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A Review on Artificial Intelligence in Pharmacy (AI)

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ABSTRACT:-

Artificial Intelligence (AI) has become a popular remedy for issues involving numbers and data. Numerous technological advances have resulted from this discovery in almost every industry, including engineering, architecture, education, business, accounting, health, and so forth. AI has made significant contributions to the healthcare industry in a number of areas, including the management and storage of data and information about patient medical histories, medication stocks, sale records, and more; automated machinery; software and computer applications; and diagnostic tools like CT and MRI diagnostics. All of these have been developed to support and streamline healthcare procedures. The pharmaceutical industry has not been excluded from AI's revolution in healthcare, which has made it more effective and efficient. Over the past few years, there has been a noticeable increase in interest in the applications of AI technology for the analysis and interpretation of several significant pharmacy domains, including drug development, dosage form design, polypharmacology, and hospital pharmacy. We intended to produce a thorough report that would aid every practicing pharmacist in understanding the major advancements made possible by the application of artificial intelligence (AI), in light of the field's expanding significance.

Keywords :- Artificial intelligence, pharmacy, pharmacist, Robots, Machine

Introduction:-

Humanity has come a long way in its quest to comprehend artificial intelligence. Since the dawn of global digitalization, artificial intelligence has been portrayed by the mainstream media as an extremely complex system that can solve problems facing humanity, reveal the mysteries of the universe, trigger or avert a worldwide catastrophe, and perform other momentous tasks.It is possible that this 1995 AI program, created by Newell and Simon, was the first of its kind. John McCarthy is recognized as the father of artificial intelligence and is credited for eventually coining the term. Artificial intelligence (AI) is a branch of study that studies intelligent machine learning, primarily through intelligent computer programs that produce outcomes akin to those of human attention. In general, this process entails gathering information, creating effective methods for using that information, presenting precise or approximative conclusions, self-corrections, and adjustments. Artificial intelligence (AI) is typically used to analyze machine learning and mimic human cognitive activities . AI technology is used to obtain meaningful interpretation and to conduct analyses that are more accurate. From this angle, artificial intelligence (AI) technology combines a variety of practical statistical models with computational intelligence. Reflecting on the past 25 years, pharmacy has done a great job of addressing the growing demand for prescriptions, even when faced with pharmacist shortages, growing operating costs, and lower reimbursements. Pharmacy has also done a great job of leveraging enabling technology automation to improve workflow efficiency and lower operating costs while promoting safety, accuracy, and efficiency in every pharmacy setting. Automated dispensing gives pharmacists more time to engage [1].

Although attempts by classical philosophers to characterize human thought as a symbolic system date back to 1956, the discipline of artificial intelligence (AI) was not fully established until 1956, when the name was invented at a conference held at Dartmouth College in Hanover, New Hampshire.This article's goal was to review many AI-related subjects. The topics covered include the general overview and classification of artificial intelligence (AI), its applications in hospitals, the pharmaceutical industry, and retail pharmacies. Additionally, the aim is to raise awareness of AI as a potential future component of pharmacy practice, to motivate pharmacists to embrace this advancement, and to make every effort to acquire the necessary skills so that they can contribute to the much-anticipated development.[2].

Fig no.1(Artificial Intelligence in pharmaceutical Market)

General Overview:-

The contemporary environment facing the pharmaceutical business is characterized by long and costly drug discovery cycles as well as pressure from payers and consumers on prices. Merely analyzing drug discovery data is insufficient.Pharma needs to take note of the analytics in order to stay competitive.Artificial Intelligence, another disruptive technology, is used to achieve this. AI may be characterized in simple words as "It is the study of ideas which enable computers to do the things that make people seem intelligent.[3].

