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Review Article

OVERVIEW: EMBRACING TOOLS OF ARTIFICIAL INTELLIGENCE IN PHARMACEUTICALS

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Abstract

Background: Artificial intelligence is the wide diversifying core area from computer science having versatile applicability in pharmaceutical industries. Artificial intelligence is a stimulation of human intelligence processes by machines, especially computer system. In the past few years, the usage of Artificial intelligence has expanded into nearly every sector. **Main Body:** This review describes how Artificial intelligence is being used in the pharmaceutical industry. In this overview, the applications of Artificial intelligence are explored, including research and development, epidemic forecasting, better medicine adherence and dose, disease diagnostics, marketing, etc. Also discussing the various approach how such technology used extensively to manipulate and improve design of drug as well stage to stage progress in pharmaceuticals. **Conclusion:** As with the help of Artificial intelligence tools many hurdles are left from research and development to the manufacturing and dispensing of medicines. Research and development have lots of room for expansion in the realm of Artificial Intelligence. This brings both difficulties and optimism, as is the case with most technical advancements. Because of the usage of digital technology in today's data collection, the volume and dimension information will continue to grow substantially. This technology showing the excellent uses and approaches in pharmacy in current era and will be many more in future.

Keywords: Artificial Intelligence, Artificial Narrow Intelligence, Drug Adherence and Dosage, Physiochemical Properties.

INTRODUCTION

The field of technology has witnessed a huge expansion since the industrial revolution. Technology has mostly replaced many challenging manual tasks, which is very beneficial to humanity. One of the technical advancements that have allowed to replace the physical tasks performed by humans in a variety of industries is artificial intelligence (AI). A field of science and technology known as artificial intelligence develops intelligent machines and computer programmes to carry out a variety of tasks that require for human intellect. It is a system that can reflect a variety of human abilities. [1] This includes anything from learning-based applications to reasoning and language processing. One of the most frequently applied types of AI in the medical field is machine learning. ML is a sort of AI that largely depends on statistical techniques and relies on computers rather than humans to infer associations and make predictions. [2] Whether you are familiarized with AL or not, we are all dependent upon it nowadays. Currently, we use AL frequently in our everyday lives, particularly in social media, search engines, product recommendations, email filters, etc. With the aid of the information encoded in it, AL is capable of judging objects, qualities, categories, and relationship between all of them. [3]Clinical decision-making, disease detection, and automation are all greatly influenced by AI's rapid expansion of the healthcare industry. Because AI has the capacity to examine vast amounts of data from various modalities, there are prospects for it to be further investigated in the pharmaceutical and healthcare fields [4]. The top 10 pharmaceutical companies now incorporating A.I. are as follows:Pfizer, Roche, Novartis, Johnson & Johnson, MSD, Sanfoi, Abbive, Glaxosmithkline, Amgen, and Gilead Sciences.

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MAIN TEXT

AI, machine learning and deep learning

AI is defined as the application of methods that allow computers to imitate human behavior. Machine learning (ML), a subfield of AI, employs statistical techniques and has the capacity to learn either explicitly or implicitly. Artificial neural networks are used in deep learning (DL), a further branch of machine learning that adapts to and learns from the huge amount of experimental data [5].

Objectives of AI

- Creation of Expert Systems: It entails the development of advanced, automated technologies that can guide people towards the best courseof action.
- Implementation of Human Intelligence in Computers: Comparable cognitive patterns will be developed in computers as a result, enabling them to behave like people and make the right decisions when faced with challenging challenges. Through the use of algorithms, this will enable automated operations and lower the workload for humans.
- Multi-Domain Application: Computer science, cognitive science, statistics, psychology, engineering, ethics, the natural sciences, healthcare, space technology, logic, linguistics, and other fields will all reap advantages from AI.
- Applications in Computer Science: Numerous methods, including Search and Optimization, Logic, Control Theory, Language Analysis, Neural Networks, Classifiers, Statistical Learning Methods, and Unpredictable Methods for Uncertain Reasoning, are developed with the aid of AI to address a broad spectrum of challenging circumstancesin the field of computer science. [6]

