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INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)

Vol. 04, Issue 06, June 2024, pp: 2248-2254

e-ISSN : 2583-1062

Impact Factor: 5.725

A REVIEW ON: ARTIFICIAL INTELLIGENCE IN PHARMACY

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ABSTRACT

AI's objective is to develop intelligent modeling that supports knowledge visualization, issue solving, and decision-making. It has the power to improve failing healthcare systems with new efficiency, medications, diagnostics, and economics in the ever evolving environment we live in. Artificial intelligence (AI) is the capacity of a computer-controlled robot or digital computer to carry out tasks normally performed by intelligent people. Automation, software, and computer programs have all been developed to assist and streamline healthcare procedures. These incorporate indicative advances like X-ray, Radiation innovation, CT diagnostics, Mechanical medical procedure and some more. AI has advanced significantly in the field of healthcare, playing important roles in the administration and storage of data and information, including patient medical histories, drug inventories, sales records, and so on. Al has lately risen to prominence in a variety of pharmacy-related fields, such as drug discovery, developing drug delivery formulations, hospital pharmacy, customized medication, and multi drug pharmacology.

Keywords: Artificial Intelligence, Drug discovery, Formulation development for drug delivery Hospital pharmacy, Multidrug pharmacology.

1. INTRODUCTION

Artificial intelligence is the study of intelligent computer programs that absorb information in a way similar to human attention. Cognitive abilities (AI). Typically, this process comprises obtaining information, creating effective plans for utilizing it, presenting exact or approximative results, and self-correcting or adjusting as needed. Artificial intelligence (AI) is frequently dissected by humans to imitate human mental components. AI can be used to produce more accurate analyses and helpful interpretations. Artificial Intelligence has the potential to be applied in pharmaceutical and healthcare research due to its ability to analyze large volumes of data from various sources. Many recent studies go into great detail about the use of AI in healthcare and other fields. Artificial intelligence (AI), natural language processing (NLP), physical robot uses deep learning and brain network models to identify clinically relevant early-stage viewpoints in imaging data, particularly in the context of malignant growth. NLP uses computer programs to understand and interpret spoken language. These days, ML techniques are typically applied in NLP to examine unstructured s, mechanical cycle robotization, and other AI technologies are employed in the healthcare sector. Data sets and preserves as lab reports, expert notes, and other documents. Through organizing the key information from multiple text-based and symbolic sources that directs treatment decisions and dynamic conclusions. AI-based solutions have been identified as platforms that may draw from various data sources, such as biometrics, imaging, biomarkers, patient-reported symptoms, etc. AI advancements have made it possible to recognize potential illnesses early on, which increases the likelihood that they can be prevented. Numerous medical specialties, including nursing, telemedicine, housekeeping, imaging, and surgery, Physical robots are used in rehabilitation, etc. Robotic process automation leverages inexpensive, easily programmable technology that can perform structured digital tasks for administrative purposes and function as a semi-intelligent system user. An additional option is to use this in conjunction with image recognition. This technology may be used by the healthcare system to automate repetitive processes like billing and patient record updating. AI is essential to the pharmaceutical industry because of its wide range of applications in all stages.

2. ARTIFICIAL INTELLIGENCE

The terms artificial intelligence (AI), also known as machine intelligence, and robotics are often used interchangeably. While robotics is simply the design of machines that can perform difficult, repetitive tasks, AI is the display of human-like behaviors or intelligence by any computer or machine. Robots may be able to move or transport objects on their own through automation, but these "intelligent capabilities" were never intended for robots; instead, simulated intelligence is the area of software engineering that focuses on creating intelligent PCs that can perform tasks that would typically be perform Artificial intelligence (AI) is widely used in the creation of digital computers and computer-controlled robots that are capable of carrying out the same mental and cognitive tasks as humans. These mental and cognitive functions include language, reasoning, perception, and problem-solving, to name a few. Because the type of AI that is currently in use is only meant to perform specific tasks like searching the internet, recognizing faces and voices, controlling automobiles, and so on, it is also known as weak AI or narrow AI. The long-term objective of the

