AI IN PHARMACEUTICAL INDUSTRY – A SURVEY PAPER

Abstract

Artificial intelligence, a subfield of computing that focuses on finding solutions to problems with the help of symbolic computing, has grown into a problem-solving science with wide-ranging implications for fields as diverse as commerce, engineering, and medicine. The term "artificial intelligence" (AI) in the pharmaceutical industry describes the use of programmed algorithms to problems that have historically required human cognition. Recent years have seen a revolution in drug discovery, illness treatment, and other pharma-related endeavours thanks to the use of artificial intelligence. In the present survey article, we have examined the use of artificial intelligence (AI) in medicinal chemistry (ANN, Deep neural network), the relevance of AI in pharmacy, the use of AI in pharmacy, the advantages and disadvantages of Ai in pharmacy, and current developments in the field of pharmacy.

Keywords: Artificial Intelligence; Pharmacy; Robotics; algorithm; Ai in pharmacy

Authors

Dr. Jyothi A P
Assistant Professor
Department of Computer Science & Engineering
Faculty of Engineering and Technology
Ramaiah University of Applied Sciences
Bengaluru, Karnataka, India.
jyothiarcotprashant@gmail.com

Shivaranjini. C
Student
Department of Computer Science & Engineering
Faculty of Engineering and Technology
Ramaiah University of Applied Sciences
Bengaluru, Karnataka, India.
shivaranjini.cranju@gmail.com

Usha Shree B N
Student
Department of Computer Science & Engineering
Faculty of Engineering and Technology
Ramaiah University of Applied Sciences
Bengaluru, Karnataka, India.
Ushashree1809@gmail.com

I. INTRODUCTION

All domains of science have been invaded by the development of computing and technology. One fundamental aspect of computer science is Artificial Intelligence (AI), which has impacted everything from basic engineering to medical technology [1]. Pharmacy is key in the development, manufacture, storage, safe and effective use, and regulation of pharmaceuticals and drugs. Pharmaceutical is the clinical science that connects medical science with chemistry [2]. Each phase of the medication design process uses AI technology, which significantly lowers the cost and lowers the health risks associated with preclinical trials. Based on the vast amount of pharmaceutical information and machine learning process, AI is a useful tool for data mining. In recent years, AI technology has evolved into a fundamental component of business due to its numerous practical applications in the technical and scientific worlds. The emerging push to adopt the use of artificial intelligence (AI) in pharmacy[3], particularly drug development, formulation creation for medication administration, and other monitoring devices, has already moved from talk to optimism. There are two main categories of developments in AI technology. The first one consists of traditional computing methodologies like expert systems, which are able to simulate experiences and demonstrating the conclusions drawn from the principles, such as expert systems [4]. The second one consists of artificial neural network-based modelling systems for how the brain functions (ANNs). In drug discovery and drug delivery formulation development, MANY Artificial Neural Networks (ANNs) like Deep Neural Networks (DNNs) or Recurrent Neural Networks (RNNs) are being employed.

II. WHY AI IS REQUIRED IN THE PHARMACY

Pharmacists, according to a U.S. News poll of 150 working professionals, had the 13th highest median salary. It was determined that the average pay for a pharmacist is $120950, and that the unemployment rate for pharmacists is 1.6% [5]. For decades, pharmacists' primary responsibility has been to check that their customers receive the correct medication in the correct dosage and that, in the event that they are taking numerous drugs, there are no negative drug-drug interactions. But the situation has altered considerably during the previous five years. Big data and AI have made robots more reliable for use in healthcare, and many organisations are now using robots under human supervision to do tasks that were previously done by people. Pharmaceutical firms have access to a vast library of chemicals that show promise in the treatment of a wide range of ailments. However, businesses lack the resources necessary to reliably identify them as such. Drug research and manufacture is a complex process that can take a pharmaceutical business 12–14 years and up to $2.6 billion to complete. For this reason, AI can be quite helpful to the pharmaceutical industry. By shortening the medication development process, AI helps lower overall costs, improves ROI, and might potentially result in lower prices for the consumer. Artificial intelligence's main perk is that it can process and analyse vast amounts of data that would overwhelm traditional computers. Current applications of AI tend to be theoretical in nature. Artificial intelligence (AI) has more processing capacity than any other instrument now in use, making it ideal for study, especially into the effects of genetic mutation.

