

Artificial Intelligence and Digital Applications in Pharmacy: Reality and Future Trends in Improving Healthcare and Enhancing Patient Experience

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ABSTRACT

The use of digital technologies and artificial intelligence has led to the development of healthcare systems. In the field of pharmacy, these technologies have proven effective in improving drug development, increasing patient adherence to treatment, managing clinical trials, and facilitating the process of providing medications to patients anytime, anywhere. The emergence of personalized medicine has also accelerated transformations in the pharmacy profession, especially after the Covid-19 pandemic, as digital transformation efforts in this sector have accelerated. This study reviews the reality of the use of artificial intelligence and digital applications in pharmacy, focusing on common applications such as drug screening, dosage management, and big data analysis. In addition, the research addresses the challenges associated with the use of these technologies such as data privacy issues, consent, and the need to continuously update databases. Finally, the future opportunities available for artificial intelligence in improving healthcare services through automation, data analysis, and personalization of treatments to suit patients' needs are reviewed.

Keywords: Artificial Intelligence, Pharmacist, Healthcare, Patient care

Introduction:

The world has witnessed a global shift towards artificial intelligence in the field of healthcare, as it has proven its effectiveness in helping develop and simplify drugs, improve patient adherence to treatment, deliver drugs anytime and anywhere, and increase the efficiency of clinical trials [1].

Pharmacy has been witnessing rapid transformations since personalized medicine has become the standard in healthcare [2]. Many efforts have been invested in developing new technologies to serve pharmacy as a profession, and the Covid pandemic in 2019 came as an extraordinary accelerator for these efforts and the growth of digital health [3]; however, the pharmaceutical sector has grown more after recent developments in the field of artificial intelligence and the huge investment in it by countries and companies, which calls for the attention of pharmacists to focus on the advantages of digital applications and artificial intelligence in pharmacy [4,5]. Artificial intelligence is defined as the ability of machines to simulate intelligent human behavior with its many applications in the field of healthcare [6].

Common applications of artificial intelligence include computer screening and disease target identification, drug formulation development, drug dosing error management, and clinical trial management [4]. Moreover, the algorithms on which artificial intelligence and digital applications are based allow for the examination of drug interactions and thus enhance health outcomes [7,8].

In terms of patient care, digital technologies and artificial intelligence have facilitated the healthcare process, ordering and delivering medication to patients, and obtaining online pharmacy consultations with pharmacy specialists [9], as well as supporting patients' commitment to regular medication without direct pharmacist supervision with the help of augmented reality (AR) technologies [10]. Despite the many opportunities that come with emerging technologies, there are many challenges that must be taken into account in the use of artificial intelligence and digital applications in pharmacy, such as data confidentiality [11], increased costs, and others [4,12].

Therefore, the aim of this review is to explore the reality of using artificial intelligence and digital applications in pharmacy and their importance in enhancing healthcare, as well as reviewing the advantages and challenges and thus coming up with recommendations on the use of this technology in pharmacy.

What is artificial intelligence in pharmacy?

Artificial intelligence in pharmacy is about using advanced algorithms and machine learning techniques to improve processes from drug discovery to medication administration [5]. AI can help pharmacists deliver more efficient and effective care, leading to improved patient outcomes. AI can automate routine tasks like inventory management and data entry, freeing up pharmacists to focus on what really matters [13]. In patient care, AI tools that alert to potential drug interactions and improve prescription accuracy are helping [14].

AI in pharmacy is transformative. It's a tool that supports pharmacists, makes our jobs easier, and improves the care we deliver. By embracing AI, we can improve operational efficiency, enhance patient safety, and deliver more effective care all while preserving the human element that makes our profession so valuable [4,15].