Artificial intelligence and robotics:-

Robotics and artificial intelligence have a long history of scientific debate and collaboration as well as a common origin.It may be argued that not all machines are robots, and virtual agents are undoubtedly a concern of artificial intelligence.A robot is a piece of hardware, and artificial intelligence is a hypothesis.[4] The relationship between these two lies in the fact that the robot is controlled by software agents that interpret information from these sensors, make decisions about what to do next, and then focus their energies on acting in the real environment.It is widely used in robotics . Additionally, patients will look into potential drug options as they become more involved in their healthcare decision-making. Pharmaceutical businesses can further ensure that the proper information is supplied at the appropriate time to promote informed talks about patents and providers by implementing target audience marketing.[5]

Types of AI:-

AI scientists categorized AI technology according on whether it was implemented or not. They are listed in the following order:-

Type 1:-

We refer to this kind of AI system as a reactive machine. For instance, the IBM chess algorithm Deep Blue defeated Garry Kasparov in the 1990s. It lacks the memory to draw on prior experiences, yet it is capable of identifying checkers on a chessboard and making predictions.

Type 2:-

A limited memory system is the name given to this kind of AI system. This approach can apply lessons learned from the past to current and upcoming issues. Only this strategy is used in the design of various decision-making functions in autonomous cars.

Type 3:-

This type of AI system is called as "theory of mind". It means that all humans have their thinking, intentions, and desires which impact the decisions they make. This is a non-exist AI.[6]

Type 4:-

These are called self-awareness. The AI systems have a sense of self and consciousness. If the machine has self-awareness, it understands the condition and uses the ideas present in others' brains. This is a non-existing AI.

Application of AI:-

AI is used in hospital-based health care systems in a variety of ways, including determining appropriate or available administration routes or treatment strategies, organizing dosage forms for individual patients, and more[7].

Maintaining of medical records:-

Maintenance of the medical records of patients is a hard task. By using the AI system, data collection, storage, normalization, and tracking are made simpler. In a brief amount of time, Google's Deep Mind Health Project [8] helps to quickly uncover medical records.

Treatment plan designing:-

AI systems are required to maintain situational control. The treatment plan provided by this technology takes into account all of the prior data and reports, clinical expertise, etc. With the help of insights gained from working thousands of hours with physicians at Memorial Sloan Kettering Cancer Center, IBM Watson for Oncology[9] is a software as a service that uses cognitive computing to make decisions. It analyzes patient data against thousands of past cases and offers treatment options to help oncology clinicians make well-informed decisions.

Health support and medication assistance:-

AI technology has been shown to be effective in recent years for both pharmaceutical assistance and health support services. Molly[10], a virtual nurse created for a start-up, is greeted with a friendly face and voice. Its goal is to support patients with their chronic ailments during doctor appointments and assist them in directing their own treatment. An program called Ai Cure[11] that works with a smartphone's webcam tracks patients and helps them manage their diseases.

Drug creation:-

Pharmaceuticals require billions of rupees and more than ten years to manufacture or create. The AI program "Atomwise"[12], which makes use of supercomputers, is helpful in determining treatments from the molecular structure database. It launched a virtual search campaign for an Ebola virus treatment that is both safe and effective using already available medications. Two medications that led to an Ebola infection were found using technology.

AI helps people in the health care system:-

Among the ten most promising technologies of 2016, the "open AI ecosystem" [13] was listed. Compiling and contrasting the data from social awareness algorithms is helpful. A great amount of data, including treatment history and patient medical history from childhood until that age, is recorded in the healthcare system.

