Chapter 7

Personalized Care: Prevention of Lifestyle Diseases

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Abstract

Personalized care, which includes personalized medicine, personalized nutrition, and even personalized exercise, is a useful and a more effective method for the treatment and control of lifestyle diseases such as type 2 diabetes and cardiovascular diseases. The relationship between nutrients, diet and gene expression (commonly called as nutritional genomics or nutrigenomics) and precision or personalized medicine have received considerable attention of researchers, clinicians, drug developers, practitioners of traditional system of medicine, and regulatory agencies over the years. Many, if not all, of the common human debilitating conditions including cancer, obesity, cardiovascular diseases and diabetes are related directly or indirectly to an individual's nutritional status and its genetic make up. Understanding the interplay between diet and genes may help provide direction upon which personalized therapy can be used for the treatment and management of these catastrophic life-threatening conditions, including strategies for their prevention. In this era of human healthcare where the diagnosis of the disease and treatment of the patient are perceived to be patient-tailored, due to the differences in the genetic make-up of individuals and their lifestyle, personalized human healthcare could be the most effective method for the treatment and prevention of debilitating diseases with a high morbidity and mortality. This chapter provides an insight into the potential of individualized care in life-threatening complications.

Keywords: individualized care, precision medicine, lifestyle diseases, chronic inflammatory diseases

1. Introduction

Personalized or individualized care, which includes personalized medicine, as well as personalized nutrition and even personalized exercise, is an individual (patient)-centric, integrative, and holistic approach for the treatment and management of lifestyle diseases. Personalized

care, a term often used interchangeably with precision medicine (an essential piece of personalized care which specifically refers to the medical treatment of the patient) is a more comprehensive term (than personalized or precision medicine) that represents an overarching philosophy for patient care, taking the advantage of personalized medicine and pharmacogenomics, as well as personalized nutrition and exercise. Personalized medicine, as defined by Schleidgen et al. [1] as an emerging area of medical care seeking to improve stratification and timing of healthcare by utilizing biological information and biomarkers on the level of molecular disease pathways, genetics, proteomics, as well as metabolomics, is an essential piece of personalized care. The key issue of personalized or individualized medicine remains how a targeted therapy can be used to tackle rapidly increasing chronic health burden by maximizing therapeutic efficacy and minimizing drug toxicity risks for an individual. Since the completion of the human genome project in the year 2000, the field has continued to evolve over the years especially from pharmacogenetics to pharmacogenomics so as to effectively monitor the multigenic effect on drug response [2]. Realization of the limitation of pharmacogenetics leads to the emergence of pharmacogenomics, which determines how genes affect a person's response to drugs. This has opened up avenues for individualized identification of genetic variants using wide genome approaches through the use of latest and most recent methods, thus providing ways for determining molecular targets with the help of available DNA-based diagnostic screening tools [3].

A growing body of evidence has shown that chronic human diseases and conditions such as type 2 diabetes (T2D), cardiovascular diseases (CVD), atherosclerosis, obesity, and metabolic syndrome are associated with unhealthy lifestyle, which includes bad eating habits, physical inactivity, smoking, and exposure to stress [4]. A lifestyle modification with personalized nutrition and personalized physical activity is believed to play a central role in the prevention, management, and treatment of these life-threatening conditions [5]. Currently over 2500 genetic tests are available for the detection of diseases [6]. Ongoing efforts are being made to determine genetic risk of individuals to some of these diet-related conditions, like T2D and obesity, through available testing and screening methods so as to minimize the public health burden [7, 8]. Newer methods involving nanodiagnostic tools such as the DNA-based bionanosensors have recently emerged and are presumed to be safe and cost-effective with high specificity for early detection of the disease [9]. There is a vital need to educate the patients by the physicians and healthcare workers including the dietitians on the benefits of a well-balanced diet since failure to meet the nutritional requirements results in an array of conditions that occur due to the deficiency of certain nutrients. For example, the deficiencies of vitamins and minerals such as zinc, selenium, magnesium, chromium, and iron deficiencies have been reported in conditions like diabetes [10] and cystic fibrosis [11], especially among children. More recently, boron is getting recognition as an important trace element that may contribute significantly by mitigating the harmful effects in at least some of these diseases by augmenting the innate immune response and other mechanisms, such as stabilizing the complex membrane and macromolecular structures. Nutrient, especially the micronutrient deficiencies in early childhood or at a later stage may result in great economic burden that can lower a country's GDP [12]. Individualized nutrition and personalized care have the potential of a positive impact on the healthcare sector with certain changes in the system [13]. Some of the required changes may involve largely policy issues and healthcare infrastructural changes [14], as well as economic changes [15, 16] to lower the cost of medication.