III. AI IN DRUG DISCOVERY

There are five stages in the process of developing drugs where AI and ML could be used. By enabling researchers to delve deeply into enormous research data sets and strengthen their scientific intuition, ai and machine learning are changing the nature of scientific discovery. With the help of this technology, Benevolent AI was able to pinpoint a number of substances, including molecule A, which has the potential to treat ALS (Amyotrophic Lateral Sclerosis). Using accumulated knowledge of chemical biology, Cherkasov et al. came up with the notion to create tiny peptides with broad-spectrum antibiotic activity. They randomly created two sizable libraries of 9-amino-acid peptides using peptide element technology and taking use of the amino acid makeup of the more active peptide. In order to create in silico models that symbolised antibiotic activity, the data collected was combined with Artificial Neural Networks, which are electronic representations of the neural structure of the brain. Deep neural networks (DNNs) are a unique method that Aliper et al. has presented for predicting the pharmacological actions of various medications. By analysing data on gene expression, the research team taught DNNs to make predictions about the therapeutic effects of various medications. These findings came from research using human cell lines.

IV. AI IN HOSPITAL PHARMACY

1. **Upkeep of medical records:** Keeping track of patients' medical records is a difficult endeavour. By using an AI system, data collection, storage, normalisation, and tracing are made simple. The Google Deep Mind health initiative, which was created by Google, helps to quickly extract medical records. As a result, this project is beneficial for providing quicker and better healthcare. This project supports at Moor Fields Eye Hospital NHS in its efforts to enhance eye care.

2. **Designing a treatment plan:** With the use of AI technology, effective treatment programmes can be designed. The AI system is required to maintain control when a patient's health gets critical and choosing an appropriate treatment plan becomes challenging. The treatment plan provided by this technology takes into account all of the prior documents and information, clinical expertise, etc.

3. **Health care and medication help:** In recent years, the usage of AI technology has been found to be effective for both medication assistance and health support services. 6 The voice and visage that Molly (a virtual nurse created by a start-up) hears are friendly. Its purpose is to support patients with chronic conditions in between medical appointments and to assist individuals in directing their own care. The smartphone webcam app Ai Cure keeps track of patients and helps them manage their diseases.

V. ADOPTION OF AI IN THE PHARMACEUTICAL INDUSTRY

Despite the excellent level of medical care provided today, developing new drugs is getting harder. As a result, overall revenues are generally declining, and many firms are searching for cutting-edge management solutions to address this. To improve R & D performance and create novel medicines, more efficient procedures, information choices, and strong forecasting analytics tools are required. AI steps in at this point.

