ISSN No:-2456-2165

Predictive, Preventive, Personalized and Participatory Medicine as a Model for Precision Periodontal Health Care

Dr. Neha.H.N. (Post Graduate); Dr. Nagarathna D.V. (Professor)
Department of Periodontology and Implantology
A.J Institute of Dental Sciences, Mangalore, India-575004

Abstract:- Periodontal disorders are chronic inflammatory illnesses affecting the supporting tissues of teeth, seen in most common seen in adults. Traditional approaches to periodontal care often rely on reactive measures, addressing symptoms rather than underlying causes. The paradigm of predictive, preventive, personalized, and participatory (p4) precision periodontal care is modelled by medicine. This article explores how p4 principles predictive tools like biomarkers, preventive strategies, personalized treatment plans and participatory patient involvement can address periodontal health challenges. The integration of artificial intelligence and advanced diagnostic patient outcomes and cost-effective care.

Keywords:- *Precision Medicine, Predictive, Preventive, Personalized, Participatory (p4) Medicine.*

I. INTRODUCTION

One of the most common illnesses, periodontitis is a major public health problem because of its increasing prevalence and serious socioeconomic consequences[1].

The foundation of "P4 medicine" is the idea that clinical practice should shift from an impulsive to a proactive approach to patient care[2]. Predictive, preventive, personalized, and participatory medicine are indicated by each "P," and they hold promise for the future of medical practice.

They highlighted a method or order that prioritizes p4 medicine's predictive and preventative elements. Omics technology, which offers the large data sets to quantify an individual's health or illness states, serves as the basis for giving priority to its customizable and participative aspects[3]. With equal patient and practitioner participation in comprehensive health care, P4 medicine adopts a new paradigm of integrative and holistic approaches to patient management.

Technology developments will enhance every facet of healthcare delivery, and the use of precision medicine may impact new diagnostics, risk assessments, and patient involvement[2].

II. HISTORY

Oncology professionals are familiar with the idea of precision medicine. In order to customize treatment choices, a precision-based approach to oncology analyses baseline data to forecast a patient's reaction to treatment. Periodontal diseases have been shown to have a similar behavior. Archibald Garrod (1857-1936) Known as the father of precise medicine, and was the first to recognize the pervasiveness of individual variance in both health and disease[4]. The double helix structure of DNA was hypothesized by James Watson and Francis Crick in the 1950s and 1960s, opening the door for genetics and molecular biology. Paul Berg created recombinant DNA technology in the 1970s, which made it possible for researchers to work with genes and provide the groundwork for genetic studies[5]. The goal of the international scientific research initiative known as the Human Genome initiative (1990–2003) was to map every gene in the human species.

P4 medicine started to make inroads into dentistry in the early 2000s as it was becoming more popular in the healthcare industry. A new approach to healthcare was envisioned in the year 2011 by biologist Leroy Hood, who focused on four key pillars: predictive, preventative, personalized and participatory treatment. This medical strategy integrates cutting-edge technologies to give patients precise, customized care. To capture these ideas, he came up with the name "P4 medicine." For the dentistry profession, the p4 medicine models present both new potential and challenges. Our objective has always been to provide predictable and enhanced results for our patients in the twenty-first century, and modern technologies like risk management enable us to do this.

