develop long-term illnesses like those affecting the endocrine or cardiovascular systems is one area where predictive analytics could be useful. Predictive models can prioritise efforts to prevent or treat diseases by identifying those at highest risk based on factors including demographics, medical history, and lifestyle. Another potential application of predictive analytics is the forecasting of hospital readmissions.

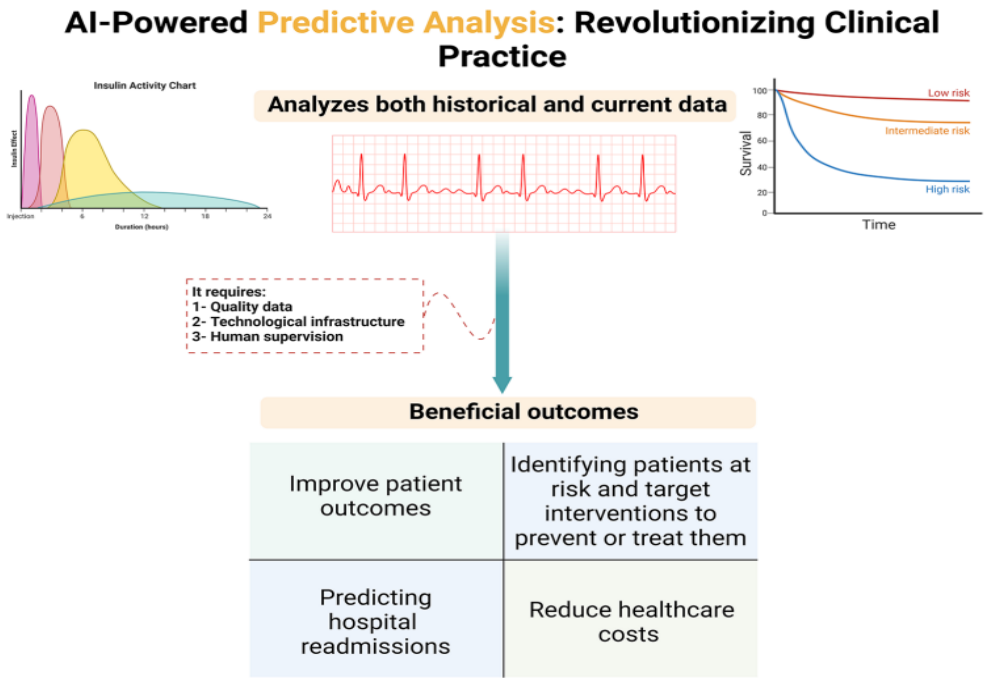

Fig. 2: Predictive Analytics Driven by Artificial Intelligence: A Key to Leveraging Patient Data

Another potential application of predictive analytics is the forecasting of hospital readmissions. Patients at a higher risk of being readmitted to the hospital can be identified using predictive models, allowing for more focused efforts to prevent unnecessary readmissions (Fig. 2). The patient's background information, including their social circumstances and medical history, is analysed to achieve this objective.

Establishment of working groups, guidelines, and frameworks

The process of determining best practises in a variety of industries is being revolutionised by AI. It may take a long time to identify the knowledge gap, formulate a plan of action, write up the plan, publish it, and disseminate it to the healthcare community. Using data from clinical trials and real-world patient outcomes in the same area, AI can aid in the first step of data mining by discovering newly available data. Then, with the help of scientists and other experts, AI systems may sift through mountains of data in search of patterns and trends that can inform the continued development of evidence-based standards. Because of this, crucial clinicians providing supervision can be informed of developments in a timely manner, which has important clinical and ethical consequences.

The use of AI for medical research and patient counselling With the help of AI, healthcare providers would have access to new decision-making resources. AI would recommend this setup. The ability of hospitals

and other healthcare facilities to use automation-enabled technology to enhance patient safety, accuracy, and efficiency in care has grown in recent years. The necessity to raise the standard of care provided to patients is what has prompted this shift. When AI is integrated with cutting-edge technologies like NLP, ML, and analytics, it can provide healthcare providers with vastly improved timeliness, precision, and freshness in their data. According to the McKinsey Global Institute, the pharmaceutical industry's use of machine learning and artificial intelligence might add almost $100 billion per year to the US healthcare system. Researchers claim that the technologies they studied aid in decision-making, increase the potential for innovation, boost the effectiveness of research and clinical trials, and lead to the creation of new tools that are useful for healthcare providers, patients, insurers, and regulators.

