Special Issue 5
2022

https://www.theghmethod.com

The GH-Method

Viscoelastic or Viscoplastic Glucose Theory (VGT #69): A Study of Cardiovascular Disease (CVD) Risk Probability % versus m2 (Glucose), m3 (Blood Pressure), and m4 (Blood Lipids) Using a Customized Software Program and VGT Energy Tool from Physics and Engineering Based on GH-Method: Math-Physical Medicine (No. 658)

Gerald C. Hsu*

eclaireMD Foundation, USA

Keywords: Viscoelastic; Viscoplastic; Cardiovascular disease; Type 2 diabetes; Glucose; Blood pressure; Blood lipids; Fasting plasma glucose; Postprandial plasma glucose

Abbreviations: CVD: cardiovascular disease; LD: lifestyle details; MC: medical conditions; T2D: type 2 diabetes; SD: space domain; TD: time domain; PPG: postprandial plasma glucose; FPG: fasting plasma glucose; MPM: math-physical medicine

1. INTRODUCTION

The author has been a type 2 diabetes (T2D) patient since 1995. Beginning in 2012, he started to collect his body weight and finger-piercing glucose data every day. In addition, since 2015, he accumulates other medical condition-related biomarker data, including a combination of blood pressure (BP), heart rate (HR), and blood lipid data along with important lifestyle details (LD). Based on the collected big data, he further organized them into two main groups. The first is the medical conditions group (MC) with 4 chronic disease-related categories: weight, glucose, BP, and blood lipids. The second is the lifestyle details group (LD) with 6 root-cause and lifestyle-related categories: food & diet, exercise, water intake, sleep, stress, and daily life routine. As of 1/1/2015, he calculated a unique combined daily score for the 10 categories within the MC and LD groups. The combined scores of the 2 groups, 10 categories, and 500+ detailed elements constitute an overall "metabolism index (MI)" value. This MI model includes the root causes from 6 major lifestyle inputs and symptoms of 4 rudimentary chronic diseases: obesity, diabetes, hypertension, and hyperlipidemia. Therefore, it can serve as the foundation and building block for his additional research work that can expand into various diseases associated with different organs, such as cardiovascular disease of the heart (CVD) and stroke of the brain. In his CVD risk studies, glucose, BP, and blood lipids play significant roles in the combined CVD risk. To summarize their risk contribution level to arteries in the heart (heart attacks) or brain (stroke), glucose damages the overall strength and integrity of blood vessels (both arteries and micro-vessels): BP causes artery ruptures (~20% to 30% of CVD/stroke cases) and lipids lead to artery blockages (~70% to 80% of CVD/stroke cases). His math-physical medicine research methodology can offer quantitative estimates of the degrees of damage or risk contributions for the heart disease and stroke death group, which is the No. 1 killer in the US.

As we know, lifestyle details cause rudimentary chronic diseases which further influence more complicated diseases, such as heart problems (CVD & CHD), chronic kidney disease (CKD), stroke, diabetic retinopathy (DR), neuropathy, hypothyroidism, and others. Some genetic

Available online: 30 July 2022

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

conditions and lifetime unhealthy habits, such as smoking, alcohol consumption, and illicit drug use would account for approximately 15% to 25% of the root cause of rudimentary chronic diseases & their complications, including cancers and dementia. In addition to the genetic conditions, lifetime unhealthy habits and certain harmful external environmental factors, such as radiation, air and water pollution, food poison and pollution, toxic chemicals, and hormonal therapy, along with chronic inflammation can also contribute to the causes of a variety of cancers. All of the above-mentioned diseases fall into the category of "symptoms" which are the result of "root causes" from poor lifestyle and unhealthy habits.

Since December of 2021, he has written and published 60+ medical articles using the viscoelasticity and viscoplasticity theories (VGT) from physics and engineering disciplines on chosen medicine subjects. These papers aim to explore some hidden biophysical behaviors and provide a quantitative understanding of inter-relationships between the CVD risk probability % and a selected set of multiple influential factors which are also called "risk factors". The hidden biophysical behaviors and possible inter-relationships among the CVD/Stroke risk probability and selected multiple risk factors are "time-dependent" which means that all of these values are changing from time to time. This is why he utilizes VGT from physics and engineering to conduct his medical research work.