Healthcare system analysis:-

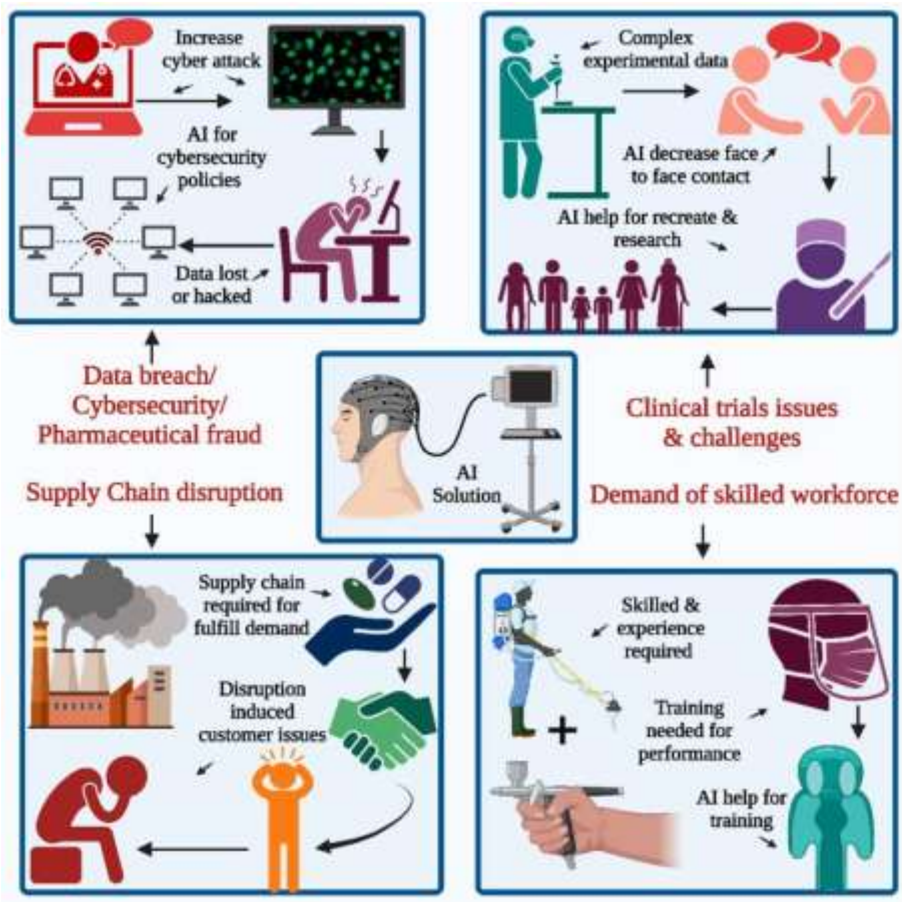
In the healthcare system, if all the data is computerized then retrieval of data is easy. Netherland maintains 97% of invoices in digital format which contain treatment data, physician names, and hospital names. Hence, these can be retrieved easily. Zorgprisma Publiek, a local company analyses the invoices with the help of IBM Watson cloud technology.

AI and development of pharmaceuticals [14]:-

Leading pharmaceutical businesses are working with AI vendors and using AI technology into their manufacturing processes to find new drugs and conduct research and development. Reports reveal that 62 percent of healthcare organizations are thinking of investing in AI shortly, and 72 percent of corporations believe AI will be vital to how they do business in the future. Pharma News Intelligence delves at existing AI use cases, the best usage of the technology, and the future of AI and machine learning to provide a better understanding of the future of AI in the industry.

AI in pharmacy practice in hospital and community :-

Email personalization is made possible by machine learning algorithms, which enable faster and more accurate personalization than any human. It is possible to boost service delivery efficiency by utilizing chatbots . Chatbots can simulate interactions between consumers and salespeople or customer service representatives. Walgreen teamed up with telehealth company Medline to establish a video chat platform that enables patients to communicate with medical specialists. AI has applications in inventory management as well. Imagine being a retail pharmacist who can forecast what your patients will require in the near future, stocks them, and uses customized software to send emails to remind them of prescription requirements. Not all retail pharmacy stock management companies, such as Mckessons, Liberty, Winpharm, PrimeRx, and WinRx, use AI or machine learning. For instance, German online and catalog retailer Otto group used tools developed by AI startup Blue Yonder. 90% of the products that Otto will sell in the next 30 days can be predicted with this software. Medical Center prepares and tracks prescriptions using robotic technology. They claim that the technology has flawlessly prepared 3,50,000 doses of medication. The robot has shown itself to be far superior than humans in terms of both size and medication delivery accuracy. The automated system can also prepare sterile preparations intended for chemotherapy and fill intravascular syringes with the appropriate medications, adding to its capabilities. The thin plastic ring contains all of the medications that a patient needs to take within a 12-hour period[15].



