

A Clinic Case of Type 2 Diabetes Control Flow Using Quantitative Lifestyle Management and Glucose Predictions (Part of the Math-Physical Medicine)

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Introduction

The author has spent 8-years monitoring and researching medical conditions and lifestyle details of a patient (himself), who has been diagnosed with type 2 diabetes (T2D), hypertension, hyperlipidemia for a period of 20 years. He has experienced many complications from diabetes such as kidney, bladder, foot ulcers, cardiovascular issues, and so forth. As seen in the chart (Figure 1), his medical examination data during the period from 2000 to 2010 were:

BMI: 31 (weight 210 lbs. & 44 inches waistline)

Average Daily Glucose: 280 mg/dL

A1C: 10%

ACR: 116 mg/mmol

Triglycerides: 1161 mg/dL

| Health Exam Record | 2010 | 2017 |
|--------------------------------------|-------|------|
| A1C (<6.4%) | 10.0 | 6.1 |
| 90-days Average Glucose (<120 mg/dL) | 279 | 113 |
| ACR (<30) | 116.4 | 12.3 |
| Triglycerides (<150) | 1161 | 67 |
| HDL(>40) | 24 | 48 |
| LDL(<130) | 174 | 74 |
| Total Cholesterol (<200) | 253 | 118 |
| BMI (<25.0) | 31.0 | 24.7 |
| Wight (lbs.) | 210 | 167 |
| Waistline (inch) | 44 | 34 |

Figure 1: Health Data Comparison between 2010 and 2017

The author decided to research diabetes in depth to save his own life. He spent the first two years from 2010 to 2011 to study internal medicine, with an emphasis on six chronic diseases, followed by two more years from 2012 to 2013 to learn food science and nutrition. He spent the entire year in 2014 to define, investigate, and develop a quantitative metabolism equation. During the period of 2015 through 2017, he developed four mathematical models for predicting his metabolic conditions. In the beginning of 2018, he focused on the interconnectivity study between chronic diseases and heart attack or stroke.

This paper provides concrete results and practical ways via a flow diagram (Figure 2) to demonstrate how he controlled his metabolic diseases, especially T2D, via a quantitative lifestyle management and glucose prediction technology.

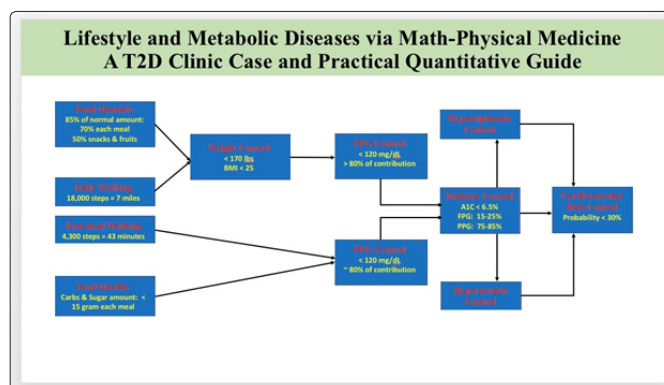


Figure 2: A Flow Diagram on Practical and Quantitative Guideline of T2D Control

Method

Since 2012, he has collected and processed ~ 1.5 M data regarding his metabolic conditions and lifestyle management details. He is a trained mathematician, engineer, and industrialist; therefore, he applied all of his disciplines learned from his educational and work backgrounds to conduct his own research and developed artificial intelligence (AI) based tools for his own use. He utilized mathematics, physics, structural and mechanical engineering, electronic and signal processing, computer science, machine learning, big data analytics, and AI, except for biology and chemistry which he has not learned. This is why he calls his method a “Math-Physical Medicine” approach.

In 2014, using advanced mathematics and engineering modeling concept (finite element method), he developed a metabolism index (MI) model which defines multiple interactions of four disease outputs (weight, glucose, lipids, blood pressure) and six lifestyle inputs (food, water, exercise, sleep, stress, daily life routines).

