Special Issue 5
2022

The GH-Method

Viscoelastic Medicine Theory (VMT #430): Relationships Between Synthesized PPG and FPG with Other Four PPG Components Using Viscoplastic Energy Model of GH-Method: Math-Physical Medicine (No. 1032)

Gerald C. Hsu*

eclaireMD Foundation, USA

Abstract

The author's paper number 090, published in 2019, delved into postprandial plasma glucose (PPG) based on a geometric model, Open-High-Close-Average (OHCA), using the candlestick model from the stock market. The abstract of paper number 090 is included in the introduction section of this paper number 1032.

Subsequently, the author revisited the same subject with an expanded understanding of glucose, incorporating additional data collected from 2018 to 2024, spanning 7 years. Additionally, he has used an energy model associated with the space-domain viscoplastic medicine theory (SD-VMT) to produce quantitative findings regarding relationships between synthesized PPG and fasting plasma glucose in the early morning (FPG) with the four PPG OHCA components.

In summary, the five energy ratios of his synthesized PPG between Y2018 and Y2024 are: FPG = 26%; PPG at 0-min (Open) = 18%; PPG at 60-min (High) = 21%; PPG at 120-min (2-hours) = 17%; PPG at 180-min (Close) = 18%

The time-zone energy distributions are: Y2018-Y2021 = 71%; Y2022-Y2024 = 29%

Fasting plasma glucose (FPG) serves as the baseline of PPG level and contributes the highest energy at 26%, while the high or peak PPG contributes the second highest energy at 21%. The open PPG at 0 minutes, the PPG at 120 minutes, and the close PPG at 180 minutes have each contributed similar energy levels around 17% to 18%.

Key message:

Individuals with type 2 diabetes (T2D) can lower their FPG level (the baseline of PPG) through body weight reduction and subsequently control their high PPG levels (hyperglycemia) through both reduced carbohydrate and sugar intake, coupled with post-meal walking exercise. By doing so, they can effectively manage their T2D condition without medication.

Keywords: Viscoelastic; Viscoplastic; Diabetes; Glucose; Biomarkers; Insulin; Neuroendocrine

Abbreviations: CGM: continuous glucose monitoring; T2D: type 2 diabetes; PPG: postprandial plasma glucose; FPG: fasting plasma glucose; SD: space-domain; VMT: viscoelastic medicine theory; FFT: Fast Fourier Transform

Available online: 8 April 2024

*Corresponding author: Gerald C. Hsu, eclaireMD Foundation, USA

1. Abstract of Paper No.090

This study introduces simple and straightforward equations for predicting postprandial plasma glucose (PPG) levels, utilizing CGM sensor-monitored data and the candlestick charting method.

Candlestick charting, initiated by a Japanese rice merchant in Osaka around 1850 and introduced to the Western world by Steve Nison in 1991, is widely employed in stock market analysis for forecasting stock price trends.

Over a span of 401 days (5/5/2018 - 6/10/2019), the author gathered approximately 29,300 glucose readings through a CGM sensor on his upper arm. He also adapted the Candlestick Charting technique, creating a new glucose model termed the "OHCA Model" (open-high-close-average) by analyzing 1,203 individual PPG waveforms related to various meals and physical activities.

The synthesized PPG waveform's OHCA values are as follows:

• Open at 0 minutes: 126 mg/dL

• High at 60 minutes: 147 mg/dL

• Close at 180 minutes: 132 mg/dL

• Averaged Sensor: 136 mg/dL

• Averaged Finger: 116 mg/dL

Analysis of carbohydrate/sugar intake grams and post-meal walking steps led to several key findings:

• The average carbohydrate/sugar intake per meal is 15.4 grams, which correlates to a PPG increase rate of 1.4 mg/dL per gram, peaking at about 60 minutes post-meal consumption.

• The average post-meal walking exercise is 4,200 steps, contributing to a PPG reduction rate of 3.6 mg/dL per thousand steps, reaching a lower value at 180 minutes post-consumption.

• A 17% discrepancy between averaged CGM sensor PPG (136 mg/dL) and finger PPG (116 mg/dL) highlights the limitation of traditional finger-piercing tests in capturing glucose spikes (hyperglycemia), potentially leading to many diabetes complications.

• The PPG's triangular geometry indicates a triangle base point (TB) of 128 mg/dL, a triangle peak point (TP) of 147 mg/dL, and a triangle midpoint (TM) of 137 mg/dL, closely aligning with the averaged CGM sensor reading (136 mg/dL).