2. Lifestyle diseases

Lifestyle factors such as bad eating habits, sedentary lifestyle, high-calorie diet and excessive alcohol intake increase the rate at which some or most chronic human diseases develop. Most of these diseases, which include cancer, diabetes and atherosclerosis, are a leading cause of death and pose great health and economic burden to the country [17]. Prevalence of diabetes, in particular, continues to increase in the world. Diabetes is projected to be the seventh leading cause of death by the year 2030 [18]. Lifestyle changes such as personalized exercise (physical activity), personalized diet (nutrigenomics), and relaxation techniques (meditation and yoga) can help prevent or at least minimize the occurrence, as well as the prevalence, of these diseases [4].

Lifestyle changes and somewhat drug intervention have profound effect on the development and progression of chronic human diseases, including the disease progress, for example, from the prediabetes stage to diabetes, or even diabetes-associated complications. However, it is not clear who may or may not respond appropriately to a particular therapy. This is because individuals are different. Lifestyle changes like healthy eating and physical activity can do a lot of wonder in preventing chronic diseases when coupled with individual awareness to disease through genetic risk testing and other methods. Personalized or individualized nutrition holds great promise in the future and can be used to identify associations between genes, nutrients, and a disease so as to improve public health [19].

3. Diet-related chronic conditions

3.1. Diet and physical activity

Diet and (lack of) physical activity constitute some of the major contributory factors for the development of chronic illnesses, both noncommunicable and communicable, directly impacting the immune system of the body and metabolism. Diseases like tuberculosis fail to develop if an individual's lifestyle is healthy with respect to diet and physical activity. In diet-related complications such as obesity and T2D, a complex interplay of several factors including both genetic predisposition and lifestyle of an individual has been reported [5, 19]. These factors can have serious devastating effects on health, as the appearance of one disease may increase the chance for another disease; for example, obesity alone may lead to an increase in T2D and CVD [20].

Diet-related diseases are generally chronic in nature and are often associated with age and type of diet (nutrition) [21]. Personalizing diet, i.e., increasing the nutritional quality of diet and genotyping (nutrigenomics), leads to achieving a better health [22]. Earlier, global guidelines on food, certain food groups, and other nutrient requirements of the population were recommended with the overall view of preventing or delaying the onset of diet-related diseases. Nowadays, with an increased understanding of genetic differences pertaining to nutritional requirements among individuals, scientists are making efforts to

categorize these guidelines based on inter-individual variation in dietary response resulting in a personalized diet, thus preventing chronic diet-related conditions [21]. Over the years, a number of clinicians and researchers have tried to demonstrate the importance of dietary modifications to achieve healthy and sustainable weight loss among overweight and obese individuals. However, these attempts could not yield positive results because of different metabolic roles of macromolecules such as the lipid, protein and carbohydrate in energy homeostasis and differences in metabolism. These molecules have a great effect on metabolism, appetite, and thermogenesis, which support the idea of considering the fuel value provided by each macromolecule separately. At times, even when considered separately, nature and kind of food constituents matter. For example, a diet which can reduce the risk of T2D and CVD is important for people who already have the disease. In this case, a fiber-rich or nonstarch polysaccharide diet, like whole grain, legumes, fruits and vegetables, is the most appropriate diet.