During 2015 through 2017, he further developed four prediction tools, including Weight, FPG, PPG, and A1C based on his various

knowledge such as signal processing, optical physics, statistics, mathematics, engineering modeling, machine learning, AI, and various industrial design knowledge from his defense, nuclear power, and semiconductor work experience.

He utilized 1,570 days data (1/1/2014 - 4/20/2018) to study fasting plasma glucose (FPG) and 1,054 days data (6/1/2015 - 4/20/2018) to study postprandial plasma glucose (PPG). He also used time-series, spatial, and frequency-domain to analyze these big data in order to extract deep buried valuable information.

Results

The summarized findings for FPG, PPG, and A1C are as follows:

FPG

It is approximately 15% - 25% of A1C formation. Weight has >85% contribution to FPG formation. Correlation between FPG and Weight is >70%. FPG Analysis Results (Figure 3) show the main findings regarding FPG.

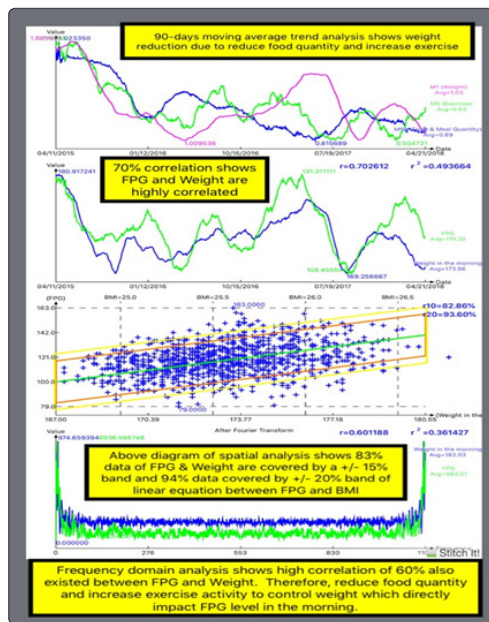


Figure 3: FPG Analysis Results via Time-Series Analysis, Spatial Analysis, and Frequency-Domain Analysis

He has reduced his food quantity to 85% of normal intake amount and also walked ~18,000 steps (7 miles or 11 km) per day. Combining these two efforts, he reduced his weight from 198 lbs. to 169 lbs. and waistline from 44 inches to 34 inches over 3-5 years. The consequence of the weight reduction lead into a healthy range of FPG values at < 120 mg/dL.

PPG

It is approximately 75% - 85% of A1C formation. PPG's contributing factors are carbs & sugar intake (~38% contribution), post-meal walking exercise (~41% contribution), weather temperature (~10% contribution) and 12 other influential factors (combined together has ~11% contribution). PPG Analysis Results (Figure 4) show the main findings regarding PPG.

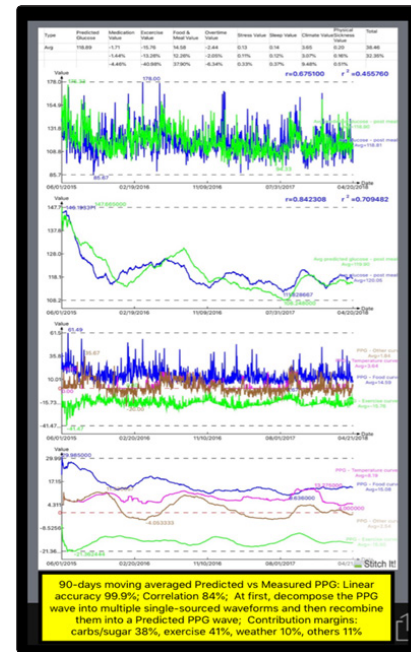


Figure 4: PPG Analysis Results via Time-Series Analysis, Contribution Margin Analysis, and Signal Process Analysis (decomposition and reintegration of major sub-waveforms)

His average carbs & sugar intake is ~15 gram per meal, and post-meal walking is ~4,400 steps. The combination of these two major factors contributes ~80% to decrease his average PPG value to <120 mg/dL.