Furthermore, this research presents two practical formulas for diabetes management:

• A 1.4 mg/dL PPG increase per gram of carbohydrates/sugar ingested, and

• A 3.6 mg/dL PPG decrease per thousand steps walked.

This paper underscores the significance of physical phenomena observation, mathematical analysis, computational tools application, and the integration of biomedical knowledge for the discovery of precise biomedical insights regarding the human body through the GH-Method: math-physical medicine approach.

Key Message:

This paper highlights two simple yet practical formulas based on PPG's triangular geometry model, offering a valuable tool for Type 2 Diabetes (T2D) patients to effectively predict and manage their PPG levels and diabetes conditions.

1.1 Biomedical and Engineering or Technical information:

The following sections contain excerpts and concise information on meticulously reviewed by the author of this paper. The author has adopted this approach as an alternative to including a conventional reference list at the end of this document, with the intention of optimizing his valuable research time. It is essential to clarify that these sections do not constitute part of the author's original contribution but have been included to aid the author in his future reviews and offer valuable insights to other readers with an interest in these subjects.

Pathophysiologically, can FPG serve as the baseline of PPG?

Pathophysiologically, fasting plasma glucose (FPG) can serve as a baseline for postprandial plasma glucose (PPG). Fasting plasma glucose represents the glucose level in the blood after an overnight fast and is generally used as a reference point for measuring the impact of food intake on blood

© all copyrights reserved by Gerald C. Hsu

glucose levels. After eating, the increase in blood glucose from FPG levels is referred to as postprandial glucose rise. Understanding the relationship between FPG and PPG is crucial in managing conditions such as diabetes and assessing overall glycemic control.

In a 180-minute PPG waveform, the opening PPG at 0-minute close to both 120-minutes or 180-minutes?

In a 180-minute postprandial plasma glucose (PPG) waveform, the opening PPG at 0 minutes would be closer to the PPG at 120 minutes than to the PPG at 180 minutes. As the 0-minute PPG represents the initial blood glucose level after eating, it is closer in time to the reading at 120 minutes than it is to the reading at 180 minutes. The actual PPG levels at both 120 minutes and 180 minutes actually depend on post-meal exercise activities.

1.2 MPM Background:

To learn more about his developed GH-Method: math-physical medicine (MPM) methodology, readers can read the following three papers selected from his published 760+ papers.

The first paper, No. 386 (Reference 1) describes his MPM methodology in a general conceptual format. The second paper, No. 387 (Reference 2) outlines the history of his personalized diabetes research, various application tools, and the differences between the biochemical medicine (BCM) approach versus the MPM approach. The third paper, No. 397 (Reference 3) depicts a general flow diagram containing ~10 key MPM research methods and different tools.

The author's diabetes history:

The author was a severe T2D patient since 1995. He weighed 220 lb. (100 kg) at that time. By 2010, he still weighed 198 lb. with an average daily glucose of 250 mg/dL (HbA1C at 10%). During that year, his triglycerides reached 1161 (high risk for CVD and stroke) and his albumin-creatinine ratio (ACR) at 116 (high risk for chronic kidney disease). He also suffered from five cardiac episodes within a decade. In 2010, three independent physicians warned him regarding the need for kidney dialysis treatment and the future high risk of dying from his severe diabetic complications.

In 2010, he decided to self-study endocrinology with an emphasis on diabetes and food nutrition. He spent the entire year of 2014 developing a metabolism index (MI) mathematical model. During 2015 and 2016, he developed four mathematical prediction models related to diabetes conditions: weight, PPG, fasting plasma glucose (FPG), and HbA1C (A1C). Through using his developed mathematical metabolism index (MI) model and the other four glucose prediction tools, by the end of 2016, his weight was reduced from 220 lbs. (100 kg) to 176 lbs. (89 kg), waistline from 44 inches (112 cm) to 33 inches (84 cm), average finger-piercing glucose from 250 mg/dL to 120 mg/dL, and A1C from 10% to ~6.5%. One of his major accomplishments is that he no longer takes any diabetes-related medications since 12/8/2015.

In 2017, he achieved excellent results on all fronts, especially his glucose control. However, during the pre-COVID period, including both 2018 and 2019, he traveled to ~50 international cities to attend 65+ medical conferences and made ~120 oral presentations. This hectic schedule inflicted damage to his diabetes control caused by stress, dining out frequently, post-meal exercise disruption, and jet lag, along with the overall negative metabolic impact from the irregular life patterns; therefore, his glucose control was somewhat affected during the two-year traveling period of 2018-2019.