Pharmacy practice

In healthcare systems, pharmacy practice is an important part of healthcare and plays a pivotal role in promoting patient health. Pharmacy practice includes safe medication

administration, medication review, drug compatibility, medication therapy management (MTM), medication information, and patient education [16]. The spread and evolution of infectious diseases has led to the complexity of drug regimens and prescriptions and increased administrative tasks. Therefore, there is a need to employ digital technologies and artificial intelligence in pharmacy practice to enhance the practice of the profession and the provision of medical services to patients [5]. The integration of artificial intelligence technologies provides pharmacists with tools and systems that help them make accurate, evidence-based clinical decisions. Using artificial intelligence and machine learning algorithms, pharmacists can quickly analyze large amounts of patient data, including medical records, laboratory results, and medication profiles. This allows them to identify potential drug interactions, assess the safety and effectiveness of medications, and provide recommendations to patients [5,17].

The role of artificial intelligence in pharmacy practice

Review prescriptions and determine treatment plan:

A recent systematic study indicates that the majority of AI applications currently being studied in the field of pharmaceutical services were developed to review prescriptions, as these applications analyze the prescribed medication and its relationship to the diagnosis and have the ability to audit the doses written by the doctor, and other drug conflicts, due to the fact that reviewing prescriptions is the first historical task of the pharmacist [18].

AI experts use various medical databases to train the machine, and this study showed that the algorithms outperformed traditional systems in their ability to detect problems related to medications, but they are still unable to replace the expertise of pharmacists, due to the emergence of results of recent research that have not yet been included in the databases used, which, despite their scarcity, can change the method of medical intervention on the patient [4]. The quality and accuracy of the data used to train the algorithms is a pivotal point, and updating the databases continuously to this day remains a challenge. On the other hand, most of these models were trained using data from only one center, and we cannot currently adopt or generalize them without conducting a prior study on the target sample to verify their conformity and credibility [19].

Mediaware Solution is an AI program based on machine learning approach and detecting medication errors by identifying statistically abnormal prescriptions, as many studies have indicated the program's ability to detect medical errors that current systems could not identify [20,21]. It is worth noting that the program allows the doctor to be notified directly and the prescription to be modified without referring to and interacting with the pharmacist. One of the companies trying to invest in this field is Arine, which launched a platform that provides pharmacists with the necessary data to provide comprehensive patient care services such as medication therapy management (MTM), health consultations for patients to modify their lifestyle, and remote healthcare coordination [16].

Medical Records Maintenance:

Artificial intelligence tools facilitate the process of managing and maintaining patients' medical records, as they collect, analyze, and store data, and can be tracked using artificial intelligence tools. The literature indicates the importance and role of blockchain in protecting medical and insurance records from unjustified interventions [22]. One of the modern applications that rely on artificial intelligence is "Google Deep Mind", which is being developed by Google, which contributes to managing medical records and the ability to extract data in record time, which contributes to enhancing the quality of healthcare for patients [23].

Big Data Analysis:

AI can analyze the vast amounts of data available in the pharmaceutical sector, including clinical data, clinical trials, and scientific studies. This data can be used to improve understanding of diseases, develop new treatments, and improve healthcare in general [24].

Clinical decision support:

AI can help doctors and pharmacists make informed clinical decisions, by analyzing clinical data and providing accurate recommendations to doctors on disease diagnosis, treatment, and appropriate drug dosages. *IBM Watson for Oncology*, a software-as-a-service, is a cognitive computing decision support system that analyzes patient data against thousands of historical cases and provides insights and treatment options to help oncologists make informed decisions [5].

Drug creation:

The process of creating and developing drugs requires complex processes that consume time and money. AI tools provide the process of developing drugs *Boston-based Biopharma* has developed big data for patient management. It keeps the data to find out why some patients survive diseases. They have used biological data of patients and AI technology to figure out the difference between healthy and disease-friendly weather conditions, helping in drug discovery and design, healthcare and problem-solving applications [5].