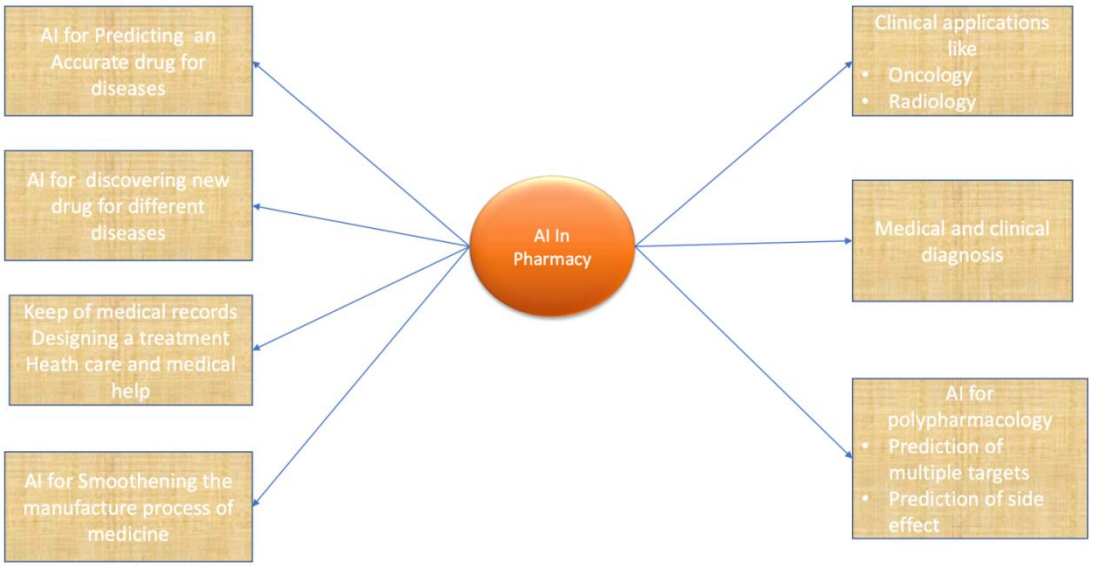

Figure 1: Different uses of AI in Pharmacy

1. **AI technology positive aspects:** Possible benefits of intelligent machines

- **Minimizing the likelihood of making an error's:** AI helps to reduce mistakes and improve efficiency. As intelligent -robots -are built with "metal bodies" that are strong enough to withstand the harsh conditions of space, they are often dispatched there to learn more about the universe.

- **Challenging exploring:** In the mining industry, AI proves its worth. It also finds application in the fossil fuels industry. Due to their ability to overcome human mistake, AI systems are now able to conduct oceanographic research.

- **Applications in medicine:** As a whole, AI software can assist doctors evaluate their patients and examine any potential hazards from the prescription they're considering prescribing. Artificial intelligence (AI) applications, such as numerous artificial surgery simulators (such as gastrointestinal, heart, brain, etc.) can help medical students learn about surgical procedures.

- **Absence of a rest period:** Machines are designed to operate for extended periods of time without getting confused or bored, unlike humans, who can only sustain their attention span for around eight hours before needing a break.

- **Lead to more rapid of technological advancement:** Most cutting-edge technical developments throughout the world now rely heavily on AI systems. It aspires to the development of novel compounds and can generate a variety of computer modelling programmes. Delivery of drugs formulations are also being created with the help of AI technologies.

2. The drawback of AI Technology

- **Costly:** The introduction of AI results in a significant financial outlay. The time and money spent on complex machine development, operation, and service is well worth it. The research and development department needs a lot of time to create only one AI system. The software that runs on AI machines needs to be kept up to date on a routine basis. Re-installations and computer recoveries are time-consuming and expensive.

- **There will be no human copies made:** AI-enhanced robots have the advantage of being able to mimic human thought processes without experiencing any of the downsides, allowing them to carry out their tasks without bias or prejudice. It's impossible for robots to make decisions and give accurate reports in the face of novel challenges.

- **Inability to think outside the box:** Neither sensitivity nor emotional intelligence can be replicated in an AI-powered machine; hence such devices are incapable of producing anything truly novel. Hearing, seeing, feeling, and thinking are all faculties unique to the human species. Aside from rational cognition, they can also employ their imagination. Machines cannot replicate these characteristics.

- **Unemployment:** Large-scale job losses might result from the broad use of AI technologies across industries. Human employees may lose their work ethic and inventiveness if they are laid off, which is why it's so bad.

VI. CURRENT TRENDS OF PHARMACY USING ARTIFICIAL INTELLIGENCE

Over the past year, the worldwide pharmaceutical sector has seen some remarkable changes as a result of the COVID-19 epidemic. The development of effective medicines and vaccinations to defend humans against by the deadly virus has been accelerated by the use of newer, speedier technology. A vaccine has never been created less than a year after a disease becoming known to humans. The COVID19 outbreak has brought to light the urgent need for a more rapid and effective supply of drugs, oxygen, and vaccines. Automation is thus the most obvious answer to this problem. Automation will make it easier to provide affordable, trouble-free, adaptable, and streamlined medical supplies and life-saving drugs across the supply chain of the pharmaceutical business.

VII. EMERGING TRENDS IN THE PHARMACEUTICAL INDUSTRY

With the aid of AI and ML, the market has begun concentrating on its capacity to match expanding client demands. Drug, collaborative training, NLP, and computer vision are given particular attention. However, 2022 demands that pharma go further and take into account all of the trends in the pharmaceutical sector that will influence the worldwide market this year.

- **Integrating wearable technology:** Pharma businesses can now do more than just create, promote, and sell pharmaceuticals thanks to the integration of wearable technology. Patients now have more control over how they manage their health and

make important choices thanks to technology. We already have a variety of remote patient monitoring tools that enable medical professionals to monitor metrics for blood pressure and glucose levels as well as chronic diseases like diabetes and asthma.

