



APPLICATION OF AI IN PHARMACY: A REVIEW

¹Lukman Abdulrouf Mulla , ²Bhosale Rohit Raju, ³Tashif Zakiruddin Shaikh

Students, T.Y. B. pharmacy, SAJVPM's COPSRC, Kada, Tal. Ashti, Dist. Beed, Maharashtra, India.

Abstract: The industrial landscape, particularly the pharmaceutical industry, is being quickly transformed by artificial intelligence (AI). AI is being used more and more in the pharmaceutical sector to automate, improve, and personalize processes ranging from medication administration to drug development. This article will look at the applications of AI in inventory management, personalized medicine, drug safety and quality control, and patient counseling. For drug development, polypharmacology and hospital pharmacy, as well as drug discovery research. The goal of AI is to create intelligent modeling that aids in problem solving, knowledge visualization, and decision making. Software, computer programs, and automation have all been created to help and expedite healthcare procedures. AI has stimulated computer-aided drug discovery. AI has the potential to significantly improve medication management and patient care. This review explores various AI applications and future approaches in the field of pharmacy practice.

Keywords: Artificial Intelligence, Drug Discovery, Personalized Medicine, Inventory Management, COVID -19, Support Vector Medicines (SVM)

INTRODUCTION

AI, first introduced in 1956, is rapidly expanding in healthcare and healthcare education. Health profession students have a basic understanding of AI principles and technologies, reducing inefficiencies and errors in traditional pharmacy systems that rely on manual processes and human expertise. In order to improve the efficiency of this process, the innovative industry is increasingly turning to computing and AI to narrow down the list of candidates to test, saving a lot of time and money on downstream testing. A subfield of computer science known as artificial intelligence (AI) studies intelligent machines that solve issues through symbolic programming. It has been actively engaged in the field of issue solution science by utilizing pharmaceutical engineering and workplace health care. Data digitalization in the pharmaceutical industry has increased significantly in recent years. With relation to the pharmaceutical sector, artificial intelligence (AI) is indispensable because of its broad applicability in all stages. It is evident that artificial intelligence (AI) affects pharmaceutical products at every stage, from product management to medicine creation. The following topics were covered in this review's discussion on artificial intelligence (AI).

- 1) AI In Drug Discovery
- 2) AI In Personalized Medicine
- 3) AI In Drug Safety
- 4) AI In Quality Control
- 5) AI In Inventory Management
- 6) AI In Patient Counselling

1. AI in drug discovery

Data digitalization in the pharmaceutical industry has increased significantly in recent years. With relation to the pharmaceutical sector, artificial intelligence (AI) is indispensable because of its broad applicability in all stages. It is evident that artificial intelligence (AI) affects pharmaceutical products at every stage, from product management to medicine creation. (5naturerewiwves)

We see several dimensions for AI to create value in drug discovery, including greater productivity (faster speed and/or lower cost), broader molecular diversity and improved chances of clinical success.

2. AI in personalized medicine

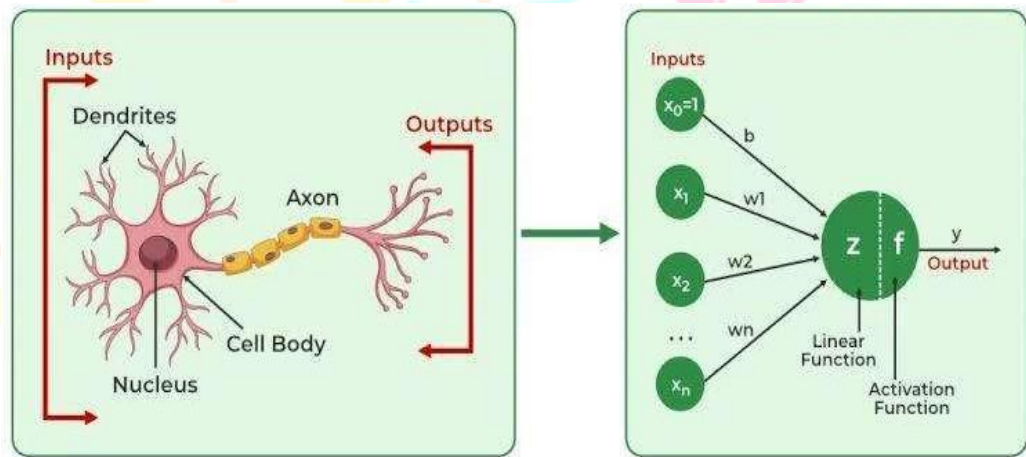
Following AI algorithms used in personalized medicine,

2.1 Naïve Bayesian

The Naïve Bayesian (NB) algorithm, named after Thomas Bayes, is a probabilistic model used in spam filtering, recommender systems, text classification, medical applications, and weather forecasting. It is robust against noise and requires minimal training data. However, it has disadvantages such as loss of accuracy due to class conditional independence and assumes zero probability for new predictors.

