NANOTECHNOLOGY AND AI THE FUTURE THAT HOLDS THE PHARMACEUTICAL INDUSTRY

Abstract

Every field has its own advancements and trends that don't volatile tomorrow, after a month or a year. Advancements and trends should not only help the present but the past for many more years together. One such futuristic trend in the field of biotechnology that has and will have advancement is the involvement of nanotechnology and AI in life sciences. Biotechnology itself is a broad spectrum of research hub where technology along with biology plays an important role in diagnosis, treatment, drug formulation, drug repurposing, drug molecule identification, and imaging. Nanomedicine is the use of nanotech in the field of pharmaceuticals for easy and accurate diagnosis, drug delivery to particular sites, imaging of the area, and precision medicine are made easy with the help of nanomedicine combined with AI. AI integrated with nanomedicine for diagnosis and drug delivery was briefed for better identification of nanomedicine with AI.

Keywords: Artificial Intelligence, Nanomedicine, futuristic trend, Drug delivery, Diagnosis

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I. INTRODUCTION

The year 2019 can never been forgotten with the outbreak of the pandemic locked in our houses waiting for the drugs or any technologies to come out of the new normal. In the era of new technologies and growing amount of new techs day by day advancements we were not able to find the right vaccines from the thousand and millions of drug candidates. Anti-viral drugs that are opted to cure HIV, Ebola that have a wide range of antiviral activity was chosen as first preference. Remdesivir a drug used to treat Ebola was given as a first measure for COVID 19. Still, when all these drugs repurposed or combination of the drugs, their uses and disadvantage of them were not found. People went to vaccinations an easy method while still an oral drug is at early stage even after two long years. There are many other diseases across the globe which can be treated with drug repurposing or identification of a suitable drug compound can save lives. In the era of digitalization and technologies we still lack in many ways. Nano medicine and diagnostics using nanotechnology combined with AI can address most of the diagnostic and treatment problem. No one in the world is alike nor is no two alike. Just like that diagnostics of the same diseases cannot be identified in an easy way for two different people. Hence nanotechnology with AI helps in reaching the segments of diagnostics with clear and better imaging and collection of the omics data helps to know the background of the patient there by knitting their diagnostic and treatment procedures. The diagnostics of nanotech with AI like nanopore sequencing and omics helps in precision medicine and customized diagnosis of patients affected with diseases. Nanomedicine with AI on the other hand can reach the blood brain barrier while they can be visualized. Nanomedicine often enters the particular area of action and then releases the drug compound. The drug delivery along with the drug purposing attaining synergy is made easy with AI. There are numerous algorithms and models that help in drug delivery. ANN (Artificial Neural Network) is a well-known and one of the widely used models in MRI scan with drug delivery mechanisms. With nanotechnology itself being a futuristic application in the field of medicine. Nanotechnology with AI can definitely decode much more sectors and innovations in the field of biotechnology studying the endless possibilities of humankind and the core it.

II. ARTIFICIAL INTELLGENCE IN DRUG DELIVERY SYSTEM FOR VARIOUS TYPES OF DISEASES

AI has a vast range of applications in almost all the techno industries. AI has also set its foot in the biotechnology industry for its various applications and advantages when compared to other system. AI has been used to deliver drugs, drug discovery, stabilizing the proteins, liposome, and so on. The various application of AI in nanotech, nano medicine, disease recovery and stabilization are discussed as one of the current and the futuristic aspects of biotechnology.

1. **AI in Nanomedicine:** Nanotechnology itself is a very vast field with millions of applications in tons of industries still unwinding their utmost possibilities. The use of nanotechnology can be seen in industries like computer science, mechanical, civil, architectural and what not they have stepped in the life science stream of biotechnology also. Nano defines a small molecule or particles that are much smaller than the size measurement we see in a microbiological laboratory. The use of nanotechnology needs to be optimized almost in every aspect when they are used for drug delivery. Drug delivery itself is a vast field where enormous methods and techniques are used for the safety

delivery of the selected drug into the targeted area. Nanotechnology is a great boon in the pharmaceutical industry and in the medicinal field. Nanotechnology allows the delivery of drug at the right time, right dose to the particular site. The usage of nanotechnology in the field of medicine is nanomedicine. Nanomedicine embeds particles that are of nano-size used for drug components and imaging agents that can improve the outcomes after treatments and efficiency in contrast. the drawbacks in the traditional drug delivery are enhanced using nanomedicine. The drug dosage, timing and the area of action varies from person to person (nikita 2022). There are few regions in the human body were the drug molecules are not able to penetrate and the first pass effect is also high.