He started his COVID-19 self-quarantined life on 1/19/2020. By 10/16/2022, his weight was further reduced to ~164 lbs. (BMI 24.22) and his A1C was at 6.0% without any medication intervention or insulin injection. In fact, with the special COVID-19 quarantine lifestyle since early 2020, not only has he written and published ~500 new research articles in various medical and engineering journals, but he has also achieved his best health conditions for the past 27 years. These achievements have resulted from his non-traveling, low-stress, and regular daily life routines. Of course, his in-depth knowledge of chronic diseases, sufficient practical lifestyle management experiences, and his own developed high-tech tools have also contributed to his excellent health improvements.

On 5/5/2018, he applied a continuous glucose monitoring (CGM) sensor device on his upper arm and checks his glucose measurements

© all copyrights reserved by Gerald C. Hsu

every 5 minutes for a total of 288 times each day. Furthermore, he extracted the 5-minute intervals from every 15-minute interval for a total of 96 glucose data each day stored in his computer software.

Through the author's medical research work over 40,000 hours and read over 4,000 published medical papers online in the past 13 years, he discovered and became convinced that good life habits of not smoking, moderate or no alcohol intake, avoiding illicit drugs; along with eating the right food with well-balanced nutrition, persistent exercise, having a sufficient and good quality of sleep, reducing all kinds of unnecessary stress, maintaining a regular daily life routine contribute to the risk reduction of having many diseases, including CVD, stroke, kidney problems, micro blood vessels issues, peripheral nervous system problems, and even cancers and dementia. In addition, a long-term healthy lifestyle can even "repair" some damaged internal organs, with different required time-length depending on the particular organ's cell lifespan. For example, he has "self-repaired" about 35% of his damaged pancreatic beta cells during the past 10 years.

Energy theory:

The human body and organs have around 37 trillion live cells which are composed of different organic cells that require energy infusion from glucose carried by red blood cells; and energy consumption from labor-work or exercise. When the residual energy (resulting from the plastic glucose scenario) is stored inside our bodies, it will cause different degrees of damage or influence to many of our internal organs.

According to physics, energies associated with the glucose waves are proportional to the square of the glucose amplitude. The residual energies from elevated glucoses are circulating inside the body via blood vessels which then impact all of the internal organs to cause different degrees of damage or influence, e.g. diabetic complications. Elevated glucose (hyperglycemia) causes damage to the structural integrity of blood vessels. When it combines with both hypertension (rupture of arteries) and hyperlipidemia (blockage of arteries), CVD or Stroke happens. Similarly, many other deadly diseases could result from these excessive energies which would finally shorten our lifespan. For an example, the combination of hyperglycemia and hypertension would cause micro-blood vessel's leakage in kidney systems which is one of the major causes of CKD.

The author then applied Fast Fourier Transform (FFT) operations to convert the input wave from a time domain into a frequency domain. The y-axis amplitude values in the frequency domain indicate the proportional energy levels associated with each different frequency component of input occurrence. Both output symptom value (i.e. strain amplitude in the time domain) and output symptom fluctuation rate (i.e. the strain rate and strain frequency) are influencing the energy level (i.e. the Y-amplitude in the frequency domain).

Currently, many people live a sedentary lifestyle and lack sufficient exercise to burn off the energy influx which causes them to become overweight or obese. Being overweight and having obesity leads to a variety of chronic diseases, particularly diabetes. In addition, many types of processed food add unnecessary ingredients and harmful chemicals that are toxic to the bodies, which lead to the development of many other deadly diseases, such as cancers. For example, ~85% of worldwide diabetes patients are overweight, and ~75% of patients with cardiac illnesses or surgeries have diabetes conditions.

In engineering analysis, when the load is applied to the structure, it bends or twists, i.e., deform; however, when the load is removed, it will either be restored to its original shape (i.e, elastic case) or remain in a deformed shape (i.e. plastic case). In a biomedical system, the glucose level will increase after eating carbohydrates or sugar from food; therefore, the carbohydrates and sugar function as the energy supply. After having labor work or exercise, the glucose level will decrease. As a result, the exercise burns off the energy, which is similar to load removal in the engineering case. In the biomedical case, both processes of energy influx and energy dissipation take some time which is not as simple and quick as the structural load removal in the engineering case. Therefore, the age difference and 3 input behaviors are "dynamic" in nature, i.e., time-dependent. This time-dependent nature leads to a "viscoelastic or viscoplastic" situation. For the author's case, it is

© all copyrights reserved by Gerald C. Hsu

"viscoplastic" since most of his biomarkers have continuously improved during the past 13-year time window.