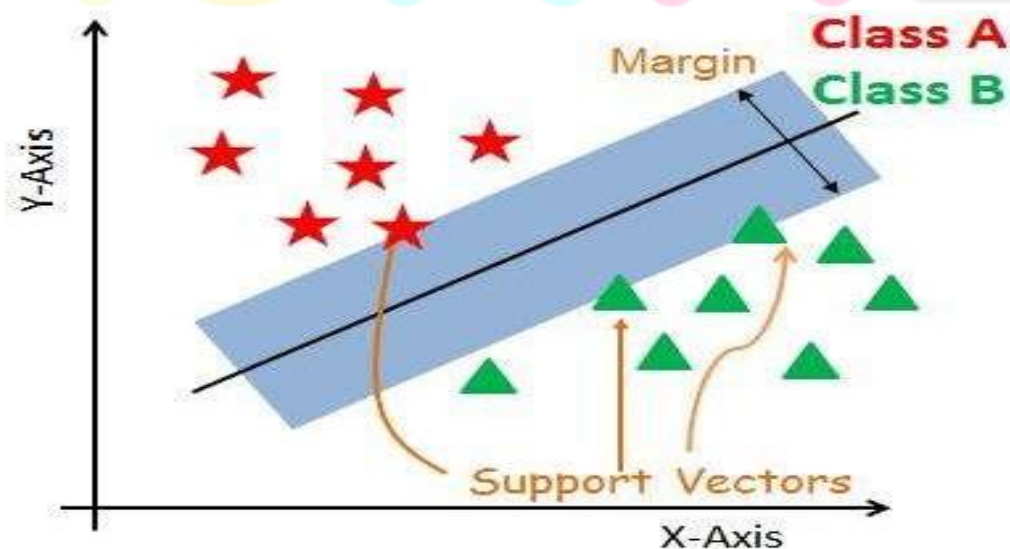
2.2 Artificial Neural Network

Artificial neural networks (ANNs) are being used in medicine for a variety of purposes, such as diagnostics, imaging, back pain, dementia, myocardial infarction, acute pulmonary embolism, arrhythmias, pathology and prognosis evaluation of appendicitis, and mental neuropsychiatric diseases. Both linear and nonlinear models can be learned using neural networks. Statistical methods can also be used to assess the correctness of neural network-created models. Neural networks can tolerate noise and incomplete data. Because neural network models can be updated, they are versatile and appropriate for dynamic environments like the health sector. Since ANNs are black box algorithms, they are not very good at revealing its structural details. Furthermore, even if it can draw generalizations from a set of examples, its predictions may be wholly inaccurate if it only observes cases falling within a particular range.



2.3 Support Vector Machines (SVM)

SVM offers benefits, which are as follows, as stated by: Even in cases where the input data are not linearly separable, SVM theoretically generates accurate results for classification. Furthermore, the accuracy result is independent of the level of human experience in determining the linearization function to use for nonlinear input data. One drawback of SVM, as a non-parametric method noted by, is that its outcomes are opaque. According to, the largest restriction is related to the kernel selection. To get an accurate result for any work or issue, it must be set correctly. A kernel selection for job "A" that yields precise results might yield subpar results for task "B."