Classification of AI

- Artificial Narrow Intelligence (ANI) or Weak AI: It carries out a limitedvariety of tasks, such as facial recognition, car steering, chess practice,traffic signaling, etc.
- Artificial General Intelligence (AGI) or Strong AI: It carries out every task like a human and is referred to as human-level AI. It can simplify human intelligence and do challenging tasks.
- Artificial Super Intelligence (ASI): It is more intelligent than humans and more active in painting, mathematics, space, etc. than humans. AI can be divided into the following categories depending on whether they are already existing or not:

    - Type 1: It is used for applications with restricted capabilities thatcannot draw on prior knowledge since it falls short of a memory system. It's referred to as a reactive machine. Examples of this memory include an IBM chess programme that has the ability to forecast moves and detect the checkers on the chessboard.
    - Type 2: It has a meagre memory system that it can use to draw on prior knowledge to address various issues. There are some recorded observations that are utilized to record subsequent actions in automatic cars' decision-making systems, but these records are not kept forever.
    - Type 3: The "Theory of Mind" is the foundation of it. It means thatpeople's individual thoughts, intentions, and desires have an impact on the decisions they make. This is a hypothetical AI system.
    - Type 4: it is conscious and self-aware, meaning it has a sense ofwho it is. Another non-existent AI system is this one.[7]

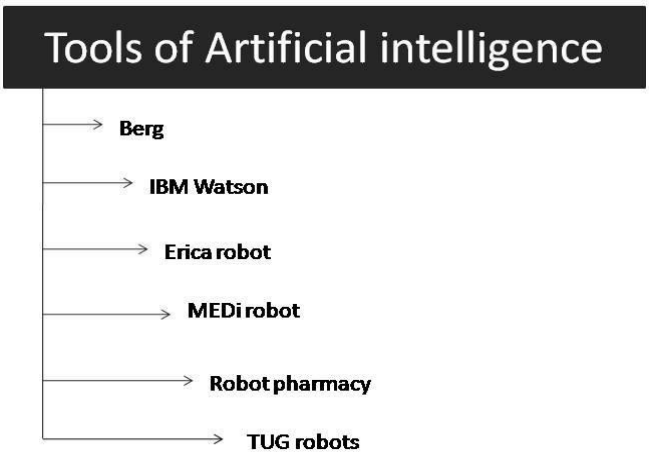

Figure 1. Tools of AI

Tools of AI: To fulfill the needs of the pharmaceutical sector today, many AI tools have been developed. These tools have produced encouraging results. The following are names of some of the AI tools that have become extremely popular in the pharmaceutical industry. IBM Watson, Robot pharmacy, MEDi robot, Ericarobot, TUG robots, Berg [8]

Application of AI: The different applications of AI in the pharmaceutical industry are mentionedunderneath-

- Research and development
- Improve drug adherence and dosage
- Forecasting an epidemic or pandemic
- Disease diagnosis
- AI in drug prescription
- AI in retail pharmacy store
- Marketing
- AI in market prediction and market analysis

Research and development

Researchers claim that using these technologies promotes decision-making, inspires innovation, boosts the effectiveness of clinical trials, and aids in managing of side effects. According to predictions, 62% of healthcare organizations are considering investing in AI soon, and 72% of businesses think AI will be essential to how they conduct business in the future [9]. Only 13.8% of medications pass clinical trials successfully, according to an MIT research. Additionally, a pharmaceutical company must spend anywhere from US$ 161 million to US$ 2 billion for a medicine to successfully complete a clinical trial and receive FDA approval. These are the two key factors driving the growing adoption of AI by the pharmaceutical industry to lower operating costs, increase medicine and therapy affordability, and increase the success rates ofnew drugs [10].

The various uses of AI in research and development are outlined underneath.