4. AI-Assisted Medical Imaging Diagnosis

The ability for medical professionals to recognise and keep track of a wide range of medical conditions is made possible by medical imaging, making it a crucial component of modern healthcare. However, decoding medical images can be a tough and time-consuming process that requires specialised knowledge as well as training in the relevant fields. Artificial intelligence has the potential to revolutionise medical imaging diagnosis by assisting medical professionals in the process of understanding medical pictures and providing diagnoses that are both more precise and more quickly. AI-assisted medical imaging diagnostics offer a number of benefits, the most significant of which is the ability to improve both the diagnostic accuracy and speed. Large amounts of data from medical images can be utilised to train AI algorithms to recognise patterns and potential outliers. Because of this, medical professionals may be able to study and interpret images in a shorter amount of time, which may lead to quicker and more accurate diagnoses. Diagnostic procedures for medical imaging that are supported by AI may potentially help to reduce diagnostic errors and diagnostic variability. People's interpretations of medical imaging could be impacted by a wide variety of factors, such as fatigue, distraction, and individual differences in interpreting information, amongst others.

On the other hand, AI systems have the ability to provide analysis that is consistent and impartial, which reduces the likelihood of errors occurring and improves the precision of diagnoses. Medical imaging diagnostic that is supported by AI can potentially make it possible to provide healthcare that is more tailored and efficient. It is possible for AI algorithms to analyse medical pictures in order to identify unique patient features such as age, sex, and medical history, which may then be used to tailor therapies as required. When this is done, the risk of problems occurring is minimised, and the possible outcomes for patients are better.The risks associated with using AI for medical imaging diagnostics must be mitigated. One of the most critical issues is the necessity for extremely vast and diverse datasets while training AI systems. It may be difficult to get medical imaging datasets, and these datasets may not be representative of the population at large, both of which could add bias into AI models. It is essential that AI algorithms be trained using a wide number of distinct test datasets to ensure the highest levels of accuracy and efficiency.

Diagnostics that are supported by AI in medical imaging present additional challenges, one of which is the necessity of collaboration between AI algorithms and human medical professionals. AI algorithms may be able to provide insightful assessments, but they cannot take the place of the knowledge and discretion of healthcare professionals. It is necessary to develop AI algorithms that can work in conjunction with medical professionals in order to provide accurate and prompt diagnosis. Precision, speed, and the power to tailor care for each patient are all areas where AI has the potential to enhance medical imaging diagnostics. AI-aided diagnostic medical imaging processes may not only improve turnaround times and accuracy but also pave the way for more individualised treatment plans. However, there are still several obstacles that need to be cleared before artificial intelligence may be widely used in medical imaging diagnosis. Many challenges must be surmounted, such as the requirement of many different datasets and the requirement of collaboration between AI algorithms and medical professionals.