Time-dependent output strain and stress of (viscous input*output rate):

Hooke's law of linear elasticity is expressed as:

Strain (ε: epsilon) = Stress (σ: sigma) / Young's modulus (E)

For biomedical glucose application, his developed linear elastic glucose theory (LEGT) is expressed as:

PPG (strain) = carbs/sugar (stress) * GH.p-Modulus (a positive number) + post-meal walking k-steps * GH.w-Modulus (a negative number)

where GH.p-Modulus is the reciprocal of Young's modulus E.

However, in viscoelasticity or viscoplasticity theory, the stress is expressed as:

Stress = viscosity factor (η: eta) * strain rate (dε/dt)

where strain is expressed as Greek epsilon or ε.

In this article, in order to construct an "ellipse-like" diagram in a stress-strain space domain (e.g., "hysteresis loop") covering both the positive side and negative side of space, he has modified the definition of strain as follows:

Strain = (body weight at a certain specific time instant)

He also calculates his strain rate using the following formula:

Strain rate = (body weight at next time instant) - (body weight at present time instant)

The risk probability % of developing into CVD, CKD, and Cancer is calculated based on his developed metabolism index model (MI) in 2014. His MI value is calculated using inputs of 4 chronic conditions, i.e. weight, glucose, blood pressure, and lipids; and 6 lifestyle details, i.e. diet, drinking water, exercise, sleep, stress, and daily routines. These 10 metabolism categories further contain ~500 elements with millions of input data collected and processed since 2010. For individual deadly disease risk probability %, his mathematical model contains certain specific weighting factors for simulating certain risk percentages associated with different deadly diseases, such as metabolic disorder-induced CVD, stroke, kidney failure, cancers, dementia; artery damage in heart and brain, micro-vessel damage in kidney, and immunity-related infectious diseases, such as COVID death.

Some of the explored deadly diseases and longevity characteristics using the viscoplastic medicine theory (VMT) include stress relaxation, creep, hysteresis loop, and material stiffness, damping effect based on time-dependent stress and strain which are different from his previous research findings using linear elastic glucose theory (LEGT) and nonlinear plastic glucose theory (NPGT).

2. RESULTS

Figure 1 shows Data table, TD and SD results.

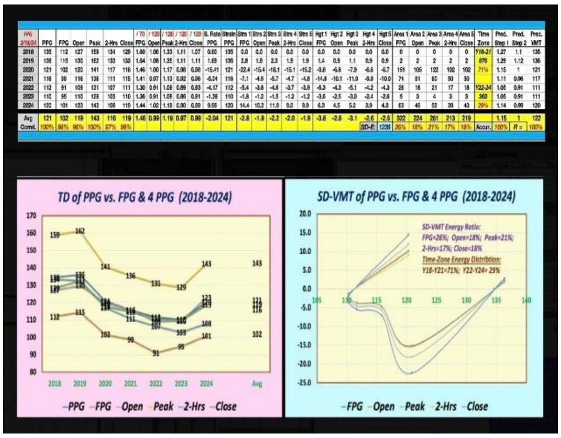


Figure 1: Data table, TD and SD results.

3. CONCLUSION

In summary, the five energy ratios of his synthesized PPG between Y2018 and Y2024 are:

- FPG = 26%
- PPG at 0-min (Open) = 18%
- PPG at 60-min (High) = 21%
- PPG at 120-min (2-hours) = 17%
- PPG at 180-min (Close) = 18%

The time-zone energy distributions are:

- Y2018-Y2021 = 71%
- Y2022-Y2024 = 29%

© all copyrights reserved by Gerald C. Hsu

Fasting plasma glucose (FPG) serves as the baseline of PPG level and contributes the highest energy at 26%, while the high or peak PPG contributes the second highest energy at 21%. The open PPG at 0 minutes, the PPG at 120 minutes, and the close PPG at 180 minutes have each contributed similar energy levels around 17% to 18%.

Key message:

Individuals with type 2 diabetes (T2D) can lower their FPG level (the baseline of PPG) through body weight reduction and subsequently control their high PPG levels (hyperglycemia) through both reduced carbohydrate and sugar intake, coupled with post-meal walking exercise. By doing so, they can effectively manage their T2D condition without medication.

4. REFERENCES

For editing purposes, the majority of the references in this paper, which are self-references, have been removed from this article. Only references from other authors' published sources remain. The bibliography of the author's original self-references can be viewed at www.eclairemd.com.

