

# Future of Precision Medicine with AI

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## **Abstract:**

Precision medicine — the “tailoring of medical treatment to the individual characteristics, needs and preferences of a patient” that has led to personalized new approaches to treatment based on genetics, environmental and lifestyle factors — is a promising but fast-moving paradigm for delivery of health care. [Relevant/Material Odyssey Markers Related] Content This module advocates an approach that considers visible and invisible factors for personalised approach in drug therapy. But the complexity and size of the data needed for precision medicine is a serious challenge. In this regard, we find that the Artificial Intelligence (AI) such as machine learning and deep learning techniques are becoming a major enabler and creating a positive environment for future. AI tools can analyse medical images, lab results and patient histories for patterns that a trained clinician might miss with astonishing accuracy. In genomics, artificial intelligence expedites the analysis of DNA sequences and the discovery of gene-disease relationships essential for personalized therapeutics. Predictive analytics helps to predict disease risk, treatment response, while Natural Language Processing (NLP) tools further aid precision medicine extracting insights from unstructured clinical texts. Challenges in Integrating AI with Precision Medicine Although AI has the potential to revolutionize precision medicine, its integration is not without challenges. To enable this effective, ethical and equitable implementation of AI, we need to overcome challenges surrounding data privacy, algorithmic bias and access inequities to AI technologies. Additionally, regulatory and clinical approval pose major challenges to converting AI models into usable clinical applications. AI is also set to have a transformative impact on how we approach precision medicine, enhancing clinical decision-making, accelerating drug discovery, and harnessing healthcare accessibility in the future. By continuing with interdisciplinary.

## **Artificial Intelligence in Precision Medicine: [1] [28]**

### **Introduction:**

Precision medicine is changing the healthcare landscape, providing personalized healthcare based on idiosyncratic aspects of each patient. Instead of using a one-size-fits-all treatment protocols, combining genetic, environmental and lifestyle factors by which it will Deliver more precise, efficient and tailored medical care. The bedrock of precision medicine is the ability to handle and make sense of large and complicated streams of data—an effort that By the way, it Note: would be impossible without the

strength of Artificial Intelligence (AI) [10] [21] [28]. The field of medicine has taken a very different turn, with AI now being regarded as a major force in transforming healthcare, with its ability to analyse massive datasets, find patterns that are beyond human perception and deduce clinical insights. Predicting disease onset, optimizing treatment and enhancing patient monitoring are just a few of the ways in which AI is accelerating the progress toward precision medicine at an unprecedented pace. Especially in chronic illnesses (the most common, e.g. diabetes) artificial intelligence allows that unprecedented degrees of personalization in diagnosis, treatment and prevention. [2] [10] [21] [28]

This article will take a look at the growing collaboration between AI and precision medicine providing examples and describe how these integrated approaches are forming a foundation for a shift in healthcare. With diabetes as our flagship example, we will explore how AI is not only assisting but also reimagining personalized care delivery. [10] [21] Steers health systems away from the classic tricks and cures toward person-to-person, personalized remedies for multifactorial maladies. The solution that forms the basis of this paradigm change is AI, optimizing health treatment and management services, supporting data gathering and monitoring, enabling predicting patients' health deterioration and enhancing overall caring and efficiency. [10][21].

### **AI Technologies Driving Precision Medicine: [10] [21]**

Two subcategories within AI — machine learning (ML) and deep learning (DL) — allow systems to learn from data, automatically improving themselves over time without even being explicitly programmed. In medical diagnostics, these technologies study patterns in imaging, lab results and clinical notes to assist — and in some cases surpass — human diagnostic capabilities. [10] [11] [16] [21] [25]

For example, in radiology, convolutional neural networks (CNNs) are being trained to identify diabetic retinopathy from retinal scans with accuracy comparable to that of an expert ophthalmologists. These systems can sift through thousands of images in no time, speed and access to early diagnosis — particularly in regions with a shortage of specialists. For example, in oncology, ML models can detect tumors in mammograms and classify cancer subtypes based on histopathological slides. These tools not only enhance diagnostic accuracy, but also minimize differences in interpretation among human clinicians.

