

## Diabetes & its Complications

# Using Math-Physical Medicine to Analyze Metabolism and Improve Health Conditions

Gerald C. Hsu\*

eclaireMD Foundation, USA.

### \*Correspondence:

Gerald C. Hsu, eclaireMD Foundation, USA, E-mail: g.hsu@eclairemd.com.

Received: 04 October 2018; Accepted: 14 November 2018

**Citation:** Gerald C. Hsu. Using Math-Physical Medicine to Analyze Metabolism and Improve Health Conditions. Diabetes Complications. 2018; 2(4): 1-6.

### Keywords

Diabetes, Blood levels, Cardiac issues, Metabolism.

### Introduction

Diabetes is a metabolic disorder in which plasma glucose blood levels are abnormally high and the body cannot produce enough insulin or become insulin-resistant. Studies have shown that people with diabetes have a higher risk of getting cardiovascular disease and stroke. In order to fully understand a particular patient's diabetes condition, the patients and their medical professionals need to have a broad sense of the disease, in-depth knowledge, and quick view of the patient's metabolism status, i.e. overall health state. By having a simple indicator that dynamically demonstrates a general health status on a daily or momentary basis can benefit them.

The basic requirement for patients with type 2 diabetes (T2D) to control their disease is to know their glucose values. The definition of glucose values here includes fasting plasma glucose (FPG), taken in the morning before breakfast, and postprandial glucose (PPG), measured after the first bite of food two hours later three times per day. However, glucose testing is invasive, inconvenient, and costly. Most T2D patients are not performing the measurement on a regular basis for these reasons; therefore, it is important to find an alternative way to achieve a quick, easy, painless, low-cost, effective, and accurate testing method available for these patients.

I was diagnosed with T2D since 1995 and, by 2010, my health was in a "near-collapse" state. I suffered from five episodes of cardiac issues, high possibility of requiring kidney dialysis in the near future, bladder problems, foot ulcer, and other medical complications. As a result, I decided to focus on diabetes in order to save my own life. I spent nearly 8-years (~20,000 hours) researching an effective way to help myself to control my diabetes

conditions via a scientific, yet simplified, and effective lifestyle management method. My health condition comparison between 2010 and 2017 can be seen in (Figure 1).

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
Triglyceride (<150)	1161	67
HDL (>40)	24	48
LDL (<130)	174	74
Total Cholesterol (<200)	253	118
BMI (<25.0)	31.0	24.7
Weight (lbs.)	210	167
Waistline (inch)	44	34

**Figure 1:** Health Data Comparison between 2010 and 2017.

Since I am a mathematician, engineer, and an industrialist, I catalyzed my efforts by performing the following standard steps:

- phenomena observation
- data collection
- equation development
- mathematical and statistical analysis
- seeking practical answers for problem-solving
- developing user-friendly tool for patients to use

This paper describes how I achieved my health goals by monitoring my daily overall health (metabolism) status and also predicting

my daily glucose values automatically via my invented “math-physical medicine” approach.

## Methods

### Data

All data was collected in its entirety from one patient only, myself, via a customized software over 7.5 years since 2012. My educational and work backgrounds have provided the practical experience on how to collect and categorize “clean data” from the beginning. Otherwise, for many data analysis projects, research scientists usually spend 70% to 80% of their time and resources to clean up “dirty” or “contaminated data” before launching their “real” research work, which include data process, analysis, and interpretation. As a result, I started my project by developing a software program since 2010. I was able to collect and process more than 95% as clean data and needed very little data cleaning and organizing efforts afterwards. This project does not need to be concerned with data interference and data contamination problems due to different sources of genetic conditions, various lifestyles, and contradicting data source interpretations. These data come from a consistent sample source, making it much easier for me to dive into one variable and extract the buried information.

I learned an important work ethic from Professor Norman Jones at MIT in the early 1970s about data integrity. In this study, I used my measured data as the base for future data comparison and research. I have safeguarded the integrity of my collected data and has never altered its original content or influenced its integrity. In this way, all results from using my developed prediction tools are compared against the measured glucose and A1C values.