Current pharmaceutical challenges and the role of AI:-

Because of their many benefits, small molecules are the subject of ongoing research in the pharmaceutical business to improve goods and consumer satisfaction. While the preparation of synthetic derivatives is inexpensive, the chemical synthesis process is straightforward. There are thus a lot of stable and effective small-molecule-loaded formulations available in the pharmacy industry.

These procedures put more financial pressure on businesses to innovate more. To make up for the problem brought on by tiny molecules and the inadequate distribution of research and discoveries, the biomolecular medication business is nevertheless expanding quickly. The shape and reactivity of small molecules determine their effects .

The supramolecular sequence and the spatial conformation also affect their stability and function Certain biomolecules, like insulin and adalimumab, are highly profitable products. Given that infusion is these biomolecules' preferred and most practical mode of administration, the pharmacokinetic characteristics of these compounds complicated.

Pharmacokinetic modulation and molecular stability are critical components of nucleic acid-based research.

The pharmacokinetic exposure and optimization of these molecular forms are critical objectives. New technical advancements may be useful in addressing these obstacles and resolving related issues .Although AI has enormous potential in medication delivery innovation and drug development, it still has some significant limitations that will require human intervention or intellectuals to comprehend the complicated data.

The majority of AI predictions are based on datasets, but the interpretation of the results, due to the gray zone, necessitates human intervention to reach the appropriate conclusion. Additionally, AI can encounter issues with algorithm bias when processing information for predictions and assessing hypotheses, and docking simulations frequently result in the discovery of inactive molecules [16].

As a result, a comprehensive review of these characteristics still requires human intervention for effective decision-making and cross-verifications to rule out system bias concerns. Nonetheless, there is enormous promise for AI applications, and further research may be able to lessen AI's limits and make it more effective and dependable .

In terms of artificial intelligence, the approach that is being used makes use of machine learning or any of its subsets, including natural language processing and deep learning. Both supervised and unsupervised learning are possible, and the kind of algorithm used is also very important. Unlike unsupervised learning, which works with unknown outcomes, supervised learning is a machine learning process that makes use of known inputs (features) and outputs (labels or targets). With the supervised approach, several inputs or attributes are used to predict the output, such as labels or targets. Conversely, the goal of unsupervised classification is to form feature-homogeneous groupings .Several artificial intelligence (AI) models have been investigated to improve various parts of the pharmaceutical product development process.

Supervised AI Learning:-

Task-driven strategies involve setting specific goals for achieving desired outcomes from a given set of inputs. This approach uses labeled data to train algorithms for tasks like data classification or outcome forecasting. It is widely applied in many applications, including image recognition, natural language processing, and predictive modeling.Classification (i.e., label prediction) and regression (i.e., quantity prediction) are the two most common supervised learning problems. Depending on the type of data in a particular problem domain, supervised learning problems can be solved using a variety of approaches. Naïve Bayes, K-nearest neighbors, support vector machines, ensemble learning, random forest, linear regression, support vector regression, and other methods are some examples of these techniques. [17].