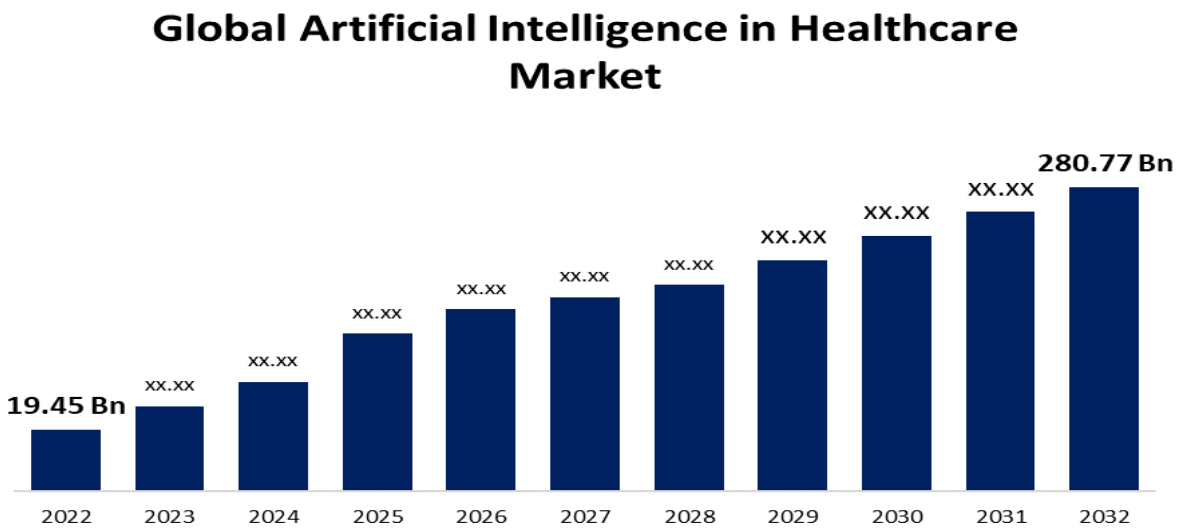

Fig 3: Global Artificial Intelligence In Healthcare Market

With a CAGR (Compound Annual Growth Rate) of 30.6% between 2022 and 2032, as shown in Figure 3, the global market for AI in healthcare is expected to rise from USD 19.45 billion in 2022 to USD 280.77 billion by 2032.

AI is revolutionising the healthcare sector by improving patient diagnosis, treatment, and overall care through the use of data analysis and machine learning algorithms. This is happening as a result of AI's use of these two approaches. Artificial intelligence is able to sift through vast amounts of patient records and imaging data, among other types of medical information, to unearth useful insights and assist with clinical decision-making. It makes it possible to create individualised treatment regimens, enhances the accuracy of picture interpretation, contributes to medical research, and makes it easier to remotely monitor patients. However, concerns like as the privacy of users' data and the legislative frameworks that govern it need to be addressed.

5. Improving Patient Outcomes

Predictive analytics is a relatively new field of study in healthcare that uses AI and ML to examine patient data and provide prognoses about future outcomes. Predictive analytics can help healthcare practitioners improve patient outcomes and decrease healthcare expenses. Predictive analytics has several applications in healthcare, including disease diagnosis, risk assessment, and treatment planning. Medical records, test results, and demographic information are just some of the sorts of data that predictive analytics algorithms can mine for patterns in attempt to forecast patient outcomes. One significant benefit of using predictive analytics in healthcare is the identification of those at risk for developing particular diseases or conditions. Predictive analytics algorithms can identify people with specific disease risk factors and offer individualised preventative therapy by studying patient data. By using predictive analytics, doctors might potentially help a patient avoid getting type 2 diabetes by alerting them to the need to make certain lifestyle changes.

One other benefit of using predictive analytics in healthcare is the ability to create individualised plans for treatment. By analysing a patient's characteristics and health record, predictive analytics algorithms can design personalised treatment programmes. A patient's medical records can be analysed by a predictive analytics algorithm to help select the most effective treatment. By decreasing unnecessary hospitalisations, predictive analytics may help patients more effectively navigate the healthcare system. By analysing patient data, predictive analytics algorithms can pinpoint those patients most likely to be readmitted and develop interventions to keep them out of the hospital. A patient with a high risk of readmission after surgery may be identified by a predictive analytics programmer, who may then recommend post-operative steps to reduce the likelihood of readmission. Predictive analytics' usage in healthcare has its benefits, but it also has its dangers. The lack of sufficient reliable data is a concern. Large amounts of high-quality data are needed for both training

and executing predictive analytics systems. However, it is difficult to develop trustworthy and effective predictive analytics models due to the fragmented and inconsistent nature of healthcare data.

One challenge is the necessity of open communication and teamwork among medical experts. As a result of the sheer volume of data and projections generated by predictive analytics systems, healthcare personnel may experience information overload. Open channels of communication and coordination among medical experts are crucial for improved patient care and more precise predictions. Predictive analytics has the potential to enhance patient outcomes and save healthcare expenses by utilising AI and ML to examine patient data and forecast results. Finding patients at risk for acquiring diseases, generating individualised treatment plans, and avoiding unnecessary hospital readmissions are all areas in which predictive analytics can benefit healthcare practitioners in making educated decisions about patient care. Better provider collaboration and communication, as well as more high-quality data, are needed to fully realise the benefits of predictive analytics in healthcare.

As the number of applications for AI expands, the healthcare industry will have to deal with new moral dilemmas. The application of AI in healthcare raises questions concerning patient privacy, algorithmic bias, and the proper place of healthcare professionals in decision making.Privacy protection for patients is an important ethical consideration. A large amount of patient data is necessary for AI systems to perform successfully. Patients have a right to privacy, thus getting their permission to use their data in AI algorithms is necessary. Providers of medical care have a legal responsibility to protect the confidentiality of their patients' personal information. Another ethical concern is the possibility of prejudice in algorithms. The degree to which AI systems are impartial depends on the information they are taught. It seems to reason that biassed data used to train AI algorithms would produce biassed algorithms. When a computer algorithm is taught with data that primarily consists of white people, it may have trouble correctly diagnosing diseases among patients of different races.Health care professionals have emphasised the importance of using a large and diverse dataset to train AI systems.