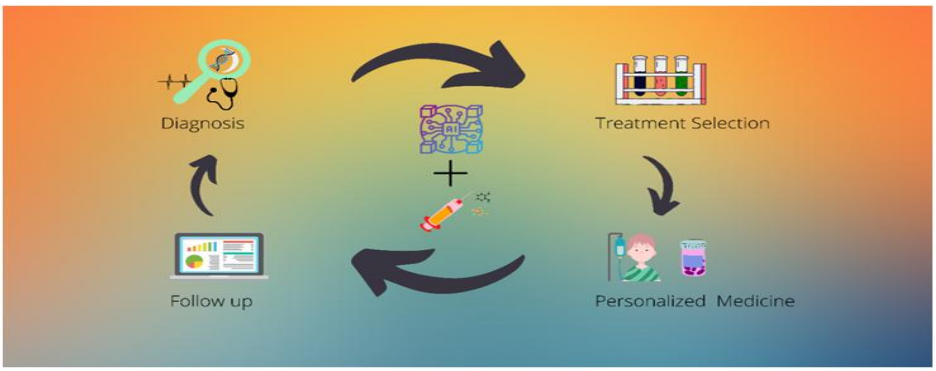

Figure 1: Nanomedicine with AI a Cycle for Better Health, Diagnosis, Treatment and Recovery

Nanomedicines can surpass these barriers, have greater efficiency in action, high recovery rate and was able to target the specific region. With few nanomedicines that are being approved by the FDA like abraxane, liposomal drug molecules, silicon, polymers, carbon-based materials, metals, composites, imaging devices are used in the field of nanomedicine for deter diagnosis, imaging, screening and drug delivery. Nanomedicine is used along with AI because of synergy. Nanocarriers like liposomes, nanocapsules, nanospheres, carbon nanotubes and many carriers are used along with AI for drug delivery for diseases. Synergy or synergism is a term that is used to define the balance that was obtained when two or more drugs are combined and was used as a combination therapy to an individual. Drugs often act as an antagonist for the same patient as they differ in the course of time. Reaching synergy was quite an impossible task when the traditional method was considered. Some compounds maybe quite promising and obtain a good level of synergy but when they are really combined they don't perform up to the standard [1]. Synergy is dose specific, patient specific and time dependent which is always been a hurdle for drug discovery and delivery. There are few drugs that are impossible to combine but when combined they outperform the ones that are expected to perform well. Other than synergy maintaining a global optimization value where the drugs don't react in different ways for the patients with the same disease is another feisty task. The level of synergism and the reaction method pathway, dosage and site of action differ for patients in the course of time. In order, to optimize the dosage, track the pathway, find the gene or any area of interest to maintain the global optimization standard nanomedicines are combined with artificial intelligence (AI). AI helps in dynamic modulation and treatment in patients addressing the drug and dosage space and optimization simultaneously giving better efficiency [2].Big data approaches were used to

collect the medical history, genetics, omics and what will be the outcome of the therapy. This helps to scrutinize the information and target the drug therapy with much safer and efficient way. The use of CURATE.AI technology helped in liver transplant immunosuppressant studies by optimizing the dosage rates using parabolic personalized dosing (PPD) targeting tacrolimus. The use of AI along with nanomedicine is used to cure many diseases like cancer, cardiovascular diseases, brain diseases, antiviral, immunology, targeted therapy, personalized or precision medicine studies and much more.