A footnote should be mentioned here. The author previously conducted similar medical analyses using a traditional statistical regression method based on these same datasets of selected biomarkers. Generally speaking, statistical methods only deal with numerical characteristics of collected datasets and do not connect with the internal physical characteristics or behaviors of biomarkers of internal organs. In other words, statistical methods have no implicit connections with internal biophysical behaviors or biomedical phenomena. Incidentally, the accuracy and applicability of results using any statistical method are heavily dependent on data sample selection, the size of the dataset, and the time-window coverage of the chosen data. If we are not careful with the sensitivities of data selection, our observed statistical results can be misleading or even offer wrong conclusions. Therefore, we must select appropriate statistical methods and meaningful datasets, along with judging and treating the conclusions of statistical analysis results very cautiously.

The following defined VGT equations are used to establish the stress-strain diagram in a space domain (SD):

Strain
= ε (CVD risk %)
= individual CVD risk % at the present time

Stress
= σ (based on the change rate of strain, CVD risk, multiplying with a chosen viscosity factor, m2, m3, or m4)
= η * (dε/dt)
= η * (d-strain/d-time)
= (viscosity factor η using individual m2, m3, or m4 at present time) * (CVD risk at present time - CVD risk at a previous time)

At first, he calculates the respective hysteresis loop areas corresponding to each component of stress (or viscosity factor) and then computes the respective hysteresis loop areas corresponding to each sub-period in the time domain (TD), to judge the energy levels associated with each viscosity factor and each sub-period in time.

Next, he applies the viscoelastic perturbation model to calculate the following predicted CVD risk %.

Perturbed or predicted CVD risk %
= strain value (CVD risk %) at present time + stress value at present time (i.e., CVD risk change rate * m2, m3, or m4)

Finally, he compares the predicted CVD risk based on the VGT model against the calculated CVD risk based on the overall MI model to obtain prediction accuracy and waveform similarity via correlation coefficient. Through trial-and-error calculations, he can then nail down the most feasible combination of risk contribution from the three biomarkers (m2, m3, and m4). For example, in his study, he has tried 9 cases of combinations of m2, m3, and m4, where he identified the combination using 34% of glucose, 33% of BP, and 33% of lipids would offer the highest prediction accuracy and

waveform correlation in comparison with his calculated CVD risks based on the MI model.

At this point, it is necessary to briefly describe his health history. The author was diagnosed with T2D in 1997 with a random glucose check at a 300 mg/dL level; however, his T2D condition most likely began earlier (he guesses in 1995). He suffered his first two chest pain episodes in 1993-1994 and three more heart episodes until 2007. His primary physician informed him that he had diabetic kidney issues in 2010. He then consulted with two more clinical doctors who advised him to immediately start insulin injections and kidney dialysis. This was his wake-up call. He then decided to save his own life by conducting his self-study and research on food nutrition and chronic diseases that same year. His health profile in 2010 was: body weight at 220 lbs. (BMI 32 which is obese), average glucose at 280 mg/dL (>140 mg/dL which is diabetes), fasting plasma glucose (FPG) in the early morning at 180 mg/dL (>125 mg/dL which is hyperinsulinemia), lab-tested HbA1C at 10% which means severe diabetes, triglycerides at 1160 mg/dL which is hyperlipidemia (target: <150 mg/dL), and his ACR at 116 which means kidney damage (target: <30). In summary, by 2010, he has also suffered a total of five heart episodes, chronic kidney diseases, hypothyroidism, diabetic retinopathy, foot ulcer, neuropathy, diabetic constipation, diabetic skin fungal infection, etc.

Over the past ~13 years, he has made significant lifestyle changes. For example, he consumes less than 15 grams of carbohydrates and sugar per meal (his target is below 20 grams of carbs/sugar intake amount), avoids processed food, reduces his food quantity by 50%, walks 6-7 miles or 10-11 kilometers daily (his target is at least 9,000 steps each day), sleeps 7-8 hours each night, and reduces stress as much as possible. In addition, he has never drunk alcohol, smoked cigarettes, or used any illicit drugs in his life.

