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APPLICATIONS OF AI IN THE HEALTH CARE SERVICES AND ITS GLOBAL IMPACT ON ONLINE PHARMACY PLATFORMS

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ABSTRACT

An overview of the technology and its potential applications is provided in this article. In addition, this paper will examine how artificial intelligence technologies are currently used in computer games, accounting databases, medical image classification, hospital inpatient care, network intrusion, power system stabilisation (PSS) design, medical are a medicine, and to protect computer and communication networks from intruders. The rapid advancement of artificial intelligences, digital technologies is transforming the pr sector, redefining drug discovery distribution and patient care. Develop In many capacities, intelligent machines will eventually replace or improve human talents. The intelligence displayed by software or robots is known as artificial intelligence. It belongs to the domain of computer science. The study of artificial intelligence is growing in popularity among computer scientists since it has greatly improved human lives in many ways. The performance of the industrial and service systems has significantly increased over the last 20 years because to artificial intelligence. Artificial intelligence research has spawned the expert system, a fast-expanding technology. Expert systems, a type of application of artificial intelligence, are frequently employed nowadays to tackle complicated issues in a variety of industries, including science, engineering, commerce, medicine, and weather forecasting. The quality and efficiency have increased in the sectors using artificial intelligence.

Review on: Artificial Intelligence (AI) IN Pharmacy

KEYWORDS: Artificial Intelligence, Robotics, Components, global impact, Drug discovery, online pharmacy platforms

INTRODUCTION

Recently, AI technology becomes a very fundamental part of the industry for useful applications in many technical and research fields. Reflecting on the past 25 years, pharmacy has done a great job of addressing the growing demand for prescriptions, even when faced with pharmacist shortages, growing operating costs, and lower reimbursements. Pharmacy has also done a great job of leveraging enabling technology automation to improve workflow efficiency and lower operating costs while promoting safety, accuracy, and efficiency in every pharmacy setting. Automated dispensing gives pharmacists more time to engage with a greater volume of patients while also enhancing their health outcomes[4].

The first application of a computer in a pharmacy presumably dates back to the 1980s and since then, computers have been utilized in everything from data collection, retail pharmacy management, clinical research, drug storage, pharmacy education, clinical pharmacy, and lots more, and with the emergence of artificial intelligence, there is no telling just how much the Pharmacy sector will evolve in the long run.

There have been several expert systems developed in medicine to assist physicians with medical diagnosis[5]. Recently, several programs focusing on drug therapy have been described[6]. They guide drug interactions, drug therapy monitoring, and drug formulary selection. There are many aspects of pharmacy that AI can have an impact on and the pharmacists to consider these possibilities because they may someday become a reality in pharmacy practice.

The purpose of this article was to review topics related to AI. The topics include AI general overview and classification, AI uses in hospitals, the pharmaceutical industry, and retail pharmacies and to create awareness for AI as a component of pharmacy practice in the future, to encourage pharmacists to embrace this advancement, and as much as possible put in the effort to acquire the relevant skills, which will enable pharmacists to contribute towards the much-envisaged development.

AI general overview

The term AI (also known as machine intelligence) is very commonly confused and used interchangeably with robotics and automation. While robotics is simply the creation of machines that can carry out difficult repetitive tasks, AI refers to the exhibition of human-like behaviours or intelligence by any computer or machine [7]. Traditionally, robots were not built to possess these “intelligent capabilities” even though they may be able to move or carry objects independently using a designed program and surface sensors in a process known as automation. AI, in essence, is the field of computer science that specializes in the creation of intelligent machines, developed with the ability to perform tasks that will ordinarily be associated with a human being[8].

AI is frequently applied to the development of digital computers or computer-controlled robots with the capacity to autonomously execute intellectual and cognitive human-like processes. Such intellectual and cognitive processes include learning, reasoning, problem-solving, perception, and language. The form of AI currently in use today is referred to as narrow AI or weak AI because it is only designed to perform narrow tasks like internet search, facial and voice recognition, controlling and driving cars, and so on. However, the long-term goal of the AI community is to have machines that can autonomously outperform humans’ at all cognitive tasks. The AI that involves creating machines that can perform all human cognitive tasks will be the general AI or Strong AI (ADI)[9].

