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# ARTIFICIAL INTELLIGENCE IN THE PHARMACEUTICAL INDUSTRY: APPLICATIONS, FUTURE OF CLINICAL PHARMACY CHALLENGES AND TECHNOLOGY DRUG DELIVERY DESIGN

**Adarsh Pratap Singh[1], Sandeep Prakash*[1], Saurabh Kumar[1], Neha Gautam[1], Firdous Bano[1], Harshit Gupta[1], Lavkush Maurya[1], Sandeep Kumar[1], Sneh Lata[1], Ajay Kmar[1]**

*[1]DKRR Pharmacy Shikshan Sansthan Sitapur Uttar Pradesh India.

***Corresponding Author: Sandeep Prakash**

DKRR Pharmacy Shikshan Sansthan Sitapur Uttar Pradesh India.

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## ABSTRACT

Artificial intelligence (AI), machine learning (ML), and deep learning (DL) are gaining increased interest in many fields, into pharmaceutical Research has catalyzed transformative advancements across drug discovery, clinical development, manufacturing, and postmarket surveillance. This review comprehensively examines AI's role in modern pharmacotherapy, beginning with its historical evolution in life sciences and progressing to cutting-edge applications such as AlphaFolddriven protein modeling, natural language processing (NLP) for biomedical literature mining, and AIaugmented pharmacovigilance. Methodologically, we synthesize interdisciplinary insights from peer-reviewed literature (2013–2026), highlighting innovations in cheminformatics (e.g., QSAR, RDKit), predictive toxicology, and personalized medicine. Case studies illustrate AI's capacity to compress drug development timelines, as seen in COVID-19 repurposing efforts and de novo kinase inhibitor design. However, challenges persist, including algorithmic bias, regulatory ambiguities, and the "black-box" nature of deep learning models. By critically evaluating successes and limitations, this review underscores AI's potential to redefine pharmaceutical innovation while advocating for robust frameworks to ensure ethical, transparent, and clinically translatable AI deployment

**KEYWORDS:** artificial intelligence in pharmacy drug discovery; Applications, Future of clinical Pharmacy Challenges And Technology drug delivery design , optimization; AI-driven healthcare

## INTRODUCTION

Artificial intelligence (AI) has emerged as an innovative technology across numerous industries, particularly in healthcare, where it holds the potential to revolutionize drug discovery and optimize pharmacy practices. The continuous evolution of AI, fueled by advancements in machine learning and data science, has facilitated the development of innovative solutions to complex challenges in the pharmaceutical sector. AI's adoption is underpinned by the progression of algorithms capable of learning, adapting, automating processes, and performing sophisticated data analysis, paving the way for enhanced decision-making and operational efficiency.[1] drug discovery rapidly reshapes the pharmaceutical industry, which is driven by substantial financial investments and an expanding market. In 2023, the global AI in drug discovery market was valued at approximately $1.5 billion, with projections indicating a compound annual growth rate (CAGR) of 29.7%, potentially reaching $11.8 billion by 2030.[2] Similarly, Fortune Business Insights.[2] reported a higher market valuation of $3.54 billion in 2023, with expectations expected to grow to $7.94 billion by 2030, reflecting a CAGR of 12.2%. These estimates underscore the significant economic potential of AI technologies in revolutionising drug discovery processes Machine learning models accurately predict compound efficacy and safety, streamlining early-stage drug development and enabling drug repurposing. These capabilities significantly reduce the time and costs associated with traditional drug discovery

