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# Review of Artificial Intelligence in Pharmacy

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**ABSTRACT**

Artificial intelligence (AI) has emerged as a promising technology with great potential for transforming various aspects of healthcare, including pharmacy practice. AI has the capability to optimize drug discovery and development, improve medication safety and management, enhance clinical decision-making, and personalize patient care. However, the adoption of AI in pharmacy practice faces several challenges and barriers that need to be addressed for its widespread implementation.

**Keywords:** Artificial intelligence [AI], Pharmacy, Machines, Artifical neural network.

## Introduction

AI is a branch of science that deals with intelligent machine learning, primarily through intelligent computer programs, which produces outcomes akin to how people pay attention. The current state of the pharmaceutical business is hampered by expensive and protracted drug discovery cycles as well as pricing pressure from Payers and Consumers. It is not enough to merely analyse drug development data; Pharma must also take note of the analytics in order to stay competitive. Artificial intelligence, yet another disruptive technology, is used to achieve this. AI innovations have recently had a significant impact on the healthcare industry, sparking a lively debate about whether AI doctors will ultimately take the place of human doctors.

Recent successful applications of AI in healthcare have been made feasible by the expanding availability of healthcare data and the quick development of big data analytic methods. Strong AI techniques can uncover clinically pertinent information buried in the enormous amount of data with the help of pertinent clinical questions, which can then help with clinical decision-making.

## Recent Trends

### Automation in Research and Development

The development of artificial intelligence is more recent. Although lab automation systems have been around since the 1990s, it has only been in the last few years that they have really taken off, thanks in large part to labs focused on high-throughput screening, combinatorial chemistry, automated clinical and analytical testing diagnostics, and large-scale biorepositories. Robotics and other technological advancements have made it possible to create a completely automated library.

### PAT (Process analytical technology)

PAT is another innovative development. This is crucial in assisting pharmaceutical firms to concentrate on ongoing innovation and be more creative to enhance their manufacturing procedures. This results in better product yields, better utilization, and less waste, which saves customers money.Instrumentation is just one aspect of PAT.In order to understand crucial process factors, it must be able to interact with and gather data from a variety of instruments and analyzers. It also needs to perform complex multivariable calculations and modelling.

### Computational fluid dynamics

With the aid of computational fluid dynamics, product designers can quickly and affordably compare various ideas.

The following problems can be resolved with CFD, allowing for quick and cost-effective analysis of different drug delivery designs using a 3D model of human physiology.

Animal experimentation has traditionally been used to assess drug discovery systems, but results are not thought to be adequately reliable when applied to humans, whose physiology, for example, can differ significantly from animals'. Because of this, it is frequently the case that significantly different doses are released from the same initial sample, making meaningful comparison difficult.

Drugs can be administered through a variety of different routes, such as subcutaneously, rectally, orally, nasally, and so on.

With the help of CFD, it is possible to simulate these routes and forecast how a drug will dissolve and be absorbed under specific conditions. [6]

### Pharmaceutical Applications

Artificial intelligence (AI) has significant applications in the pharmaceutical industry, revolutionizing drug discovery, development, and patient care. Here are some pharmaceutical applications of AI:

- **Drug Discovery**: AI is used to accelerate the drug discovery process by predicting the potential efficacy of drug candidates, optimizing chemical structures, and identifying potential targets for drug development. AI algorithms analyze large datasets of chemical compounds and biological data to identify promising drug candidates, which can save significant time and resources compared to traditional methods.
- **Drug Development:** AI helps in streamlining the clinical trial process by analyzing data from clinical trials, identifying patterns, and making predictions. This can aid in the selection of appropriate patient populations, optimizing dosages, and predicting adverse effects, leading to more efficient and cost-effective drug development.
- **Personalized Medicine:** AI can analyze large datasets, including genomic data, electronic health records, and patient-reported outcomes, to identify patterns and make predictions for personalized treatment plans. This can enable physicians to tailor treatments based on an individual's unique genetic makeup and medical history, leading to more effective and safer therapies.
- **Virtual Health Assistants**: AI-powered virtual health assistants or chatbots can provide personalized health information, answer patient queries, and assist with medication management. These virtual assistants can improve patient engagement, provide remote monitoring, and enhance patient education and adherence to treatment plans.
- **Drug Repurposing:** AI can analyze large databases of existing drugs and their known properties to identify potential new uses for existing drugs. This can accelerate the drug development process as repurposing existing drugs can bypass some of the time-consuming steps of drug discovery and development.
- **Supply Chain Optimization:** AI can optimize the pharmaceutical supply chain by predicting demand, optimizing inventory management, and reducing waste. This can lead to cost savings, improved efficiency, and better availability of medicines to patients.
- **Adverse Drug Reaction Prediction:** AI algorithms can analyze real-world data, including electronic health records and social media, to predict adverse drug reactions, which can help in identifying potential safety concerns of drugs and lead to improved patient safety.
- **Fraud Detection:** AI can be used to detect fraudulent activities, such as counterfeit drugs, in the pharmaceutical supply chain, helping to ensure the safety and authenticity of medications.
- **Image and Speech Recognition:** AI can aid in image and speech recognition for diagnosis and monitoring of diseases, such as cancer, through techniques like computer-aided diagnosis (CAD) and speech analysis. This can assist physicians in making accurate diagnoses and monitoring treatment response. [3] [5] [6]

## Artificial Neural Network

Artificial Neural Networks (ANNs) are a type of computational model that is inspired by the structure and function of the human brain. ANNs consist of interconnected nodes or neurons that process and transmit information to make predictions, recognize patterns, and learn from data. ANNs are widely used in various fields, including machine learning, deep learning, and artificial intelligence.

Artificial Neural Networks (ANNs) have found several applications in the field of pharmacy. Here are some examples:

- **Drug Discovery:** ANNs can be used in the early stages of drug discovery to predict the activity and properties of potential drug candidates. They can learn from large datasets of chemical structures, molecular properties, and biological activity data to identify molecules with desired pharmacological properties, such as drug potency, bioavailability, and safety. ANNs can help pharmaceutical companies save time and resources by narrowing down the search for potential drug candidates and reducing the number of compounds that need to be synthesized and tested.
- **Drug Formulation and Optimization:** ANNs can be used to optimize drug formulations by predicting the solubility, stability, and release characteristics of drugs in different dosage forms, such as tablets, capsules, and injections. By training on experimental data, ANNs can help optimize the formulation of drug products to improve their efficacy, safety, and patient acceptability.
- **Drug Interaction Prediction:** ANNs can be used to predict drug-drug interactions (DDIs), which occur when two or more drugs interact in the body, leading to changes in their pharmacokinetics or pharmacodynamics. ANNs can learn from large datasets of drug interaction data, including drug structures, dosages, and patient characteristics, to predict potential DDIs and assess their risks. This can help pharmacists and healthcare professionals in making informed decisions about drug therapy, avoiding adverse drug interactions, and improving patient safety.
- **Pharmacokinetics and Pharmacodynamics Modelling:** ANNs can be used to model the pharmacokinetics (PK) and pharmacodynamics (PD) of drugs in the body. They can predict drug concentrations in various tissues and organs over time, as well as their effects on biological targets, based on factors such as drug properties, dosages, and patient characteristics. PK/PD modelling using ANNs can help optimize drug dosages, dosing regimens, and treatment strategies, and can be useful in personalized medicine and individualized drug therapy.

- **Disease Diagnosis and Patient Outcome Prediction:** ANNs can be used for disease diagnosis and patient outcome prediction in pharmacy practice. By training on large datasets of patient data, including clinical and demographic information, ANNs can learn to predict the probability of disease occurrence, severity, or response to treatment. This can help pharmacists and healthcare professionals in making accurate diagnoses, developing treatment plans, and predicting patient outcomes.
- **Medication Adherence Prediction:** ANNs can be used to predict medication adherence, which is an important factor in the success of drug therapy. By analyzing patient data, including medication history, patient characteristics, and behavioral factors, ANNs can predict the likelihood of patients adhering to their prescribed medication regimens. This can help pharmacists and healthcare professionals in identifying patients at risk of non-adherence and developing interventions to improve medication adherence.
- **Drug Safety and Adverse Drug Event Prediction:** ANNs can be used to predict drug safety and adverse drug events (ADEs), which are unintended harmful effects of drugs. ANNs can learn from large datasets of drug safety data, including adverse drug event reports, electronic health records, and patient data, to predict the risks of ADEs associated with specific drugs or drug combinations. This can help pharmacists and healthcare professionals in identifying potential safety concerns, monitoring patients for ADEs, and implementing appropriate interventions to prevent or manage ADEs. [2]