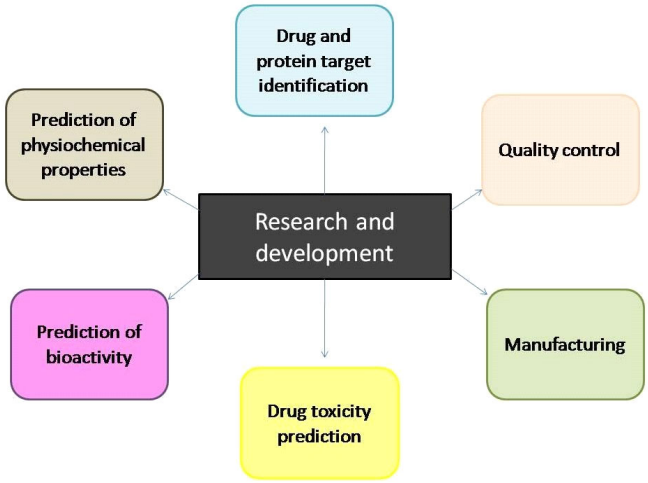

Figure 2. Various uses of AI in research and development

Drug and protein target identification

Finding the most appropriate drug candidates and identifying the pharmacological target are the first steps in the computational drug discovery process. Target selection, which evaluates the draggability of lead compounds and prioritizes prospective targets, thus plays a crucial role in disease pathophysiology. The target selection process requires thorough approaches that participate in the heterogeneous data, comprehend the molecular-level mechanisms of illness manifestations, and also aid to discover the patient- specific alterations due to the complexity of human disease. Advanced methods like AI/ML have been applied to overcome these challenges. [11] The development of ML-based methods has made it relatively simpler to ascertain a target protein's three-dimensional structure. This is important for drug discovery because novel medications are created based on the three-dimensional ligand-binding environment of a protein. Alpha Fold is a recently developed AI-based tool from Google's

DeepMind that can infer the 3D structure of proteins from their amino acid sequences. It was trained on PDB structural data. Protein 3D structures are predicted by Alpha Fold in two steps: An amino acid sequence of a protein is first converted to a distance matrix and a torsion angle matrix using a CNN, and then, using a gradient optimization technique, these two matrices are converted into the three-dimensional structure of a protein [12].

Prediction of physiochemical properties

Evaluating the compound's physical characteristics, bioactivity, and toxicity is apart of the secondary drug screening. Physical and chemical characteristics reveal all facets of medication activity and have a significant impact on drug candidates' clinical success rates. A small molecule drug candidate requires to have the best safety profiles, be sufficiently soluble and permeable to reach its site of action and so engage its targets. Therefore, a new chemical entity can be developed with advantageous pharmacokinetic and pharmacodynamic profiles by accurately predicting the physicochemical properties. To forecast some important physicochemical features, including water solubility, membrane permeability, and lipophilicity, researchers have utilized ML-driven techniques. In the supporting information, we include a thorough explanation of each attribute as well as a discussion of the ML-based methods used to explicitly estimate the water solubility, membrane permeability, and lipophilicity. In preclinical development, absorption, distribution, metabolism, and excretion toxicity (ADME-T) profiles are further optimized to produce prediction models of physicochemical features by effectively processing huge amounts of chemical data.[13] MMP with ML has been used to predict many bioactivity properties such as oral exposure, distribution coefficient (logD), intrinsic clearance, absorption, distribution, metabolism, and excretion (ADME), as well as mode of action. This is due to the dramatic increase in public databases (such as ChEMBL and Pubchem) that contain a large number of structure-activity relationship (SAR) analyses [14].

Prediction of Bioactivity

In practice, a significant portion of medications made from natural ingredients are ineffective because they lack bioactivity. As a result, drug bioactivity assessment has emerged as a hot topic in the drug discovery process. Experiments conducted in vitro and in vivo can imitate the actions of molecules in the human body, but they are nevertheless costly as well as time-consuming. AI approaches have been successfully used to forecast pharmacological bioactivities, such as anticancer, antiviral, and antibacterial activities, because to their cost-effectiveness and time economy. In order to forecast antibiotic activity, Stokes et al. presented a directed message passing neural network. They created a molecular graph for each molecule in line with its SMILES before obtaining the feature vector based on atomic features (such as the number of bonds for each atom) [15]. Recently, new techniques for predicting drug candidates' bioactivity have been created. In this context, Tristan et al. used a graph convolutional network to extract a signature of the drug target site by encoding discrete molecules into a continuous latent vector space (LVS). In molecular space, LVS enables gradient-based optimization, enabling predictions based on differentiable models of binding affinity and other features [14].