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artificial intelligence (AI) community is to create computers that can autonomously outperform humans in all cognitive tasks-made by people. The overall computer-based intelligence, also known as solid computer-based intelligence (ADI), intends to build robots capable of performing all human-related me. The term artificial intelligence (AI) refers to a machine's or computer's ability to act, think, behave, and function like a person. Well-known examples of AI-controlled systems include the Siri feature on Apple's iPhone, Alexa on Amazon, and self-driving cars produced by Google, Mercedes, BMW, and Tesla, to name a few. Knowledge engineering is the process of giving robots access to copious amounts of data about the human environment so they can mimic humantal tasks. Behavior, which could be regarded as AI's cornerstone. "Machine learning," a different type of artificial intelligence makes use of statistical models and algorithms to raise the predictive accuracy of software programs without requiring explicit programming. It was founded on the premise that robots could learn from data, identify problems, and make decisions with little to no assistance from humans. Examples of applications for artificial intelligence (AI) include self-driving Google cars, extortion detection, and online proposal services like those offered by Amazon and Netflix. AI has been the subject of a great deal of skepticism, criticism, and misconceptions, most centered around safety concerns and potential hazards posed by the development of robots with human-like cognitive abilities. Forbes has identified artificial intelligence (AI) as potentially becoming a political issue in 2019. Some people have expressed concern that the development of artificial intelligence (AI) systems that are more intelligent than humans could be even more destructive and spell the end for humanity as a species. This is in addition to concerns that AIs could be used as weapon so mass devastation and warfare. Due to the possibility that we won't be able to predict how AI systems smarter than we are would behave, they think that these incredibly smart robots might wind up influencing people. Scientists believe that most safety concerns about such systems could be reduced if future super intelligent AI systems' "goals" could be aligned with human objectives.

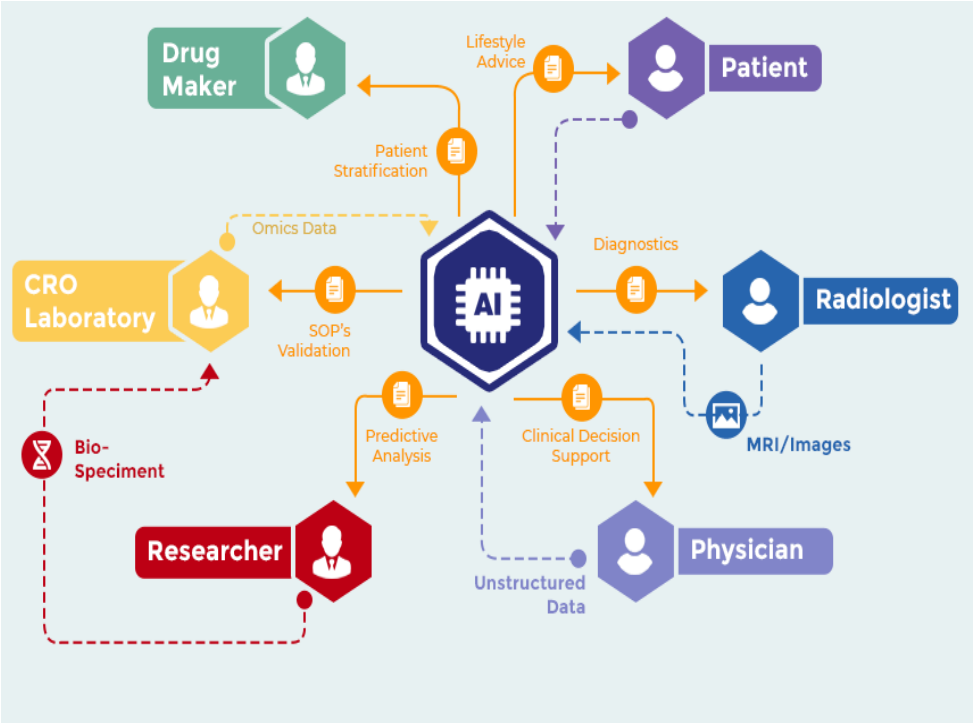

Fig 1: Artificial Intelligence In Pharmaceutical industry.

