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THE FUTURE OF HEALTH CARE: INDIVIDUALIZED TREATMENTS WITH PERSONALIZED MEDICINE

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Abstract

Personalized medicine, also known as 'individualized therapy,' The future of healthcare is to undergo a transformative shift towards individualized treatments through the implementation of personalized medicine. This approach tailors medical interventions to the unique genetic, environmental, and lifestyle characteristics of each patient, revolutionizing traditional one-size-fits-all models. By leveraging advanced technologies such as genomics, proteomics, and data analytics, healthcare providers can offer more precise diagnoses, prognoses, and therapies. Personalized medicine promises to enhance treatment efficacy, minimize adverse reactions, and optimize healthcare resource allocation. Embracing this paradigm shift holds the potential to significantly improve patient outcomes and redefine the landscape of modern healthcare delivery.

Key words: personalised medicine, health care, individualized treatment, genomics, genetics, patient engagement, diagnostic analysis.

I.INTRODUCTION

Personalized medicine, sometimes called "individualized therapy," is the practice of prescribing the precise medications and therapies that are most appropriate for a given person while taking into account their genetic makeup and environmental circumstances[1] Personalized medicine, known as precision medicine, embodies a medical paradigm that categorizes individuals into distinct cohorts, where medical choices, procedures, treatments, and/or therapeutics are customized to the specific patient based on their anticipated reaction or susceptibility to illness. The designations personalized medicine, precision medicine, stratified medicine, and P4 medicine are utilized interchangeably to delineate this concept, although certain authors and institutions differentiate these terms to signify specific subtleties.[2] The objective of personalized medicine is to move away from a universal approach and enhance patient well-being through customization to attain optimal results in the realms of disease prevention, diagnosis, and therapy.[3]

II.UNDERSTANDING INDIVIDUALIZED TREATMENT

One of the most notable advancements in the field of healthcare lies in the transition towards Personalized Medicine. The conventional approach of employing universal treatments is now being substituted with therapies that take into account an individual's distinct genetic composition, lifestyle, and medical background. For instance, the utilization of Genomic sequencing enables healthcare providers to pinpoint genetic variations that could impact how a patient reacts to certain medications. This information empowers the selection of the most optimal and secure treatment alternatives, thereby reducing adverse effects and enhancing the rates of treatment success. Personalized Medicine exhibits significant potential particularly in the realm of conditions such as cancer, where treatments can be precisely tailored to the patient's particular subtype of cancer.[4]. Figure [5]