processes while improving the precision of outcomes.[3] Beyond drug discovery,

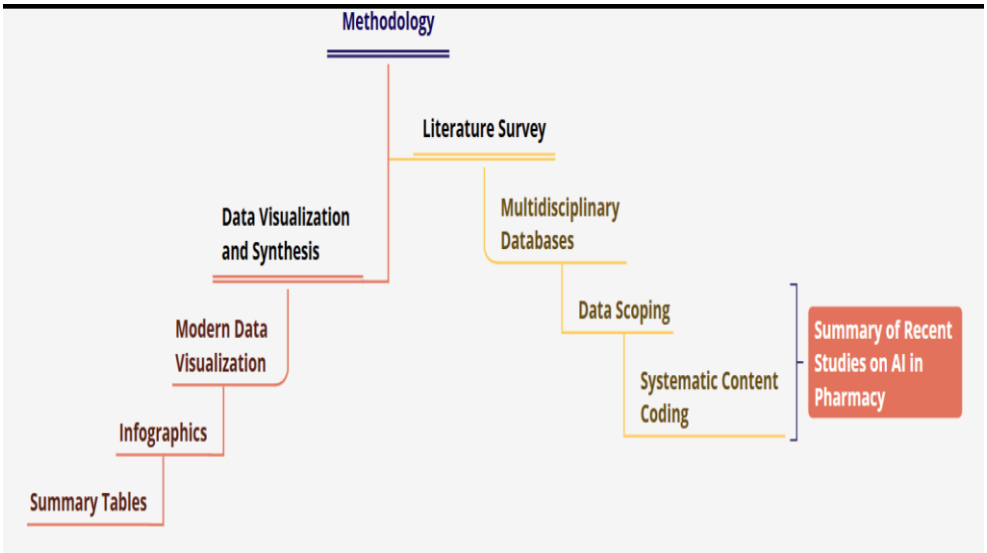
AI transforms pharmacy operations by enhancing medication management and personalising patient care. By integrating AI-driven technologies, pharmacists are equipped with data-driven tools that support precise clinical decision-making. These systems analyse extensive datasets, such as patient medical records and medication histories, to anticipate adverse drug events, optimise dosages, and streamline workflows, ultimately improving patient outcomes.[4,5]

This shift towards AI-enhanced pharmacy practices also empowers pharmacists to play a pivotal role in patient safety and therapeutic effectiveness. Despite the groundbreaking potential of AI in drug discovery, its broader applications in pharmacy practice remain underexplored. Key areas such as medication adherence and patient education, which are critical to achieving optimal health outcomes, have not yet received the attention they deserve in current research. Bridging these gaps could unlock a more holistic integration of AI technologies, fostering innovative strategies that care, elevate quality care, and strengthen patient engagement in pharmacy settings This research paper will delve into the underutilised potential of AI in pharmacy practice, examining its role in advancing medication adherence, enhancing patient education, and optimising pharmacy operations. By addressing existing gaps in our knowledge, this study aims to provide actionable insights and recommendations for leveraging AI to create a more patient-centred and technology-driven approach to pharmaceutical care.[6]

This exploration will highlight case studies and examples where AI has successfully transformed pharmacy practices, illustrating the tangible benefits that can be achieved through its strategic implementation. Through these insights, this paper will also explore challenges and barriers to adopting AI technologies in pharmacy settings, offering solutions to facilitate a smoother integration process for healthcare professionals.[7]

## METHODOLOGY

The systematic process employed to search for, curate, and extract the most recent and relevant literature on AI applications in pharmacy practices. This process ensures a comprehensive and up-to-date review of advancements, challenges, and emerging trends in the field.[8]