Drug toxicity prediction

Engaging new medications in the market is quite difficult because of drug safety. Clinical trial attrition is frequently triggered by unexpected toxicities, and post marketing safety concerns result in undesirable morbidity and mortality. [16] Toxicology is a measure of a substance's undesirable or harmful consequences. One of the key processes in the drug development process is the evaluation of toxicity, which identifies compounds that are toxic to people. [17] To address drug safety, two systems are complementary. Clinical trials evaluate a drug's safety and efficacy for the intended application in advance of getting FDA approval. Drugs are monitored after they are marketed. Adverse event (AE) reports are employed in the pharmacovigilance (PV) [16] process to make sure that the safety data for a medicine is current. For determining the toxic properties of unknown proteins and peptides, experimental toxicological techniques such as in vivo and in vitro methods can be used. However, timely risk assessment, cost of evaluation, and the desire to reduce animal testing are the main factors that lead to an inclination towards the applicability of in silico techniques such as molecular modelling and machine learning (ML). [18] An ensemble model named DeepTox incorporates a three-layer deep neural network (DNN) as the foundation for predicting the toxicity of compounds. The remaining compounds are encoded using the aforementioned 0D to 3D molecular descriptors, which are used as input of DNN, after conducting data cleaning and quality check. The number of hidden units, learning rate, and dropout rate are just a few of the hyperparameters that may be tuned and optimized to create the DeepTox pipeline. In terms of toxicity prediction, comparative results using the Tox21 dataset show that DeepTox performs better than its competitors. [17]

Manufacturing

The pharmaceutical business is given a power boost by AI's use in manufacturing. Since modern manufacturing systems with AI are attempting to impart human knowledge to machines with an increasing interest in efficiency and better product quality along with a reduction in the complexity of the processes of manufacturing, the AI is continuously changing the manufacturing process (Paul *et al.,* 2021). With modern methods like CFD, Reynolds Averaged Navier-Stokes solvers technology thatis used to analyse the stress level in machines, and the misuse of automation in many pharmaceutical processes, AI platforms are making the production process incredibly simple. Simultaneously, according to Chen et al (2016), mathematical simulations are also leading to improved methods for addressing complicated low challenges in manufacturing**.** Numerous chemicals, including sildenafil and diphenhydramine hydrochloride, have been produced using it with the highest yield and purity that is comparable to usual synthesis. By using AI technologies and associated neuro-fuzzy logic, the working capacities of granulation have grown to 600L. With the aid of equations, they offer prediction regarding the amount of fluid to be added, the speed at which the granulating machine must operate, the diameter of the granules, and other factors. Metaclassifiers and tablet classifiers are tools that help administer quality control of the final product by identifying potential production errors in tablets. Also, it reduces the manufacturing process cost [19]

Quality control

The WHO describes quality control as a complete set of actions taken to guarantee the identification and purity of a specific medication. The pharmaceutical industry's fundamental operation is quality control. The primary objective of manufacturing engineering at the moment is to develop a trustworthy production process that might eventually to increase productivity, artificial intelligence applications in pharmaceutical development and drug delivery have been created. [20] Drug makers face a pressing issue with inadequate quality control. Supply chains, product development, production, and quality control have become increasingly complex in recent years as a result of more active chemicals being used in pharmaceuticals and an escalating, quickly expanding demand. For any medicine company and their clients, a lack of oversight and effective quality control has dire consequences. Customers are at risk for allergic reactions that could be fatal due to contamination. The effects of those mistakes may lead to legal action, harm to one's reputation, and FDA regulatory action. For quality control, production, and manufacturing issues caused by these rising complexities and pressures, drug producers must chose the skills AI and other technologies give. The use of AI for product definition in this context, as well as the gathering of pertinent data in support of the process development or characterization could be quite important. [21]