Monitoring the level of therapeutic drugs:

Artificial intelligence technologies help monitor the level of drugs in the blood, as artificial intelligence has the ability to monitor the level of drugs in the blood and suggest appropriate doses based on less information than currently applied, and Bayesian statistics programs combine previous research data with current patient information to create an accurate prediction and provide appropriate recommendations regarding the dose for each patient, and there are many companies that provide these programs for a large fee, such as those provided by Stanford University, but recently free options have appeared such as the *ClinCalc* program and the *VancoCalc* program, and many studies have been conducted on them to improve their accuracy and reliability, and what makes these applications a technological revolution in themselves

is their ability to predict the appropriate dose from only one to two blood samples, which reflects their importance in financial and labor cost files [25].

Challenges of using technology and artificial intelligence in pharmacy

Despite the advantages that technology and the use of artificial intelligence in the field of pharmacy bring, it also faces challenges such as [26,27]:

- **Data Quality:** The effectiveness of using AI depends on the quality of the data used, which requires accurate, comprehensive, and reliable data.
- **Data Privacy:** Health data can be sensitive and private and requires strict security measures to protect it from unauthorized access or illegal use. There may be concerns about maintaining patient privacy and maintaining the confidentiality of their medical data.
- **Trust and Acceptance:** There may be a challenge in accepting AI as a tool in the field of pharmacy. Doctors, pharmacists, and patients may find it difficult to trust and fully rely on AI recommendations.
- **Legislation and Regulations:** There are strict laws and regulations governing the pharmacy sector and the use of health data. It is important to ensure that the use of AI follows these laws and regulations and that it respects patient rights and medical ethics.
- **Lack of Skills and Training:** There may be a lack of skills and training necessary to use AI in the field of pharmacy. Its effective and safe application requires specialized training and high technical skills.
- **Legal Liability:** The use of AI in the pharmaceutical industry raises legal questions and liability issues. Ensuring a clear legal framework is required to define responsibility and rights in this context.

These challenges must be well addressed to ensure that the potential of AI to improve patient care and advance pharmacy is fully exploited.

Future trends for the AI of in the pharmaceutical sector

Future trends in the use of AI in pharmacy are constantly increasing due to the impact of digital technologies on healthcare delivery. AI can manage huge amounts of data, manage medical records, and launch e-health programs, which contributes to telemedicine and improving community health.

In pharmacy, AI has tremendous potential as it offers many benefits that can significantly enhance efficiency and patient care. AI helps automate routine tasks, as pharmacies can automate critical processes such as processing prescriptions, checking drug interactions, and managing inventory, and also reduces the possibility of human error, thus increasing the overall efficiency of pharmacies [28].

Moreover, AI can play a pivotal role in personalized medication management. Especially for patients with chronic diseases, digital technologies and AI help monitor patient monitoring continuously, provide timely reminders to take

medications, and dynamically adjust treatment plans based on individual health data [29]. This personalized management ensures that patients receive optimal care tailored to their specific needs, which may improve treatment outcomes. The integration of AI into electronic health records represents another important advancement. By integrating AI with electronic health records, healthcare providers can access real-time patient data. This integration enables healthcare professionals to make more informed care decisions, improving the quality of patient care [30]. Furthermore, it significantly reduces the likelihood of medication errors, a critical issue in healthcare.

Conclusion:

The impact of AI in pharmacy has been evident in bringing about radical transformations and advanced innovations in this sector by enhancing the accuracy and speed of drug discovery, improving the clinical trial stages to develop drug manufacturing processes, supporting pharmacists in making accurate clinical decisions, improving drug safety, and increasing efficiency in daily operations. These technologies can enhance the effectiveness of patient care. Despite the significant challenges facing the use of these technologies, such as data quality and privacy, the future holds many opportunities to improve healthcare. It is important that research and development in this area continues to ensure the seamless integration of digital technologies into pharmacy while maintaining ethical and regulatory standards. Ultimately, AI can radically transform how healthcare is delivered, contributing to improved patient outcomes across the board.

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