Continuity is vital for starting treatment at the right time and in the right way. And moreover, deep learning algorithms that analyze multiple layers of patient data simultaneously are being developed, taking into account aspects such as genetics, blood/circulatory markers, imaging modalities, as well as EHR data across systems. records (EHRs). AI parses this assortment of data and provides a fuller, more complete picture of patient health. It is no doubt that AI take an important part in medical industry [2] [10] [21]

### **AI in Genomics and Gene Therapy [4] [10] [21]**

Interpreting genomic data underpins precision medicine. With low-cost sequencing technologies, the world has been flooded with genetic data. But you need AI to make sense of it. AI methodologies assist in the identification of mutant variants associated with disease, the elucidation of gene expression patterns, and the position of genetic variants in relation to phenotypic outcome. In diabetes, it involves common T2D variants, as well as rare monogenic forms e.g., MODY (MODY stands for Maturity-Onset Diabetes of the Young).

[4] [10] [21] A growing number of genetic loci, more than 400 to date, have been linked to diabetes risk, most contributing modest effects individually. AI is great at finding complex interactions among these variants, modeling polygenic risk scores that can stratify patients better than any individual marker. For gene therapy, AI helps design and optimize gene-editing approaches. It predicts the effects of CRISPR-based interventions, and helps reduce off-target

effects, improving the safety profile of potential cures. For rare genetic forms of diabetes, AI-guided gene editing could some day allow corrective therapies to be implemented at the molecular level. [4] [10] [21]

#### **Revising Procedures to Data and Actions**

Genetic sequences, images and records of human health add up to heaps of data discarded on a daily basis in modern medicine. AI can be very labour intensive, taking a long time to sift through and organize such information. When learning from experience, algorithms bring up new ideas, new business models, new correlation, new timeline that very hard to capture by human intelligence. [10] [21]

#### **Unprepared for Genomics Invention [4]**

Innovative and potent techniques used by AI are shattering ceilings when it comes to scanning and scrutinizing DNA. Shifts health systems away from the traditional methods and cures toward individual, customized therapies for multifactorial diseases. The cornerstone solution throughout this shift is AI, which optimizes health treatment and management services, supports data gathering and monitoring, enables predicting patients' health deterioration, and enhances overall caring and efficiency. [10] [21]

#### **Changing Procedures to Data and Actions**

Every strand of genetic sequence, imaging, and storing of medical records contribute to endless heaps of data in modern medicine. The task of organizing such information can be labour intensive and time-consuming for AI. Algorithms that learn from experience surface new ideas, business models, correlation, and timelines that seemed impossible to grasp through human intelligence. [10] [21]

#### **Unprecedented Inventions of Genomics [4]**

New and powerful methods employed by AI are breaking ceilings when it comes to scanning and examining DNA. They assist figuring out genetic mutations associated with certain conditions, analysing predisposed conditions, them alongside what and how do DNA variants impact drugs? Formulating such vital aspects of illness shaping add greatly towards disease treatment on personalized organism made more precise for parts such as oncology or rare diseases. [10] [21]

#### **Dynamic Techniques for Specific Goals**

AI inscribing individual dose regimens based on genetic understanding of the clinical scenarios they faced together with adherence to rational pharmacotherapy and coded systems is among the notable possibilities provided systems implementing AI A new era of healthcare industry is emerging with artificial intelligence (AI) and precision medicine at the forefront. These technologies are advancing the way we apply diagnoses, treatments, and even preventative measures as we aspire towards a future in which medicine is tailored to personal needs. [10] [21] [28]

### **AI: The Key to Personalization [10] [21]**

As granules of data become precision medicine's lifeblood, AI fast becomes its heart. Undertaking tasks such as genetic sequencing and outlining lifestyle patterns, AI has proven its mettle by analysing complex data sets at incredible speeds. By sorting through data, AI uncovers trends and relationships that make it possible for clinicians to customize medical decisions, medical care to each individual patient becomes feasible. [10] [21]

### **Transforming the Diagnostics**

AI's contribution to precision medicine is strikingly apparent in the field of diagnostics. Machine learning enables the identification of anomalies within medical imaging, flags early signs of disease and even aids in proposing possible diagnoses from a patient's history. Thanks to these tools, human error grows less prevalent as the steps undertaken yield immense precision and speed that ensure early intervention can be facilitated.