2.1 Classification of artificial intelligence AI:

Artificial Intelligence can be classified into two groups based on its type and prevalence. The following groups of AI can be distinguished based on their respective capacities:

1. Weak AI or Artificial Narrow Intelligence (ANI):

It can only do a limited number of things, like recognize faces, steer a car, play chess, and read traffic signals, among other things.

2. Strong AI or artificial general intelligence (AGI):

It is a subset of artificial intelligence that can carry out any task that a human could perform. It can improve human understanding and facilitate the completion of testing projects.

3. Artificial Genius (ASI):

This invention is far smarter than humans and far more interested in math, painting, and other subject like space than they are Regardless of whether they exist now or not, computer-based intelligence can be divided into the related classes.

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i) Type 1: It is utilized for applications with a narrow scope that are unable to use prior knowledge because it does not have a memory system. We refer to it as a "reactive machine."

ii) Type 2: It can solve a variety of problems by applying prior knowledge, but its memory is limited. Certain recorded observations are used to record subsequent actions in the automated car's decision-making systems; these recordings are not stored indefinitely.

iii) Type 3: The "Hypothesis of Psyche" serves as its foundation. It suggests that unique viewpoints, desires, and aspirations influence people's decisions. AI does not exist in this system.

iv) Type 4: It is self-aware, having a sense of self and consciousness of itself. This is just one more nonexistent AI system.

Diagnosis and Illnesses:

When classifying patients, the severity of their illness burden should be taken into account, and AI can be a major diagnostic tool. A person's illness is named after them once they receive a diagnosis, which is determined by particular prior problems. Typically, it is best to maintain a record of every patient's health report forms in order to compile most evaluations obtained from performing examinations and tests. Based on the information obtained, particularly with regard to the medical prerequisites for a timely diagnosis, the appropriate decisions are made. The physicians alone have the final say over the analysis, which is subject to modification .These days, deep learning, neural networks, and algorithms are commonly employed in technology to recognize, extract, and process all of the data that has been gathered. Cancer and dementia are the two primary conditions for which AI has become relevant, Hepatitis can be diagnosed using unsupervised learning. But deep learning has changed expectations and made many evolutionary adjustments. One can obtain correlations. AI's appropriateness is frequently improved by larger data sets and more varied entries, although the outcomes are occasionally incomprehensible. There are various uses for deep learning in diagnostics, such as the classification of dermatological conditions and the detection of atrial fibrillation. Cross validation can be used to randomly divide data into multiple groups for algorithm estimation. Three critical areas are given particular weight in the typical AI metrics: specificity, sensitivity, and accuracy. Numerous studies focused on predictive modeling, which was demonstrated by their capacity to predict when Parkinson's disease would manifest. The chest X-ray images were used to create the rib segmentation algorithm, which is used to diagnose lung disorders. Traditional methods are ineffective for rib-wise segmenting X-ray images due to a variety of issues. In this study, chest X-ray images of patients with pneumonia were combined with unpaired samples to create an algorithm. After that, a multi-scale network picked up the characteristics of the pictures. The study found that this approach works well with better rib segmentation and could be useful for diagnosing lung cancer and other lung conditions. Recently, scientists have used machine learning and algorithms to categorize and identify cardiac arrhythmias by analysis of ECG data.

Drug Discovery:

The protracted and challenging process of developing new drugs includes steps such as the identification and validation of therapeutic targets, the optimization of lead compounds, and the evaluation of drug efficacy and safety. Historically, researchers have tested a number of chemicals in the hopes of discovering a viable treatment candidate. This process of trial and error has been the foundation of treatment development. However, some drug candidates might not progress past the preclinical stage, and this process can be time-consuming and ineffective. AI can be applied to several phases of drug discovery, such as target identification and preclinical and clinical development.