Improve drug adherence and dosage

Artificial intelligence is being used in pharmacy at a rate that has never been witnessed before. AI is becoming more popular in the pharmaceutical industry to determine the proper dosages of medications to be taken in order to protect drug users. In addition to assisting with patient monitoringthroughout clinical trials, it also recommends the proper dosage at regular intervals. [22] In numerous aspects, AI has the potential to enhance Drug Adherence and Dosage.

Personalized treatment plans: To develop individualized plans, AI may analyze patient information including medical history, age, gender, and other variables. this covers the choice of the best medication, the dose, andthe length of the course of therapy. A customized treatment plan can aid patients in sticking to their drug schedule and enhance therapeutic results.

Predictive modelling: Massive databases may be analyzed by AI to find trends and forecast patient behavioral patterns. For instance, AI can identify which patients are most likely to forget to take their prescription or stop taking it completely. Using this information, targeted treatments and reminders may be given to increase medication adherence.

Real time monitoring: Artificial intelligence (AI) can be used to regularly track patients to make sure they are taking the right dosage at the right time. This involves the use of smart tablets, which have sensors that can monitor a patient's medicine intake. When patients miss doses or administer the incorrect dosage, real-time monitoring can notify healthcare professionals.

Side effect management: By examining patient data, AI can potentially beused to manage the side effects of medication. AI can determine which patients are most likely to experience side effects and offer customized management recommendations. This can encourage individuals to take their prescribed medications as directed and minimize their temptation toforego medical care. [23]

- **Forecasting an epidemic or pandemic**:

After 2000, pandemics have been testing AI's capacity to deal with extreme situations. High processing power and the availability of historical and real- time data are the two main aspects that influence AI algorithms. Early warning and notices, disease forecasting and identification, global disease monitoring inreal-time, analysis and visualization of spreading trends, infection rate and trend prediction, rapid treatment decision-making, pathogen study and analysis, and drug discovery are just a few of the various roles that artificial intelligence (AI) plays during pandemics. AI speeds up the actual performance of each of them. [24] Many pharmaceutical businesses and healthcare providers now utilize AI and ML to track and predict epidemic outbreaks around the world. These technologies generate information from a wide range of online sources, analyze how different geological, environmental, and biological factors affect population health in various regions, and attempt to draw connections between these factors and previous epidemic outbreaks. Such AI/ML models are especially beneficial for developing nations without the financial and medical infrastructure needed to handle an epidemic outbreak. [25] The use of AI in the pandemic was briefly summarized, including early infection detection and diagnosis, treatment monitoring, contact tracing, case and fatality predictions, drug and vaccine research, decreased a burden of healthcare providers, and disease prevention. [26]

- **Disease diagnosis:**

Large volumes of patient healthcare data may be collected, processed, and analyzed by doctors using the latest machine learning technologies. Sensitive patient data is being safely stored in the cloud or other centralized storage systems by healthcare providers all over the world utilizing ML technology. Electronic medical records (EMRs) are what are used for this. Any infectious disease is nearly impossible to avoid, and preventing its spread requires continual research and data collection. Therefore, making quick decisions based on accurate information can have a big impact on people's life both socially and financially. The finest aspect of using AI in healthcare is that itallows for advancements in everything from data collection and processing to surgical robot programming. This section explains the many methods and uses of artificial intelligence in healthcare applications, as well as disease symptoms, diagnostics concerns, and an outline for disease detection modelling utilizing learning models and AI. For the purpose of developing a treatment plan and guaranteeing patients' wellbeing, a precise diagnosis is essential. Particularly in general clinical practice and remote areas, human errors limit the diagnostic accuracy and efficiency since understanding medical knowledge is a difficult cognitive activity. Convolutional neural networks, knowledge graphs, and transformers are a few examples of artificial intelligence (AI) techniques that have been proven to be effective and promising in helping with and improving disease diagnosis and even treatment. The use of AI in the diagnosis process helps doctors increase the precision and effectiveness of their diagnoses, resulting in the provision of newly available digitalized healthcare services. [27] A new illness detection model based on the convergence of AI and IoT is presented in