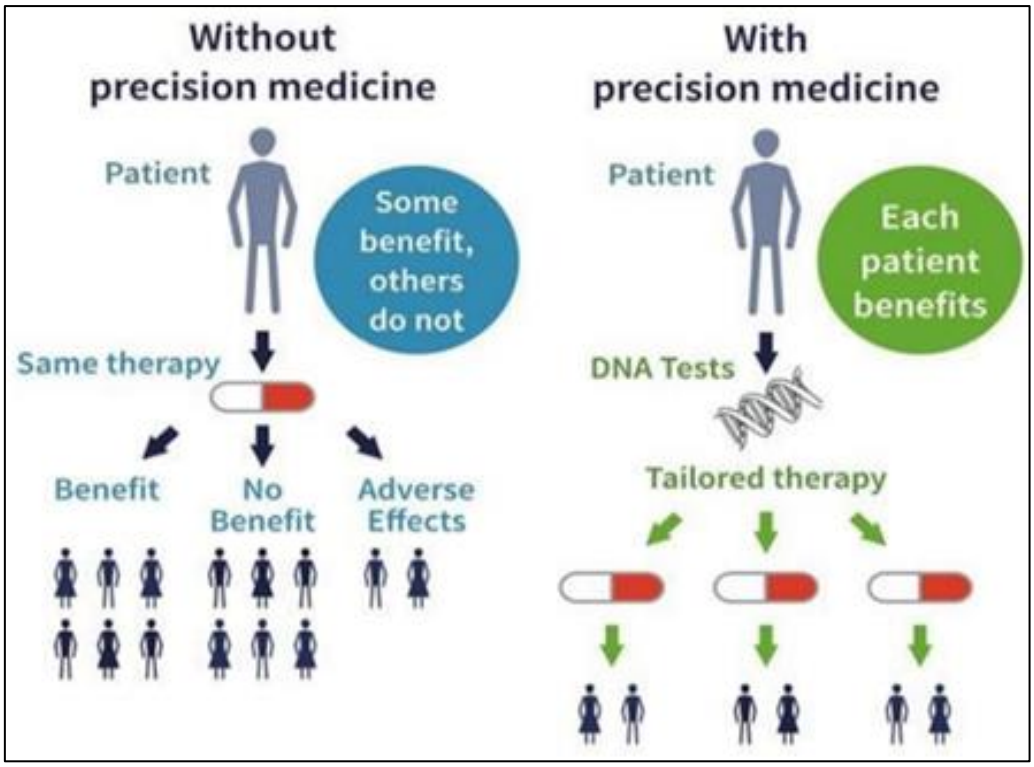

Fig.1 Importance of Precision Medicine

III. APPLICATION OF P4 IN PERIODONTAL HEALTH AND DISEASES

Periodontal diseases are categorized using stages and grades. This approach requires an integrative, multisector approach that combines clinical expertise with advancements in systems biology and technology.

The 2018 Periodontal Disease Classification supports this model by categorizing diseases based on severity, progression, and modifying risk factors. An important concept in P4 medicine is allostasis. The process by which an organism's internal environment is adaptively changed to satisfy observed and expected demands, or the body's adaptive mechanism to preserve equilibrium, is known as allostasis, with allostatic load contributing to conditions like gingivitis and periodontitis[6].

Disease management in P4 periodontics can be proactive or reactive, and this approach enhances the prediction, prevention, personalization, and participation of patients, leading to better outcomes and overall health[7].

A. Classification (2018) applied to p4 medicine:

- *Predictive:*

The classification system incorporates risk assessment tools and biomarkers and by genetics to predict the onset a progression of periodontal disease and also helps in early detection and proactive management.

- *Preventive:*

By the various stages and grades of periodontitis, the classification system facilitates targeted preventive strategies. By customized oral hygiene programs, regular monitoring and patient education can prevent the progression of early-stage periodontal diseases.

- *Personalized:*

The staging and grading framework supports personalized treatment plans based on the individual's disease severity, risk factors, and overall health status. Personalized interventions, such as specific antimicrobial therapies or surgical procedures depends upon the patient's clinical profile.

- *Participatory:*

The classification promotes patient involvement by providing information about their periodontal health status. Digital health tools and communication platforms helps the patients to take an active role in their medical treatment.

B. P4 Periodontics: A Novel Approach to Management

The four essential components of a customized strategy and stratification of patients for the handling of all chronic diseases must be taken into account when incorporating p4 periodontics into treatment strategies. These include disease severity, activity of diseases, control of the disease, and treatment responses.

➢ *Severity of the Disease*

Determining the severity of an illness is crucial since it establishes the necessary treatment intervention levels. Visual assessment and two-dimensional radiography are the main techniques employed; more recent developments include 3D radiographic imaging, real-time microbiome assessment of disease indicators in saliva, and gingival crevicular fluid.

➢ *Activity of Disease*

Determining whether periodontitis is active at the moment or in a state of inactivity or remission should be a key component of managing the condition.

➢ *Control of Disease*

The knowledge that periodontitis is an opportunistic infection that has been altered by the host's inflammatory response forms the basis of current control techniques. Therefore, it's critical to address the impacts of infection and inflammation as well as to discover risk factors and moderating factors linked to the onset and course of disease.

➢ *Treatment Responses*

Responses to traditional periodontal treatment can vary, as they do for many chronic disorders. A key element of individualized periodontics will be figuring out each patient's particular reaction to periodontal therapy[8].