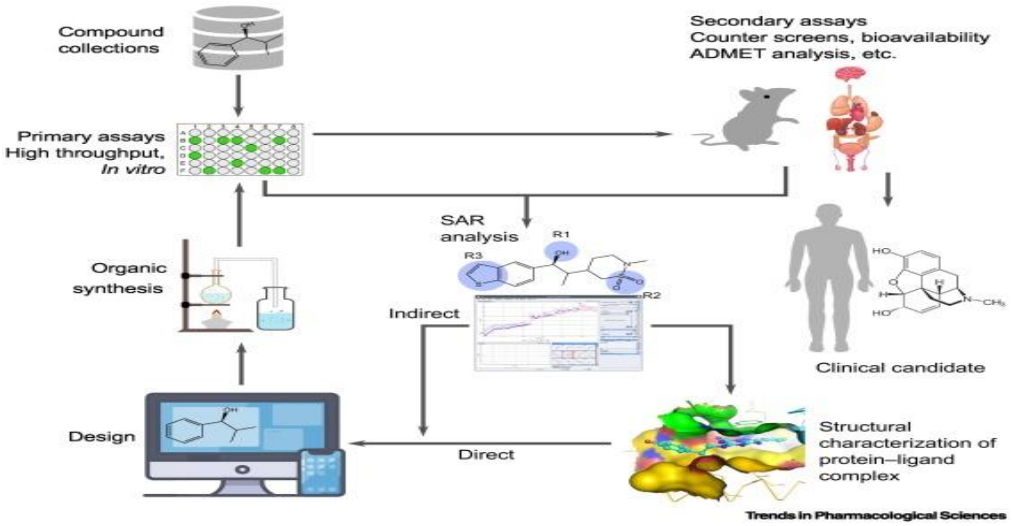

Fig 2: Artificial Intelligence In Drug discovery

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AI target identification:

An essential first step in the drug development process is identifying novel therapeutic targets, which are biological processes or molecules implicated in a disease process. Artificial Intelligence (AI) has the potential to analyze large databases of biological and molecular data, revealing therapeutic targets that were previously unknown or disregarded. Machine learning algorithms are able to identify using the data currently available to predict which goals have the best chances of success.

Lead optimization using AI:

After a promising pharmacological target has been identified, scientists must develop compounds that can interact with the target and have a therapeutic effect. AI can help optimize these compounds by anticipating their properties and improving their structure. For example, machine learning algorithms can predict a substance's solubility, stability, and bioavailability based on its molecular structure. They are also able to predict whether a chemical will be hazardous or have unfavorable side effects. Time and money can be saved by identifying possible leads early on and reducing the number of compounds that need to be synthesized and assessed. Artificial Intelligence can assist in the optimization of these compounds by anticipating their characteristics and improving their structure. For example, machine learning algorithms can predict a substance's solubility, stability, and bioavailability based on its molecular structure. They are also capable of predicting whether a chemical will be hazardous or have unfavorable side effects. Time and money can be saved by identifying possible leads early on and reducing the number of compounds that need to be synthesized and assessed. Virtual screening, de novo drug design, retro synthesis and reaction prediction, and de novo protein design are a few popular applications of AI in drug discovery. These applications can be broadly classified into two categories: generative and predictive tasks. Artificial intelligence (AI) can be used by researchers to analyze massive amounts of data and predict which compounds have the best chance of succeeding in clinical trials. Researchers are employing AI to discover new therapeutic targets and enhance the planning of clinical trials.

Clinical Trials Using AI:

AI has the potential to be extremely beneficial in the field of clinical trial optimization. By analyzing patient data and identifying patient subgroups most likely to benefit from a particular medication, artificial intelligence (AI) enables researchers to design more effective and cost-effective clinical trials. Clinical studies can be completed faster and for less money if this is done, increasing the likelihood of success. AI has the potential to identify potential safety concerns at an early stage, providing researchers with the chance to modify the trial's plan or stop it altogether if necessary.