the current research work for smart healthcare systems. The goal is to create a disease diagnosis algorithm for diabetes and heart disease using the convergence of AI and IoT. The many stages of the provided model include data collection, the initial processing, classification, and parameter adjustment. The data collection procedure is carried out by IoT devices like wearables and sensors, and AI approaches then process this data to diagnose the illness. The Crow search Optimization algorithm-based Cascaded Long Short Term Memory (CSO-CLSTM) model is used in the suggested AI and IoT convergence method for disease detection. Additionally, this study uses the isolation Forest (iForest) technique to weed out outliers. The 'weights' and 'bias' parameters of the CLSTM model are tuned using CSO in order to enhance the diagnostic result. Here, CSO is used since it enhances the CLSTM method's diagnostic results. Using healthcare data, the CSO-LSTM model's efficacy was verified. [28]

- **AI in drug prescription:**

Prescription mistakes are one of the key issues that customers or patients still face nowadays. Due to various sorts of drug-drug interactions or other interactions, these mistakes might occasionally cause patients to experience life-threatening situations. Some Drugs should not be prescribed to patients who have kidney illness, diabetes, hypertension, or any of the other conditions listed above. Physicians must take into account a number of criteria before prescribing a single medication. Currently, the doctor investigates the patients and examines their prior medical records to do this. AI can reduce prescription error rates as well as the harmful and toxic repercussions of drug prescription errors. AI-based knowledge robots can serve as a customized self-service consultant for patients or clients, offering the same types of advice and support that the top specialists in the world would be able to provide. These AI bots will send patient information to the outside pharmacy as well as retrieve patient information. Additionally, after reviewing the patient's entire medical history, these AI bots will suggest the optimal medication for the individual, and then they will check and validate the medication that was provided. [30]

- **AI in retail pharmacy store:**

It is possible to forecast a patient's future medication needs by using AI- powered data analytics. The chemist can choose the best stock purchases by using AI to predict the patient's medicine purchases. Even while there are currently available inventory management programmes and tools used in retail pharmacies, like Mckessons, Liberty, Winpharm, PrimeRx, and WinRx, not all of them make use of artificial intelligence or machine learning. For instance, the German online and catalogue retailer Otto group[45] used software created by Blue Yonder, an AI business. 90% of what Otto will sell in the next 30 days can be predicted with 90% accuracy by this software. By permitting direct delivery of the goods from the supplier to the consumer without having to transit through the warehouse, this decreased the delivery schedule for purchased products from one of more than a week to one of two days.[9]

- **Marketing:**

Given that the pharmaceutical industry is fundamentally a sales-driven one, pharma companies can use artificial intelligence to create marketing campaigns that are more specialized and focused. AI tools can be used to: Gather real-time customer data, chart the customer journey, and better comprehend the demands, preferences, behavior, etc. of the client Measure the effectiveness of marketing campaigns and analyze important performance metrics such as conversion rates, retention rates, etc. to create distinctive marketing strategies that are in line with the specific needs of theclient as well as the company's business objectives. Eliminate any shortcomings in current strategies by doing a comparative review of previous marketing initiatives. Additionally, it can be used to forecast the performance of marketing initiatives.[29]

