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A Review on Artificial Intelligence and It's Applications

Prof. Dhengle Ashwini B[1], Aradwad Vaishnavi[2], Vedant Bidve[3], Balaji Gomchale[4], Supriya Tompe[5]
Department of Pharmacy, Godavari Institute of Pharmacy, Kolpa, Latur

Abstract: It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable. While no consensual definition of Artificial Intelligence (AI) exists, AI is broadly categorized as the study of computation that allow for perception, reason and action Today, the amount of data that is generated, by both humans and machines, far outpaces. Human's ability to absorb, interpret, and make complex decisions based on that data. Artificial intelligence forms the basis for all computer learning and is the future of all complex decision making. This review provides an overview of various AI-based approaches utilized in pharmaceutical technology, highlighting their benefits and drawbacks. Nevertheless, the continued investment in and exploration of AI in the pharmaceutical industry offer exciting prospects for enhancing drug development processes and patient care.
Keywords: artificial intelligence (AI); disease diagnosis; drug discovery; epidemic; personalized medicine; prediction.

I. INTRODUCTION

Artificial Intelligence (AI) is the branch of computer science which deals with intelligence of machines where an intelligent agent is a system that takes actions which maximise its chances of success. It is the study of ideas which enable computers to do the things that make people seem intelligent. The central principles of AI include such as reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects. It is the science and engineering of making intelligent machines, especially intelligent computer programs.

Artificial intelligence (AI) is a combination of various intelligent processes and behaviour, developed by computational models, algorithms or a set of rules which supports the machine to mimic the cognitive functions of humans such as learning, problem-solving, etc. AI is expeditiously penetrating the field of the healthcare sector and has a huge impact on clinical decision making, disease diagnosis, and automation. There are opportunities for AI to explore further in the field of pharmaceutical and healthcare research because of its ability to investigate enormous data from various modalities. Some of the current studies elaborate on the utilisation of AI in healthcare and other sectors. The AI technologies in the healthcare industry include machine learning (ML), natural language processing (NLP), physical robots, robotic process automation, etc. In ML, neural network models and deep learning with various features are being applied in imaging data to identify clinically significant elements at the early stages, especially in cancer-related diagnoses. NLP uses computational techniques to comprehend human speech and derive its meaning. Lately, ML techniques are being widely incorporated in NLP for exploring unstructured data in the database and records in the form of doctors! notes, lab reports, etc. by mapping the essential information from various imagery and textual data which helps in decision making in diagnosis and treatment options. The ongoing disruptive innovation creates a pathway for the patients to receive a precise and rapid diagnosis and customised treatment interventions.

AI-based solutions have been identified which include platforms that can make use of a variety of data types viz. symptoms reported by the patients, biometrics, imaging, biomarkers, etc. With the advancements in AI, the ability to detect potential illness well ahead is made possible, leading to a greater probability to prevent as an outcome of detection at a very early stage. Physical robots are being used in various healthcare segments including nursing, telemedicine, cleaning, radiology, surgical, rehabilitation, etc. The robotic process automation uses technology, which is inexpensive, easy to program and can perform structured digital tasks for administrative purposes and act like a semi-intelligent user of the systems. This can also be used in combination with image recognition. The need for a proficient workforce in the healthcare industry is persistent, necessitating the continuous provision of training to healthcare personnel to augment their involvement in routine duties. Identifying skill gaps in the workplace is a crucial undertaking within the pharmaceutical industry. It is imperative to effectively address the identified gaps through appropriate remedial measures while acknowledging that providing adequate training can also pose a significant challenge. As per a report presented by certain authorities, it has been observed that approximately 41% of supply chain disruptions occurred in June 2022.

The report further highlights that supply chain disruption has emerged as the second-most-formidable challenge to overcome. Several pharmaceutical industries are anticipating further advancements in their supply chain, as well as innovative models to address these challenges, with the potential to enhance business resilience.