Formulation development for drug delivery:

Many types of intelligent drug releasing systems are designed with on demand dosage adjustment, rates of drug release, targeted releasing, and drug stability in mind. With regard to self monitoring systems for drug release, the appropriate algorithms are helpful for managing the quantity and duration of drug release. Generally, designing drug delivery systems has some drawbacks, such as the inability to forecast the link between formulation parameters and reactions. This is connected to both the outcomes of the treatment and the unforeseen events publication. As such, AI techniques are helpful in forecasting the likelihood of drug delivery in dosage forms and the effectiveness of medicine dosage.

1. Dispersions of solids:

By using ANN modeling and experimental design, solid carbamazepine dispersions have been created using poloxamer 188 and Sol plus. To increase the solubility and rate of dissolution of carbamazepine, solid carbamazepine dispersions were created. These solid dispersions of carbamazepine-Soluplus-poloxamer 188 were made by the solvent casting technique.

An analysis of the relationships between different factors and drug dissolution characteristics has already been conducted using ANN modeling (feed forward back propagation) with the logistic sigmoid activation function in order to maximize drug dissolution rate. In this investigation, the solid drug dispersions were created by employing combinations of poly (vinyl pyrrolidone) and polyethylene glycol as carriers.

2. Micro-emulsions and Emulsions:

Formulations for stable oil-in-water emulsions have also been created using ANNs. This paper presents the fatty acid optimization.

The amount of alcohol needed to make oil/water emulsions was investigated. The unreliable variables (factors) examined in this paper were the lauryl alcohol concentrations and the passage of time. The variables that yielded consistent results were droplet size, zeta potential, conductance, and viscosity. Validation testing revealed a strong correlation between ANN-predicted values and the experiment's outco ANNs have also been used in the miniature emulsion plan, where it was simple to analyze the accuracy prediction in light of the concept of the miniature emulsion derived from the formula.

3. Tablets:

The lattice tablet plan has used both static and dynamic ANNs to show the dissolving profiles of various framework tablets. The genetic algorithm optimizer tool and Monte Carlo simulations were used in this work for the ANN-based modeling.

The expert used choice trees and Elman dynamic brain organizations to precisely figure out dissolving characteristics of lipid-based and hydrophilic network tablets with discharge designs for directed medication. The Elman neural network-based modeling showed the effective modeling of drug releasing patterns by various formulas of hydrophilic as well as lipid-based matrix tablets, in contrast to the majority of widely used multilayer perceptron and static networks. In a study, feed forward back propagation and a multilayer perceptron were used to create metformin HCl matrix tablets for sustained release. The in vitro metformin HCl release pattern of the matrix tablets was optimized to produce the optimized formulations.

Healthcare pharmacy:

AI is used in the hospital-based health care system in many different ways, including choosing suitable or easily accessible administration methods or treatment guidelines, as well as organizing dosage forms for individual patients.

1. Maintaining medical record:

Maintaining patient medical records is challenging. Data collection, storage normalization, and tracing are all made easier by the AI system. The clinical records are swiftly deleted by the Google project on emotional well-being. This drive therefore benefits the provision of quicker and higher-quality medical services. This initiative will improve the quality of eye care provided by the Moor Fields Eye Hospital NHS.

2. Developing a treatment plan:

AI technology can be used to create effective treatment plans. The AI system must remain in charge when a patient is in a severe state and it is challenging to choose the best course of treatment. The treatment plan for this technology incorporates all of the data, clinical information, and prior reports.