As of April 25, 2022, his health profile for the first 4 months of 2022 was: body weight at 169 lbs. (BMI 24.95 which is normal weight), daily average glucose at 106 mg/dL, FPG in the early morning at 94 mg/dL, lab-tested A1C at 5.8% which is non-diabetes, triglycerides at 108, and ACR at 16. Another significant accomplishment is that he has discontinued taking 3 different kinds of diabetes medications since 12/8/2015.

Recently, the author has modified his developed software for iPhone to include the capability of calculating the strain (ε) change rate, i.e. $d\varepsilon/dt$, and then be able to multiply with a selected viscosity factor (η). With this enhanced feature embedded in his software program, he can then avoid using the Excel program on a PC to conduct his needed VGT analysis. Now, he can conduct multiple VGT analyses based on thousands of daily data on his iPhone, instead of under the restriction of using "period data", such as annual, quarterly, or monthly, via Excel program on a PC which requires significant data preparation time.

Most of the author's medical papers are based on his collected biomarker data from his own body over the past 12+ years. His research work is based on quantitative analysis of the collected data using a math-physical medicine methodology, not using the traditional biochemical and statistical research approach in the current medical research arena. In other words, he describes his observed biophysical phenomena using 10 numerical digits mainly and using English words to depict some other supporting matters. This is different from the traditional medical research papers or psychological behaviors studies which utilize 26 English alphabet letters to describe most of their contents. Of course, this is a result of the author's educational shortcomings in both biology and chemistry fields. Based on his past 13-year of self-study and intensive research on internal medicine and food nutrition, he has observed that most biomedical phenomena do follow the basic law of physics. As a result, certain principles and modeling techniques of engineering can be applied easily in medical research. In this situation, a medical subject can then be easily analyzed and interpreted using various mathematical tools from the lower foundation level, while applying applicable physics knowledge from the middle level, and utilizing various engineering modeling techniques from the upper application level.

2. METHODS

To offer a simple explanation to readers who do not have a physics or engineering

background, the author includes a brief excerpt from Wikipedia regarding the description of basic concepts for elasticity and plasticity theories, viscoelasticity, and viscoplasticity theories from the disciplines of engineering and physics, and his developed metabolism index (MI) Model in this method section.

2.1 Relationships between biomedical causes and biomedical symptoms

As a mathematician/engineer over 40 years and now conducting his medical research work for the past 13 years, the author has discovered that people frequently seek answers, illustrations, or explanations for the relationships between the input variable (force applied on a structure or cause of a disease) and output variable (deformation of a structure or symptom of a disease). However, the multiple relationships between input and output could be expressed with many different matrix formats of 1 x 1, 1 x n, m x 1, or m x n (m or n means different multiple variables). In addition to these described mathematical complications, the output resulting from one or more inputs can also become an input of another output, which is a symptom of certain causes that can become a cause of another different symptom. This phenomenon is indeed a complex scenario with "chain effects". In fact, both engineering and biomedical complications are fundamentally mathematical problems that correlate or conform with many inherent physical laws or principles. In his medical research work, he has encountered more than 100 different sets of biomarkers with almost equal or more amounts of causes (or input variables) and symptoms (or output variables).

Since December of 2021, the author applied theories of viscoelasticity and viscoplasticity (VGT) from physics and engineering disciplines to investigate more than 60 sets of input/output biomarkers, including nearly 10 sets of cancer cases. The purpose is to identify certain hidden relationships between certain output biomarkers, such as cancer risk, and its corresponding multiple inputs, such as glucose, blood pressure, blood lipids, obesity or overweight, and metabolism index of 6 lifestyle details and 4 chronic diseases. In this study, the hidden biophysical behaviors and possible inter-relationships among the output symptom and multiple input causes are "time-dependent" and change from time to time. These important time-dependency characteristics provide insight into the cancer risk's moving pattern. It also controls the cancer risk curve shape, the associated energy created, stored, or burned inside during the process of stress up-loading (moving upward or increasing) and stress down-loading (moving downward or decreasing) of the input biomarkers with the output biomarker of cancer risk %. This VGT application emphasizes the time-dependency characteristics of involved variables. In the medical field, most biomarkers are time-dependent since body organ cells are organic in nature and change all of the time. Incidentally, VGT can generate a stress-strain curve or cause-symptom curve, known as a "hysteresis loop" in physics, in which area size can also be used to estimate the relative energy created, stored, or burned during the process of uploading (e.g., increasing glucose) and unloading (e.g., decreasing body weight) over the timespan of the cancer risk %. He calls this relative energy the "VGT energy".