### Metabolism Monitoring

For the entire year of 2014, I have conducted research and development on the subject of relationship between overall health and chronic diseases. Initially, I tried to find a clear definition on metabolism but failed. For example, the Webster Dictionary defines “metabolism as the organic processes (in a cell or organism) that are necessary for life.” Finally, I tried to define metabolism in a quantitative way. I used advanced mathematics, nonlinear engineering modeling (the finite element concept and dynamic plastic behavior of structural engineering), big data analytics, computational automation, and artificial intelligence (AI) to develop a set of mathematical models and equations to describe “metabolism”.

I defined “metabolism” as a qualitative form of “energy body needs” which is an organic process containing detailed and easily measured quantities, including metabolic conditions (weight, glucose, lipids, blood pressure) and daily lifestyle data (food, water, exercise, stress, sleep, healthy daily routine). This metabolism equation contained a total of 10 categories, which included 6 inputs and 4 outputs, in the “Health Space”. Since input, output, and the biomedical system are dynamic, i.e. they are changing with time; I included “Time” as the eleventh category.

In addition to the major categories, such as food and exercise, I

also investigated the impact on my metabolism by other secondary factors, such as traveling, bowel movement, urination, tension & anxiety, disturbance on daily life routine pattern, and bad health habits, psychological effect on the physiology of my health, etc. Within each “Space” category, there are many more elements. For example, there are 9 elements in sleep, 33 in stress (not all elements are suitable for everyone), and approximately 100 for food and meal, etc. At the end, there are 11 categories comprised of ~500 elements. In total, there are approximately 1.5 million data collected and stored in the cloud over 7.5 years, which will be further analyzed. With such a big volume of data, a customized computer software program was necessary for handling the data collection, processing, and analysis.

I created two new terms known as the Metabolism Index (MI) and General Health Status Unit (GHSU). MI is the total score reflecting the body’s health condition (i.e. state of metabolism), which combined all of the 10 categories. GHSU is a moving average value of the past 90-days daily MI scores. Originally, I defined MI to fall within the range of 0.5 (best condition) to 1.5 (the worst condition). When both MI and GHSU are under 1.0, your health status is generally good. However, if these values are over 1.0, you may have some health issues or related lifestyle problems. For myself, I finalized an optimal set of elements within each category and also defined my desired healthy level status: 170 lbs. for body weight; 120 mg/dL for glucose; 120/80 for SBP/DBP; and 150/40/130/200 for triglycerides/HDL-C/LDL-C/total cholesterol. The break-even line between a “healthy state” and an “unhealthy state” is 73.5%. A value below this percentage is regarded as healthy and a value above the line is unhealthy.

### Glucose and A1C Prediction

Besides the Metabolism Model that was developed in December of 2014, three other prediction models were also released during the period of 2015 – 2017: Weight Prediction on April 11, 2015; Post-meal Glucose (PPG) Prediction on June 1, 2015; and Fasting Glucose (FPG) Prediction on July 3, 2017. These four models together provided tremendous assistance and accurate guidance to help control my diabetes and other three chronic diseases, including obesity, hypertension, and hyperlipidemia. After the release of Weight Prediction, I gradually included and completed all of the list items in my prediction models by using the lifestyle data. Therefore, the “time window” of my data collection and analysis started on April 11, 2015. Summarized findings can be seen in the “Results” section.

After developing capabilities on predicting both FPG and PPG, I further developed a machine-learning statistical algorithm to convert daily average glucose value into an estimated daily A1C and automatically readjust it when new quarterly A1C lab-tested data was available.

During 2012 - 2014, I specifically added in a 15% “safety margin” on top of the estimated A1C to cover the possible variance generated by different chemical process and various environmental factors associated with the A1C testing done in the laboratory.