3. Assistance with daily tasks:

Additionally, computer-based intelligence innovation helps with repetitive tasks like deciphering radiography, X-ray images, ECG, reverberation, and so forth to identify and analyze abnormalities or illnesses. One of the primary areas of strength for a "mental partner" with and logical abilities is an IBM calculation called Clinical Sieve. To use medical data and deep learning to improve the patient's condition, a medical start-up is required. There is a particular PC program for every significant component that is used in particular disease situations. Almost all imaging tests, including CT, ECHO, ECG, and X-rays, may require profound learning.

4. Medical precision:

AI has a positive impact on genomics and genetic evolution. For the purpose of finding patterns in genomic data and medical records that link particular mutations to particular illnesses, an AI system known as Deep Genomics is useful. This method informs medical professionals about the processes that occur within a cell when DNA is altered by genetic variation. Craig Venter, the creator of the human genome project, developed an algorithm that uses DNA to provide information about a patient's physical characteristics. The application of "Human Longevity" AI technology can assist in determining the exact location of vascular disorders and cancer in their early stages.

5. Making of drugs:

It takes more than ten years and billions of dollars to conduct pharmaceutical research and development. To determine the therapies from artificial intelligence (AI) tool Atomwise, which uses supercomputers to store molecular structure databases, is useful. It started a virtual search program for an effective and safe Ebola virus treatment that made use of already-approved drugs. The method identified two drugs that aided in the Ebola virus's spread. months or even years. A biopharma company in Boston invented big data for patient management. To ascertain the reasons behind some patients' illness survival, data is withheld.

Digital therapy:

1. Radiotherapy:

Using structures, a simple automated computer program can implement the clinical recommendations. The patient's anatomy and physiology can be analyzed by the treatment planning system, which can also mimic the mental process that is frequently involved in manual therapy planning. It is encouraging that dosage models for spatial dose and three-dimensional dose distribution are accurate, Radiation oncology can provide detailed information on tumors by utilizing a variety of imaging biomarkers. Radiomics can be used to forecast side effects and treatment outcomes for individual radiation therapy patients.

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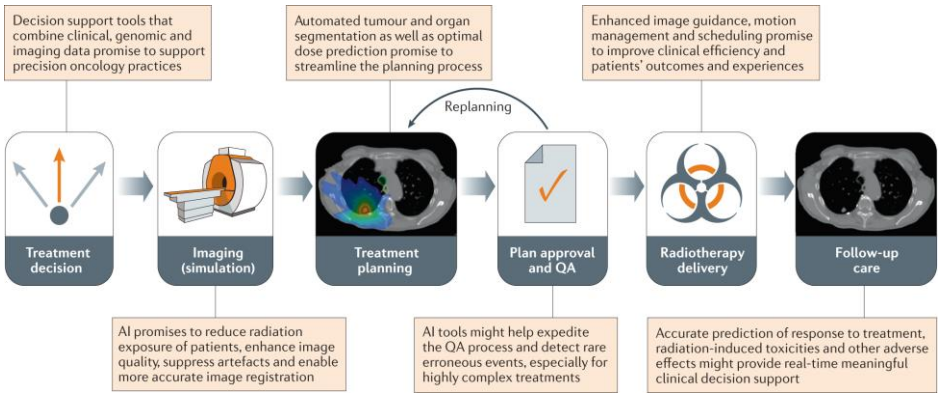

Fig 3: Process of radiotherapy

2. Retina with AI:

Assessing people's health has become much simpler thanks to high-resolution retinal imaging. Using high-definition medications, a radiologist or ophthalmologist can develop a customized treatment plan and establish a continuously evolving learning healthcare system. Singular retinal images can yield highly personalized data.

