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Artificial Intelligence in Pharmacy

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ABSTRACT:
Artificial intelligence (AI) is the field of computer science that specialises in the development of intelligent machines capable of doing jobs normally associated with humans [8]. It has emerged as a transformational technology, revolutionising a wide number of industries around the world. AI has enabled unprecedented levels of automation, efficiency, and decision-making by combining intelligent algorithms, machine learning (ML), and data analytics.
AI has come a long way in healthcare, having played significant roles in data, information storage and management – such as patient medical histories, medicine stocks, sales records, and so on; automated machines; software and computer applications like diagnostic tools such as MRI radiation technology, CT diagnosis and many more have all been developed to aid and simplify healthcare measures.Without a doubt, artificial intelligence has revolutionised healthcare, making it more effective and efficient, and the pharmaceutical business is no exception. In recent years, there has been a significant increase in interest in the application of AI technology for analysing and interpreting various essential areas of pharmacy, such as drug development, dosage form design, hospital pharmacy, and so on.
Keywords: Artificial intelligence, machine learning, pharmacy, pharmacist

I. INTRODUCTION

AI is a technique that enables machines to mimic human behaviour. AI has many abilities like:

- It can give reasons
- It discovers meaning
- It gives guidance towards any process
- It generalizes and learns from past experiences

AI works through various dimensions such as machine learning, deep learning, computer vision, NLP i.e natural language processing and RPA i.e robotic process automation.

AI technology is exercised to perform more accurate analyses as well as to attain useful interpretation. In this perspective, various useful statistical models, as well as computational intelligence, are combined in AI technology.

In pharmacy, AI is applicable in various areas such as Drug discovery and design, drug repurposing, precision medicine, clinical trial optimisation, supply chain and manufacturing, personalized medicines, drug formulations, medical image analysis, healthcare data security, pharmacology, drug treatment optimization.

Applications of AI

AI in Drug Discovery and clinical trials:

Drug discovery and bringing a new drug to the market is the prime objective of Pharmaceutical R&D, which is a very lengthy and costly affair. AI has the potential to ease the process, from target selection through to clinical trials of a drug. Drug discovery starts with the identification of target biological molecules that interfere in modifying the disease. In the drug discovery process, thousands of synthetic molecules are generated that could bind to the target and modify its activity for managing a particular disease. AI can help in target identification and compound screening. Computer-aided drug design, quantitative structure–activity relationship (QSAR) or quantitative structure–property relationships (QSPR), ADMET predictor, ALGOPS program, Chem Mapper, Deep Tox, eToxPred, TargeTox and PrOCTOR are the important tools in this process.

Clinical trials of a new molecule consume most of the time and budget of the drug discovery process, and AI has been used in improving the quality of trial design, patient selection, dose selection, patient adherence, trial monitoring and endpoint analysis. BNMs have potential application in clinical trial design and dose selection, whereas OCR and NLP provide an efficient method in patient identification and characterization. RBM, video monitoring and wearable sensors are cost-effective techniques in patient monitoring and patient adherence.

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- **Drug formulation and manufacturing:**

The development or creation of pharmaceuticals takes more than a decade and consumes billions of rupees. AI automates and optimizes manufacturing processes, reducing waste and improving production efficiency. AI-powered sensors and algorithms monitor product quality in real time, detecting defects or inefficiencies in the manufacturing process. AI systems predict machinery failures and maintenance needs, preventing production downtime

- **Drug treatment optimization**

Drug Treatment optimization is also possible with Artificial Intelligence. AI analyzes patient data to recommend optimal drug dosages tailored to individual needs. AI tracks patient data to monitor and predict side effects in real -time, allowing for timely intervention. It also suggests the most effective treatment pathways for patients based on their medical history and current health status. "Atomwise", an AI technology that uses supercomputers, is useful to find out the therapies from the database of molecular structure.

A Biopharma company in Boston developed big data for the management of patients. It reserves data to find the reasons why some patients survive diseases. They used patients' biological data and AI technology to find out the difference between healthy and disease-friendly atmospheric conditions. It helps in the discovery and design of drugs, healthcare, and problem-solving applications.

AI is also useful in predicting drug interactions, toxicity testing and molecular modelling. Drug repurposing can also be done with the help of AI as it identifies potential new uses for existing drugs by finding patterns in molecular structures and disease mechanisms. It also predicts how known drugs might interact with different diseases, suggesting repurposing opportunities. Machine learning models can analyse preclinical data to find new therapeutic potentials for existing drugs. Personalized medication is the area where AI can help. It works by genomic data analysis, treatment customization, and risk prediction models. AI is also helpful in diagnostics. AI tools analyse MRI, CT scans, and X-rays to detect diseases like cancer, heart conditions, and neurological disorders. AI enables precise segmentation of medical images, aiding in treatment planning and monitoring of disease progression. AI constructs detailed 3D models of internal body structures, aiding in complex surgical planning.

AI in Pharmacy practice:

Pharmacy practiceis an integral part of the healthcare system, which ensures safe and effective medication management and optimized patient care, through various activities such as medication reconciliation, medication review, medication therapy management (MTM), providing drug information, patient education, adverse drug reaction (ADR) monitoring and interprofessional collaborations.[7]Machine learning models allow emails to be personalized at a speed and accuracy greater than that of any human being. Chatbots can be used to increase the efficiency of service delivery. AI can also be useful in inventory management. Predicting the patient's drug purchase through AI will help the pharmacist to make proper stock procurement decisions. The incorporation of AI technologies provides pharmacists with tools and systems that help them make accurate and evidence-based clinical decisions. By incorporating AI into clinical practice, health care professionals can augment their decision-making processes and provide patients with personalized care. AI allows for greater collaboration between different healthcare services provided to a single patient. For patients, AI may be a useful tool for providing guidance on how and when to take a medication, aiding in patient education, and promoting medication adherence and AI may be used to know how and where to obtain the most cost-effective healthcare and how best to communicate with healthcare professionals, optimize the health monitoring using wearable devices, provide everyday lifestyle and health guidance, and integrate diet and exercise.