Table 1: Nanotechnology with AI in Drug Delivery and Diagnosis

Disease	Nanotechnology with AI	Research models and effectiveness
Alzheimer Disease (AD)	Naive Bayes (NB), K-Nearest Neighbor (KNN), and Support Vector Machine (SVM), Artificial Neural Networks (ANN).	These joint models with constrained frequency was able to achieve best accuracy of 97% in the diagnosis along with MRI **[3]**.
Parkinson's Disease (PD)	Machine learning, D Convolutional Neural Network (D-CNN), graph convolutional neural network (GCN),	Used o detect different dimensions of the brain with an accuracy of above 90% in both male and female. Mostly all the above models are used with different combinations according to the area **[3]**.
Major Depressive Disorder (MDD)	Support Vector Machine (SVM), Generative Adversarial Network (GAN	Has about 75% accuracy. SVM, and GAN was the widely used models of which SVM alone can detect above 90% with accuracy when compared to GAN **[4]**.
Cancer Treatment	CURATE.AI	Has been used to monitor and deliver drug mostly for combination therapy diseases **[4]**.
Cancer Treatment	Quadratic phenotypic optimization platform.	Helps in the optimization of drug for prostate cancer (PSA) which controlled the growth of the cancer **[5]**.
Viral Diseases	Tenofovir with Quadratic phenotypic optimization platform.	Tenofovir is a drug used along with HIV. The drug dosage can be decreased after use for a long time and without relapse. The drug was optimized and monitored with the help of AI in nanomedicine **[5]**.
Cardiovascular Diseases	Deep Learning	Obstructive coronary artery prediction **[5]**.
Cardiovascular Diseases	Unsupervised learning	Identify high risk phenotypic patterns, ventricular functions on the left, echocardiogram **[5]**.
Cardiovascular Diseases	Supervised Learning	Prediction of cardiac arrest by myocardial perfusion **[5]**.
Mycobacterium tuberculosis (MTB) infection	Nano medicine with AI	From 14 drug candidates was able to identify the powerful combinations that have changed as antagonist making drug discovery and repurposing a time saving and cost efficient **[6]**.

Applications of AI in nanomedicine

- AI with nanotechnology can make drug repurposing easy by reducing the antagonist.
- They save time and are cost effective
- They can track the area of interest and reach any part in the body
- Have less relapses and better recovery rates
- At least 5-fold increase in specificity, sensitivity and accuracy
- Optimization of nanocarriers using AI
- Easy and effective way for precision medicine.

2. Nanotechnology with AI in precision diagnostics: Each person is unique along with the differences that can be seen in the naked eyes such as gender, age, height, eye colour, blood type and so on we also have unique signature such as molecular signatures. Because of different molecular signatures there are changes in the phenotype and responses for the drug in different patients. This state of diversity among the patients are been especially in cancers that are caused by the mutations that lead to the intra tumour and interpatient heterogenecities that can complicate the diagnosis in the treatment of cancer. The main aim of precision medicine is to provide a specific treatment regimen for each person according to their multiple genetic and epigenetic characteristics.

The purpose the nano materials has also been contributing precisely for all the medical stages, some of the new collection technologies of omics such as single-molecule nano pore sequencing methods that will be used for the fast, safe and secure single-molecule detection that has the longest sequence length and can maintain the context of gene. Nano medicine was also used as a biomarker and for the treatment of cancer this approach is mainly used to for reducing the side-effects and improving the efficacy of the drug by using the targeted systems for the analysis of drug activity inside the body of the patient [7].

Various advancements in nano medicine that is mainly the fabrication technique that can help in increasing the understanding of the cancer biology and promoting the rational design for the targeted therapy. Even if there are advancements in nanotechnology, the usage of sensors in nanotechnology and targeted nanomedicine made only limited success in the clinical translation in the cancer field. Artificial intelligence is one of the branches of computer science that can relate the machines to perform the task that will require human intelligence. The machine learning a part of artificial intelligence is an approach that can train the algorithm by using large sets of data and it will be applied to find the patterns and can classify the data to get an optimal solution to the problem that is presented. The machine learning and artificial intelligence are generally used in different fields of medicine that will include medical imaging and the gene expression pattern analysis. For the design of nanomaterials and implementations the computational method using the artificial intelligence are used. The artificial intelligence and the other computational methods that are used in the nano informatics were applied for the design of nanomaterials and implementation of those materials in the treatment of medicine.

Algorithms can be used for processing the set of data and can recognise the complex pattern easily so they can be used for the improved design of nanotechnology mainly in the diagnostics and treatment. The artificial intelligence algorithms can be used for the nano particle interaction prediction with the drug target, biological media, cell membrane and along with that the encapsulation of drug molecule and the release of kinetic that can help in the optimisation of nano medicine formulations. Along with that recognition of patterns and the algorithm classifications can also be used for the differentiation between the healthy person and patients and that can help in prediction of efficacy of drugs in patients. These types of analysis are essential in cancer medicine because of the complexity of the mechanism [1].