3. Cancer and AI:

By speeding up the cycle and maintaining high accuracy, artificial intelligence helps identify diseases. PET imaging of lymphoma based on artificial intelligence is used to assess growth problems, which is subsequently used to depict the cancer, quantify heterogeneity, and determine treatment response. Due to gastrointestinal disorders, patients' risk is assessed using colon rectal malignant growth (CRC) screening, and nighttime visual imaging is crucial in predicting the progression of gastric malignant growth. AI, accurate blood testing, and endoscopic imaging can all help prevent cancer from spreading too quickly if detected early. However, only retrospective evidence can be gathered because AI lacks adequate randomization and blinded controlled experiments. Furthermore, in some trials, the prediction models were unable to support the cancer prognosis.Later on, a number of models such as the Random. The Cox Survival Regression Algorithm, the Multi-Task Logistic Regression Algorithm, and the Survival Forest Algorithm have all grown more complex and are now more likely to be predictive. Due to these developments, gastroenterology has automated the assessment of risk classification, location, and amplification using endocytoscopy, which hasn't been applied in actual patient care.

Uses of artificial intelligence in pharmacy:

1. AI technology has been use to identified for analyzing as well as interpreting some important fields of pharmacy like drug discovery, dosage form designing, polypharmacology,and hospital pharmacy.

2. AI is primarily utilized to increase speed and accuracy in the healthcare realm.

3. AI is used in Diagnosing patients, AI algorithms analyze medical imaging data, such as X-rays, MRIs ,and CT scans, to assist healthcare professionals in accurate diagnosis.

4. AI is utilized in drug discovery for target identification, lead optimization, and clinical trial design.

5. AI can also be used to develop pharmacophore models, QSAR models and de novo drug designing of the molecules

3. CONCLUSION

With the advent of more advanced and new generation AI technology, healthcare has changed in terms of awareness, effectiveness in providing treatment, identification of impending issues, accurate illness diagnosis beforehand, and most recent methods for therapies. In recent years, there has been a significant increase in the attention given to the application of AI technology to the study and comprehension of various significant aspects of pharmacy, including drug development, dosage form design, poly pharmacology, hospital pharmacy, and related topics. This is a result of artificial intelligence (AI) technology mimicking human thought and decision-making processes.

4. REFERENCE

[1] Davenport T, Kalakota R. The potential for artificial intelligence in healthcare. Future healthcare journal. 2019 Jun;6(2):94.The potential for artificial intelligence in healthcare. Future healthcare journal. 2019 Jun;6(2):94.

[2] Hussain A, Malik A, Halim MU, Ali AM. The use of robotics in surgery: a review. International journal of clinical practice. 2014 Nov;68(11):1376-82.

[3] Khan ZH, Siddique A, Lee CW. Robotics utilization for healthcare digitization in global COVID-19 management. International journal of environmental research and public health. 2020 Jun;17(11):3819.