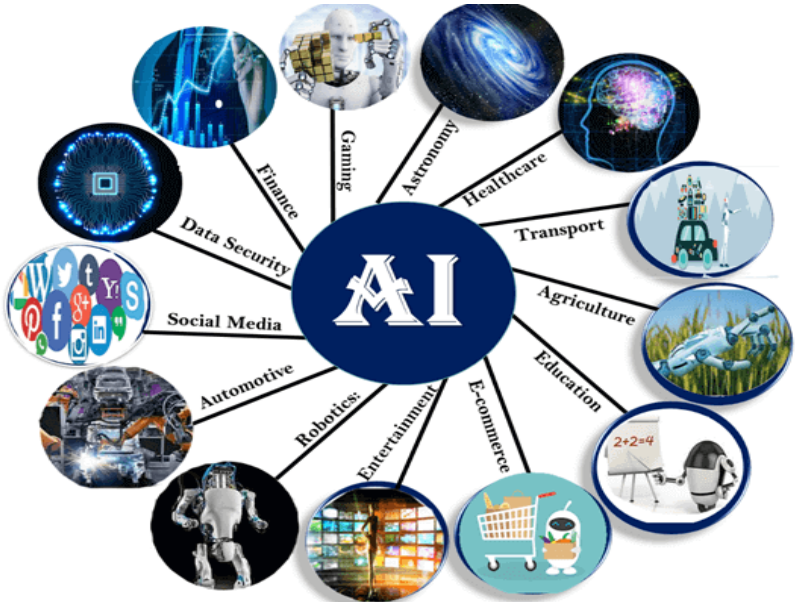



### Background

The Evolution of Artificial Intelligence in the Pharmaceutical Industry The concept of AI is rapidly emerging across various fields, driving pivotal advancements in industries such as manufacturing, finance, and healthcare. This adoption stems from the evolution of algorithms that enable systems to adapt and embrace automation. Algorithms in AI achieve their goals by facilitating learning, decision-making, data processing, and analysis, paving the way for innovative solutions to modern challenges. AI is rapidly revolutionising industries worldwide, with healthcare being one of the primary beneficiaries of its advancements. AI offers trailblazing potential in pharmacy, particularly in enhancing medication management and personalised patient care.[1] By integrating AI-driven technologies, pharmacists are empowered with sophisticated tools that support precise, data-driven clinical decisions.[4] Through AI algorithms and machine

### Applications of AI

Artificial Intelligence has various applications in today's society. It is becoming essential for today's time because it can solve complex problems with an efficient way in multiple industries, such as Healthcare, entertainment, finance, education, etc. AI is making our daily life more comfortable and fast. Following are some sectors which have the application of Artificial Intelligence:




**1. AI in Astronomy**

Artificial Intelligence can be very useful to solve complex universe problems. AI technology can be helpful for understanding the universe such as how it works, origin, etc.[9]

**2. AI in Healthcare**

In the last, five to ten years, AI becoming more advantageous for the healthcare industry and going to have a significant impact on this industry. Healthcare Industries are applying AI to make a better and faster diagnosis than humans. AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach to the patient before hospitalization.

**Figure. AI in Helthcare**

**3. AI in Gaming**

AI can be used for gaming purpose. The AI machines can play strategic games like chess, where the machine needs to think of a large number of possible places.

**4. AI in Finance**

AI and finance industries are the best matches for each other. The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.[10]

**5. AI in Data Security**

The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital world. AI can be used to make your data more safe and secure. Some examples such as AEG bot, AI2 Platform,are used to determine software bug and cyber-attacks in a better way.


**Figure. AI Cybersecurity.**

**6. AI in Social Media**

Social Media sites such as Facebook, Twitter, and Snapchat contain billions of user profiles, which need to be stored and managed in a very efficient way. AI can organize and manage massive amounts of data. AI can analyze lots of data to identify the latest trends, hashtag, and requirement of different users.[11]

**7. AI in Travel & Transport**

AI is becoming highly demanding for travel industries. AI is capable of doing various travel related works such as from making travel arrangement to suggesting the hotels, flights, and best routes to the customers. Travel industries are using AI-powered chatbots which can make human-like interaction with customers for better and fast response.

**Figure. AI in Transportation**

**8. AI in Automotive Industry**

Some Automotive industries are using AI to provide virtual assistant to their user for better performance. Such as Tesla has introduced TeslaBot, an intelligent virtual assistant. Various Industries are currently working for developing self-driven cars which can make your journey more safe and secure.[12]

**9. AI in Robotics**

Artificial Intelligence has a remarkable role in Robotics. Usually, general robots are programmed such that they can perform some repetitive task, but with the help of AI, we can create intelligent robots which can perform tasks with their own experiences without pre-programmed.

Humanoid Robots are best examples for AI in robotics, recently the intelligent Humanoid robot named as Erica and Sophia has been developed which can talk and behave like humans.

**10. AI in Agriculture**

Agriculture is an area which requires various resources, labor, money, and time for best result. Now a day's agriculture is becoming digital, and AI is emerging in this field. Agriculture is applying AI as agriculture robotics, solid and crop monitoring, predictive analysis. AI in agriculture can be very helpful for farmers.

**Figure.AI in Agriculture**

**11. AI in E-commerce**

AI is providing a competitive edge to the e-commerce industry, and it is becoming more demanding in the e-commerce business. AI is helping shoppers to discover associated products with recommended size, color, or even brand.[13]

**12. AI in education:**

AI can automate grading so that the tutor can have more time to teach. AI chatbot can communicate with students as a teaching assistant.

AI in the future can be work as a personal virtual tutor for students, which will be accessible easily at any time and any place.