Readers may use this article as long as the work is properly cited, and their use is educational and not for profit, and the author's original work is not altered.

For reading more of the author's published VGT or FD analysis results on medical applications, please locate them through platforms for scientific research publications, such as ResearchGate, Google Scholar, etc.

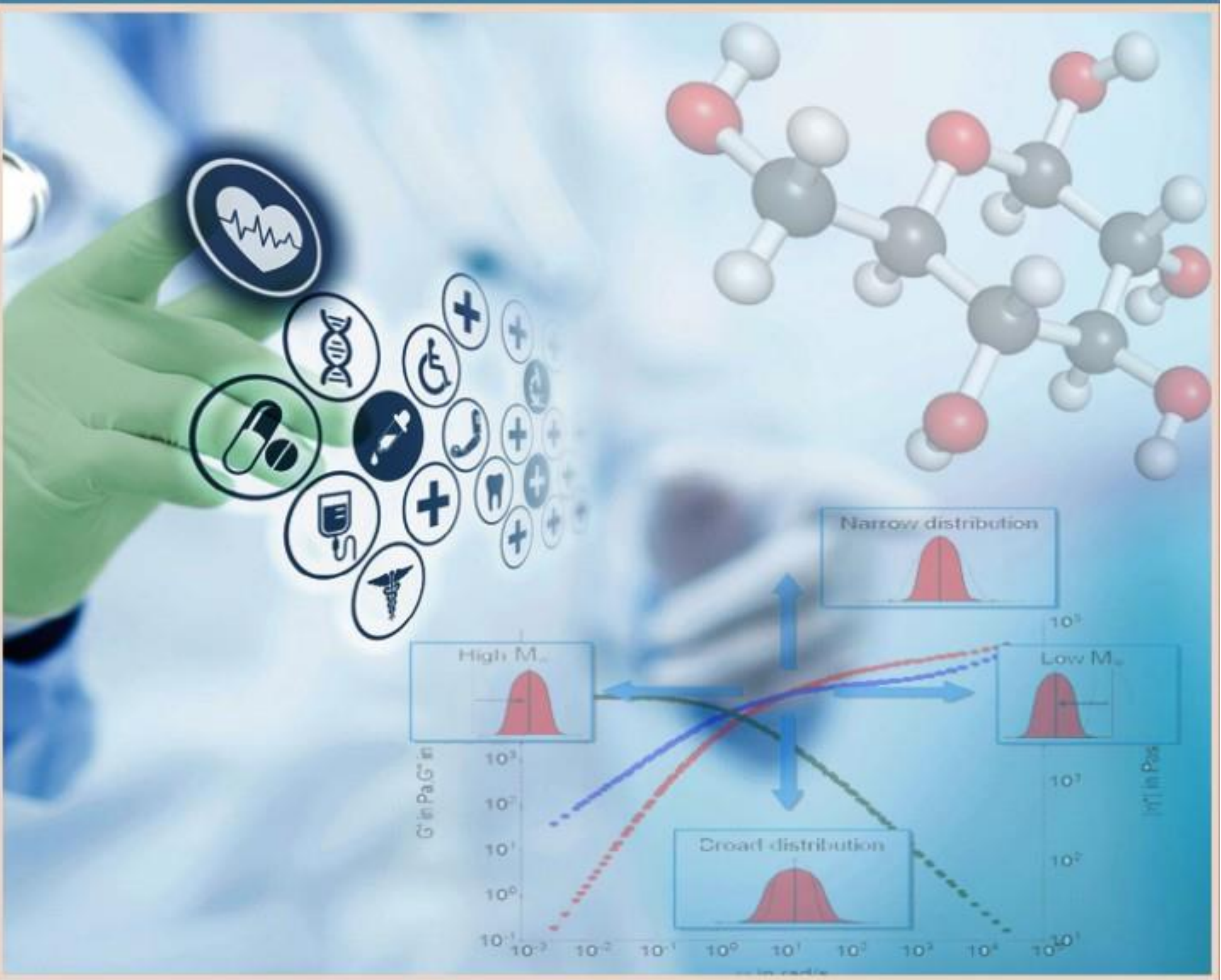
© all copyrights reserved by Gerald C. Hsu

Special Issue | Issue No. 5

The GH-Method

Viscoelastic and Viscoplastic Glucose Theory Application in Medicine

Gerald C. Hsu



https://theghmethod.com

2022

© all copyrights reserved by Gerald C. Hsu