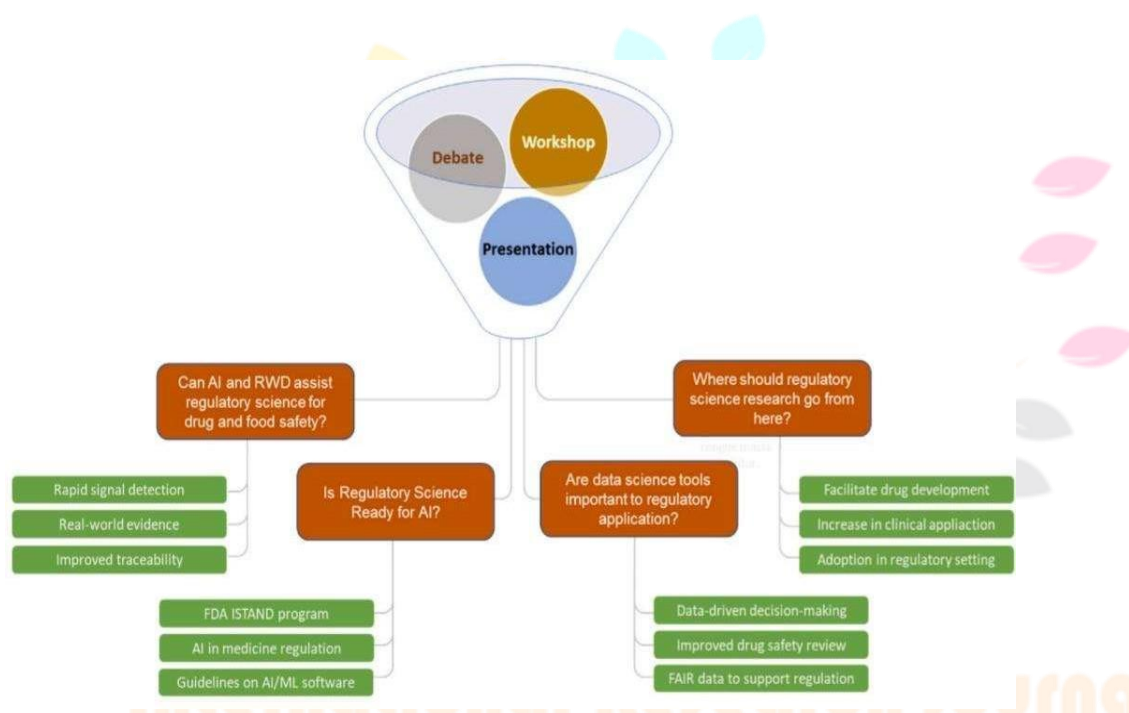


3. AI in drug safety

With members from more than ten countries, the Global Coalition for Regulatory Science Research (GCRSR) was founded in 2013 (www.gcrsr.net). Through the yearly Global Summit on Regulatory Science (GSRS) conference, one of the primary goals of GCRSR is to enable communication amongst international regulators regarding the emergence of new technologies with regulatory implications. "Regulatory Sciences for Food/Drug Safety with Real-World Data (RWD) and Artificial Intelligence (AI)" was the main topic of discussion at the 11th annual GSRS conference (GSRS21).

To address the four distinct subjects, GSRS21 used three distinct formats. A number of talks showcased cutting-edge RWD and AI research ideas and advancements. Furthermore, a workshop exhibited and/or showcased the instruments now employed by diverse regulatory bodies globally, followed by a discussion on the function of regulatory science in enhancing AI's preparedness for the regulatory landscape. The general conversation provided insight into the current state of artificial intelligence applications in the regulatory sciences, as well as the evolution and future prospects of these technologies.

Regulatory agencies like US-FDA are taking a very active role in facilitating AI's clinical applications. For example, US FDA has posted a list of more than 500 regulatory authorizations of AI/ML-enabled medical devices across many different medical disciplines.



4. AI in Quality Control and assurance

4.1 Quality control

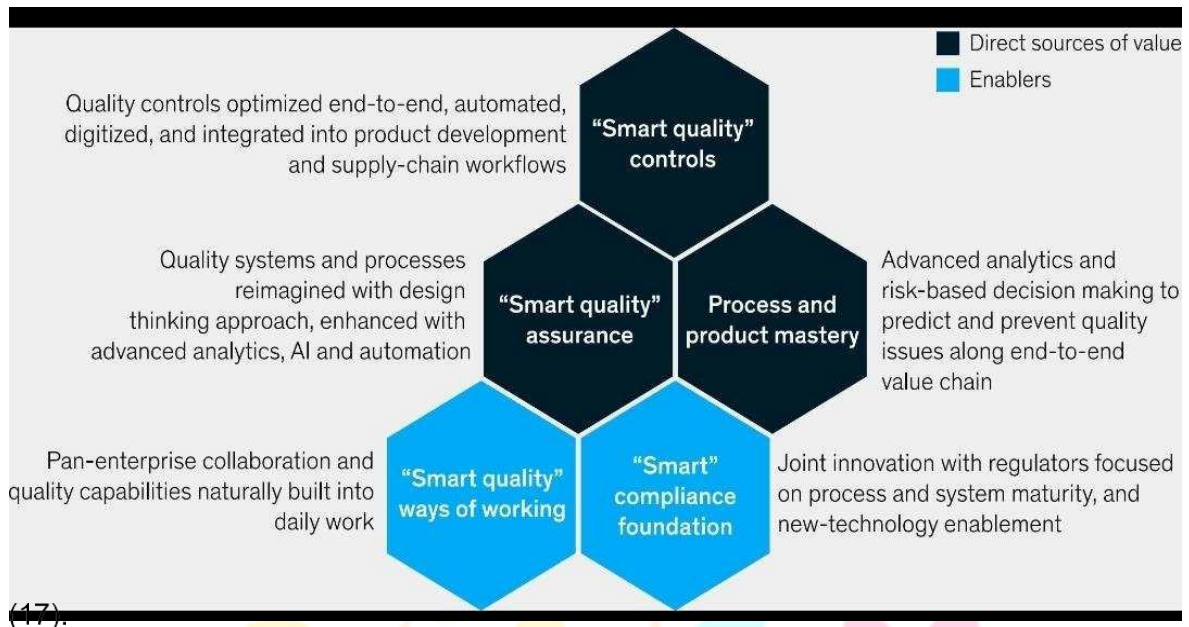
Artificial intelligence (AI) will enable quality control systems to get more advanced, able to identify even the smallest flaws and guarantee that strictest legal requirements are met. This will lessen the need for manual inspections while improving product quality and safety.