In simple terms, AI refers to the ability of machines and computers to think, act, behave and function as human beings. Familiar examples of AI-controlled systems include Apple’s SIRI (in iPhone)[10], Amazon’s Alexa[11], and the self-driving cars of Google, Mercedes, BMW, and Tesla to name a few[12]. The core of AI can be Knowledge Engineering, in which machines are assembled with access to abundant data and information relating to the human world, which enables them to be able to mimic human behaviour. Machine Learning is another type of AI, which involves the use of algorithms and statistical models to improve the accuracy of software applications in predicting outcomes without being distinctly programmed. It was established based on the idea that machines can learn from data, identify problems and make decisions with minimum human help or intervention. Applications of machine learning include self-driven Google cars, fraud detection, and online recommendation offers like those on Amazon and Netflix[13].

The global impact of online pharmacy platforms

In recent years, the landscape of pharmacy practice and education has undergone a significant transformation, driven by technological advancements and catalyzed by the global COVID-19 pandemic. A study highlighting the increasing consumer trust in online medication purchases pre, during, and post-pandemic reveals a shift in consumer behaviour towards online pharmacies [14]. This trend underscores a greater reliance on these platforms, where the perceived benefits significantly outweigh the perceived risks, indicating a positive reception and growing trust in digital healthcare solutions.

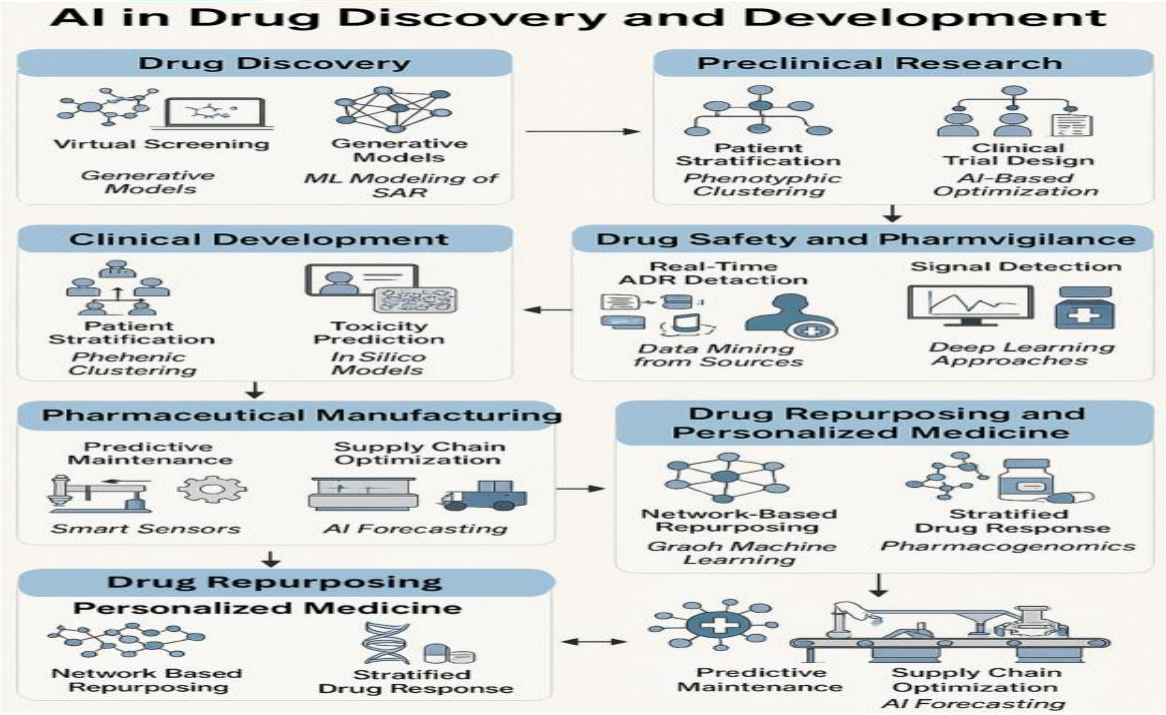
The adoption of telehealth including telepharmacy, exemplifies this shift. In the United States, patient adoption of telehealth services surged from 11% in 2019 to 46%, with healthcare providers expanding their telehealth visits [15]. This shift is a reflection of how adaptable the healthcare sector is to digital

platforms and how customer acceptance is increasing. The epidemic has also served as a catalyst, hastening the creation and uptake of online telepharmacy services throughout the world. The "new normal" has forced the addition of new platforms to support established sources of health information. The creation and evaluation of an online telepharmacy service in the Philippines during the pandemic serves as an example of this, demonstrating how quickly the global pharmacy industry adopted digital solutions. These services are essential for providing and elucidating pharmaceutical information within the context of primary healthcare delivery; they are not merely supplementary [16]