It should be emphasized here that both cancer risk % and its associated VGT energy are estimated relative values, not "absolute" values.

The following defined stress and strain equations are used to establish the VGT stress-strain diagram in a space domain (SD):

VGT strain
= ε (symptom)
= individual symptom at the present time

VGT stress
= σ (based on the change rate of strain, symptom, multiplying with one or more viscosity factors or influential factors)
= η * (dε/dt)
= η * (d-strain/d-time)
= (viscosity factor η using normalized factor at present time) * (symptom at present time - symptom at a previous time)

Where the strain is the cancer risk percentage and the stress is his cancer risk change rate multiplied by several chosen input biomarkers as the individual viscosity factor. In his VGT studies, sometimes, he carefully selects certain normalization factors for each input biomarker, respectively. The normalization factors are

the dividing lines between a healthy state and an unhealthy state. For example, 170 lbs. for body weight, 6.0 for HbA1C, 120 mg/dL for glucose, 180 mg/dL for hyperglycemia, 73.5% for overall MI score, and 10,000 steps for daily walking exercise, etc.

2.2 Elasticity, plasticity, viscoelasticity, and viscoplasticity (LEGT & VGT)

The difference between elastic materials and viscoelastic materials (from "Soborthans, innovating shock and vibration solutions").

What are elastic materials?

Elasticity is the tendency of solid materials to return to their original shape after forces are applied on them. When the forces are removed, the object will return to its initial shape and size if the material is elastic.

Medical analogy: The medical application is when cause or risk factors are reduced or removed, the symptoms of certain disease would be improved or ceased.

What are viscous materials?

Viscosity is a measure of a fluid's resistance to flow. A fluid with large viscosity resists motion. A fluid with low viscosity flows. For example, water flows more easily than syrup because it has a lower viscosity. High viscosity materials might include honey, syrups, or gels – generally things that resist flow. Water is a low viscosity material, as it flows readily. Viscous materials are thick or sticky or adhesive. Since heating reduces viscosity, these materials don't flow easily. For example, warm syrup flows more easily than cold.

What is viscoelastic?

Viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Synthetic polymers, wood, and human tissue, as well as metals at high temperature, display significant viscoelastic effects. In some applications, even a small viscoelastic response can be significant.

Medical analogy: Viscoelastic behavior means material has "time-dependent" characters. Biomedical data, i.e. biomarkers, are time-dependent due to body cells are organic which changes with time constantly.

Elastic behavior versus viscoelastic behavior

The difference between elastic materials and viscoelastic materials is that viscoelastic materials have a viscosity factor and the elastic ones don't. Because viscoelastic materials have the viscosity factor, they have a strain rate dependent on time. Purely elastic materials do not dissipate energy (heat) when a load is applied, then removed; however, a viscoelastic substance does.

Medical analogy: Most of the biomarkers display time-dependency; therefore they have both change-rate of time and viscosity factor behaviors. Viscoelastic biomarkers do dissipate energy when a cause force is applied on it.

The following brief introductions are excerpts from Wikipedia:

"Elasticity (physics):

The physical property is when materials or objects return to their original shape after deformation.

In physics and materials science, elasticity is the ability of a body to resist a distorting influence and to return to its original size and shape when that influence or force is removed. Solid objects will deform when adequate loads are applied to them; if the material is elastic, the object will return to its initial shape and size after removal. This is in contrast to plasticity, in which the object fails to do so and instead remains in its deformed state.

Hooke's law states that the force required to deform elastic objects should be directly proportional to the distance of deformation, regardless of how large that distance becomes. This is known as perfect elasticity, in which a given object will return to its original shape no matter how strongly it is deformed. This is an ideal concept only; most materials that possess elasticity in practice remain purely elastic only up to very small deformations, after which plastic (permanent) deformation occurs.