As outlined below, it has a number of uses in the pharmaceutical sector :-

- Drug Discovery and Design:-It is possible to forecast the characteristics or activity of novel therapeutic options using supervised learning algorithms. The model may identify patterns and connections between desired outcomes and molecular properties by training on a dataset of known substances and the actions that go along with them. This helps with drug discovery and design by enabling the prediction of novel compounds' activity, potency, or toxicity
- Predictive Maintenance and Quality Control:- By training on data from manufacturing processes, equipment sensor data, or quality testing results, the model can learn to predict equipment failure, product quality deviations, or process abnormalities, allowing for proactive maintenance and quality assurance . Supervised learning can be used for predictive maintenance and quality control in pharmaceutical manufacturing.
- Drug Target Identification:-By examining biological data, supervised learning algorithms can assist in identifying possible drug targets. The model can learn patterns and indicate possible targets for more research by being trained on data pertaining to genomic, proteomic, or transcriptomic traits and their relationship to treatment response or illness progression
- Disease Diagnosis and Prognosis:-Based on medical data, supervised learning algorithms can be used to forecast patient outcomes or make illness diagnoses. The model can learn to classify patients into distinct illness categories or predict disease progression or response to treatment by training on labeled datasets that comprise patient features, clinical data, and disease outcomes [18].
- Adverse Event Detection:-Pharmacovigilance data can be used to classify and identify drug-related adverse events using supervised learning algorithms. The model can assist in the identification and characterization of adverse events by learning to spot patterns and potential safety signals by training on labeled adverse event reports.
- Predictive Modeling for Clinical Trials:-Clinical trial results can be predicted by supervised learning. The model can be trained to predict patient response, treatment efficacy, or safety outcomes using historical clinical trial data, which includes patient characteristics, treatment interventions, and trial outcomes. This data can improve patient selection and serve as a guide for trial design .

Unsupervised AI Learning:-

When an algorithm receives no labeled data, it is said to be engaged in unsupervised learning. Rather, its job is to find patterns and connections on its own in the data. This method is frequently applied in exploratory data analysis and is helpful for identifying hidden clusters or structures in a dataset. This strategy, which is sometimes referred to as a "data-driven methodology," seeks to identify patterns, structures, or insights in unannotated data.

Popular techniques like clustering algorithms (e.g., hierarchical clustering, K-means, K-medoids, single linkage, complete linkage, BOTS), association learning algorithms, and feature selection and extraction techniques (e.g., Pearson correlation, principal componeint analysis) based on the characteristics of the data can be used to address a variety of unsupervised learning tasks [19].

Pharmaceutical applications might benefit from unsupervised learning approaches in AI, especially for data visualization, pattern identification, and exploratory analysis, as will be discussed below:-

- Clustering:- Data points are grouped by clustering algorithms according to their similarities, which makes it possible to find logical groups or clusters within the data. To find subgroups with comparable traits, clustering can be used in pharmaceutical applications on a variety of datasets, including gene expression patterns, chemical structures, and patient data. Target identification, patient stratification, and the discovery of various classes of chemicals or disorders can all benefit from this
- Anomaly Detection:-Anomaly detection algorithms identify rare or unusual data points that deviate significantly from the expected patterns. In the pharmaceutical industry, anomaly detection can be useful for detecting adverse events, identifying potential safety concerns, and uncovering data quality issues. Unsupervised anomaly detection techniques, such as the local outlier factor (LOF) or isolation forest, can help highlight abnormal patterns or data points that warrant further investigation.

- Association Rule Mining:-The Apriori algorithm is one example of an association rule mining tool that looks for intriguing relationships or associations between objects in a collection. Association rule mining can be used in the pharmaceutical industry to analyze data on adverse events, drug-drug interactions, and co-occurrence patterns between drugs and medical problems. These methods can help with pharmacovigilance efforts, reveal patterns in medicine use, and offer insights into possible drug interactions.
- Topic Modeling:-Topic modeling algorithms, such as latent Dirichlet allocation (LDA), extract latent topics or themes from large text datasets. In the pharmaceutical industry, topic modeling can be used to analyze the scientific literature, clinical trial reports, or social media data to identify key research themes, emerging trends, or patient sentiments. This can aid in literature mining, competitive intelligence, or understanding patient perspectives [20].