- **AI in market prediction and marketanalysis:**

The pharmaceutical industry will succeed if they create and promote a breakthrough drug. Due to the implementation of multiple restrictions and the companies' failure to embrace new marketing technologies, research and development output in the pharmaceutical sectors is on the decline even if access to large cash and resources is available. Today, market forecasting is made simpler by the ongoing development of digital technologies. Using decision-making models, AI technologies aid in a better comprehension of the pharmaceutical market. These models aid in the collection of mathematical and statistical data, and based on their comprehension, they explore new methods for market prediction. Another crucial component of a product's ongoing market expansion is market design, and this is another area where AI might prove very helpful. By doing a thorough analysis of the fundamental requirements for the product from the perspective of the consumer and comprehending the need of the market, AI aids in building the framework of the market. The product can now be introduced online with the help of AI. Various software that operates on pre-set algorithms aids in the seamless operation of the Product in the cutthroat market. The software uses digital strategies to draw customers' attention to the product, such as showing adverts and sending them to the product's website with just one click. Such strategies have raised product knowledge among the general population as well as among doctors who will prescribe it before company medical representatives [30].

Challenges that pharmaceutical companies face while trying to adopt AI

- The technology's inexperience Due of its youth and esoteric nature, AI still seems like a "black box" to many pharmaceutical businesses.
- Inadequate IT infrastructure, this is a result of the fact that the majority of IT applications and infrastructure in use today were not created or designed with artificial intelligence in mind. Even worse, pharma companies must spend a lot ofmoney on upgrading their IT infrastructure.
- Since a large portion of the data is in free text format, pharmaceutical companies must go above and beyond to compile and convert this data into a format that can be analyzed. Even with all of these restrictions, one thing is certain. AI is already transforming the biotech and pharma industry. [31]

Here are several well-known forecasts on how AI will affect thepharmaceutical sector:

AI will be used for more technical advancement : The potential of AI to revolutionize the industry has already been

acknowledged by pharmaceutical professionals. The digital future of the sector is being drivenby AI and machine learning. Leading pharmaceutical businesses have already worked with AI vendors; shortly, manufacturing, discovery, and research will all benefit more from the technology.

AI will be used for the management of chronic diseases

Pharmaceutical and medicine development firms from around the world should spend more in AI to speed up the study of chronic diseases and fatal illnesses. Oneof the main causes of death in the US is chronic disease. It is fair to assert that AI will be employed to enhance the treatment of chronic conditions, reduce administrative expenses, and undoubtedly, improve patient health. Cancer, chronic renal disease, diabetes, and idiopathic pulmonary fibrosis are a few of the chronic diseases that will be discussed in the upcoming years.

AI will be used to refine the candidate selection process: By optimizing the process of picking candidates in clinical trials, AI will reshape the future of medicines. Through careful data analysis and candidate pool screening, it will guarantee that the best applicants are selected for trials. To reduce errors, factors that affect how accurate the findings are can also be filtered.

AI will enhance the process of medical data extraction: The availability of AI and machine learning tools is predicted to increase significantly in the next years. Associations will be better able to accurately screen and diagnose patients because to this. AI will also make it possible for professionals to get more valuable information out of the current medicaldata. [32]

Conclusion

Pharmaceutical businesses are looking for more advanced solutions as they encounter more complex challenges every year. The AI forces pharmaceutical corporations to embrace digitalization because they have no other choice. Research and development, clinical trials, drug discovery, manufacturing, quality control, disease diagnosis, marketing, etc. have all been significantlyimpacted by the application of AI. IT outperforms humans by a factor of a thousand in speed, accuracy, time savings, cost savings, and labour efficiency. Through thorough market analysis and prediction, AI can also help establish the product's safety and efficacy in clinical trials, as well as ensure correct costing in the market. AI also play a significant role in data storage such as patient medical history, medicinal stock, sale records etc. In summary, the potential of AI in the pharmaceutical sector is very promising. Consequently, it is expected that AI will soon demonstrate to bea very useful tool in the pharmaceutical industry.

List of Abbreviations

AI: Artificial Intelligence
ML: Machine Learning
EMRs: Electronic Medical Records
WHO: World Health Organization
FDA: Food and Drug Administration
DNN: Deep Neural Network
AE: Adverse Event
PV: Pharmacovigilance
LVS: Latent Vector Space
SAR: Structural Activity Relationship
ANI: Artificial Narrow Intelligence
AGI: Artificial General Intelligence
ASI: Artificial Super Intelligence

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