[10] [11] [21]

### **Drug Development And Target Therapies [9]**

AI is aiding the development of new therapies while simultaneously assisting in their administration. AI helps formulate treatment strategies in oncology by studying active tumour genes. The healthcare industry is pivoting more than ever before in history, particularly regarding how medicine is diagnosed and treated. The combination of "AI" systems with precision medicine are blending into new pathways in which medicine is being understood. Modernized technologies are directed towards interpreting data which eases the process of providing real time health data regarding lifestyle, environment, and genetics of an individual, making it curriculum-specific. Super computers driven with algorithms able to analyse complex systems at astonishing accuracy and rate have catalysed the process even more. [10] [21]

### **What Is Precision Medicine?**

This is better defined as the practice of treatment being conducted on the discriminated patient basing the judgment on highly advanced and ultra specific medical practices, decisions, and products. In other words, it aims at unique psychological mechanisms guiding the illness of distinct people. Applying Artificial Intelligence along with clinical, and behavioural data, the genomic details alongside its other elements of life is the aim of the practice. [28]

With pinpointed procedures being adopted to treat complicated forms of malignancy, the AI's super computers tackling with complex datasets at astonishing speed has already displayed to be of immense potency in providing targeted medicine. Precision medicine in the present century is seen lacking being systemic towards the sectors of health. The impending changes precision medicine and artificial intelligence (AI) will install on the healthcare sector are astronomical. In the next decade, we're looking at a more streamlined and universal system that caters to everyone on an individual basis. To elaborate on precision medicine, it aims to deploy treatment that is intricately curated the precise physiological attributes of a patient, while AI can scale its use for the masses. [10] [21] [28]

### **Example of Precision Medicine**

As opposed to treating every individual suffering a similar illness with the same medication and enforcing a singular strategy like traditional medicine does, precision medicine takes an intricate approach. It takes into immense consideration personal genetics, environment, microbiomes and everything else that sets a patient apart from the rest. Imagine being able to cure someone with a condition by only making them undergo treatment which requires the least side effects and restoration time while guaranteeing the highest effectiveness. Sounds impossible? That is precision medicine.

### **The Role of Ai in Precision Medicine [10] [21]**

There is a reason AI is deemed a 'game changer' -because it truly is. When utilized properly, the value it brings is

undefinable. In terms of healthcare in general, the data that is generated now days is incomprehensible to individuals. With genomic sequences of patients along with their imaging scans and health records being accumulated continuously, AI proves to be the only feasible solution to analysing all of the complex and ever changing data efficiently and productively. AI can enhance accurate diagnosis and minimize human errors, which can be particularly effective when combined with clinical expertise, in personalized medicine. This change from conventional approaches to targeted treatment is a prime example of moving towards a more specific, data-driven healthcare system. This evolution emphasizes the necessity to combine technology with clinical expertise to maintain a high bar for patient care. [2] [6] [10] [21]

#### **Self-Medication To Precision Medicine: Ai [10] [21]**

Self-medication has become fashionable in recent years, inspired by the idea that traditional treatments may be useless, or even dangerous, and by advances such as human genome projects. This advances allow to identify subtypes of disease from genetic data or others methods like histology, many feel that prevention and pain management of disease will increase. Genetic studies, for example, can demonstrate which patients with particular conditions are most likely to get benefit. AI is crucial in interpreting data, drawing conclusions, discovering new patterns, and assisting physicians in decision-making. Companies have shown that supercomputing, deep learning and AI can dramatically improve precision in personal medicine. [4] [7] [10] [16] [21] [25]

The evolution of the drug from the Hippocrates to the twentieth century sheds light on a transition to evidence-based reliance. Advances in technology and innovation of treatment are transforming the ways doctors listen to and help patients. Today, medical decisions are founded on swift research work and exhaustive clinical trials, which grant access to advancements in treatment, but also require comprehensive inquiry into potential side effects.

Integration of low-cost genome sequencing, sophisticated biotechnology and health sensors are amplifying this transformation in everyday live. But with this information and digital health revolution driven by smartphones and healthcare providers also comes the challenges of data analysis and interpretation. [5] [10]

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