II. SCOPE OF ARTIFICIAL INTELLIGENCE IN PHARMACY

1) Manufacturing process improvement
2) Drug discovery and design
3) Processing biomedical and clinical data
4) Rare disease and personalized medicine
5) Identifying clinical trial candidates
6) Predicting treatment results
7) Predictive biomarkers
8) Drug repurposing

A. *Artificial Intelligence in Disease Diagnosis*

Disease analysis becomes pivotal in designing a considerate treatment and safeguard- ing the wellness of patients. The inaccuracy generated by humans creates a hindrance for accurate diagnosis, as well as the misinterpretation of the generated information creating a dense and demanding task. AI can have varied applications by bringing about proper assurance in accuracy and efficiency. After a vivid literature survey, the applications of various technologies and methodologies for the purpose of disease diagnosis have been reported. With the evolution of the human population, there is always an ever-increasing demand for the healthcare system, according to varied environmental manifestations. A substantial amount of evidence has revealed that though vulnerable, contradictory, non-analyzing incongruities exist, the development of new methods can define the application capability by portraying the current existing scenario that has not been covered. It is important to categorize the patients based upon whether he/ she is severely affected by the diseases, and the AI can gain importance in diagnosis. Diagnosis refers to the state where, upon certain pre-existing problems, one!s condition is designated. It is always advised to maintain every patient!s health report forms, so as to collect the majority of reviews that are obtained via performing examinations and testing. Upon gathering information, the appropriate outcomes are mainly concerning the health care needs for a timely diagnosis. There is availability of multiple diagnostic strategies which are leading to trust issues and thus, one needs to focus on AI for identification and determination of the early predictive stage of the disease more than the treatment or diagnostic phase. Such diagnosis can help to initiate the early treatment, and initial treatment can bring noticeable changes in the patients as well as improved efficiency in AI modules. Nowadays, identification, extraction and catering all the collated data would lead to ample technology usage based on deep learning, neural networking and algorithms. Cancer and dementia are the two major diseases where AI has gained importance. Hepatitis can be diagnosed through unsupervised learning. Among many examples of deep learning in diagnostic, one is the classification of dermatological diseases and atrial fibrillation detection. Accuracy, sensitivity, and specificity are three important aspects where the common measurements of AI focus. On the basis of the literature analysis, the clinical aspects which can supervise the deep learning network and neural pathways using support vector machine, nearest neighbor, random forest, decision tree, logistic regression, naive Bayes, discriminate analysis and convolution neural network can generate the results in a more holistic approach. Many studies were performed for the predictive modelling, which was noticeable for predicting early Parkinson!s disease. Rib segmentation algorithm was developed using the chest X-ray images for diagnosis of lung diseases. Traditional methods are not useful in rib-wise segmentation of X-ray images due to various limitations. In this research, they have developed an algorithm via unpaired sample augmentation of chest X-ray images of pneumonia patients; later, a multi-scale network learns the features of images. The study reports that such algorithm achieves good performance with better rib segmentation which could be useful in diagnosing lung cancers and other lung diseases. Recently, algorithm and machine leaning was used by the researchers in identification and classification of cardiac arrhythmia by processing the electrocardiograms signals. In another study, tuberculosis was classified and diagnosed by using the optimization genetic algorithm (GA) and support vector machine (SVM) classifier.

B. *Artificial Intelligence in Digital Therapy/Personalized Treatment*

AI has the potential to derive a meaningful relationship within the raw datasheets that can be further used in the diagnosis, treatment, and mitigation of the disease. A variety of newer techniques which are used for computational understanding in this emerging field have the potential to be applied in almost every field of medical science.