- **Management and analysis of data:** One of the biggest barriers to the commercialization of new medications is the cost of research and innovation. Lack of appropriate drug development and distribution has a cascading effect on public health. Pharma scientists can shorten research cycles and hasten the discovery and dissemination of novel treatments by utilising big data. Big data can also be used to anticipate a drug's side effects, speeding up the time required for clinical studies. Shorter R&D cycles can help patients pay less for their prescriptions because the costs of research and innovation drive up drug prices.

- **Universal process:** Single-use technology (SUT) is being adopted by more pharmaceutical businesses in their manufacturing procedures. As more members of the industry become aware of the fantastic benefits of this technology, this change is continuing. High-level processes can be facilitated at a wider scale by SUT-powered bioreactors. Additionally, the technique enables the production of more dependable goods, doing away with the need to sterilise containers.

- **Perfect medicine:** A novel approach to illness diagnosis, treatment, and prevention is provided by precision medicine. This technology aids physicians in making precise, fact-based recommendations by using the patient's DNA and lifestyle.

VIII. INNOVATIONS IN TECHNOLOGIES AND LIFE SCIENCE TRANSFORM IN PHARMACY

The future of pharmacy is being changed by exponential change, which is speeding disruption throughout the health care value chain. Smart mirrors that monitor changes in your health using cutting-edge cameras and your breath are now being developed by researchers. Home health care bots are being developed and tested by a number of businesses, while older workers in Japan are employing exoskeletons to increase the amount of manual labour they can perform.

Smartphones are becoming more capable of diagnosing illnesses including urinary tract infections and diabetic eye disease at the point-of-care and at home. An origami robot that can be ingested and commanded to repair a wound has been created in laboratories. Businesses are developing a food-as medicine strategy to control blood sugar levels and enhance general health utilising the gut flora.

IX. THE FUTURE OF AI IN PHARMACY INDUSTRY

It's crucial to start with the consumer and consider how their path through the healthcare system will alter if you want to fully comprehend our vision for the future of pharmacy. The function of the pharmacy and pharmacist is evolving in a way that may not even be recognisable by today's standards as technology becomes more pervasive and integrated. Along with an expanding role for tele health and virtual health care, we observe a

convergence of health and wellness. A speciality pharmacy communicates to the market that it is looking to the future by investing in new AI technologies. Such investments will position the pharmacy as a partner that will enable its patients to obtain the highest degree of accurate treatment, with the greatest potential for positive results at the lowest feasible costs, in the eyes of manufacturers, prescriber's, and payers.

X. SUGGESTION

Companies should start by identifying and being honest about their core strengths and how those are durable and/or transferable in order to move confidently into the future of pharmacy. Although there are still opportunities to make extra income, forward-thinking businesses are considering issues like: Who will be a competitor or disruptor in our ecosystem, whether they are internal or external? Who might be a supporter? How quickly will our industry innovate in comparison to how quickly the ecosystem is changing? What will happen if danger moves toward or away from us, and how will that affect us? should we innovate now to take charge of the future, or should we wait until the disruptor's win market share and prove the concept, at which point entry into the market will be considerably more expensive? In the end, the problem for the majority of businesses is a lack of ideas for how to proceed. Instead, it involves prioritising and harmonising these concepts to decide where and how much funding should be allocated to guarantee their inclusion in pharmacy's future. So companies must be more expertises and should be able to overcome all these challenges.

XI. CONCLUSION

As deep learning and neural networks improve and mature, and as interconnected and AI-based medical databases are built and improved, the role of AI technology in medical diagnosis and teaching will become more prominent. It will undoubtedly usher in a new era of reform in medical education information technology. The use of automated work flows and databases for effective AI-based analyses has proven beneficial. As a result of the use of AI approaches, the design of new hypotheses, strategies, prediction, and analyses of various associated factors can be easily accomplished with the benefit of less time consumption and lower cost. AI is doubtless a new big thing in the field of pharmacy. Companies that are more flexible and adopt AI faster will gain more strategy advantages, experts anticipate that implementation of AI will soon be necessary to compete in the industry.