A sedentary lifestyle equally contributes to lifestyle diseases. It has been identified as a link between obesity, diabetes, metabolic syndrome, CVD, and death [23]. Physical inactivity is widely believed to be the primary cause of most preventable chronic conditions including diabetes, obesity and CVD. Therefore, physical activity may delay or prevent these and other chronic conditions [24]. Weight loss is recognized as one of the baseline strategies employed to deal with chronic inflammatory diseases like diabetes and CVD [25]. Obese individuals are overweight and prone to develop chronic inflammatory diseases. A holistic approach focusing on changes in lifestyle including changes in diet to suit individual's needs, and physical activity, together with compatible precision medicine and ridding of the bad habits is bound to have beneficial effect on the management and prevention of life-threatening diseases and associated complications.

3.2. Type 2 diabetes

Individuals with type 2 diabetes are often faced with insulin resistance (IR) challenge arising from an accumulation of triglycerides in adipose tissues. Studies have shown that weight loss can bring significant improvement in IR both in T2D and in those with impaired glucose tolerance [26]. Nonetheless, there is an array of inter-individual variations with regard to improvement in insulin sensitivity and glycemia because of the individual response to changes in lifestyle factors such as the weight, diet and physical activity [5].

Increasing evidence has shown that single-nucleotide polymorphisms (SNPs) exist in diabetes [27, 28], which gives a lot of scope for the treatment based on genetic characteristics of an individual. These genetic differences are considered as markers of diabetes risk as they can be used to predict the disease and also to determine diabetes onset [29]. Nearly 80 genetic loci are thought to influence genetic susceptibility to both types of diabetes. An integral part of diabetes management and self-management education, medical nutrition therapy (MNT), was designed to provide patients with specific care as well as guidelines on lifestyle changes an individual can make and maintain in order to improve health [30]. Once individuals' basic nutritional requirements have been achieved, chances of developing disease are rare even for diabetics where nutrient supplementation may be an issue of concern [31].

3.3. Obesity

Management of obesity consists of the ability to lose weight either through exercise or personalized nutrition (non-pharmacological), or may involve the use of drugs. Due to individual genetic makeup and myriad of environmental factors, different individuals respond differently to exercise; some may even show resistance [32, 33]. Personalized exercise may help prevent unwanted individual response. In addition, identification of specific polymorphisms such as obesity-related SNPs may help find differences in dietary response to caloric restriction. Personalized nutrition is, therefore, expected to play a role in determining the kind and nature of diet suitable for different individuals owing to the environmental and genetic differences. Many of the diet-associated health burdens have been linked to SNPs, which is used to predict individual response to drugs in a population [34]. The most common examples of these polymorphisms are leptin/leptin receptor polymorphism (related to obesity gene), apolipoprotein (E and A1), which is related to CVD, and methylenetetrahydrofolate reductase (MTHR) related to folate metabolism [35].

3.4. Cardiovascular diseases

Cardiovascular diseases (CVDs) are a group of metabolic diseases arising from atherosclerosis [36]. CVDs account for the most common cause of morbidity and mortality in the world [36], with poorly controlled diabetes as one of the promoting factors. Newer technologies involving large-scale genotyping and sequencing have allowed for identification of heritable CVD risks which can be used in personalized treatment. Epigenetics and personalized attempts are increasingly proving beneficial and providing a new way to treat CVDs [37]. In the near future, it is hoped that the DNA sequence variants associated with CVD or which show association with the beneficial or adverse effects of medication and used to predict CVD risk may be identified and guide the decision of choosing the best medication and dose to individual patients.

3.5. Cancer

Much of the successful personalized treatments have been recorded in the area of oncology with many tumors and cancers being targeted with individualized regimens. Today, the world is witnessing a rapid progress in the upcoming field of personalized medicine with the emergence of genotyping industry for screening/testing, leading to an increased use of of precision medicines for cancer therapy. Many of these drugs are already available in the market and include kinase inhibitors [38]. Imatinib, lapatinib and erlotinib are some selective kinase inhibitors which are used to target anaplastic lymphoma [38].