The complex clinical problems need to be solved with the challenge of acquiring, analyzing, and applying vast knowledge. The development of medical AI has helped clinicians to solve complex clinical problems. The systems such as ANNs, evolutionary computational, fuzzy expert systems and hybrid intelligent systems can assist the healthcare workers to manipulate the data.
The ANN is a system that is based upon the principle of the biological nervous system. There is a network of interconnected computer processors called neurons that can perform parallel computations for data processing. The first artificial neuron was developed using a binary threshold function. The multilayer feed forward perceptron was the most popular model having different layers, such as input layer, middle layer, and output layer. Each neuron is connected through links having numerical weight. Paul Werbos introduced a new technique called #Back propagation learning" in 1974, which has a suitable learning algorithm. The ANN has been used in diagnosis image analysis, data interpretation and waveform analysis. Fuzzy logic is a science of reasoning, thinking and inference that can recognize and use real-world phenomena.

1) AI in Radiotherapy

Automated treatment planning is a recent technology, which is highly beneficial in radiotherapy treatment planning. Automated treatment planning is efficiently improving the plan quality, consistency, and error rate. The treatment workflow can be organized into three categories, i.e., automated rule implementation, reasoning modelling of prior knowledge in clinical practice and multi-criteria optimization. A simple automated computer program with structures can implement the clinical guidelines. The treatment planning system can analyses the anatomy and physiology of the patient and can also mimic the reasoning process, which is generally followed in manual treatment planning. Three- dimensional dose distribution and dose models for spatial dose have shown promising accuracy. Radiomics can give in-depth information about tumors with the help of several imaging biomarkers. Radiomics can be implemented for the prediction of outcomes and toxicity for individual patients! radiation therapy.

2) AI in Retina

The high-resolution imaging of the retina has given the scope to assess human health remarkably. From a single photograph of the retina, one can extract highly personalized data; with high-definition medicines, the ophthalmologist/retinol gist can define a personal therapy and establish a continuously improving learning healthcare system.

3) AI in Cancer

With the huge applicability of AI, it has gained importance in the fields of diagnosing and treating various cancers. The lymphoma subtypes of non-Hodgkin lymphoma were predicted by using gene expression data in a multilayer perceptron neural network. The neural network has 20,863 genes as the input layer and lymphoma subtypes as the output layer. An artificial neural network was used to identify the new prognostic markers of MCL using the gene expression data and reported that 58 genes predicted the survival with high accuracy, and 10 genes were associated with poor survival and 5 genes with favorable survival. AI is used in cancer diagnosis by minimizing the time with high accuracy. AI-based PET imaging of lymphoma is used in tumor burden evaluation which was later applied in characterization of tumor, quantification of heterogeneity, as well as prediction of treatment response. In gastrointestinal cancer, colorectal cancer (CRC) screening technology is used to analyze the malignancy in patients and prediction of the *Helicobacter pylori* infection by visual nocturne play a crucial role in predicting the gastric cancer progression. Early diagnosis through proper blood tests, endoscopic imaging and AI can influence the progression of the cancer. With these advancements, automation in diagnosis of malignancy has been achieved via gastroenterology, not only for classification but also for detection and magnification using endocytoscopy, which has not been used in real practice. In the last decade, AI has been very promising in the diagnosis of breast cancer. AI- assisted techniques are the combination of both quantitative and qualitative MRI features, which is applicable to predict treatment response in breast cancer patients, even before the start of neoadjuvant chemotherapy (NAC).

4) Artificial Intelligence in Other Chronic Diseases

Different computerised therapies are available based on computer programming techniques. Many companies have installed such assistance, which generally provides virtual coaching through text messages with the use of the mobile applications, and with the use of AI, nutrition recommendations can also be given specifically based upon the gut microbiome. Arterial fibrillation can be predicted with the use of an integrated system based upon deep learning, single-lead ECG sensor and physical activity via accelerometer data along with a smart watch. Case-based reasoning, which is designed using AI technique, is being extensively used in the management of diabetes.