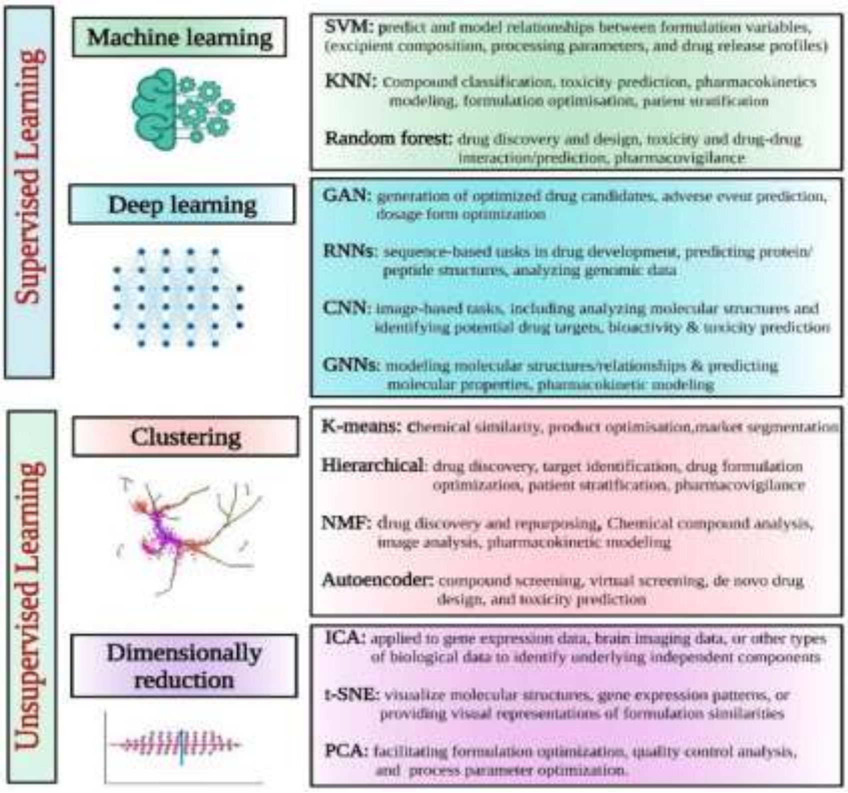


Fig no. 3

AI for Oral Solid Dosage form Development:-

AI is the use of modern tools and software to obtain human-like skills. Over the past few years, this kind of innovation has proven beneficial in numerous industries, including the pharmaceutical sector, particularly during the product development stage. The application of these technical advancements can reduce the amount of time, money, and resources needed for production and efficient supply chain delivery to final consumers. Additionally, it offers a more comprehensive framework for comprehending how process parameters affect product formulation and production.

Run Han et al. investigated using machine learning techniques to forecast the stability of solid dispersion over a six-month period. The use of machine leaching in solid dispersion dissolving investigations was examined by Hanlu Gao et al. To create a classification model that aids in further differentiating between the spring and parachute types of dissolution profiles, they employed a random forest algorithm. Additionally, it helped to sustain supersaturation with a sensitivity and accuracy of 86% and 85%, respectively. Based on the regression model generated by the random forest technique, the time-dependent release of the medication was anticipated .

Tablets are one of the most often used dosage forms in the pharmaceutical industry, where solid dosage forms are the norm. Depending on the kind of tablet, there are numerous components to the preparation. AI can support both the investigation of the desirable properties involved in the formulation and the search for its optimal form. With the use of automated technologies and algorithms, AI is also anticipated to handle obligations. The regulatory bodies face a challenge in updating their policies about current good manufacturing practice (cGMP) due to the deployment of AI.[21]

A variety of artificial intelligence (AI) technologies, including neural networks, fuzzy logic, and artificial neural networks (ANNs), in addition to genetic algorithms, are used to design stable dosage forms and improve comprehension of the inputs and outputs for operations and processing. While evolutionary algorithms are utilized to forecast the outcomes of the use of input parameters, artificial neural networks (ANNs) are used to improve prediction abilities for solid dosage forms .

AI can also be used to forecast drug release in the setting of systemic drug delivery. It is also used to look into the impacts of important processing parameters that are essential to the production of tablets, which might guarantee uniform quality control procedures. Tablet flaws have been identified using some AI applications.