IV. PREDICTIVE PERIODONTAL MEDICINE

Predictive medicine aims to predict when disease-perturbed networks will arise by understanding the molecular basis of diseases. Combining lifestyle, general health data, medical and family histories, and genetic tests, systems medicine can predict the like hood of an organ becoming diseased or biological network disruptions leading to disease. Periodontal disease requires combining sophisticated evaluations like Allostatic load, epigenetics, the microbiota, and the inflammasome with well-established risk factors like smoking and poorly managed diabetes. Molecular diagnostics using saliva, and gingival crevicular fluid play a central role, enabling data collection across healthcare settings to build algorithms that identify at-risk individuals. Since a single biomarker cannot predict periodontal disease activity or severity, so combination of biomarkers is used to predict the diseases activity[9].

A. Preventive Periodontal Medicine

The goal of periodontology has always been to prevent periodontal disease. with predictive and preventive measures working together to address future risks. By identifying risk factors and encouraging behaviour and lifestyle changes, preventive strategies promote overall wellness rather than focusing solely on disease[10]. Regular check-ups allow physicians to monitor patients over time, detecting potential health disruptions before symptoms arise. This proactive approach preserves wellness, preventing minor issues from developing into major health problems. In this way, a person's health can be maintained without the sickness state ever materializing. Early sickness detection is a useful ability, reducing future risks for health is a useful tool, and it can stop small issues from developing into large problems[8].

B. Personalized Periodontal Medicine

Customizing oral healthcare decisions, procedures, and/or products to meet the unique needs of each patient is the focus of personalized medicine[11]. The term "personalized medicine" describes the use of pharmacogenomics in clinical management of an individual, utilizing new molecular tools and equipment to enable more individualized health care based on each person's unique traits. Not every patient reacts to a medication in the same way. This is the rationale behind the creation of the customized medicine idea.

Although the phrase "personalized medicine" seems novel, it is actually an extension of more conventional methods for diagnosing and treating illnesses more precisely. Since the same treatment strategy does not work for every patient, the more recent customized medicine notion has supplanted the outdated "one cuts fits all" idea[12]. The application of this model in periodontology, in particular, offers the potential to improve individualized therapy algorithms by offering discriminating patient stratification models. In order to make well-informed clinical decisions regarding disease susceptibility, site-specific risk, and treatment interventions, personalized medicine for periodontal diseases uses saliva to create subclinical profiles, identify and measure particular phenotypes, inflammatory indicators, collagen degradation biomarkers, potential pathogens, and genotypes. One might envision application at several levels, including as screening, disease detection, treatment outcome monitoring, and identifying resistant or advancing cases, when contemplating the potential use of saliva in a personalized approach for periodontal disease. Using saliva to identify people at risk for future disease activity during the screening phase allows for more stringent risk management techniques, preventive care, and/or behavioural changes on the patient's part to delay the start of disease. The primary goal of personalized medicine is to give each person better results and optimal oral health care[13].

Prevention of the disease and, to some extent, treatment planning will be aided by knowledge of the disease pathways, genomic interactions, and novel biomarkers of oral problems prior to the onset of the disease. Patients who receive prompt diagnosis may benefit from focused therapy.

C. Participatory Periodontal Medicine

An essential component of integrated periodontal treatment has always been empowering patients to actively manage their periodontal health. It is widely acknowledged that people need to be involved in their care, which includes a customized, predictive, and preventive strategy. Therefore, a patient-centred adoption of "oral health literacy" will be necessary for participatory periodontics[6].

The process by which patients get and apply basic health knowledge and assistance services to help manage their own health is known as health literacy.

Self-tracking gadgets that let patients track their own health-related data are a single way that patients can get basic health information. Numerous apps for oral health are available, such as smart toothbrushes that may be linked to other phone apps to virtually visit the patient. These helps track how teeth are brushed in real time, but they still need to be improved because many of them are of comparatively low quality. Therefore, more appropriate validation is required, and they must be user-friendly to enable simple access to high-quality oral health data management.

V. FUTURE TASKS

We are currently investigating the actual utility of a large amount of data in order to implement precision medicine in the treatment of periodontal disease. The foundation for precision medicine will be established by creating a database of genetic data, biomarkers, and environmental variables that might be connected to the illness and by elucidating the strength of the correlation. Applying artificial intelligence and deep learning, which are now in use, is crucial to increasing the database's accuracy. It is necessary to accurately analyze large amounts of data, and researchers worldwide must keep up their diligent work in this area. It is crucial that several projects pertaining to data collecting and database development need to be created in the future[14].