The automated system can detect problems and memorises the best effective solution for the individual patient. It is already in use for the optimisation of insulin therapy. Other techniques such as the vector regression technique are also in fashion for diabetes care. AI techniques can also be used to assess the risk of a particular disease. Advanced AI techniques that can work upon the molecular level such as molecular phenotyping, genomics, epigenetic alterations, and the development of digital biomarkers can also be used in the management of different diseased conditions. With the use of newer techniques, patients can manage their diabetes through web-based programs mobile phones and smart phones.

C. Artificial Intelligence in Drug Discovery

The possibility of the development of a large number of drug molecules from a chemical space becomes lengthy due to lack of appropriate technologies, which can be improvised by using AI in the drug development process. The quantitative structure–activity relationship affects the various parameters! forecasting activities such as log P or log D, which can foresee the predictions and generation through computations and can justify the biological safety, efficacy and adverse effects, including the pharmacokinetics of the significant molecule. The enormous space requires a delocalization of molecules by the three-dimensional distribution of molecules and their properties. It is advisable to collect all prior information regarding the selectivity and the positioning of the molecules for showing the bioactivity using numerous domains including PubChem, ChemBank, DrugBank and ChemDB. QSAR is geared for the potential application of the drug candidate through AI-based QSAR approaches. If the traditional approaches are followed for obtaining the statistical differences, the biological activity discovered and developed can take a decade to control. The solubility, partition coefficient, degree of ionization and intrinsic permeability of the drug affect target receptor binding when designing a new drug. Algorithms include molecular descriptors, such as Simplified Molecular Input Line Entry System (SMILES), to forecast the binding properties. A quantitative structure–property relationship (QSPR) is generally used for the determination of the six physicochemical properties, known as the Estimation Program Interface Suite. Deep learning and neural networks based on the ADMET predictor and ALGOPS pro- gram have been utilized for the prediction of the lipophilicity and solubility of various compounds. Many undirected graphs are utilized for predicting solubility. The surface area, mass, hydrogen count, refractivity, volume, log P, surface area, sum of the indices, solubility index and rotatable bonds are considered for the prediction of a new chemical entity.

1) AI in Clinical Trials

In drug discovery, clinical trials are the longest and require a huge amount of investment. Despite the time and capital invested in clinical trials, the success rate is only marginal for those that obtain approval from the Food Drug Administration (FDA). There are several bottlenecks in clinical trials, and those can lead to failure of the trial. Those bottlenecks include the insufficient number of participants, drop-outs during the trial, side effects of the test drug, or inconsistent data. The process of execution and conducting of clinical trials includes clinical trial design, patient recruitment/selection, site selection, monitoring, data collection and analysis. Out of these processes, patient recruitment and selection is the cumbersome process where 80% of the trials overshoot the enrolment timeline, and 30% of phase-III trials are prematurely terminated due to patient enrolment challenges. Trial monitoring in a multi-centered global trial is a very expensive and time-consuming process.

2) Clinical Trial Design, Patient Identification, Recruitment and Enrolment

As per the FDA, AI models are useful in improving the quality of trial design, patient selection by reducing population heterogeneity, prognostic enrichment, and predictive enrichment. There are many applications of such BNMs in clinical trial design, for example, the dose selection in clinical trials involving cancer patients, immuno-oncology and cell therapy trials. Dose selection is complicated due to the heterogeneity of the patients, which may lead to inaccurate dose selection and selection of future target populations. BNMs are an efficient and effective tool for dose selection in such patients because it considers all the variable and heterogeneity of the study subjects. Bayesian nonparametric design is used for adaptive dose selection in multiple populations. This facilitates the borrowing of information across multiple populations while considering the heterogeneity of the populations. Such models help in accurate optimal dose selection, which minimizes the inaccuracy. AI provides an opportunity to combine patient data with the electronic medical record (EMR) including omics data and other patient data, scattered among different locations, owners, and formats. Such analysis using computer vision algorithms such as optical character recognition (OCR) and Natural language processing (NLP) can provide an efficient process in patient identification and characterization.