AI in hospital pharmacy:

AI-driven platforms streamline communications between pharmacists and clinicians by delivering real-time updates on patient medications, potential drug interactions, and dosage recommendations derived from integrated patient data. Such seamless integrations position pharmacists as essential members of healthcare teams, ensuring both patient safety and therapeutic effectiveness.

AI also plays a pivotal role in quality improvement. By identifying patterns in medication errors and adverse drug reactions, AI can offer insights into potential systemic issues, thus informing quality improvement strategies. For

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example, Google's AI has demonstrated its ability to predict adverse events in hospitals and formulate preventative measures, leading to enhanced patient safety and overall care quality. For example, in 2018, Google unveiled a significant advancement in cardiovascular disease (CVD) studies. Their researchers, harnessing machine learning techniques, crafted an AI model capable of estimating an individual's heart disease risk by examining the retina.

In patient education, AI plays a vital role, translating sophisticated medical advice into more digestible and comprehensible formats. Interactive chatbots, such as Buoy Health, offer personalized advice about medication usage, diet changes, lifestyle modifications, and treatment plans, fostering increased understanding and compliance.

Overall, AI can enable clinical pharmacists to concentrate their efforts on delivering superior, patient-centric care rather than on administrative duties, leading to improved patient outcomes and increased job satisfaction and professional fulfilment for pharmacists.

- **AI in community pharmacies**

AI promises to revolutionize community pharmacy practice, extending its impact beyond pharmacists' primary responsibilities.

Firstly, AI enhances supply chain management. AI algorithms can analyze a vast amount of data, including past sales, seasonality, local health trends, promotional activities, and even external factors like weather patterns or disease outbreaks, to predict demand for various medications. This helps pharmacies maintain an optimal inventory, minimizing stockouts (when high-demand items run out) and overstock (where items remain unsold, potentially expiring before being sold). Furthermore, AI automates the reordering processes to maintain optimal inventory levels. By monitoring stock levels in real-time and automatically generating purchase orders to replenish stocks when levels fall below certain thresholds, this technology can save staff time and help ensure essential medications are always readily available for purchase. AI tools can also evaluate suppliers based on factors like reliability, cost, delivery speed, and product quality.

Secondly, AI can improve Automated Dispensing Systems (ADSs). AI can significantly increase accuracy and precision in dispensing, learn from past errors, and employ machine learning algorithms for continuous system optimization. AI's capability to swiftly sort and label medications, anticipate maintenance needs, and tailor dispensing according to each patient's specifications will not only maximize operational efficiency but also foster personalized patient care. By integrating automated dispensing with other aspects of pharmacy management, such as inventory control and electronic health records, AI can further streamline medication processes from prescription generation to billing. AI's ability to cross-reference dispensed medication against patients' health records provides an extra safeguard, promptly alerting pharmacists of potential drug interactions or patient allergies, thus greatly enhancing patient safety. Automated dispensing gives pharmacists more time to engage with a greater volume of patients while also enhancing their health outcomes[4].

Thirdly, AI assists in advancing public health monitoring. AI systems can analyze large-scale health data sets to detect trends in disease outbreaks, drug usage patterns, and other public health issues that may require a response by pharmacists or public health organizations. For instance, AI could detect an upsurge in reported flu symptoms from certain regions through data parsing, subsequently notifying pharmacists in those regions about potential outbreaks. This will prompt them to stockpile antiviral medications, flu shots, and over-the-counter remedies in anticipation of increased demand. Furthermore, AI can aid pharmacists in tackling health equity challenges by analysing data such as pin codes, demographics, and medical histories. By correlating pin codes with socioeconomic indicators and health outcomes, AI can pinpoint areas with pronounced health disparities, offer tailored patient recommendations, and provide insights for specific policy actions. Such understanding can pave the way for more strategic and effective healthcare initiatives. For example, AI might pinpoint areas with high adult diabetes rates, which can inform the creation of educational programs, provision of complementary medications, or enhanced access to care for affected individuals.

Forth, AI helps in maintaining medical records. Maintenance of the medical records of patients is a complicated task. The collection, storage normalizing, and tracing of data are made easy by implementing the AI system. Google DeepMind health project (developed by Google) assists to excavate the medical records in a short period. Hence, this project is a useful one for better and faster health care.

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II. CONCLUSION

AI is a technique that enables machines to mimic human behaviour due to its multitude of abilities. AI is helping in reducing the timeline as well as cost cutting in the drug discovery process. The parameters such as quality of trial design, patient selection, dose selection, patient adherence, trial monitoring and endpoint analysis in clinical trials are being boosted by AI. AI is automating and optimizing pharmaceutical manufacturing processes and reducing waste. Personalized emails and chatbots are helping in the pharmacy practice field. AI is seamlessly integrating the position of pharmacists in hospital pharmacy as essential members of healthcare teams, ensuring both patient safety and therapeutic effectiveness. In community pharmacy, AI algorithms analyze a vast amount of data, including past sales, seasonality, local health trends, promotional activities, and even external factors like weather patterns or disease outbreaks, to predict demand for various medications. This helps pharmacies maintain an optimal inventory.

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