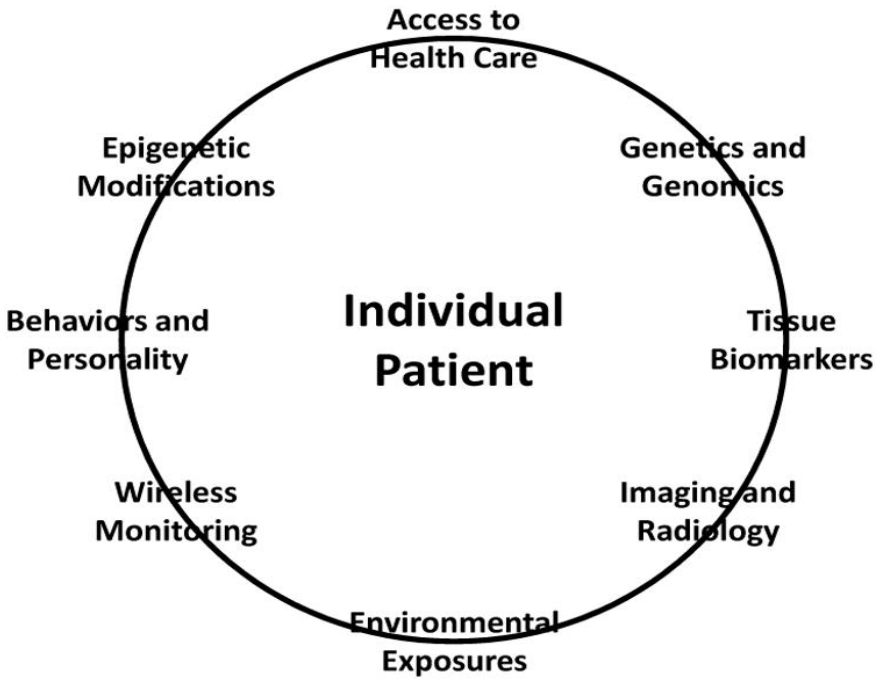

Figure 1: Individualized treatment

III. GENOMICS IN PERSONALISED MEDICINE

Personalized medicine" was defined in 2011 by the National Cancer Institute of the National Institutes of Health, USA, as a type of medical care that takes into account a person's genetics, proteins, and environment to prevent, diagnose and treat disease. The addition of the word "personalized" stems from the fact that medical diagnosis and treatment can now be carried out with much greater precision because to technological advancements (Personalized Medicine Coalition, 3rd edition, 2011). Given this, it is obvious that genetics will be essential to the advancement of customized medicine, if not the only factor. Genetics is the study of individual genes, whereas genomics is the study of the intricate interactions between numerous genomic markers that are found in both genes and intergenic regions however the differentiation between environmental and epigenetic factors is more quantitative than qualitative.

3.1. Human Genetic Variation and Personalized Medicine:

As a basis for implementing personalized medicine, recognizable differences between patients and their disease states must be identified, and tests must be developed to detect these characteristics, or biomarkers, in individual patients. One kind of biomarker is genetic variation, which can take many different forms, from large-scale changes in the human karyotype to single nucleotide polymorphisms (SNPs). Such polymorphisms may or may not have functional consequences but can serve as markers to distinguish one individual's genetic material from that of another, or to determine a disease state. Personalized medicine and molecular diagnostics depend on understanding the relationships and/or functional effects of certain polymorphisms in human disease.[6]

IV.MOLECULAR DIAGNOSTIC TECHNOLOGIES FOR PERSONALISED MEDICINE

Numerous molecular diagnostic technologies that are useful for personalized medicine have been reviewed previously. This review is limited to discussion of the following technologies:

- innovations in PCR for rapid and quantitative results
- study of genetic variations: CNVs
- direct molecular analysis without amplification
- DNA sequencing biochips/microarrays

- Cytogenetics
- nanobiotechnology.

4.1. Role of PCR in the Development of Personalized Medicine:

Several PCR-based methods are used in the development of personalized medicine:
The majority of applications for PCR-based techniques are in the laboratory and require a lot of time. Real-time quantitative PCR can be applied to analysis of clinical samples to help in the stratification of patients for personalized medicine strategies.

4.2. Direct Molecular Analysis:

Though digital PCR can be used for isolation, amplification, and detection of individual nucleic acid molecules in small volumes or surface regions, it requires microfluidic devices with thousands of channels. The next wave of ground-breaking technology lies in the direct study of individual biologic molecules. Some technologies can directly analyse individual molecules of DNA, RNA, and proteins, without the thermal cycling involved in PCR amplification.

4.3. DNA Sequencing's Place in Diagnostic and Customized Medicine:

New-generation sequencing technologies are opening up new applications in healthcare and drug discovery/development. The most important areas of application are in the diagnosis of cancer, genetic disorders, and infections. Applications include identifying disease-relevant exons in a population, investigating novel viral species in patients in connection with the progression of their condition, and looking for alterations in the genome in pathogens in relation to treatment.

4.4. Integration of Molecular Diagnostics and Therapeutics:

Molecular treatments and diagnostics integration is a key component of customized medicine. Within a combined diagnostic and therapeutic system, "diagnosis" would often refer to risk factor screening, while "therapeutics" would also encompass therapy monitoring. The development of more accurate, easier-to-use, and affordable diagnostic techniques will be a major driver of the integration of medicines and diagnostics.[1]

V. STASTERGIES

It is imperative that pharmaceutical corporations invest in these new technologies and demonstrate a readiness to collaborate with academic research teams in order to facilitate the development and rapid acceptance of PM. Finding stricter biomarkers is essential for informing a proactive strategy against PM. The ability to identify DNA circulating in the blood through liquid biopsies, which were developed recently, is one example. This kind of biopsy has been used to diagnose disease at a very early stage and is non-invasive and far less risky than regular biopsy. Pregnant women were one of the first groups to employ liquid biopsy as a test for Down syndrome. Circulating tumor DNA, or ctDNA, is now being used in studies like TRACERx to analyze and forecast the tumor progression of lung cancer. The cost of developing new treatments is unaffordable, and pharmaceutical companies are becoming more eager to reuse their current products. PM makes it possible to optimize treatment plans, which raises the usefulness of currently available products.[7]