**Figure. AI in education**

**SOME OTHER APPLICATIONS**

1. **Fraud detection.** The financial services industry uses artificial intelligence in two ways. Initial scoring of applications for credit uses AI to understand creditworthiness. More advanced AI engines are employed to monitor and detect fraudulent payment card transactions in real time.
2. **Virtual customer assistance (VCA).** Call centers use VCA to predict and respond to customer inquiries outside of human interaction. Voice recognition, coupled with simulated human dialog, is the first point of interaction in a customer service inquiry. Higher-level inquiries are redirected to a human.
3. **Medicine:** A medical clinic can use AI systems to organize bed schedules, make a staff rotation, and provide medical information. AI has also application in fields of cardiology (CRG), neurology (MRI), embryology (sonography), complex operations of internal organs etc.
4. **Heavy Industries :** Huge machines involve risk in their manual maintenance and working. So in becomes necessary part to have an efficient and safe operation agent in their operation.
5. **Telecommunications:** Many telecommunications companies make use of heuristic search in the management of their workforcesfor example BT Group has deployed heuristic search in a scheduling application that provides the work schedules of 20000 engineers.
6. **Music:** Scientists are trying to make the computer emulate the activities of the skillful musician. Composition, performance, music theory, sound processing are some of the major areas on which research in Music and Artificial Intelligence are

focusing on. Eg:chucks, Orchextra, smartmusic etc.[14]

7. **Antivirus:** Artificial intelligence (AI) techniques have played increasingly important role in antivirus detection. At present, some principal artificial intelligence techniques applied in antivirus detection It improves the performance of antivirus detection systems, and promotes the production of new artificial intelligence algorithm and the application in antivirus detection to integrate antivirus detection with artificial intelligence.[15]

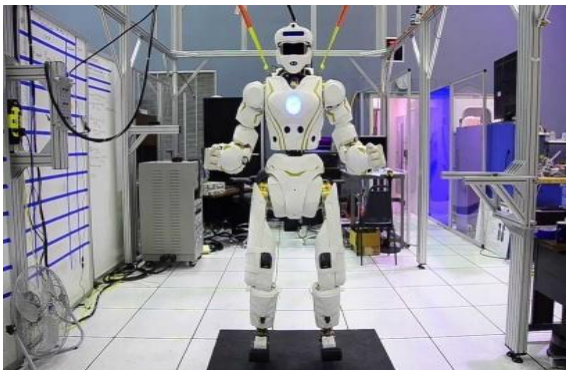


**Fig. V.d. Valkyrine.**

The self-driving car called „Waymo" which is a google initiative drives on the road without driver. Again NASA and GOOGLE are together for first ever humanoid astronaut known as „Valkyrine" [16] which is an absolute example of artificial intelligence.

**Fig. V.e Google self-driving car.**

**Potential Challenges**

Potential Challenges with AI Automation in Clinical Trial Processes Integrating AI automation into clinical trial processes holds immense potential for enhancing efficiency, accuracy, and patient-centricity. However, it also brings various technical, regulatory, ethical, and operational challenges. Addressing these hurdles is crucial for stakeholders aiming to effectively harness AI's full potential.[17]

**Technical Challenges**

Data Quality and Standardization AI systems require high-quality and diverse datasets to function optimally. A lack of standardized data formats and the need for extensive data curation can hinder AI's ability to deliver accurate insights and predictions.[18]

**Operational Challenges**

Workflow Integration Effective implementation of AI tools requires alignment with existing clinical workflows. Misalignments between AI capabilities and clinical needs can lead to inefficiencies and resistance from healthcare providers.[19] Stakeholder Engagement The successful deployment of AI systems depends on the active involvement of diverse stakeholders, including clinicians, patients, and regulatory bodies. Meeting the needs and expectations of all stakeholders is essential for widespread adoption.[20]

**Challenges of AI in Addressing AMR**

Antimicrobial resistance (AMR) poses a significant global health challenge as the misuse and overuse of antibiotics continue to drive the emergence of drug-resistant pathogens. AI offers promising solutions to combat AMR through several innovative approaches. AI-powered decision-support systems can optimize antibiotic prescriptions by analyzing patient data and infection patterns, reducing unnecessary usage, and minimizing resistance development. Additionally, AI accelerates drug discovery and repurposing by screening chemical libraries and predicting compound efficacy

against resistant strains, significantly reducing the time and cost associated with traditional drug development. Furthermore, AI enhances surveillance by monitoring large-scale health data to detect resistance trends and hotspots, allowing for proactive public health interventions. It also supports infection prevention efforts by providing actionable insights into hospital infection control, improving sterilization protocols, and identifying high-risk areas to curb the spread of resistant pathogens.[21]

**Future Directions**

As AI technology continues to evolve, its applications in pharmacy promise to revolutionize healthcare delivery and operational efficiency. By integrating advanced analytics, automation, and machine learning, AI will unlock new opportunities to optimize processes, enhance patient care, and address public health challenges—all while prioritizing ethical practices and patient-centric outcomes.