In engineering, the elasticity of a material is quantified by the elastic modulus such as the

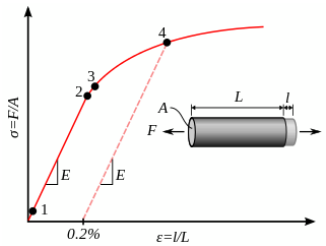
Young's modulus, bulk modulus or shear modulus which measure the amount of stress needed to achieve a unit of strain; a higher modulus indicates that the material is harder to deform. The material's elastic limit or yield strength is the maximum stress that can arise before the onset of plastic deformation.

Medical analogy: The elastic behavior analogy in medicine can be expressed by the metal rod analogy for the postprandial plasma glucose (PPG). Consuming carbohydrates and/or sugar acts like a tensile force to stretch a metal rod longer, while post-meal exercise acts like a compressive force to suppress a metal rod shorter. If lacking food consumption and exercise, the metal rod (analogy of PPG) will remain its original length, for a non-diabetes or less severe type 2 diabetes (T2D) patient.

Plasticity (physics):

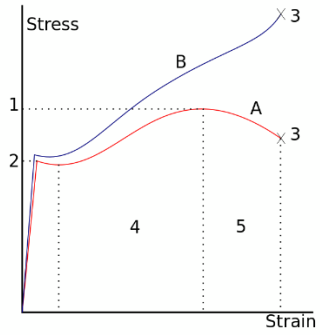
Deformation of a solid material undergoing non-reversible changes of shape in response to applied forces.

In physics and materials science, plasticity, also known as plastic deformation, is the ability of a solid material to undergo permanent deformation, a non-reversible change of shape in response to applied forces. For example, a solid piece of metal being bent or pounded into a new shape displays plasticity as permanent changes occur within the material itself. In engineering, the transition from elastic behavior to plastic behavior is known as yielding. Plastic deformation is observed in most materials, particularly metals, soils, rocks, concrete, and foams.



A stress-strain curve showing typical yield behavior for nonferrous alloys.

1. True elastic limit
2. Proportionality limit
3. Elastic limit
4. Offset yield strength



A stress-strain curve typical of structural steel.

- 1: Ultimate strength
- 2: Yield strength (yield point)
- 3: Rupture
- 4: Strain hardening region
- 5: Necking region
- A: Apparent stress (F/A0)
- B: Actual stress (F/A)

For many ductile metals, tensile loading applied to a sample will cause it to behave in an elastic manner. Each increment of load is accompanied by a proportional increment in extension. When the load is removed, the piece returns to its original size. However, once the load exceeds a threshold – the yield strength – the extension increases more rapidly than in the elastic region; now when the load is removed, some degree of extension will remain.

Medical analogy: A plastic behavior analogy in medicine is the PPG level of a severe T2D patient. Even consuming a smaller amount of carbs/sugar, the patient's PPG will rise sharply which cannot be totally brought down to a healthy PPG level even with a significant amount of exercise. This means the PPG level has exceeded its "elastic limit" and entering into a "plastic range".

Viscoelasticity:

Property of materials with both viscous and elastic characteristics under deformation.

In materials science and continuum mechanics, viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Viscous materials, like water, resist shear flow and strain linearly with time when a stress is applied. Elastic materials strain when stretched and

immediately return to their original state once the stress is removed.

Viscoelastic materials have elements of both of these properties and, as such, exhibit time-dependent strain. Whereas elasticity is usually the result of bond stretching along crystallographic planes in an ordered solid, viscosity is the result of the diffusion of atoms or molecules inside an amorphous material.

In the nineteenth century, physicists such as Maxwell, Boltzmann, and Kelvin researched and experimented with creep and recovery of glasses, metals, and rubbers. Viscoelasticity was further examined in the late twentieth century when synthetic polymers were engineered and used in a variety of applications. Viscoelasticity calculations depend heavily on the viscosity variable, η. The inverse of η is also known as fluidity, φ. The value of either can be derived as a function of temperature or as a given value (i.e. for a dashpot).