3) Monitoring Trial, Patient Adherence and Endpoint Detection

Monitoring the trial participants is another challenge in the clinical trial and can be performed by AI-enabled wearable devices. Such monitoring is real-time, individualized and power efficient. AI-assisted #smart monitoring" can use predictive analysis and data visualization in improving the data quality check and trial site performance. Patients! compliance to adherence criteria of the trial is important to obtain the reliable data and success of the trial. Video monitoring and wearable sensors capture the patient data automatically and continuously making the trial efficient in monitoring patient.

III. ARTIFICIAL INTELLIGENCE TOOL APPLICATION IN DOSAGE FORM DESIGNS

The human body system is divided into several compartments to understand the impact of drug delivery. The compartments are further simplified based on biological membranes. Physicochemical barriers are vital for biological compartments and can be implemented based on the mode of drug delivery inside the body. One of the most significant criteria for efficient drug delivery system monitoring is the rate of permeation based on the route of administration. The orally administered drug, after entering the gastric environment, must permeate through the intestinal or gastric epithelium. This step is vital for the further distribution of the drug into the bloodstream. The distribution step conveys the drug to the target site, which can be tissue or any of the specific cellular components. Intracellular molecules can also act as targets for drug entry into the body. Most of the permeation of drugs is facilitated through biological barriers, either passively or actively. Passive diffusion is based on the drug!s molecular features. The in silico models are used to predict drug distribution through computation analysis, but these results are somewhat different from the actual drug distribution study. The drug!s interaction with biological components and the availability of the drug in biological environments have a great impact on the drug!s fate in the body. This process is governed by the molecular features of the drug. For many biologically active entities and small molecules, passive permeation is inefficient and requires a specific drug delivery system. The active permeation process is driven by membrane transport and depends on complex biological interactions. This complex process must be explored by using many specific parameters through computation and systematic modeling approaches. This newer computational model is used to study the pharmacokinetic parameters of the drug delivery system. One of the major loopholes present in the research and development of the pharmacy industry is the predictability of preclinical models.

IV. ARTIFICIAL INTELLIGENCE IN FORECASTING OF AN EPIDEMIC/PANDEMIC

Pandemic is boundless and capable of causing morbidity and mortality. Globally, there have been several pandemic outbreaks, to name a few, Black Death, Spanish flu, Cholera, Influenzas, AIDS, COVID-19, and they are capable of causing social and economic interruption. There is intense interdependence between the early detection and successful management of the disease, which reduces the stress on individuals! health, economic, social, and political systems. To achieve early detection, surveillance plays a major role... Active surveillance demands huge resources, manpower and time. In practice, predicting the epidemic and pandemic is a challenge. However, with the current advancements studying the propagation of dreadful diseases is made possible. AI is the best option to achieve surveillance with the efficient utilization of resources. ML and deep learning are being incorporated in various healthcare segments and are found to be more effective when compared to human resources. The prediction of influenza epidemics is always a great challenge due to its shift in epidemic peak, periodic peaking, etc. With the incorporation of the SAAIM (self-adaptive AI model), an accurate forecast is possible even in areas with irregular seasonal influenza. For example, in Taiwan, machine learning and ensemble approaches have been used to predict seasonal influenza, and it is accurate in the pre- diction forecast. Using machine learning feed-forward propagation neural network model (MSDII-FFNN), the forecasting output precision is 90% for influenza. Machine learning anonymized mobility map (AMM) has been incorporated in predicting influenza in Australia and USA. AMM groups the data from the smart phone and can forecast the epidemics using human mobility even across the state boundaries. Mobile application was used in the Zika project to monitor the mosquito population, and the early detection was performed by incorporating AI neural networks. Vaccine-derived poliovirus (VDPV) observation has gained attention because of its outcomes. Hybrid machine learning is incorporated with the combination of random vector functional link (RVFL) networks with the whale optimization algorithm (WOA), which can predict a VDPV outbreak. In HIV/AIDS prevention measures, ML has the potential to distinguish possible candidates for pre-exposure prophylaxis. Dengue is prevalent in tropical and sub-tropical zones.