REFERENCES

[1] V. Mishra, Artificial intelligence: the beginning of a new era in pharmacy profession, Asian Journal of Pharmaceutics (AJP) 12 (02) (2018).
[2] S. Das, R. Dey, A. K. Nayak, Artificial intelligence in pharmacy, INDIAN JOURNAL OF PHARMACEUTICAL EDUCATION AND RESEARCH 55 (2) (2021) 304–318.
[3] S. D. Nelson, C. G. Walsh, C. A. Olsen, A. J. McLaughlin, J. R. LeGrand, N. Schutz, T. A. Lasko, Demystifying artificial intelligence in pharmacy, American Journal of Health-System Pharmacy 77 (19) (2020) 1556–1570.
[4] J. Dasta, Application of artificial intelligence to pharmacy and medicine., Hospital pharmacy 27 (4) (1992) 312–5.
[5] L. Meng, J. Fu, Application of artificial intelligence technology in clinical pharmacy, in: Journal of Physics: Conference Series, Vol. 1648, IOP Publishing, 2020, p. 022133

[6] Margaet Rouse. IBN Watson super computer. Available from http://www.techtarget.com/definition/IBM
[7] Sakiyama Y. The use of machine learning and nonlinear statistical tools for ADME prediction. Expert Opin Drug Metab Toxicol. 2009;5(2):149-69.
[8] Dasta JF. Application of artificial intelligence to pharmacy and medicine. Hosp Pharm 1992;27:312-5, 319-22.
[9] Flasiński M. Introduction to Artificial Intelligence. 1st ed. Switzerland: Springer International Publishing; 2016. p. 4.
[10] Ma J, Sheridan RP, Liaw A, Dahl GE, Svetnik V. Deep neural nets as a method for quantitative structure–activity relationships. J Chem Inf Model. 2015;55(2):263-74.
[11] Donepudi, P.K., 2018. AI and machine learning in retail pharmacy: systematic review of related literature. *ABC journal of advanced research*, *7*(2), pp.109-112.
[12] Flynn, Allen. "Using artificial intelligence in health-system pharmacy practice: finding new patterns that matter." *American Journal of Health-System Pharmacy* 76, no. 9 (2019): 622-627.
[13] Raza, Muhammad Ahmer, Shireen Aziz, Misbah Noreen, Amna Saeed, Irfan Anjum, Mudassar Ahmed, and Shahid Masood Raza. "Artificial Intelligence (AI) in Pharmacy: An Overview of Innovations." *INNOVATIONS in pharmacy* 13, no. 2 (2022): 13-13.
[14] Kostić, Emilija J., Dimitrije A. Pavlović, and Miroslava D. Živković. "Applications of artificial intelligence in medicine and pharmacy: ethical aspects." *Acta Medica Medianae* 58, no. 3 (2019): 128-137.
[15] Mariappan, Mahesh Babu, Kanniga Devi, Yegnanarayanan Venkataraman, Ming K. Lim, and Panneerselvam Theivendren. "Using AI and ML to predict shipment times of therapeutics, diagnostics and vaccines in e-pharmacy supply chains during COVID-19 pandemic." *The International Journal of Logistics Management* (2022)
[16] Sharma, Tamanna, Abhinav Mankoo, and Vivek Sood. "Artificial intelligence in advanced pharmacy." *International Journal of Science and Research Archive* 2, no. 1 (2021): 047-054.
[17] Kiryu, Yoshihiro. "Potential for Big Data Analysis Using AI in the Field of Clinical Pharmacy." *Yakugaku Zasshi: Journal of the Pharmaceutical Society of Japan* 141, no. 2 (2021): 179-185
[18] Baines, Darrin, Lotte Stig Nørgaard, and Charlotte Rossing. "The Fourth Industrial Revolution: will it change pharmacy practice?." *Research in social and administrative pharmacy*16, no. 9 (2020): 1279-1281.
[19] KUMAR, RITESH. "ARTIFICIAL INTELLIGENCE IN PHARMACY PROFESSION." (2022).
[20] Nakagawa, Naoto, Keita Odanaka, Hiroshi Ohara, and Shigeki Kisara. "Communication training for pharmacy students with standard patients using artificial intelligence." *Currents in Pharmacy Teaching and Learning* 14, no. 7 (2022): 854-862.