**Optimizing Supply Chain Management**

AI transforms pharmacy supply chain management by leveraging predictive analytics to analyze vast datasets, including past sales, seasonal trends, and local health data. This ensures precise forecasting of medication demand, reducing stockouts and overstock situations while maintaining optimal inventory levels. Automation streamlines reordering processes by monitoring the stock in real-time and generating purchase orders as needed, saving staff time and improving medication availability. Additionally, AI evaluates supplier reliability, cost, and product quality, enabling pharmacies to maintain high-quality inventory while minimising costs and enhancing operational efficiency.[22]

**Advancing Automated Dispensing Systems (ADSs)**

AI enhances the functionality of Automated Dispensing Systems (ADSs) by improving accuracy and system optimization through machine learning. These systems can swiftly sort and label medications, predict maintenance needs, and customize dispensing based on patient-specific requirements, enabling personalized care and operational efficiency. By integrating ADSs with inventory management and electronic health records (EHRs), AI streamlines processes from prescription generation to billing. Additionally, AI crossreferences dispensed medications with patient health records, adding a critical layer of safety by alerting pharmacists to potential drug interactions or allergies, significantly improving patient safety.[23]

**Public Health Monitoring and Equity**

AI's capabilities in public health monitoring allow for analyzing large-scale health data to detect trends in disease outbreaks, medication usage, and other public healthconcerns. For example, AI could identify a spike in allergy symptoms in specific regions, prompting pharmacies to stock medications like antihistamines and epinephrine injectors to meet increased demand. Additionally, AI addresses health equity challenges by analyzing demographic data, socioeconomic indicators, and medical histories to identify areas with significant disparities. This supports tailored healthcare initiatives, such as educational programs or increased access to care for underserved populations, like those in regions with elevated asthma rates.[24]

**Integration with Electronic Health Records (EHRs)**

AI integration with EHR systems is poised to enhance pharmacy practices by improving data analysis and accessibility. Pharmacists can use AI tools to review patient histories efficiently, monitor medication adherence patterns, and identify potential health risks, ensuring a more proactive approach to patient care.[63] Furthermore, AI-powered chatbots and virtual health assistants engage patients by providing personalized medication advice, reminders, and educational resources. These tools improve adherence, foster better health outcomes, and enhance patient satisfaction

**AI for Drug Discovery**

AI has revolutionized drug research and discovery in numerous ways. Some of the key contributions of AI in this domain include the following:

**1. Target Identification**

AI systems can analyze diverse data types, such as genetic, proteomic, and clinical data, to identify potential therapeutic targets. By uncovering disease-associated targets and molecular pathways, AI assists in the design of medications that can modulate biological processes.

**2. Virtual Screening**

AI enables the efficient screening of vast chemical libraries to identify drug candidates that have a high likelihood of binding to a specific target. By simulating chemical interactions and predicting binding affinities, AI helps researchers prioritize and select compounds for experimental testing, saving time and resources.[25]

**3. Structure-Activity Relationship (SAR) Modeling**

AI models can establish links between the chemical structure of compounds and their biological activity. This allows researchers to optimize drug candidates by designing molecules with desirable features, such as high potency, selectivity, and favorable pharmacokinetic profiles.

**4. De Novo Drug Design**

Using reinforcement learning and generative models, AI algorithms can propose novel drug-like chemical structures. By learning from chemical libraries and experimental data, AI expands the chemical space and aids in the development of innovative drug candidates.

**5. Optimization of Drug Candidates**

AI algorithms can analyze and optimize drug candidates by considering various factors, including efficacy, safety, and pharmacokinetics. This helps researchers fine-tune

therapeutic molecules to enhance their effectiveness while minimizing potential side effects.

**6. Drug Repurposing**

AI techniques can analyze large-scale biomedical data to identify existing drugs that may have therapeutic potential for different diseases. By repurposing approved drugs for new indications, AI accelerates the drug discovery process and reduces costs.