VI. HIGHLIGHTS OF PERSONALISED MEDICINE

Applications of personalized medicine in healthcare have numerous benefits. A treatment plan customized to a patient's requirements and genome will be the outcome of personalized medicine. Better diagnosis, early intervention, the creation of more effective medications, and more focused treatments could all be made possible by personalized medicine [8]. Firstly, this approach can be used to detect and diagnose diseases in a highly specific manner, categorizing them by genetic variation rather than symptom. This makes it possible to administer increasingly targeted and potent medicines, improving many people's prognoses. For instance, a highly precise BRAF-targeting medication can be used to target melanomas

with a particular mutation in the BRAF gene. The prognosis is significantly improved by this treatment because the typical melanomas treatment is not viable for these patients. Furthermore, genetic differences that can guide medicine dose can be revealed by genomic analysis, allowing patients to receive the maximum therapeutic benefit with the least amount of side effects. Thus far, this has been used to treat a wide variety of illnesses, including inflammatory bowel disease, cancer, and mental illnesses.[9]

VII. THE TRANSITION FROM CONVENTIONAL MEDICINE TO PERSONALISED MEDICINE

There are two broad groups of patients receiving modern therapies: those who gain from the treatment, i.e. responders, and those that do not benefit, i.e. non-responders. For certain drugs the patients that benefit from a therapy are just a small fraction of the patients that are being treated with the drug. The patients that do not benefit are instead treated with therapy after therapy until the right treatment is found. This method of treatment is not efficient from:

- A healthcare-cost perspective: inefficiency increases the duration and amount of treatments that patients must undergo and therefore also increase the costs;
- A patient perspective, as they not only use drugs that are not efficacious, but they might also suffer from unnecessary adverse events;
- A drug development perspective: this approach can lead to new drugs failing clinical tests while still showing a positive effect for a subpopulation of patients.[10]

VIII. PATIENT ENGEMENT AND EDICATION

Personalized medicine with electronic health records (EHRs) is a big step forward in health education since it offers centralized health information and easily accessible patient portals. Prompt health alerts are essential for medication education and treatment compliance. Timely health reminders are very important for medication education and treatment compliance. Incorporating interactive educational modules and health and wellness portals into the system may guarantee that patients receive reliable and pertinent medical information. With language translation services, this education can be globalized, and health literacy can be improved worldwide. Physicians are typically still trained using fairly outdated methods that emphasize reactive care. The various actors within the health system require whole new training in order to stay up to date with the latest developments. Working in a multidisciplinary team including physicians, nurses, medical imaging engineers, and other individuals who gather patient data is essential to this. After all, via their engagement, participation, and interaction in the policy-making process, citizens and health professionals will influence the future of PM. Even with an increase in instructional initiatives, there are still some areas that require improvement, such as target audiences, accessibility, or the instruments and techniques employed For this reason, a broad audience of politicians and citizens has to be educated and have conversations on the concept of personal health. We observe that the public lacks understanding and motivation, and that physiotherapists lack adequate training.[11]

- The future of PM will be determined by the engagement, participation, and involvement of citizens and health professionals in the policy-making process. Even with an increase in instructional initiatives, there are still some areas that require improvement, such as target audiences, accessibility, or the instruments and techniques employed. [12],

IX. DIGITAL THERAPEUTICS AND PERSONALISED APP CONTENT

The prevalence of intelligent mobile devices has captured the attention of numerous scholars in the healthcare field as a platform not only for gathering health-related information via a variety of applications but also for delivering guidance, assessments, mentoring, visual content, auditory stimuli, written communications, or links to other services, all of which could be advantageous to an individual with a

specific ailment or disorder. Consequently, there has been an introduction of the notion of a 'digital therapeutic:' a mobile application intended to address and alleviate the symptoms experienced by an individual afflicted by a medical or psychological issue [13]. The data dispensed by a digital therapeutic application to an individual may differ based on the insights gained about that individual and his or her reactions to the content provided within the application. Thus, the application can be tailored to suit the individual. Numerous digital therapeutic solutions have been subjected to assessment to ascertain their capacity to engage users and yield positive outcomes [14]. The Food and Drug Administration (FDA) in the United States has formulated protocols for the registration of digital therapeutics as legitimate, insurance-eligible, sanctioned medical technologies, and has commenced the assessment and authorization of many such applications. The initial sanctioned digital therapeutic – an application targeting substance abuse – was endorsed by the FDA in 2017 [15]. The extent to which digital therapeutics will be integrated into the healthcare system remains an unresolved inquiry.[16]