Nano materials and artificial intelligence in precision diagnostics
Omics toolkit. Expansion

The most important requirement in precision medicine practicing is the assemblage of molecular profiles for each and every patient. This will include disease relevant biomarkers that can provide a pathway for the personalized treatment plan and assemblage of molecular profile mainly based on the omics data that are comprised of genomic, epi genomic, transcriptomic, metabolomic, proteomics and microbiomic data which will all be compared together and forms a distinct molecular signature for a patient. The nanotechnology can helps in improvement of speed and precision of sequencing technologies that is mainly used in the collection of omics data that is in particular third generation sequencing methods like single-molecule real-time sequencing and nanopore sequencing will help in the direct analysis of the secondary linear molecule without any need of amplification of template that will reduce the reading errors. In the usage of nanopore sequencing method artificial intelligence can be applied in the translation process in the raw signal to the nucleotides sequence. The artificial neural network is the mostly used algorithm in the nanopore sequencing. Quantum sequencing is also a type of nano sequencing method but the machine learning algorithms are used for the interpretation of the signals like artificial neural networks.

Biomarker profile composed by nanosensors

Nanosensors are specifically designed to detect the target analyte by using the optical electromagnetic or mechanical signals. The usage of nanosensors in nanotechnology can help in diagnostic profile composing mainly for the cancer patients for achieving the disease detection of the early stage and personalize the plan for the treatment of patients and can help in the monitoring of the disease progression. The sensors that can be made more sensitive and portable can make its usage in point of care devices in cancer patients in monitoring and diagnosing. There are various clinically approved biomarkers used in cancer studies but single biomarker usage is not enough hence multiple biomarkers must be used for the improvement. The multiplex sensing of more biomarkers can be used for making the disease signature mainly based on the computational analysis so that the accuracy can be increased in diagnosis. Multiplex nanosensor arrays can also be used for the detection of target biomarker. For the multiplex analysis of a large analytes the electronic nose nanosensors are mostly used [1].

3. Future outlook in nanotechnology and AI in precision diagnostics: The process of

development and implementation of the precision medicine is making revolution in the diagnosis and care for cancer patients. The usage of AI along with precision medicine is making the process easier and less time consuming.

The classifications of patients are the most vital part in the precision medicine where the improvement needed to be done in treatment regime and must be personalised. The method called unsupervised learning method can be used where the cluster patients groups without any categorisation that is predefined can be used as assistance in the detection of the new features that can be considered as an important treatment regime for a patient.

The follow up after the completion of the treatment has not been discussed often when they are compared to the treatment and diagnostic stages. This future follow-up after the treatment can also be implemented with the help of artificial intelligence and they can group it and they can be considered as the precise follow-up treatment for the patients. Some of the combination techniques such as microfluidic techniques and the smart phone integrated platform can also be provided for simplifying the patient oriented devices and will allow more frequent follow ups without even increasing the burden on the medical teams.

Computation method can become essential for the implementation process of process in medicine from the starting of molecular data collection to the treatment stages and diagnostic stages. Artificial intelligence can also be used for the classification of patients, drug suitability screening for patients and for nanomedicine optimisation according to their properties.

The specific computational models designing process for each and every patients according to their needs is another emerging approach that can help in the improvement of process and medicine accuracy. There are some computational approaches and simulations models for the treatment of hepatitis c patient on the drug used is Ribavirin. This approach can be translated for the cancer patients that can help in improved metabolomics, diagnosis and screening of drugs.

There are various usage of integrating the artificial intelligence systems into the biotechnology that can improve the efficiency and accuracy of the machines in all the fields including pharmaceuticals research, enzymology, medicine, fermentation technology and so on.

III. CONCLUSION

From the chapter we can conclude that biotechnology and artificial intelligence will make the greater heights in the future. Artificial intelligence used in drug delivery systems can be used as a cure for various types of diseases. The integrated usage of nanotechnology along with the artificial intelligence that helps in the treatment and diagnosis are discussed. The nano medicine can be used for the treatments of various diseases including alzheimer disease, cancer, hiv and other diseases were listed in the paler. Here, nanotechnology combined with artificial intelligence in the precision diagnostics of the cancer is described in detail where the computational models used in artificial intelligence systems for the

treatment, diagnosis, relapse of each person and its future outlook has also been described. From this we can identify that the future with the help of artificial intelligence technology integrated with various other biotechnological fields and studies to make a prospective future.

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