VI. ARTIFICIAL INTELLIGENCE AND DISEASE PREDICTION

The establishment of computer systems that can imitate human behavior is known as artificial intelligence. Clinicians are using this more and more as an aid in the diagnosis and treatment of illnesses[15]. In order to forecast disease outbreaks and assess disease surveillance instruments, artificial intelligence (AI) has been extensively researched and used in public health surveillance.

AI-based systems have been used to analyze intraoral photographs and microscopic pictures of dental plaque in order to detect periodontal disease. AI models for diagnosing periodontal disease, evaluating bone loss, and detecting halitosis have shown good accuracy and dependability.

Dental implant planning can benefit from artificial intelligence (AI), which also helps dentists make decisions. Additionally, it aids in implant design optimization and implant type detection[16].

VII. CONCLUSION

In order to promote health and well-being across the entire course of illness experience, oral health care providers and their patients can collaborate by embracing the four pillars of p4 periodontics. In order to significantly improve the quality of life, this strategy must include well-organized population screening protocols that use innovative diagnostic biomarkers of disease states, targeted prevention of widespread human pathologies, optimal treatment planning, and personalized medicine[17]. This strategy also has the benefit of potentially lowering overall population costs, which addresses ethical and social concerns about healthcare affordability and access[18].

REFERENCES

[1]. Valdes, G et.al; A patient stratification tool for interpretable decision making in the era of precision medicine; Sci.Rep;2016;6.
[2]. P. Mark Bartold et.al; P4 Medicine as a model for precision periodontal care; Clin. Oral Investing.;2022;26;5517-5533.
[3]. James Amarcum; Multimorbidity, p4 medicine and holism; J. Eval.Clin. Pract.;2016;213-215.
[4]. Robert L. Periman and R. Govindaraju; Archibald Garrod: the father of precision medicine; GIM;2016;18(11);1088-1089.
[5]. Stephen p Goff and Thomas Shenk: Paul Berg: Recombinant DNA trailblazer; PNAS;2023;120;47.
[6]. Leroy Hood; Health Care of the 21st Century: Predictive, preventive, personalized and participatory (p4) Medicine; JOMS;2006;64(9).
[7]. Penny Hatzimanolakis; Proactive dental care for overall wellness: Harnessing the power of p4 medicine in oral health;2023; Available online: ww.rdhmag.com/patient-care/article/14298902/proactive-dental-care-for-overallwellness-harnessing-the-power-of-p4-medicine-in-oral-health.
[8]. Pavan Kumar et.al; Biomarkers in periodontal diagnosis: Dent oral Craniofacial Res;2015;1(2);48-52.
[9]. Uzma Irshad; Emerging Insight Into- “Precision Periodontics”; Med.Res J;2022;4(3).
[10]. Kalra S, Gupta Y, Kalra B et.al; Quaternary prevention and gestational diabetes mellitus; Indian J Endocrinol Metab;2017; 21(1);1–3.

[11]. Leroy Hood et.al; Systems biology and p4 medicine; Rambam Maimonides Me d.J;2013;4(2).
[12]. Dr. Christy George et.al; Personalized periodontics; IJSRT;2022;7(3).
[13]. Gomathi G D et.al; Personalized medicine-A recent revolution in periodontics; IJPI;2019;4(3);69s-72.
[14]. Dina L. Kobte and Janet Kinney et.al; Personalized medicine: an update of salivary biomarkers for periodontal diseases; Periodontol.2000;2016;70;26-37.
[15]. Takeshi Kikuchi, Jun-Ichiro Hayashi, and Akio Mitani; NextGeneration Examination, Diagnosis, and Personalized Medicine in Periodontal Disease; J.Pers.Med.;2022;12;1743.
[16]. Priyanka Cholan et.al; The Impetus of artificial Intelligence on Periodontal Diagnosis; Brief synopsis; Cureus;2023;15(8).
[17]. Safiya Fatima Khan et.al; Artificial intelligence in periodontology and implantology-a narrative review; JMAI; 2024; 7; 23-180.
[18]. Olga Golubnitschaja; Time for new guidelines in advanced healthcare: the mission of the EPMA journal to promote an integrative view in predictive, preventive, and personalized medicine; EPMA j;2012;3;5.