**7. Toxicity Prediction**

AI systems can predict drug toxicity by analyzing the chemical structure and characteristics of compounds. Machine learning algorithms trained on toxicology databases can anticipate harmful effects or identify hazardous structural properties. This helps researchers prioritize safer chemicals and mitigate potential adverse responses in clinical trials. Overall, AI-driven approaches in drug research and development offer the potential to streamline and expedite the identification, optimization, and design of novel therapeuticcandidates, ultimately leading to more efficient and effective medications.[26]

**AI for Drug Delivery**

The integration of AI and big data in the field of pharmaceutics has led to the development of computational pharmaceutics, which aims to enhance drug delivery processes by utilizing multiscale modeling approaches. Computational pharmaceutics employs AI algorithms and machine learning techniques to analyze large datasets and predict drug behavior By simulating drug formulation and delivery processes, researchers can evaluate various scenarios and optimize drug delivery systems without the need for extensive trial-and-error experiments. This accelerates the drug development timeline, reduces costs, and increases productivity. Computational pharmaceutics involves modeling drug delivery systems at different scales, ranging from molecular interactions to macroscopic behavior. AI algorithms can analyze complex relationships between drug.

Properties, formulation components, and physiological factors to predict drug behavior at each scale. This allows for a more comprehensive understanding of drug delivery mechanisms and aids in designing efficient drug delivery systems. It helps in the prediction of the physicochemical properties of the drug, the in vitro drug release profile, and the stability of the drug. The same technology is also implemented for the better assessment of in vivo pharmacokinetic parameters and drug distribution along with in vivo-in vitro correlation studies. By utilizing the right set of AI tools, researchers can identify potential risks and challenges associated with drug delivery systems early in the development process. This allows for proactive modifications and adjustments to mitigate risks and optimize drug performance. The use of AI and computational modeling reduces the reliance on time-consuming and expensive trial-and-error experiments, minimizing the chances of unforeseen outcomes.[27]

**AI for Oral Solid Dosage Form Development**

AI involves the use of advanced tools and software to achieve human-like capabilities. Such innovation has helped in many sectors, such as the pharmaceutical industry, especially in the product development phase over the past few years. The implementation of these technological innovations can save time, money, and resources required for manufacturing and proper distribution to end customers through the supply chain. It also provides a better platform to understand the impact of process parameters on the formulation and manufacturing of products. Run Han et al. explored the utilization of machine learning methods for the prediction of solid dispersion stability for six months. Hanlu Gao et al. investigated the application of machine leaching for solid dispersion dissolution studies. They used a random forest algorithm to generate a classification model that further helps to distinguish between the spring and parachute types of dissolution profiles. It also contributed to maintaining supersaturation with eighty-five percent accuracy and eighty-six percent sensitivity. The time-dependent drug release was predicted based on the regression model created by the random forest algorithm.[28]

**Prediction of Dug Release through Formulations**

The prediction of drug release certainly has the potential for stable quality control. Drug release studies are performed through in vivo and in vitro methods, which are treated as fundamental technologies regularly evaluated or tested during product development. The release of the drug from oral solid dosage forms is based on the contribution of critical material attributes along with the processing parameters. Some of the common factors affecting drug release include compaction parameters such as the pressure used for tablet hardness setting, geometric aspects of the tablets, and drug loading characteristics. Many analysis techniques, including spectrophotometric analysis methods, have beenimplemented, or drug release studies are usually required for extensive analysis

**Application of AI for 3D-Printed Dosage Forms**

The application of AI in the field of 3D-printed dosage forms has revolutionized pharmaceutical manufacturing by enabling personalized medicine and enhancing drug delivery systems. AI algorithms can optimize the design and formulation of 3D-printed dosage forms based on patient-specific factors, such as age, weight, and medical history, leading to tailored drug therapies. By leveraging machine learning and computational modeling, AI can analyze large datasets and simulate the behavior of 3D-printed dosage forms, allowing for the rapid prototyping and optimization of drug release profiles, dosage strengths, and geometries. AI also aids in predicting and overcoming potential manufacturing challenges, optimizing printing parameters, and ensuring quality

control. Furthermore, AI-driven feedback systems can continuously improve the 3D-printing process by learning from real-time data, enhancing accuracy, reproducibility, and scalability. Overall, the application of AI in 3D-printed dosage forms holds tremendous potential in advancing personalized medicine and improving patient outcomes.[29]