The ML algorithm support vector regression (SVR) is capable of predicting with negligible error and tracking dengue outbreaks in China. In Malaysia, the ML Support vector model (SVM) using linear kernel performed the best predictor for dengue, and Bayesian network ML techniques were employed in dengue outbreak prediction. The ANN is incorporated for rapid diagnosis using TB suspect data, and the overall efficacy is more than 94%. This will help to detect the overall spread of the disease, and swift implantation of some control measure.

Using deep learning and machine learning, a CNN model named tuberculosis AI (TB-AI) identified TB bacillus and showed 97.94% sensitivity. Multilayer Perceptron Neural Network Classifier (MPNN) was suggested for the diagnosis of yellow fever, taking seven psychological symptoms of yellow fever, and achieved the prediction precision of 88%. The COVID-19 outbreak shook the entire world. AI-inspired modified stacked auto-encoder modelling was used to predict the COVID-19. Deep learning Composite Monte Carlo (CMC) in combination with the fuzzy rule was helpful in decision making and predicting the COVID-19 pandemic. A polynomial neural network with corrective feedback (PNN + CF) is used to forecast with negligible error. CNN, a deep neural network used in China, has a precise prediction efficacy. In Switzerland, the AI model (Enerpol) combined with Big Data is used in the prediction of COVID-19.

V. CURRENT PHARMACEUTICAL CHALLENGES AND THE ROLE OF ARTIFICIAL INTELLIGENCE

In the pharmaceutical industry, research on small molecules for better products and customer satisfaction is ongoing due to their multiple advantages. The chemical synthesis process is simple, while the synthetic derivative preparation is economical. Thus, many stable and potent small-molecule-loaded formulations are present in the pharmacy sector. Except for the treatment of rare diseases, many innovative small molecules face competition from generic molecules, and complex data are required for them to be launched, along with clinical trials. These processes increase the economic pressure on companies to engage in more innovation. However, the biomolecular drug industry is still growing at a rapid pace to compensate for the crisis induced by the small molecular size and poor dissemination of research and innovations. Small-molecule actions are based on their conformation and reactivity.

AI can experience issues with algorithm bias regarding the processing of information for predictions and the assessment of hypotheses. Moreover, it is not uncommon for docking simulations to result in the discovery of inactive molecules. Therefore, a critical analysis of these parameters still requires human involvement for effective decision-making and cross-verifications, to rule out system bias issues. Nevertheless, there is huge potential in AI for possible application, and thus, extensive work may be able to reduce the limitations associated with AI and make it effective and reliable. Regarding AI, the methodology employed involves the utilization of machine learning or its subsets, such as deep learning and natural language processing. The learning process can be either supervised or unsupervised, and the type of algorithm employed is also a crucial factor. Supervised learning is a machine learning methodology that involves the use of known inputs (features) and outputs (labels or targets), as opposed to unsupervised learning, which deals with unknown outputs. The supervised approach involves the prediction of output, such as labels or targets, based on multiple inputs or features. On the other hand, unsupervised classification aims to create groups that are homogeneous in terms of features. In pharmaceutical product development, various AI models have been explored to enhance different aspects of the process.

VI. ARTIFICIAL INTELLIGENCE 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 corelation 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.

VII. APPLICATIONS OF ARTIFICIAL

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 Intelligence 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.

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.

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.

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.

6) AI in Social Media
- Social Media sites such as Facebook, Twitter, and Snap chat 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.

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.

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.

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.

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, colour, or even brand.

