Chapter 6
Tailored Therapy Regimes Using Digital Twins

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ABSTRACT

A huge amount of data needs to be integrated and processed in the field of personalised medicine. In this case, the authors propose a solution that relies on the creation of digital twins. These are high resolution models of individual patients who have been computationally treated with thousands of drugs in order to find the drug that is most suitable for them. Digital twins could improve the proactiveness and individualization of healthcare services. It possesses the capability to identify irregularities and evaluate health risks prior to the onset or manifestation of a disease through the use of prediction algorithms and real-time data. Enormous databases of medical records biological and genomic data interconnected around the world by harnessing the power of super computers provides us the knowledge to create digital twins of yourself and using your data to improve the network for others after you who tend to have diseases that happen together based on similar gene expression or due to unprovoked side effects of simultaneous drug administration.

1. INTRODUCTION

Modern medicine is not our grandparent's medicine. It will not be our grandchildren's medicine either. We have fast and complete genome sequencing supercomputers to analyse all types of data, new tools and techniques that yield knowledge unavailable before. Taking an example of a group of cell was their behavior seems normal but instead of dying like they were programmed to, they form a tumour. To compact this situation we can create computer stimulation, the digital twin of a patient. To understand how we got here we need to travel to a smaller level. The differences between our genomes define our

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physical feature like the colour of our eyes or the blood type but also the chances of a developing a disease like cancer or diabetes mellitus. To find correlations between genotype and disease, we analyse thousands of positions in the genome for thousands of patients. This is only possible because of the computational powers of supercomputers.

We can also look for correlations between disease and gene expression. Gene expression is what defines the type of tissue even if all the tissues have exact same genome. By analysing expression data from different patients we can find differences in every cell and connect abnormal expression to disease according to body tissue. For example, the gene involved in glucose transport SLCA4 is under expressed in adipose and nerve tissues in diabetes type 2 patients. Understanding the cause of diseases at this level can help us develop more personalized treatments.

We can design better drugs using computer stimulations if we know which protein are involved in a disease. We can also modify the concentration, frequency and composition around the cell of a drug that prevents uncontrolled growth as in cancer patients. When we start collecting data from multiple patients we see patterns that were invisible in individual studies. Practitioners can then use the data from digital twins to determine whether early intervention is necessary and to personalize treatment by using digital twins that have patient genetic and medical history data attached to them.

Every person experiences various diseases, has a distinct genetic composition, and lives in a different environment. Additionally, these variations affect how each patient reacts to various treatments. In certain cases, the reaction may be so severe that the patient is hospitalized or worse or even dies, as a result of the intended healing treatment which is provided. As per this position paper, the provision of precision medicine will be achieved by a synergistic approach that blends induction via statistical models acquired from data, and deduction via mechanistic modeling and simulation that incorporates multiscale knowledge and data.

2. REAL TIME MONITORING OF PATIENT'S HEALTH IN DIABETES

Diabetes mellitus is caused due to damage in the metabolism and this could be due to various lifestyle and genetic conditions. In order to reverse this diabetes we have to fix the root cause of the problem that is fix the damaged metabolism, this was scientifically established in the year 2011 by Dr .Roy Taylor. On the contrary, it is not easy to fix this metabolism the reason being it varies with what you eat, how you sleep and how you breathe and the extent of physical activity. It varies with time of the day, age and it is highly intractable. With digital twin it became possible to get a complete picture of your metabolic health and hence fix the damages.

The digital twin of your body is built with 174 health markers and 3000 plus data points that are collected everyday using wearable sensors. These are FDA approved high quality sensors. This continuous glucose monitoring device is fixed on your arm and it is non-invasive, it is very safe and convenient to handle. This patch measures your blood sugar every 15 minutes without the need for fingerprints. This helps us understand the factors that are impacting the blood sugar level, whether it is food, sleep, or activity. This helps us create a cost and effect relationship between your blood sugars and these parameters.

Second sensor is a fit bit tracker like a smart watch that you wear on your wrist. It tracks your activity levels, like number of steps your heart rate and quantity and quality of sleep. Body composition monitoring helps us understand BMI, muscle mass, body fat, visceral fat, and subcutaneous fat. If the patient is suffering from BP or any associated complications, then we need one more sensor, the BP monitor,