After 4/11/2015, I have reduced this safety margin to less than 10% in order to match with better-controlled situation. This extra caution can provide a numerical safety buffer to avoid creating unnecessary panic on T2D patient, such as myself, while still serving as a daily “early warning” before I have a chance to get my A1C tested.

### Lifestyle Management

Approximately 2.1 million deaths occur every year in the United States. The major cause of death is due to diseases, only about 15% are associated with war, accidents, or suicidal acts. Among the different diseases that cause death, there is a big portion related to chronic diseases either directly caused or gradually influenced.

Medical professionals believe that, in general, there are two main reasons for these chronic diseases, genetic and lifestyle; though, no one can tell the exact percentage of each reason. Genetic research topics such as DNA and stem cell seem to be quite complex, fascinating, and elaborate but with years of research still needed. Patients with chronic disease(s) cannot change their genetic conditions, at least not yet, however, they can definitely change their lifestyle. From my experience, for whatever reasons, most medical doctors focus mainly on treatment, not on lifestyle. They refer their patients to other healthcare professionals, such as dietitian, physical trainer, psychotherapist, and so forth to seek for their help. I do believe in medical treatments, especially under emergency situations or complex health conditions; nonetheless, metabolic disorders such as diabetes requires lifestyle management to help control this disease. Therefore, in 2010, I focused on the lifestyle’s impact on diabetes in order to save my life. My purpose was to find and then develop a mathematical and scientific way to understand measure, analyze, and develop guidelines that can be used to effectively manage my diabetes via lifestyle improvements. Detailed summaries of my findings are presented in the “Results” section.

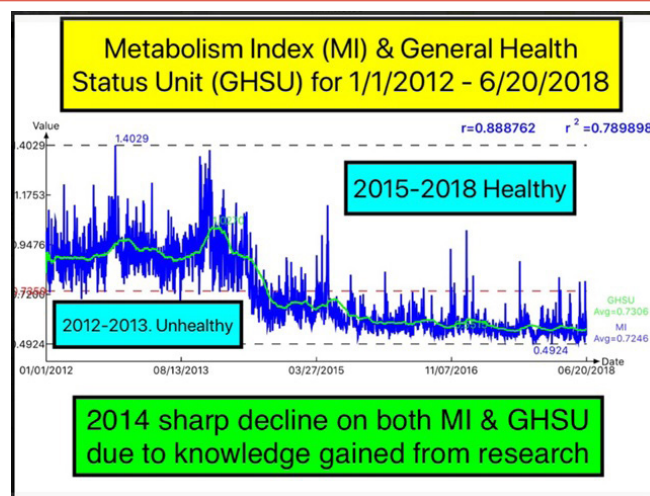
## Results

### Metabolism

The graphic curves of metabolism index (MI) and general health status unit (GHSU) show that I was very unhealthy (80%-110%) before 2013. The curve went through a sharp decline in 2014 due to knowledge gained during my research efforts. After 2015, I became “healthy” (55%-70%). On 6/21/2018, my MI is 57.1% and GHSU is 56.1%. All of my previous lab test results confirmed with this diagram showing my chronic disease conditions are well under control. The graphic curves of my data are seen in (Figure 2) using MI and GHSU.

Interestingly, my risk probability of having a heart attack or stroke dropped from 74% in 2000 down to 26.4% in 2017, which is compatible with Framingham Study’s result of 26.7%.

This is an actual application of how to control my chronic diseases via math-physical medicine, using a quantitative approach on lifestyle management. In my opinion, it can be considered as a branch of preventative medicine or translational medicine.



**Figure 2:** Metabolism Index (MI) and General Health Status Unit (GHSU) from 2012 to 2018.

### Metabolic Conditions

In previous sections, I have already discussed the methodology of several metabolism categories. The remaining section presents detailed summaries of each category. Most discussions in the medical and patient’s community center around diseases, conditions, and treatments which are the “output” of our biomedical system. Some discussions are focused on lifestyle issues which are the “input” of the same system, but lack the necessary and sufficient quantitative measurements, implementations, and proofs.