Automation tools can be used to monitor and regulate the production process, ensuring that the items are created in compliance with quality requirements. Real-time defect detection and error identification capabilities of automated quality control systems allow for timely repair.

4.2 Quality Assurance

For many years, the way pharmaceutical and medical technology firms handle quality assurance has been determined by external factors. It is still the regulatory requirements that have the most influence. Quality assurance methods and procedures have been shaped by both individual interpretations of regulations and comments obtained during regulatory inspections. At the same time, the landscape of quality management systems (QMSs) has become more complex and varied due to mergers and acquisitions, as well as the spread of various IT solutions and quality software. In the past, modernizing and combining outdated IT systems has proven to be too costly. Many quality teams have been accustomed to depending on off-the-shelf software's procedures and workflows without asking whether or not they truly meet their company's demands and the constantly changing regulatory standards, which is made more difficult by the lack of IT assistance.

The 'smart quality' approach consists of five building



5. AI in inventory management

Inventory management works hand in hand with the supply chain to achieve the objectives of efficient supply chains, cost control, and minimal delays in customer delivery.

Avoiding uncertainty is crucial for inventory management since they typically arise in lead time demand estimates. Since demand estimates are a key component of many operational decisions, they serve as the foundation for all planning operations.

DL and ML methods, sub-branches of AI, are increasingly being used in inventory management applications. These methods analyze large data sets, improve demand forecasting accuracy, and provide faster response times. Combining AI with inventory management offers lower operational costs, faster customer response times, and more contextual information. Researchers are exploring the potentials and weaknesses of these algorithms.

6. AI in patient counseling

ChatGPT (OpenAI) is a natural language processing model that uses artificial intelligence (AI) and sophisticated deep learning algorithms to generate text responses that resemble those of a human being in response to cues that the user generates. This tool can produce responses to intricate queries on a limitless range of topics rapidly, often remarkably, and precisely. Since its launch in November 2022, ChatGPT has attracted a lot of attention for its capacity to generate extraordinarily intelligent prompts for challenging questions, making it a fantastic tool for both personal and professional as well as commercial use.

For instance, a patient messages his dermatologist to ask whether, in light of his COVID-19 diagnosis, he should cease using bexarotene for the treatment of his cutaneous T-cell lymphoma. This question can be answered accurately using ChatGPT; naturally, the disclaimer states that the chatbot is "not authorized to give medical advice." An even better reaction is produced when the prompt is made more explicit, saying things like "cite scientific papers" or "be at a fifth-grade reading level."

Textbox 1. ChatGPT's response to a patient question regarding tdiscontinuation of bexarotene in the setting of active COVID-19 infection.

"If you have been diagnosed with COVID-19, it's important to talk to your doctor before stopping any medication. There is currently no scientific evidence suggesting that bexarotene should be stopped if you have COVID-19.

A study published in the Pharmacological Research journal found that bexarotene may have antiviral effects against COVID-19.(24) However, more research is needed.

In conclusion, if you have been diagnosed with COVID-19 and are taking bexarotene, it's important to talk to your doctor before stopping the medication. There is currently no scientific evidence suggesting that bexarotene should be stopped if you have COVID-19, and it may even have some potential benefits."

Conclusion

The use of artificial intelligence (AI) in pharmacy has the potential to revolutionize the industry in various ways, leading to improved patient outcomes, increased efficiency, and reduced costs. In conclusion, the integration of AI in pharmacy has the potential to transform the industry, leading to improved patient care, increased efficiency, and reduced costs. As AI technology continues to evolve, we can expect to see even more innovative applications in the future.

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