X. CHALLENGES AND ETHICAL CONSIDERATIONS

personalized Medicine (PM) is widely regarded as an innovative addition to the healthcare system, characterized by its emphasis on prevention, synchronization, and proven effectiveness.[17],[18]. Despite its potential benefits, stakeholders and consumers within the existing healthcare framework have yet to fully appreciate the advantages that PM can offer. Recent research highlights several key obstacles hindering the advancement of PM, including scientific hurdles,[19] such as the critical role of genetic markers in clinical settings and limited understanding of the molecular pathways underlying certain medical conditions. Economic barriers, operational complexities related to technology selection and system implementation for cost-saving purposes, and the safeguarding of sensitive data throughout the investigative and developmental phases also pose significant challenges.[20]. Additionally, policy-related issues concerning the collaboration between governmental research entities and regulatory bodies present further obstacles to the integration of PM into mainstream healthcare practices. The undeniable benefits of Personalized Medicine in healthcare come with significant challenges and ethical considerations. Privacy concerns surrounding patient data, biases in algorithms, and the possibility of job displacement within the healthcare sector are among the critical issues that demand careful examination. The utmost importance lies in ensuring the security and privacy of patient data. To address these concerns, it is crucial to implement robust data encryption, stringent access controls, and transparent data-sharing policies. Moreover, healthcare organizations must consistently monitor and mitigate algorithm biases to prevent the occurrence of discriminatory or inaccurate outcomes. Furthermore, the incorporation of these technologies into healthcare workflows necessitates workforce upskilling and the establishment of new regulatory frameworks. Healthcare professionals should undergo training to effectively collaborate with AI systems, utilizing their expertise in conjunction with technological advancements.

10.1. Data management and confidentiality concerns:

One of the principal obstacles encountered in the realm of individualized healthcare pertains to the administration of extensive volumes of data, such as genomic data, clinical data, and various personal details. The preservation of the confidentiality and security of this information is imperative, albeit it poses a significant challenge, especially when data is exchanged among healthcare providers and researchers.

10.2. Financial constraints and availability challenges:

Another hurdle lies in the financial constraints and availability associated with personalized medicine. Numerous genetic tests and other diagnostic instruments carry a hefty price tag, rendering them beyond reach for individuals with limited financial means. Moreover, the coverage provided by insurance for personalized medicine is frequently restricted, thereby impeding patients from receiving the necessary treatment.

10.3. Regulatory hurdles and lack of standardization:

Personalized medicine represents a nascent domain, encountering numerous regulatory obstacles. The absence of established norms and protocols for data handling, scrutiny, and elucidation poses difficulties in upholding the efficacy and dependability of personalized medical interventions and diagnostic measures.

10.4. Limited availability of genetic testing and data sharing:

Ultimately, a restricted availability of genetic testing and data sharing infrastructure exists, especially in specific regions of the globe. This circumstance may present a formidable obstacle for healthcare professionals and researchers in obtaining the necessary data for delivering personalized medical attention [1],[6],

XI. ETHICAL CONSIDERATIONS

A primary concern associated with the growing utilization of personalized medicine pertains to the ethical implications concerning patient confidentiality. An illustration of this is the apprehension that certain entities might misuse this data unethically, such as insurance firms potentially refraining from providing specific policies to individuals with genetic predispositions. Moreover, there exist additional ethical dilemmas, including the issue of incidental discoveries. The identification of a life-altering illness lacking treatment options could be considered morally questionable, given that awareness of such conditions may result in psychological distress and significantly impact a patient's well-being. Moreover, inaccuracies in findings pose an ethical dilemma, as they have the potential to lead to unnecessary healthcare costs and psychological challenges. Moreover, various concerns arise within the legal domain. For instance, challenges are present in the realm of intellectual property rights, with some asserting that restricting access to advancements may impede the progress of future personalized treatments. Additionally, the need for a revaluation of regulatory frameworks is evident, as current laws are inadequate in the context of personalized medicine.[8].

XII. IMPLEMENTAION OF HEALTH CARE SYSTEM

The evaluation outlined in existing literature suggests that the incorporation of personalized medicine (PM) into national healthcare systems should be underpinned by six fundamental themes. These encompass the healthcare infrastructure, governance structures, accessibility, public knowledge, execution strategies, and data management. Governance aspects ought to encompass a national strategy alongside comprehensive legislative, policy, ethical, social, and legal frameworks that cater to personalized medicine and the sharing of genetic information. At a broader level, it is imperative to initiate research endeavors such as establishing a national research facility, as well as enacting regulations for consumer testing or formulating a code of ethics for consumers. Furthermore, there is a necessity for collaborative study groups involving all relevant stakeholders keen on implementing personalized medicine. Additionally, it should be emphasized that the integration of personalized medicine into existing healthcare frameworks demands the synchronization of novel services and methodologies that comply with both national statutes and funding mechanisms.[21],[22]