Artificial intelligence and Robotics

Robotics and artificial intelligence have a shared origin and a long history of interaction and scholarly debate One may counter that not all machines are robots, and that artificial intelligence is definitely interested in virtual agents. Robots are produced as hardware and artificial intelligence is a hypothesis. The two are related because a software agent that receives data from these sensors, decides what to do next, and then directs the actions to be taken in the real world is what controls the robot. It is widely used in robotics.

These case studies underscore AI's versatility in addressing diverse ligand-target challenges, from de novo design to repurposing, while emphasizing the need for experimental validation to mitigate overfitting risks in AI models (Fig. 1).



Computational pharmacology and cheminformatics form the backbone of AI-driven drug discovery, enabling systematic analysis of chemical data, predictive modelling , and high-throughput virtual screening. By leveraging robust software libraries and advanced algorithms, researchers optimize drug candidates for efficacy, safety, and manufacturability. This section explores data curation strategies, quantitative structure-activity relationship (QSAR) modelling , and the computational tools powering modern insilico pipelines.

Data curation and feature engineering with RDKIT'S and Open label

High-quality data curation is critical for training reliable AI models. RDKIT, an open-source cheminformetics toolkit, facilitates the conversion of chemical structures (e.g., SMILES strings) into machine-readable formats, computes molecular descriptors (e.g., log P, polar surface area), and generates molecular fingerprints for similarity searching [19]. Open Babel complements RDKIT by enabling format interoperability (e.g., SDF to PDBQT) and preprocessing tasks like protonation state optimization for molecular docking [20].

Feature engineering in cheminformatics involves extracting physicochemical, topological, and electronic properties relevant to bioactivity. For instance, RDKIT'S Mordred modulo calculates 1826 molecular descriptors, while graph-based representations (e.g., molecular graphs with atom/bond features) are increasingly used in graph neural networks (GNNs) [21]. Challenges include handling stereochemistry, tautomerism, and data imbalance, necessitating rigorous standardization pipelines.

Digital transformation in global healthcare

The recent advancements in digital transformation within global healthcare are significantly reshaping the landscape of healthcare and pharmacy services. These transformations are largely driven by the integration of digital technologies, which are redefining the tools and methods used in health, medicine, and biomedical science, ultimately aiming to create a healthier future for people worldwide [22]. In a 2018 report [23], Amazon's potential entry into the $500 billion U.S. pharmacy market, the second-largest retail category, through mail-order and online pharmacies was highlighted as a significant industry disruptor. With licenses in at least 12 states in the US and a strategy focused on bypassing middlemen, Amazon's historical success positions it to transform the pharmacy landscape, promising enhanced efficiency and cost savings for consumers.

One of the critical areas identified in recent research is the establishment of five priorities of e-health policy making: strategy, consensus-building, decision-making, implementation, and evaluation. These priorities emerged from stakeholders' perceptions and are crucial for the effective integration and adoption of digital health technologies [24]. This holistic approach is increasingly relevant for scholars and practitioners, suggesting a focus on how multiple stakeholders implement digital technologies for management and business purposes in the healthcare sector [25]. The deployment of technological modalities, encompassed within five distinct clusters, can facilitate the development of a digital transformation model. This model ensures operational efficiency through several dimensions: enhanced operational efficacy by healthcare providers, the adoption of patient centred methodologies, the integration of organizational factors and managerial implications, the refinement of workforce practices, and the consideration of socio-economic factors [25].