Some of my previous papers have presented the output categories, including diseases, symptoms, and measurements. In this article, I will only address my data related to weight, glucose, lipids, and blood pressure. In summary, all of my four metabolic conditions are under control via a quantitative management of 6 input categories. Please see (Figure 3) for summary graph of my output data. The time window selected is from 1/1/2012 to 6/20/2018. Other than the lipid data which were collected from lab tests, all others are daily data collected by myself.

#### Summary of Metabolic Conditions:

Weight: from 190 lbs. to 170 lbs. (210 lbs. in 2000)  
 Glucose: from 140 mg/dL to mg/dL (280mg/dL in 2000)  
 A1C: from 10% to 6.5%  
 SBP / DBP: 139 / 77 mmHG to 105 / 62 mmHG  
 Lipids: all improved and within normal range

#### FPG Summary:

5 influential factors  
 Weight is the key factor (85%)  
 Achieves 99.8% accuracy & 98.6% correlation  
 Makes ~20% to 25% of A1C formation

#### PPG Summary:

15 influential factors  
 Carbs/sugar (38%) and exercise (41%) are key factors  
 Achieves 99.3% accuracy and 71.3% correlation  
 Makes ~75% to 80% of A1C formation



Please see the diagram (Figure 4) of the comparison of mathematically estimated daily A1C value vs. quarterly lab-tested A1C value.

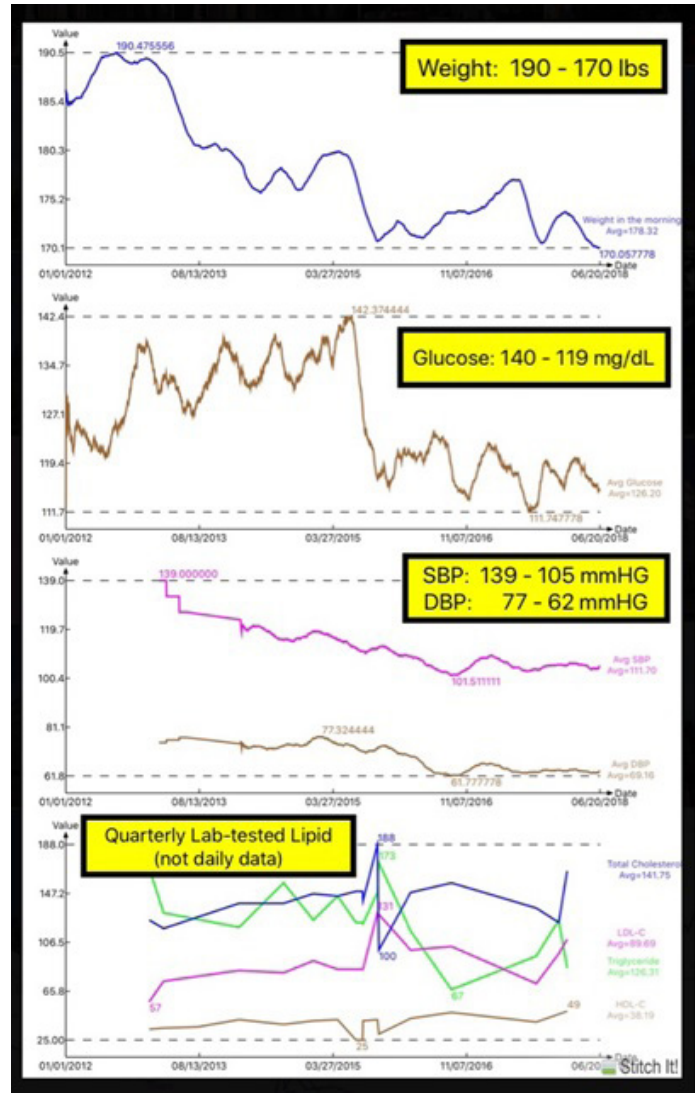


Figure 3: Metabolism Outputs (1/1/2012 - 6/20/2018).