AI role in Pharma:-

- A survey found that 80% of pharmaceutical and life sciences professionals are currently using AI for drug discovery.
- 95% of pharmaceutical companies reported that they are investing in AI capabilities.
- AI technology is helping pharmaceutical companies to shorten the drug discovery process from 5-6 years to just one year.

AI applications can potentially create between $350 billion and $410 billion in annual value for pharmaceutical companies by 2025.[22]

AI Models in Pharma Industry:-

- Generative Adversarial Networks (GANs)
- Recurrent neural Network (RNNs)
- Convolutional Neural Network (CNNs)
- Long short- term Memory Networks (LSTMs)
- Transformers Models
- Reinforcement learning (RL)
- Bayesian Models
- Deep Q- Networks (DQNs)
- Autoencoders
- Graph Neural Networks (GNNs)

Communication with Patients:-

Medication reminders can be automatically sent to users' voice assistants, messages, or phones using AI-powered systems. These reminders assist patients keep track of their prescription schedules, enhance adherence, and drastically reduce the likelihood of missing doses. Healthcare has undergone a transformation thanks to artificial intelligence technologies, which has improved patient satisfaction, health outcomes, and medication adherence .[23]

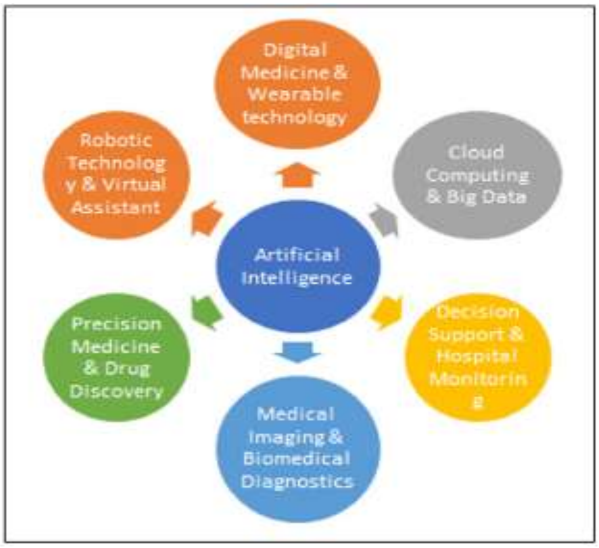


Fig no . 4

Possible Challenges to using AI in Pharmacy:-

AI's adoption may be slowed by a lack of knowledge and familiarity with its possible applications in the pharmaceutical sector. Yet another significant barrier to the mainstream application of AI is privacy and security concerns over personal data. AI systems run the risk of violating patients' confidentiality and privacy because they depend on personal data to perform essential activities. Artificial intelligence still lacks complete safety and privacy protection. Given the high cost of AI technology, incorporating AI systems in the pharmacy setting may come with a hefty financial cost. Furthermore, a lot of pharmacists can be reluctant to accept change and use AI out of concern that it would replace them in the workforce. This is most likely a result of their awareness of how AI.[24]

Advantages of AI :-

- AI is defines useful and powerful machines
- It also solving the new problem , it offers a new technique to solve our problems
- The conversions of information into knowledge
- They minmize the error
- They consume the time as compared to human

They don't take breaks like human

Disadvantages of AI:-

- High costs:- it requires huge cost to buy they are complex machines.
- Diffulties with software development.
- Few experienced programmers will required.
- We get addicted to it and we will depend on it.
- Difficulties and usefulness of artificial and robotics have difficult in the process.

Conclusion:-

Artificial Intelligence (AI) combines artificial intelligence with human expertise and resources. Even for those who view artificial intelligence as an enemy, the field of study into the technology is still in its early stages, and there are many intriguing applications being developed. Consequently, it is highly advised that pharmacists obtain the necessary hard skills to support AI augmentation. In all areas of pharmacy practice, exposure to and education regarding AI are crucial. During their PharmD program, pharmacy students ought to be exposed to the principles of AI and data science via a health informatics curriculum. Additionally, pharmacists must be permitted to learn about AI through continuous education.[25]

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