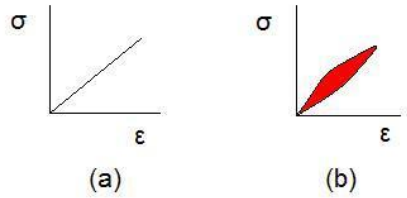
Depending on the change of strain rate versus stress inside a material, the viscosity can be categorized as having a linear, non-linear, or plastic response. In addition, when the stress is independent of this strain rate, the material exhibits plastic deformation. Many viscoelastic materials exhibit rubber-like behaviors explained by the thermodynamic theory of polymer elasticity.

Cracking occurs when the strain is applied quickly and outside of the elastic limit. Ligaments and tendons are viscoelastic, so the extent of the potential damage to them depends both on the rate of the change of their length as well as on the force applied.

A viscoelastic material has the following properties:

- hysteresis is seen in the stress-strain curve
- stress relaxation occurs: step constant strain causes decreasing stress
- creep occurs: step constant stress causes increasing strain
- its stiffness depends on the strain rate or the stress rate.

Elastic versus viscoelastic behavior:



Stress-strain curves for a purely elastic material (a) and a viscoelastic material (b). The red area is a hysteresis loop and shows the amount of energy lost (as heat) in a loading and unloading cycle. It is equal to $\oint \sigma d\varepsilon$ where σ is stress and ε is strain. In other words, the hysteresis loop area represents the amount of energy during the loading and unloading process.

Unlike purely elastic substances, a viscoelastic substance has an elastic component and a viscous component. The viscosity of a viscoelastic substance gives the substance a strain rate dependence on time. Purely elastic materials do not dissipate energy (heat) when a load is applied, then removed. However, a viscoelastic substance dissipates energy when a load is applied, then removed. Hysteresis is observed in the stress-strain curve, with the area of the loop being equal to the energy lost during the loading cycle. Since viscosity is the resistance to thermally activated plastic deformation, a viscous material will lose energy through a loading cycle. Plastic deformation results in lost energy, which is uncharacteristic of a purely elastic material's reaction to a loading cycle.

Viscoplasticity:

Viscoplasticity is a theory in continuum mechanics that describes the rate-dependent inelastic behavior of solids. Rate-dependence in this context means that the deformation of the material depends on the rate at which loads are applied. The inelastic behavior that is the subject of viscoplasticity is plastic deformation which means that the material undergoes unrecoverable deformations when a load level is reached. Rate-dependent plasticity is important for transient plasticity calculations. The main difference between rate-independent plastic and viscoplastic material models is that the latter exhibit not only permanent deformations after the application of loads but continue to undergo a creep flow as a function of time under the influence of the applied load.

Medical analogy: In viscoelastic or viscoplastic analysis, the stress component equals the strain change rate of time multiplying with the viscosity factor, or

Stress (σ)
= strain (ε) change rate * viscosity factor (η)
= dε/dt * η

The hysteresis loop area
= the integrated area of stress (σ) and strain (ε) curve
= ∮σdε

2.3 Metabolism index (MI) model

This model was developed in Y2014 by the author using the topology concept, nonlinear algebra, geometric algebra, and engineering finite element method. In summary, the human body metabolism is a complex mathematical problem with a matrix format of m causes by n symptoms, plus sometimes, one symptom or many symptoms would be turned into causes of another symptom.

This MI model contains 10 specific categories, including 4 output categories of medical conditions (body weight, glucose, blood pressure, and lipids), and 6 input categories of lifestyle details (food quantity and quality, drinking water intake, physical exercise, sleep, stress, and daily life routines). These 10 categories are comprised of approximately 500 detailed elements. He has also defined two new resulting parameters: the metabolism index or MI, as the combined score of the above 10 metabolism categories and 500 elements using his developed algorithm, along with the general health status unit (GHSU), as the 90-day moving average value of MI.