Studies focusing on value creation through digital means suggest healthcare as a consumer-centric realm ripe for center-edge transformations, characterized by self-service and feedback cycles. These transformations are vital in addressing inherent tensions between patients and physicians, steering the focus towards value co-creation and service-dominant logic [26]

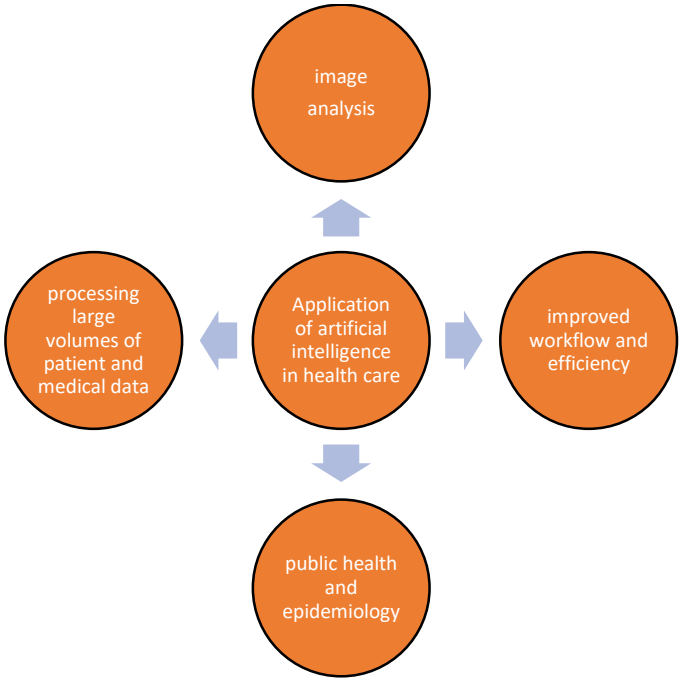
APPLICATIONS OF AI IN HEALTHCARE

The healthcare business uses medical artificial intelligence applications in the ways listed below.

Al for Drug Discovery:

Pharmaceutical businesses have been able to accelerate their drug discovery process with the use of Al technologies in healthcare. On the other hand, it automates the process of identifying targets. In addition, Al in healthcare 2021 supports medication repurposing by analysing off-target chemicals. [27]As a consequence, Al drug development accelerates the procedure and minimises repetitive work in the Al and healthcare industries.[28]

There are several treatments that top biopharmaceutical firms have developed. Pfizer is using IBM Watson, a system based on machine learning, to assist it in finding immuno-oncology therapies.. [29] It has been utilised specifically for signal and image processing, as well as for making predictions about changes in function, including bladder control, epileptic seizures, and strokes [30]



Public health and epidemiology are a third advantage of Al for healthcare. Al can help identify infectious epidemics of diseases including influenza, dengue fever, TB, and malaria. Zika virus and the current COVID-19 pandemic transmission patterns have both been predicted using artificial intelligence (Al).

Al in clinical practice:

Data collection, storage, normalisation, and tracing are significant uses of Al in the healthcare industry. Deep genomes searches for mutations and connections to the disease by identifying patterns in massive databases of genetic data and medical records.[31] A new generation of computational methods is being developed to show doctors what will happen within a cell when genetic variation, whether natural or therapeutic, modifies the DNA.

Clinical trials for the development of drugs can often last more than ten years and cost billions of dollars.[32,33]

Al in diagnosis and targeted genomic treatments

Al is used in hospital-based health care systems in a variety of ways, including arranging dose forms for particular patients and choosing appropriate or available administration methods or treatment plans[34,35]

Accuracy of medicine:

The influence of Al on genetic evolution and genomics is positive. Advanced Genomics [36] An Al system is effective for identifying patterns in genomic data and medical records that point to disease-causing mutations and connections. This technique provides clinicians with information on what happens within a cell when genetic variation modifies DN...

Beyond text, hybrid systems combine signal processing with NLP: wearable device data (e.g. ECG, gait sensors) can feed deep learning models to flag acute events, which are then corelated with patient notes for causality assessment. Multi-modal AI can also integrate imaging and lab data: one study used convolutional neural networks on in-hospital monitors to predict intra operative adverse events in real time [37]. Although social media mining raises noise and validation challenges, it offers complementary surveillance; for instance, models detected “patient-perceived” side effects missed in formal reports [38].

Primary care facilities and health worker engagement and support

Strong community-based integrated primary health care (PHC) is one of the cornerstones of UHC, quality of care, and improved health outcomes. Yet in LMICs, primary health care facilities often lack the necessary human and material resources to operate adequately.Citation[39]Health care workers (HWs), especially in LMICs, grapple with many challenges, including fragmented programming, lack of

continuous performance assessment, and the overwhelming task of managing diverse patient needs with limited resources. In addition, many LMIC health systems struggle to ensure that HWs are trained , supervised, and equipped to provide quality care.