**AI for the Detection of Tablet Defects**

The application of AI in the detection of tablet defects has revolutionized quality control processes in pharmaceutical manufacturing. AI algorithms and computer vision techniques are employed to analyze images of tablets, enabling the automated and efficient detection of defects such as cracks, chips, discoloration, or variations in shape and size. By training AI models on large datasets of labeled images, the system learns to accurately classify and identify different types of defects, achieving high levels of precision and recall. Conventional methods, such as X-ray computed tomography, have been used to analyze the internal structure of tablets, but they are still time-consuming and affect the demand for the rapid production of tablets.

**AI for the Prediction of Physicochemical Stability**

AI has emerged as a powerful tool for predicting the physicochemical stability of oral dosage forms in pharmaceutical research. By leveraging machine learning algorithms and computational models, AI can analyze and interpret large datasets, including drug properties, formulation parameters, and environmental conditions, to predict the stability of oral formulations. AI models can assess factors such as drug degradation, interaction with excipients, and environmental effects on formulation stability. These predictive capabilities enable researchers to optimize formulation designs, identify potential stability issues early in the development process, and make informed decisions to enhance the shelf life and efficacy of oral dosage forms.

**Contribution of AI to Dissolution Rate Predictions**

The dissolution rate of a drug, which refers to the rate at which it dissolves in a biological fluid, is a crucial parameter that determines its bioavailability and therapeutic effectiveness. AI has made significant contributions to the prediction of dissolution rates, aiding in the optimization of drug formulations and dosage forms. Through the analysis of vast amounts of experimental data, AI models can identify key physicochemical properties and molecular features that influence the dissolution process. These models leverage machine learning algorithms to learn complex patterns and relationships between drug properties and dissolution rates, enabling accurate predictions. By providing insights into the dissolution behavior of different drug formulations, AI facilitates the design of more effective drug delivery systems and helps in the selection of optimal formulation strategies for enhanced drug solubility and absorption. This advancement in dissolution rate prediction powered by AI empowers pharmaceutical scientists with valuable tools to accelerate drug development, optimize formulation strategies, and ultimately improve patient outcomes.[30]

**AI in Medical Devices**

The medical device is a sort of apparatus, implement, instrument, implant, or machine appliance as well as a reagent for specific medical purposes and can be used alone or in combination with the help of software or other related systems in vitro to address medical issues of patients. AI has made significant advancements in the field of medical devices, revolutionizing healthcare in various ways. Due to the pandemic, personalized medicine along with remote health monitoring has become essential and quite popular in many

**AI for Pharmacokinetics and Pharmacodynamics**

Drug development is a complex process that involves several stages, including drug discovery, preclinical studies, clinical trials, and regulatory approval. Pharmacokinetics and pharmacodynamics are crucial aspects of drug development, as they determine the optimal dosage, administration route, and safety of a drug in the body. Traditional experimental methods for pharmacokinetics and pharmacodynamics studies can be timeconsuming and expensive and may not always provide accurate predictions of drug efficacy and safety.[31]

## CONCLUSIONS

AI is transforming drug delivery technologies, enabling targeted, personalized, and adaptive therapies. By leveraging AI's capabilities in data analysis, pattern recognition, and optimization, pharmaceutical researchers and healthcare professionals can enhance drug efficacy, minimize side effects, and improve patient outcomes. AI-based methods have revolutionized the field of pharmacokinetics and pharmacodynamics. They offer several advantages over traditional experimental methods. AI-based models can predict pharmacokinetic parameters, simulate drug distribution and clearance in the body, and optimize drug dosage and administration routes. AI-based computational methods for PBPK models can simplify the development of such models and optimize their parameters, reducing the need for animal studies and human clinical trials. Computational pharmaceutics, facilitated by AI and big data, revolutionizes the drug delivery process by providing a more efficient, cost-effective, and data-driven approach. It enables the optimization of drug formulations, personalized therapies, regulatory compliance, and risk reduction, ultimately leading to improved drug manufacturing processes and enhanced patient outcomes. Overall, the integration of AI technologies holds great promise for accelerating drug development, improving patient outcomes, and revolutionizing the pharmaceutical industry,

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