VIII. CONCLUSION

Fascinated by the recent developments in AI, especially its application in healthcare and pharmaceutical research and service. Smart hospitals and healthcare facilities enabled with AI, ML and Big Data will be shaping the future healthcare sector. Pharmaceutical industries are in constant advancement with their technologies and AI will be an opportunity for minimizing the cost and time for drug development. Various applications of AI in healthcare and pharmaceutical research as well as the limitations/challenges of these technologies have been presented. The role of AI in disease diagnosis is well demonstrated by using deep learning, neural networking and unsupervised learning. These AI tools have the ability to process unstructured data and correlate with the learned data to predict an accurate outcome, which is useful in predicting a particular disease diagnosis. AI has been proven a vital technology such as intelligent computer-assisted instruction (ICAI), Case-based reasoning, vector regression technique, clinical decision support for monitoring chronic disease progress and optimizing the therapy for those diseases. Vector regression technique is useful in identifying the connections between variables; ICAI is useful in computer assisted instruction to patients to obtain an informative answer from the patients; case-based reasoning helps in solving a problem from its past similar experience and clinical decision support provides patient-specific information and knowledge to healthcare team to help in monitoring and treating a disease. Drug discovery and bringing a new drug to the market is the prime objective of Pharmaceutical R&D, which is a very lengthy and costly affair. AI has the potential to ease the process, from target selection through to clinical trials of a drug. Drug discovery starts with the identification of target biological molecules that interfere in modifying the disease. In the drug discovery process, thousands of synthetic molecules are generated that could bind to the target and modify its activity for managing a particular disease. In this process, computer-aided drug design and quantitative structure–activity relationship (QSAR) or quantitative structure–property relationships (QSPR) are used to determine the physicochemical and pharmacokinetic properties. The progressions in AI technologies are constantly evolving, and these technologies will be useful when the advantages over the limitations will be higher.

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.

REFERENCES

[1] Chen, M.; Decary, M. Artificial intelligence in healthcare: An essential guide for health leaders. In Healthcare Management Forum; SAGE Publications: Los Angeles, CA, USA, 2020.

[2] Bajwa, J.; Munir, U.; Nori, A.; Williams, B. Artificial intelligence in healthcare: Transforming the practice of medicine. Futur. Healthc. J. **2021**, 8, e188–e194.

[3] Sunarti, S.; Rahman, F.F.; Naufal, M.; Risky, M.; Febriyanto, K.; Masnina, R. Artificial intelligence in healthcare: Opportunities and risk for future. Gac. Sanit. **2021**, 35, S67–S70.

[4] Toepper, M. Dissociating Normal Aging from Alzheimer!s Disease: A View from Cognitive Neuroscience. J. Alzheimer!s Dis. **2017**, 57, 331–352.

[5] Davenport, T.; Kalakota, R. The potential for artificial intelligence in healthcare. Futur. Healthc. J. **2019**, 6, 94–98.

[6] Fakoor, R.; Ladhak, F.; Nazi, A.; Huber, M. Using deep learning to enhance cancer diagnosis and classification. In Proceedings of the International Conference on Machine Learning, Atlanta, GA, USA, 16–21 June 2013; ACM: New York, NY, USA, 2013; Volume 28, pp. 3937–3949.