## Challenges and Barriers

While the use of artificial intelligence (AI) in the field of pharmacy has great potential, there are several challenges and barriers that need to be addressed for its widespread adoption. Some of the main challenges and barriers include:

- **Data quality and availability:** AI models rely heavily on large and diverse datasets for training and validation. However, in the field of pharmacy, there may be challenges related to the quality and availability of data. Data may be fragmented, incomplete, or inconsistent, making it difficult to train accurate and reliable AI models. Additionally, there may be limitations in accessing relevant and comprehensive datasets due to issues such as data privacy, data sharing agreements, and regulatory requirements.
- **Ethical and legal concerns:** The use of AI in pharmacy raises ethical and legal concerns, such as patient privacy, data security, and consent. There may be challenges in ensuring that patient data is used in a responsible and ethical manner, and that proper consent is obtained for data collection and use. Compliance with regulatory requirements, such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States, and the General Data Protection Regulation (GDPR) in the European Union, adds complexity to the use of AI in pharmacy practice.
- **Interpretability and explainability:** AI models, including neural networks, are often considered as "black boxes" because they can be complex and difficult to interpret. The lack of interpretability and explainability of AI models in pharmacy practice can be a barrier to their adoption, as it may be challenging to understand and justify the decisions made by AI models. Ensuring transparency and explainability of AI models is important for building trust and acceptance among healthcare professionals and patients.
- **Regulatory and legal frameworks:** The regulatory and legal frameworks related to the use of AI in pharmacy practice are still evolving. There may be challenges in navigating the complex regulatory landscape and ensuring compliance with existing regulations, as well as anticipating and addressing potential future regulatory changes. The lack of clear guidelines and standards for the development, validation, and deployment of AI models in pharmacy practice can hinder their widespread adoption.
- **Technical challenges:** There are technical challenges associated with the development and deployment of AI models in pharmacy practice. These challenges include selecting the appropriate AI algorithms, optimizing model performance, handling large and complex datasets, addressing issues such as bias and fairness in AI models, and ensuring robustness and reliability of AI models in real-world settings. Overcoming these technical challenges requires expertise in AI, data science, and computational methods, which may be a barrier for some healthcare professionals.
- **Cost and resource constraints:** Implementing AI in pharmacy practice may require significant investments in infrastructure, technology, and expertise. There may be challenges related to the cost and resource constraints, especially for smaller pharmacies or healthcare settings with limited budgets and resources. The cost-effectiveness and return on investment of AI solutions in pharmacy practice need to be carefully evaluated to ensure their practical feasibility.
- **Change management and workforce readiness:** The adoption of AI in pharmacy practice may require changes in workflows, processes, and roles of healthcare professionals. There may be challenges related to change management, workforce readiness, and training to ensure that healthcare professionals are equipped with the necessary skills and knowledge to effectively use AI in their practice. Resisting to change and lack of readiness among healthcare professionals may pose a barrier to the adoption of AI in pharmacy practice. [4]

## Conclusion

In the recent years, there has been a noticeable increase in interest in the applications of AI technology for interpreting and analysing some key areas of pharmacy, such as drug discovery, dosage form design, polypharmacology, hospital pharmacy, etc. This is because AI technological approaches mimic how humans think about information, solve problems, and make decisions.

AI would benefit the world by finding a pharmacore for drug discovery & development to healthcare like ANN, CFD, & Robotics thanks to the advanced present challenges and futuristic direction. Insights from artificial intelligence can be used to more accurately describe patients and anticipated results. These insights are produced from real-world data.

It is advised that the government encourage public-private partnerships in the area of AI and health, support business investments in AI, enact laws and regulations pertaining to AI and health, effectively enforce those laws and regulations, develop policies addressing issues of confidentiality and privacy in AI-driven healthcare, and create a certification system for AI-based healthcare solutions.

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