[4] Prashanth R, Roy SD, Mandal PK, Ghosh S. High-accuracy detection of early Parkinson's disease through multimodal features and machine learning. International journal of medical informatics. 2016 Jun 1; 90:13- 21.
[5] Schneider P, Walters WP, Plowright AT, Sieroka N, Listgarten J, Goodnow Jr RA, Fisher J, Jansen JM, Duca JS, Rush TS, Zentgraf M. Rethinking drug design in the artificial intelligence era. Nature Reviews Drug Discovery. 2020 May;19(5):353-64
[6] Vaithiyalingam S, Khan MA. Optimization and characterization of controlled release multi-particulate beads formulated with a customized cellulose acetate butyrate dispersion. International journal of pharmaceutics. 2002 Mar 2; 234(1-2):179-93.
[7] Arimura H, Soufi M, Kamezawa H, Ninomiya K, Yamada M. Radiomics with artificial intelligence for precision medicine in radiation therapy. Journal of radiation research. 2019 Jan 1;60(1):150-157.
[8] Schmidt-Erfurth U, Sadeghipour A, Gerendas BS, Waldstein SM, Bogunović H. Artificial intelligence in retina. Progress in retinal and eye research. 2018 Nov 1; 67:1-29.
[9] Bang CS, Lee JJ, Baik GH. Artificial intelligence for the prediction of Helicobacter pylori infection in endoscopic images: systematic review and meta-analysis of diagnostic test accuracy. Journal of medical Internet research. 2020 Sep 16; 22(9):e21983.
[10] Zhang Z, He T, Huang L, Li J, Wang P. Immune gene prognostic signature for disease free survival of gastric cancer: Translational research of an artificial intelligence survival predictive system. Computational and Structural Biotechnology Journal. 2021 Jan 1; 19:2329-46.
[11] Yang YJ, Cho BJ, Lee MJ, Kim JH, Lim H, Bang CS, Jeong HM, Hong JT, Baik GH. Automated classification of colorectal neoplasms in white-light colonoscopy images via deep learning. Journal of clinical medicine. 2020 May 24;9(5):1593.
[12] Heba FE, Darwish A, Hassanien AE, Abraham A. Principle components analysis and support vector machine based intrusion detection system, 10th International Conference on Intelligent Systems Design and Applications, Cairo. 2010;363-7.
[13] Kadurin A, Nikolenko S, Khrabrov K, Aliper A, Zhavoronkov A. druGAN: An advanced generative adversarial auto encoder model for de novo generation of new molecules with desired molecular properties in silico. Mol Pharm. 2017; 14(9):3098-104.
[14] Paul D, Sanap G, Shenoy S, Kalyane D, Kalia K, Tekade RK. Artificial intelligence in drug discovery and development. Drug Discov Today 2021; 26:80.
[15] Liu Y. Artificial intelligence-assisted endoscopic detection of esophageal neoplasia in early stage: The next step?. World Journal of Gastroenterology. 2021 Apr 4; 27(14):1392.
[16] Ellahham S. Artificial intelligence: the future for diabetes care. The American journal of medicine. 2020 Aug 1; 133(8):895-900.
[17] Li X, Liu H, Du X, Zhang P, Hu G, Xie G, Guo S, Xu M, Xie X. Integrated machine learning approaches for predicting ischemic stroke and thromboembolism in atrial fibrillation. In AMIA Annual Symposium Proceedings 2016 (Vol. 2016, p. 799). American Medical Informatics Association
[18] Haag, M.; Maylein, L.; Leven, F.J.; Tönshoff, B.; Haux, R. Web-based training: A new paradigm in computer assisted instruction in medicine. Int. J. Med. Inform. 1999, 53, 79–9
[19] Petrović J, Ibrić S, Betz G, Đurić Z. Optimization of matrix tablets controlled drug release using Elman dynamic neural networks and decision trees. International journal of pharmaceutics. 2012 May 30;428(1- 2):57-67.
[20] Gašperlin M, Podlogar F, Šibanc R. Evolutionary artificial neural networks as tools for predicting the internal structure of micro emulsions. Journal of Pharmacy & Pharmaceutical Sciences. 2008 Mar 24; 11(1):67-76.
[21] Vaithiyalingam S, Khan MA. Optimization and characterization of controlled release multi-particulate beads formulated with a customized cellulose acetate butyrate dispersion. International journal of pharmaceutics. 2002 Mar 2;234(1-2):179-93
[22] Ebhohimen IE, Edemhanria L, Awojide S, Onyijen OH, Anywar G. Advances in computer-aided drug discovery. In: Phytochemicals as Lead Compounds for New Drug Discovery. Netherlands: Elsevier; 2020. p. 25-37
[23] Kumar KJ, Panpalia GM, Priyadarshini S. Application of artificial neural networks in optimizing the fatty alcohol concentration in the formulation of an O/W emulsion. Acta Pharm. 2011; 61(2):249-56.
[24] Davenport T, Kalakota R. The potential for artificial intelligence in healthcare. Future healthcare journal. 2019 Jun;6(2):94.
[25] Toepper M. Dissociating normal aging from Alzheimer’s disease: a view from cognitive neuroscience. Journal of Alzheimer's disease. 2017 Jan 1; 57(2):331-52.
[26] Hussain A, Malik A, Halim MU, Ali AM. The use of robotics in surgery: a review. International journal of clinical practice. 2014 Nov; 68(11):1376-82.