A1C

As seen in Predictions on FPG, PPG, and Daily Average Glucose (Figure 5), both of his glucose prediction tools have reached to >99% linear accuracy, while keeping a high correlation between predicted glucose curve and measured glucose curve. Applying his machine learned AI algorithm for converting his glucose to his estimated A1C (with a build-in numerical safety margin of 7% - 15%), his A1C prediction tool has also reached to ~97% accuracy (Figure 6).

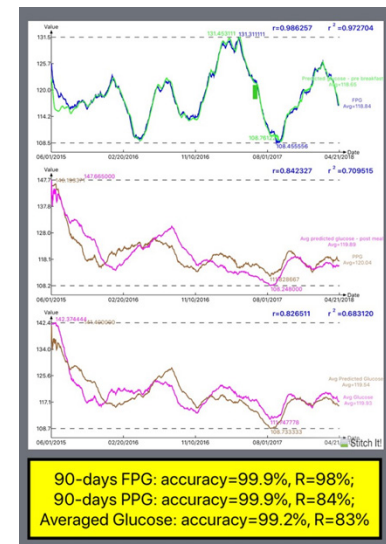


Figure 5: Extreme High Accuracy and High Correlation of Predictions on FPG, PPG, and Daily Average Glucose

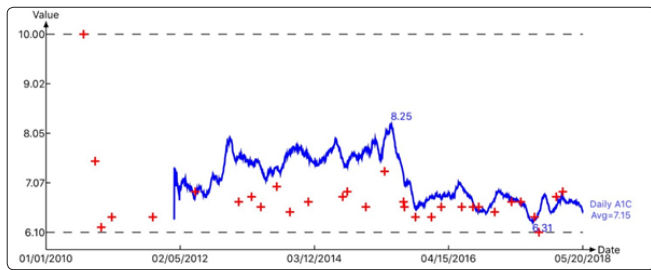


Figure 6: Estimated Daily A1C Curve (with 7% - 15% safety margin) and Lab-Tested A1C Data Since 2010

By being able to control his FPG and PPG below 120 mg/dL, his A1C was successfully brought down from 10% to ~ 6.5%.

Overall Health Conditions

After his diabetes condition improved, both of his hypertension and hyperlipidemia have become better without any special efforts. As of now, his chronic diseases are completely under control via a quantitative lifestyle management, weight prediction model, and three glucose prediction tools.

His current 2017 health data (Figure 1) are:

BMI: 24.95 (169 lbs., 34" waistline)
 Glucose: 119 mg/dL
 A1C: 6.4%
 ACR: 15 mg/mmol
 Triglycerides: 85 mg/dL

Once his metabolism diseases were under control, his risk probability of having heart attack or stroke has also been reduced from 69% in 2012 to 26.4% in 2017.

Conclusion

The patient's "nearly-collapsed" health condition in 2010 has been turned into a "nearly-perfect-controlled" situation by 2017. Furthermore, four useful prediction tools were developed via mathematical medicine. This case report has also provided concrete numerical data as shown in above four figures and practical guidance as shown in the T2D control flow diagram (Figure 2).

Limitation of Research

This article is based on data collected from one T2D patient's 8-years metabolic conditions and lifestyle details. It does not cover genetic conditions and life style details of other diabetes patients. Therefore, these conclusions and findings should be reverified for patients who have other metabolic disorder diseases. The author does believe in his own research work's results, findings, and conclusions, which are based on a thorough process of identifying the system's basic characters, careful data collection and process, developing various mathematical and statistical models, using computer science tools and artificial intelligence (AI) techniques. However, other T2D patients need to be cautious about applying his finding, results, and conclusions under different metabolic conditions.

Other Declarations

The author has never hired any research assistant or associate to help with his work except for a part-time computer programmer (~3 working hours per day). He applied his own invention of a

"Software Robot" created during 2001-2009 and his AI knowledge to produce customized computer software for this research project and diabetes control.

This project was self-funded by using his own money that was earned from a successful high-tech venture in Silicon Valley. He did not receive any financial assistance or grants from any institution or organization.

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