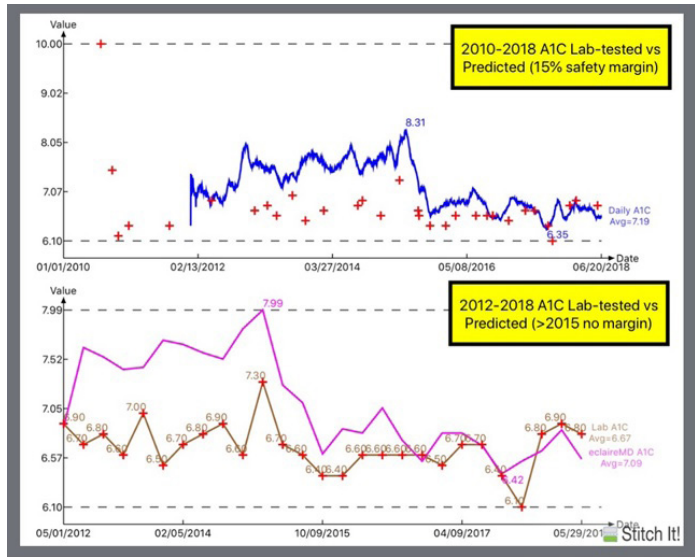


Figure 4: Comparison of Mathematically Estimated Daily A1C Value vs. Quarterly Lab-Tested A1C Value.

### Lifestyle Management

First, I will display a conversion table of Lifestyle Category Scores to a common Satisfaction Levels (Figure 5) which is self-explanatory:

Conversion Table from Lifestyle Category Score to Satisfaction Level						
Category	Worst Condition Score	Best Condition Score	MI Score	Satisfaction Level (%)	Best Condition Unit	Note
Water	1.5	0.7	0.74	95%	6 bottles (500 cc each)	drink 5.74 bottles per day
Stress	1.5	0.5	0.51	99%		
Sleep	1.5	0.5	0.63	87%		
Sleep Hours	4	8	7.15	79%	8 hours per night	sleep 7 hours and 10 minutes per night
Wakeup Times	5	0	1.76	65%		wake up 1.76 times per night
Food Total Score	1.5	0.5	0.70	80%		
Food Quantity	1.5	0.5	0.88	62%		
Food Quality	1.5	0.5	0.53	97%		
Walking Exercise	1.5	0.5	0.54	96%	18,000 steps	walk 16,627 steps in average
Daily Routine	1.5	0.7	0.73	96%		

Figure 5: Conversion Table of Lifestyle Category Scores to Satisfaction Levels.

Second, I will discuss the results associated with each input category during the period of 4/11/2015 to 6/20/2018 via (Figure 6) and (Figure 7).

The starting day of this time window was the release day of my PPG prediction model (4/11/2015).