[7] Horgan, D.; Romao, M.; Morré, S.A.; Kalra, D. Artificial Intelligence: Power for Civilisation—And for Better Healthcare. Public Health Genom. **2019**, 22, 145–161.
[8] Khan, Z.H.; Siddique, A.; Lee, C.W. Robotics Utilization for Healthcare Digitization in Global COVID-19 Management. Int. J. Environ. Res. Public Health **2020**, 17, 3819.
[9] Sahu, A.; Mishra, J.; Kushwaha, N. Artificial Intelligence (AI) in Drugs and Pharmaceuticals. Comb. Chem. High Throughput Screen. **2022**, 25, 1818–1837.
[10] Thakur, A.; Mishra, A.P.; Panda, B.; Rodríguez, C.S.; Gaurav, I.; Majhi, B. Application of Artificial Intelligence in Pharmaceutical and Biomedical Studies. Curr. Pharm. Des. **2020**, 26, 3569–3578.
[11] Lu, J.; Song, E.; Ghoneim, A.; Alrashoud, M. Machine learning for assisting cervical cancer diagnosis: An ensemble approach. Futur. Gener. Comput. Syst. **2020**, 106, 199–205.
[12] Deo, R.C. Machine Learning in Medicine. Circulation **2015**, 132, 1920–1930.
[13] Singh, A.; Mehta, J.C.; Anand, D.; Nath, P.; Pandey, B.; Khamparia, A. An intelligent hybrid approach for hepatitis disease diagnosis: Combining enhanced k - means clustering and improved ensemble learning. Expert Syst. **2020**, 38, e12526.
[14] Lin, R.H. An intelligent model for liver disease diagnosis. Artif. Intell. Med. **2009**, 47, 53–62.
[15] Ramesh, A.N.; Kambhampati, C.; Monson, J.R.; Drew, P.J. Artificial intelligence in medicine. Ann. R. Coll. Surg. Engl. **2004**, 86, 334.
[16] Albu, A.; Ungureanu, L. Artificial neural network in medicine. Telemed. J. e-Health **2012**, 18, 446–453.
[17] Hopfield, J.J. Artificial neural networks. IEEE Circuits Syst. Mag. **1988**, 4, 3–10.
[18] Hanson III, C.W.; Marshall, B.E. Artificial intelligence applications in the intensive care unit. Crit. Care Med. **2001**, 29, 427–435.
[19] Whitley, D. A genetic algorithm tutorial. Stat. Comput. **1994**, 4, 65–85.
[20] Moore, K.L. Automated radiotherapy treatment planning. In Seminars in Radiation Oncology; WB Saunders: Philadelphia, PA, USA, 2019; Volume 29, pp. 209–218.
[21] Arimura, H.; Soufi, M.; Kamezawa, H.; Ninomiya, K.; Yamada, M. Radiomics with artificial intelligence for precision medicine in radiation therapy. J. Radiat. Res. **2019**, 60,
[22] Schmidt-Erfurth, U.; Sadeghipour, A.; Gerendas, B.S.; Waldstein, S.M.; Bogunovic´, H. Artificial intelligence in retina. Prog. Retin. Eye Res. **2018**, 67, 1–29.
[23] Hunter, B.; Hindocha, S.; Lee, R.W. The Role of Artificial Intelligence in Early Cancer Diagnosis. Cancers **2022**, 14, 1524.
[24] Espinoza, J.L.; Dong, L.T. Artificial Intelligence Tools for Refining Lung Cancer Screening. J. Clin. Med. **2020**, 9, 3860.
[25] Chiu, H.Y.; Chao, H.S.; Chen, Y.M. Application of Artificial Intelligence in Lung Cancer. Cancers **2022**, 14, 1370.
[26] Chen, S. Models of Artificial Intelligence-Assisted Diagnosis of Lung Cancer Pathology Based on Deep Learning Algorithms. J. Healthc. Eng. **2022**, 2022, 3972298.
[27] Poortmans, P.M.; Takanen, S.; Marta, G.N.; Meattini, I.; Kaidar-Person, O. Winter is over: The use of Artificial Intelligence to individualise radiation therapy for breast cancer. Breast **2020**, 49, 194–200.
[28] Ji, Y.; Li, H.; Edwards, A.V.; Papaioannou, J.; Ma, W.; Liu, P.; Giger, M.L. Independent validation of machine learning in diagnosing breast Cancer on magnetic resonance imaging within a single institution. Cancer Imaging **2019**, 19, 64.
[29] Lo Gullo, R.; Eskreis-Winkler, S.; Morris, E.A.; Pinker, K. Machine learning with multiparametric magnetic resonance imaging of the breast for early prediction of response to neoadjuvant chemotherapy. Breast **2020**, 49, 115–122.