6. Conclusion

In conclusion, the use of AI in pharmacy has the potential to completely transform the industry while also providing several benefits to both customers and pharmacists. By expediting the development of new pharmaceuticals and boosting their use, as well as improving the precision and safety of medication delivery, artificial intelligence has the potential to improve patient outcomes. This approach has several potential benefits, including in the areas of drug development, chronic disease management, and medication administration. The application of AI has the potential to save healthcare expenses by increasing efficiency and decreasing human error. There are, however, a number of obstacles that need to be overcome before AI may be widely deployed in the pharmacy environment. This consideration is crucial. There may be concerns about the right to privacy and security when using AI-powered systems to monitor healthcare data, for example. There's also the possibility that chemists will need more education and training in order to effectively utilise AI tools and incorporate them into their work. When properly implemented and managed, AI in pharmacy has the potential to offer advantages much beyond the existing limitations and obstacles, ushering in a brighter future for healthcare.

References

[1] Flynn Allen Using artificial intelligence in health-system pharmacy practice: finding new patterns that matter Pharm.D., Ph.D Am J Health Syst Pharm, 76 (9) (2019), pp. 622-627, 10.1093/ajhp/zxz018 1 May

[2] B. Patra, P. Nema, M.Z. Khan, O. Khan Optimization of solar energy using MPPT techniques and industry 4.0 modelling Sustainable Operations and Computers, 4 (2023), pp. 22-28, 10.1016/j.susoc.2022.10.0

[3] S. Ahmad, M. Parvez, T.A. Khan, O. Khan A hybrid approach using AHP–TOPSIS methods for ranking of soft computing techniques based on their attributes for prediction of solar radiation Environmental Challenges (2022), 10.1016/j.envc.2022.100634

[4] S. Ahmad, M. Parvez, T.A. Khan, S.A. Siddiqui, O. Khan Performance comparison of solar powered cogeneration and trigeneration systems via energy and exergy analyses Int J Exergy, 39 (4) (2022), pp. 395-409
[5] M. Javaid, A. Haleem, I.H. Khan, R. Suman Understanding the potential applications of artificial intelligence in agriculture sector Advanced Agrochem, 2 (1) (2023), pp. 15-30, 10.1016/j.aac.2022.10.001
[6] Miller D.D., Brown E.W. Artificial intelligence in medical practice: the question to the answer? *Am J Med.* 2018;131(2):129–133.
[7] Lee K.-F. *AI superpowers: China, Silicon Valley, and the new world order.* 1st ed. Houghton Mifflin Harcourt; 2019.
[8] Marr B. How is AI used in healthcare—5 powerful real-world examples that show the latest advances. Forbes; 2018.
[9] Kalis B, Collier M, Fu R. 10 promising AI applications in health care. Harvard Business Review; 2018.
[10] Singhal S, Carlton S. The era of exponential improvement in healthcare? McKinsey Co Rev.; 2019.
[11] Konieczny L, Roterman I. Personalized precision medicine. Bio-Algorithms Med-Syst 2019; 15.
[12] 13. Kulski JK. Next-generation sequencing—an overview of the history, tools, and 'omic' applications; 2020.
[13] 15. Ekins S. Exploiting machine learning for end-to-end drug discovery and development. *Nat Mater.* 2019;18(5):435–441
[14] 17. Lavecchia A. Deep learning in drug discovery: opportunities, challenges and future prospects. *Drug Discov Today.* 2019;24(10):2017–2032.
[15] 19. Mayr A., Klambauer G., Unterthiner T., Hochreiter S. DeepTox: toxicity prediction using deep learning. *Front Environ Sci.* 2016;3:80. [Google Scholar]
[16] 20. Wu Z. MoleculeNet: a benchmark for molecular machine learning. *Chem Sci.* 2018;9
[17] 23. Merk D., Friedrich L., Grisoni F., Schneider G. De novo design of bioactive small molecules by artificial intelligence. *Mol Inform.* 2018;37.