3.6. Oral health and related diseases

Genomic information is increasing our understanding of oral health by providing an understanding of the disease etiology, thereby allowing easier diagnostic and a chance to take preventive measures to avoid the onset of oral diseases [39]. This is possible when genome

analysis and disease risk assessment is started at childhood, as it gives room for proper planning for individualized prevention and monitoring strategies. By doing so, oral health and related problems like dental caries, periodontitis, and oral cancers may be detected at the onset and treated.

3.7. Osteoporosis

Osteoporosis is a complicated preventable syndrome that affects millions of peoples, especially women, in the world. Several personalized medicine intervention procedures are being investigated to identify the individuals with a high tendency to the disease. For instance, FRAX(R) is an algorithm that enables physicians to calculate the tendency for an individual patient risk for osteoporosis for 10 years, as well as helps in the selection of appropriate drug taking into consideration the choice of the patient [40]. Prognosis, treatment, and prevention of fractures would be easier when gene variants associated with osteoporosis are identified, leading to a more personalized approach/therapy [41].

4. Conclusion

Personalized care is at the verge of a revolution in healthcare sector, with potential to revolutionize the treatment, care and prevention of a number of debilitating life threatening diseases, some of which have been discussed in this chapter (**Figure 1**). When fully implemented, the treatment of patients can be individualized in strict accordance with their individual genetic make-up, rather than traditional "one-size-fits-all" pharmacology. A person's lifestyle, which decides the overall well-being of an individual, is crucial while implementing the approach

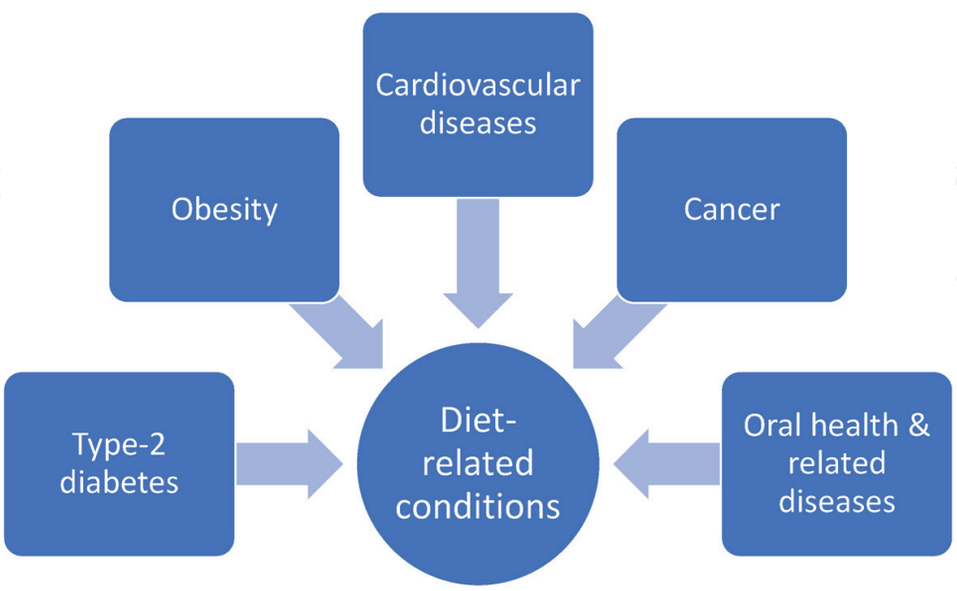

Figure 1. Diet-related conditions where personalized care can revolutionize the treatment, control and prevention of lifestyle diseases in human.

of personalized care of patients suffering from long-term lifestyle debilitating and morbid diseases through individualized nutrition, personal hygiene/oral health, and individualized needs that may be combined with relaxation techniques, such as meditation and yoga.

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