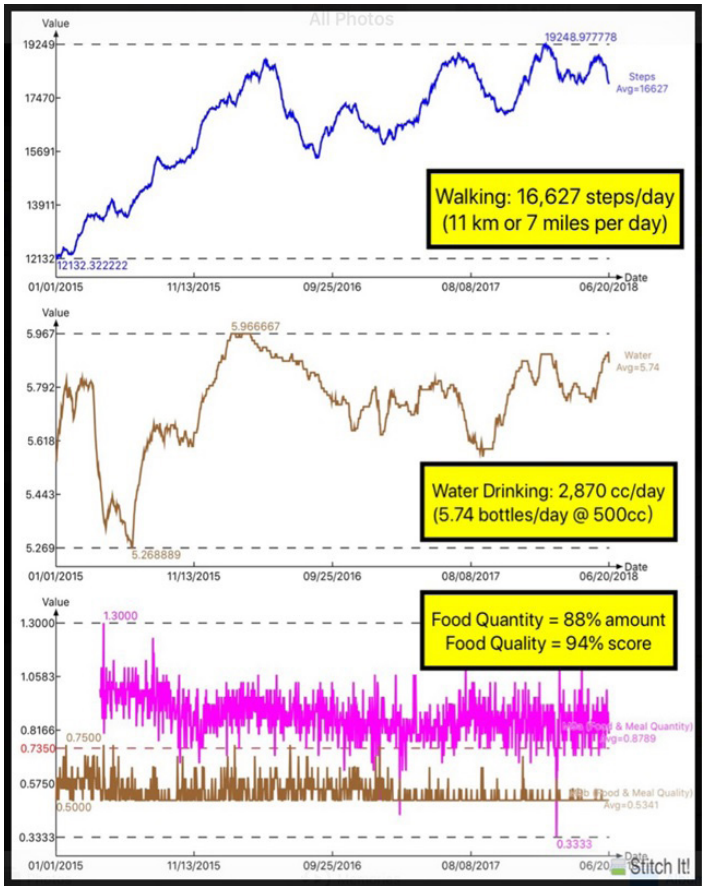
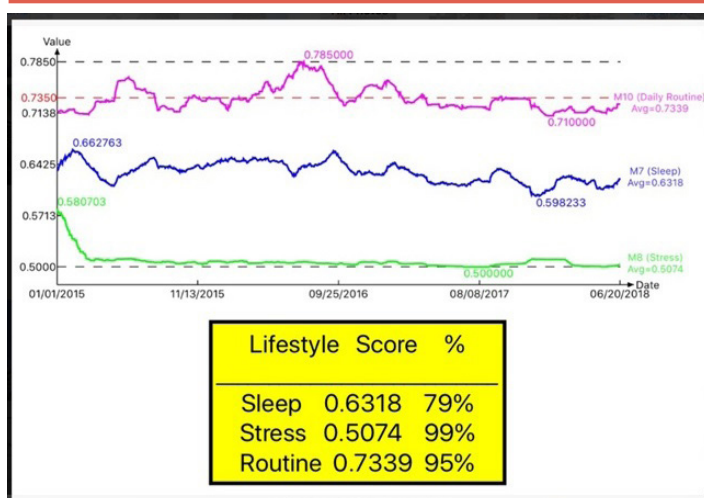


Figure 6: MI Input Categories (Food Quantity and Food Quality, Walking Exercise, Water Drinking).



**Figure 7:** MI Input Categories (Sleep, Stress, Daily Life Routine).

### Food and Meal

My food and meal score is simply the average of both quantity and quality scores. It is 0.7039 and its satisfaction level is 80%, which is a decent number.

I will repeat the difference between food quantity and food quality in order to emphasize their separate roles in controlling chronic diseases. Food & Meal Quantity control is important for weight control, and in turn to control FPG and other chronic diseases. My score is 0.8786, or in average, I only eat 88% of my normal food portion. This self-discipline allows me to reduce my weight from 190 lbs. in 2012 to 170 lbs. in late 2015 and maintain around the same level in the past three years.

**Daily Routine**  
M10=0.7000

Are the following items out-of-order?

- Short Air Travel Today: Yes No
- Long Air Travel Today: Yes No
- Trauma Today: Yes No
- Job & Work: Yes No
- Rest & Leisure: Yes No
- Exercise & Fitness: Yes No
- Food & Meal: Yes No
- Disease, Discomfort, Fatigue: Yes No
- Hay Fever & Allergy: Yes No
- Weather & Living Environment: Yes No
- Jet Lag: Yes No
- Sleep Pattern Disturbance: Yes No
- Urination & Bowel Movement: Yes No
- Brain Exercise: Yes No

**Food & Meal Quality**  
M9=0.5000

Have you violated these rules? (Default is "No")