Digital tools can support HWs and PHC facilities by offering guidance on clinical processes and connecting them to patients and peers. They can also be used for continuous capacity building and professional development, operational tasks (such as appointment management and referrals), the provision of required tests and medicines, and stock management. Use of patient management and clinical decision support tools can also facilitate reporting and promote adherence to established clinical guidelines and efficient resource allocation.

Examples of tools that are already being used by HWs and facilities are : CHARM Citation [40] (Client & Community Health Assisted Resources for Mentors), a job aid used by Mothers2mothers' mentor mothers in Angola, Ghana, Kenya, Lesotho, Malawi, Mozambique, South Africa , Tanzania , Uganda and Zambia; Life bank Nerve App Citation [41] which allows hospitals and clinics in Nigeria to conveniently order blood, oxygen and medical consumables online) ; Ilara Health's HMIS Citation [42] (Health Management Information System), a digital tool for streamlining clinic operations in Kenya via guided consultations, electronic health records, patient billing and inventory management; Global Strategies' Novi Guide, Citation [43] a neonatal care clinical decision support software available worldwide; and Maternity Foundation's Safe Delivery Application [44–46] which is a capacity building and job aid for skilled birth attendants, available worldwide with a generic version with additional language and context-specific versions for multiple countries.

The primary aim of health-related AI applications is to analyze relationships between prevention or treatment techniques and patient outcomes. AI programs have been developed and applied to practices such as diagnosis processes, treatment protocol development[47], drug development[1], personalized medicine[48], and patient monitoring and care[49], among others. As the quality of care offered for patients continues to grow in prominence, here are some ways pharmacies can leverage the continued technology explosion to impact value-based outcomes. As the most accessible and affordable healthcare stakeholder, pharmacies can become health managementcenters instead of only medication fulfillment locations. Technology can help provide more personalized healthcare offerings including advice, guidance, and an expanded suite of services (e.g., immunizations, screenings, MTM, disease state management). Health trackers and wearable will be able to provide real-time capture of data that can enable pharmacy to follow up with at-risk patients on their conditions and monitor their quality of improvement [50].

AI can be of real help in analyzing data and presenting results that would support decision making , saving human effort, time, and money, and thus helps save lives. Medical and technological advancements that have helped the healthcare related development of AI include the overall evolution of computers , resulting in faster data collection and more powerful data processing , Growth in the availability of health-related data from personal and healthcare-related devices and records, and the development of pharmacogenomics and gene databases, Expansion and industry adoption of electronic health records and natural language processing and other advancements in computing that have enabled machines to replicate human certain processes [51].

In the physician space, AI from technology companies like Microsoft is breaking into the healthcare industry by assisting doctors in finding the right treatments among the many options for cancer. Capturing data from various databases relating to the condition, AI is helping physicians identify and choose the right drugs for the right patients[52, 53]. In the pharma space, AI is working with researchers to support the decision-making processes for existing drugs and expanded treatments for other conditions, as well as expediting the clinical trials process by finding the right patients from several data sources [1, 54, 55]. Pharma is even working to predict with certain accuracy when and where epidemic outbreaks might occur, using AI learning based on a history of previous outbreaks and other media sources.

In the hospital space, AI is being used to prevent medical errors and reduce hospital readmissions. By analyzing patient data from medical and medication errors, readmission root causes, and other internal and external databases, AI will one day identify and prevent high-risk patients from developing

complications, and provide prospective care guidance, and diagnostic support, among many other clinical applications. Additionally, AI will be useful in workflow optimization and efficiency, helping eliminate redundancy in cost from duplicate or unnecessary procedures[56, 57].

CONCLUSION

Due to the complex current problems and promising future, Al would aid the world by identifying a pharmaceuticalcore for medication research & development to healthcare such ANN, CFD, & Robotics, Artificial imelligenceinsiglits may be utilised to more precisely define patients and expected outcomes. These conclusions were drawn using facts from the actual world. Because of this, artificial intelligence has opened up enticing opportunities for pharmaceutical firms that are developing a new generation of computational tools that can tell doctors what will happen within a cell when DNA is altered by genetic variation. We should be able to go forward while being aware of and understanding the repercussions of every technological advancement. We should welcome this change and accept it by using Al and striving toward a better society since, in my opinion, we are living in the era of Al revelation.

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