XIII. THE FUTURE PERSPECTIVES OF HEALTH CARE

Personalized medicine, often used synonymously with precision medicine, presents a certain degree of inaccuracy. It should be noted that there is no model in place that formulates pharmaceuticals, diagnostic strategies, treatment schemes, or medical apparatus specifically tailored for an individual patient. The concept of PM does not purport to offer customized treatment for each distinct individual. Nevertheless, PM adopts an approach that heavily relies on technology and takes into account the individual variations in genes, surroundings, socioeconomic status, and the lifestyle of each patient. It is widely acknowledged that a significant portion of the variability in drug reactions is genetically predetermined. The reason

behind why a particular antibiotic proves effective for one patient but ineffective for another remains a perplexing question. Similarly, the causes of why one patient experiences severe side effects from a chemotherapy regimen while another undergoes the treatment with minimal complications are not fully understood. The underlying explanation lies in the fact that each individual possesses a unique genetic makeup. The conventional medical practice of applying a uniform treatment approach, known as "one size fits all," is grounded in broad population-based investigations. However, this method is flawed due to the slight genetic distinctions present in each patient. There is a pressing need to replace this entire system with a more precise and accurate alternative.[23],[24].

XIV. PERSONALISED MEDICINE IN INDIA: HURDLES AND PROSPECTS

In India, personalized medicine is still in its infancy. In order to provide Indian patients with personalized treatment in the "traditional" sense, extensive infrastructure for multi-omic testing and data analysis skills are needed, both of which come at a significant financial expense. But as was already noted, precision doesn't have to begin with multi-omics methods; it can also begin with straightforward clinical data. India's vast patient base and notable variety present chances to try customisation on such low-cost, straightforward data.

The following are some possible first actions that could be done in this regard:

- Enhance data gathering and treatment capacities across the nation at different locations, incorporating uniformity-ensuring standard processes.
- It is easier to collect phenotypic data when standardized electronic health and records are invested in. In this way, we can benefit from the widespread use of mobile phones.
- Use databases and ongoing cohorts in India to find answers to problems. For instance, the multi-centre INSPIRE cohort of serology and lupus patient data can offer numerous chances for researchers to formulate pertinent queries.
- International database collation spanning many centers: Among these could be regular clinical investigations: Renal functions, blood count, C-reactive protein, and erythrocyte sedimentation rate are examples of conditions that don't require costly testing.
- Samples are bio banked to facilitate future query responding.

The conditions for researching personalized medicine in India are also ideal for addressing issues pertaining to the treatment of diseases in low- and middle-income nations. The cost of biologic DMARDS prevents their broad application. Thus, earlier studies have concentrated on determining how responsive patients are to less expensive drugs like methotrexate. The relationship between methotrexate response and polymorphisms in the genes of the purine biosynthesis route (ADORA, ATIC) [25] the ubiquitin pathway (CUL1),[26] the receptor/transporter system (MDR1) and other pathways has been neatly proven by Indian studies using a hypothesis-driven methodology. SNPs in the folate metabolism pathway, on the other hand, did not demonstrate a significant correlation [27]. These data may eventually be compiled to create a gene risk score that would help practicing physicians determine the likelihood of a methotrexate response.

Research funding opportunities for customized medicine techniques in rheumatology appear to be limited at the moment, but should increase if real research gets underway. The "All of Us" Research Program in the United States (formerly known as the Precision Medicine Initiative Cohort Program) aims to provide funding for medical innovations that prioritize improving individual health.[28] The program provides a good foundation for future research and therapeutic trials by collecting data on lifestyle, health, environment, wearable technology, and laboratory examinations. The recent launch of the Genome India Project [29], which aims to identify the genetic variety of the population, can provide the foundation for

the large-scale personalization and translation of medicine. High-propensity and endemic illnesses such as COPD, lung cancer, CVD, RA, and TB may become the frontrunners of large-scale research in delivering precision [30].

XV. CONCLUSIONS

In conclusion, the emergence of personalized medicine promotes a promising future for the healthcare sector, characterized by tailored treatments customized to the unique biological composition and health profile of individual patients. Through the utilization of cutting-edge technologies and data-driven insights, healthcare providers can deliver more precise, efficient, and patient-centered care. Advantages of personalized medicine are efficiency of care, preventive care, limit cost, and population health. The concept of personalized medicine holds the capacity to transform conventional methods of diagnosis, treatment, and prevention, ultimately resulting in enhanced outcomes, decreased healthcare expenditures, and improved quality of life for individuals across various demographics. As we move towards this envisioned future, collaborative efforts among stakeholders within the healthcare landscape will be imperative in unlocking the complete potential of personalized medicine and ensuring fair access to its advantages for all individuals.

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