- Maintain food portion control: Yes No
- Avoid process food: Yes No
- Limit carbohydrate: Yes No
- No fatty food, desert, & snack: Yes No
- Avoid sugar & sweet: Yes No
- Limit salt intake: Yes No
- Eat white meat, not red meat: Yes No
- No egg yolk, internal organ: Yes No
- Eat fish, not shellfish: Yes No
- Take protein or dairy food: Yes No
- Eat lots of vegetable & fiber: Yes No
- Eat fruit between meals: Yes No
- Drink water, not beverage: Yes No
- No alcohol drinking & smoking: Yes No
- No junk food at all: Yes No
- No eating after 8pm: Yes No
- Take vitamin & supplement: Yes No
- Maintain a regular meal pattern: Yes No
- Chew & eat slowly: Yes No
- Brush, floss & protect teeth: Yes No

**Figure 8:** 14 Elements of Daily Life Routine and 20 Elements of Food Quality.

My food quality score is 0.5291 and its satisfaction level is 97%. I could get the 100% perfect score if I followed my ready-made 20 rules (Figure 8) precisely every day; but, this is nearly impossible since food is extremely tempting to human beings. From my experience, this food quality score indeed helped me to lower my blood lipids as well as reflecting good results of my overall

health status. Genetically, I was born with low blood pressure, but previously as a businessman, I encountered many stressful events that caused me to have a period of “temporary but not so severe” hypertension. Getting rid of my stressful business and following my discipline on food and meal quality, including much less salt intake, have helped me to correct this metabolic condition.

### Conclusion

This article discusses metabolism in general and its measurement in a quantitative way using math-physical medicine approach. Through carefully selecting, defining, measuring, collecting, and analyzing 10 categories, 500 elements, and 1.5 million data of both 4 output categories of metabolic conditions and 6 input categories of lifestyle Management details, I have successfully converted my “near-collapsed” health situation into a “well-controlled” health status. Although this eight long years and 20,000 hours of work have been a difficult and tedious journey, the ending results are exciting and inspiring. More importantly, I have synthesized and simplified the process and results into a set of simple guiding rules to be used by other patients with chronic diseases. In short, my life is in my own hands and I must take over control of my health. This article summarized my struggles and discovery which I now share with the readers.

### Limitation of Research

This article is based on data collected from one T2D patient’s 8-years metabolic conditions and lifestyle details, i.e. my own data. It does not cover genetic conditions and life style details of other diabetes patients. My BMI was >31 (obese) in 2000. However, during the period of 2010-2018, I have reduced my BMI from 29.5 to 24.5 (overweight). Therefore, my conclusions and findings should be reverified for patients who are either underweight or obese. I do believe in my own research work’s results, findings, and conclusions, which are based on a careful and thorough process of identifying the system’s basic characters, developing various mathematical and statistical models, using computer science tools and AI techniques. However, other T2D patients need to be cautious about applying my finding, results, and conclusions under different metabolic conditions.

### Other Declarations

I have never hired any research assistant or associate to help with my work except for a part-time computer programmer (~3 working hours per day). I applied my own invention of a “Software Robot” created during 2001-2009 and artificial intelligence knowledge I learned to produce my needed computer software for my research project and diabetes control.

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

This lengthy article covers a lot of materials. However, there are abstracts and PowerPoints slides made solely for medical conferences are available on my website: [www.eclaircmd.com](http://www.eclaircmd.com)

---

## Acknowledgement

First and foremost, I wish to express my sincere appreciation to a very important person in my life, Professor Norman Jones at MIT. Not only did he give me the opportunity to study at MIT, but he also trained me extensively on how to solve problems and conduct scientific research.

I would also like to thank Professor James Andrews at the University of Iowa. He helped and supported me tremendously when I first came to the United States. He believed in me and prepared me to build my engineering foundation during my undergraduate and master's degree work.

## References

I created this math-physical medicine approach by myself in order to save my own life. Although I have read many medical books, journals, articles, and papers, I did not specifically utilize any data or methodology from other medical work. All of my research is my original work based on data I collected from my own body and using computer software I developed during the past 8-years. Therefore, no major problems were associated with data interference or data contamination. In addition, my knowledge, information, technique, and methodology of mathematics, physics, engineering, and computer science came from my lifelong learning from schools or industries and should not be listed as medical references. This is the reason I do not have a reference section in my research article.