A physical analogy of this complex mathematical metabolism model is similar to "using multiple nails that are encircled by many rubber bands". For example, at first, we hammer 10 nails into a piece of flat wood with an initial shape of a circle, then take 3,628,800 (=10!) rubber bands to encircle the nails, including all 10 nails. These ~3.6 million rubber bands (i.e. big number of relationships) indicate the possible relationships existing among these 10 nails (i.e. 10 original metabolism data). Some rubber bands encircle 2 nails or 3 nails and so on until the last rubber band encircles all of these 10 nails together (no rubber band to encircle a single nail is allowed). Now, if we move any one of the nails outward (i.e., moving away from the center of the nail circle), then this moving action would create some internal tension inside the encircled rubber band. Moving one nail "outward" means one of these ten metabolism categories is becoming "unhealthy" which would cause some stress to our body. Of course, we can also move some or all of the 10 nails outward at the same time, but with different moving scales. If we can measure the summation of the internal tension created in the affected rubber bands, then this summarized tension force is equivalent to the metabolism value of human health. The higher tension means a higher metabolism value which creates an unhealthy situation. The author uses the above-described scenario of moving nails and their encircled rubber bands to explain his developed mathematical metabolism model of human health.

During 2010 and 2011, the author collected sparse biomarker data, but from the beginning of 2012, he has been gathering his body weight and finger-piercing glucose values each day. More complete data collection started in Y2015. In addition, he accumulates medical conditions data including BP, heart rate (HR), and blood lipids along with lifestyle details (LD). Since 2020, he has added the daily body temperature (BT) and blood oxygen level (SPO2) due to his concerns about being exposed to COVID-19. Based on the collected big data of biomarkers, he further organized them into two main groups. The first is the medical conditions group (MC) with 4 categories: weight, glucose, BP, and blood lipids. The second is the lifestyle details group (LD) with 6 categories: food & diet, exercise, water intake, sleep, stress, and daily routines. At first, he calculated a unique combined daily score for each of the 10 categories within the MC and LD groups. The combined scores of the 2 groups, 10 categories, and 500+ detailed elements constitute an overall "metabolism index (MI) model". It includes the root-causes of 6 major lifestyle inputs and symptoms from 4 lifestyle-induced rudimentary chronic diseases, i.e. obesity, diabetes, hypertension, and hyperlipidemia. Therefore, the MI model, especially its 4 chronic disease conditions, can be used as the foundation and building block for his additional research work that can expand into various complications

associated with different organs, such as cancer.

Of course, the same methodology can be extended to the study of many other medical complications, such as various heart problems (CVD & CHD), stroke, neuropathy, hypothyroidism, diabetic constipation, diabetic skin fungal infection, various cancers, and dementia.

In general, some genetic conditions and lifetime unhealthy habits, which include tobacco smoking, alcohol drinking, and illicit drug use, account for approximately 15% to 25% of the root-cause of chronic diseases and their complications, as well as cancers and dementia.

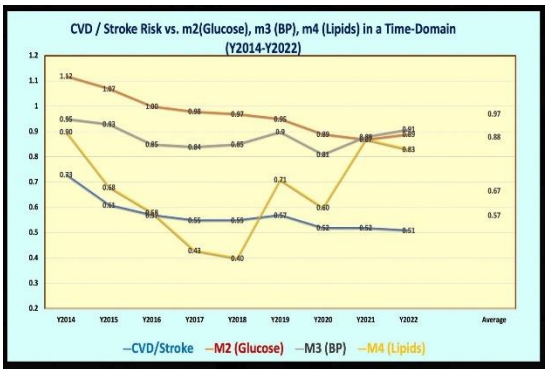
His calculated risk probability % for CKD, CVD, DR, stroke, and various cancers have some differences in their root-cause variables, their associated weighting factors for each key cause, and certain biomedical interpretations and assumptions. Specifically, the CVD/Stroke risk includes two major scenarios that combine emphasized weighting factors, blood vessel blockage due to blood glucose and blood lipids, and blood vessel rupture caused by blood glucose and blood pressure. Some recent research work have identified the relationship between pancreatic cancer with hyperglycemia and insulin resistance phenomena of type 2 diabetes, and chronic inflammation. Some aggressive prostate cancers are linked with 5 types of bacteria. There is also an evidence of a relationship between BP and DR (Reference: BP control and DR, by R. Klein and BEK Klein from British Journal of Ophthalmology). The CKD risks include hyperglycemic damage to micro-blood vessels and nerves which causes protein leakage found in urine and waste deposit within the kidneys; therefore, it requires dialysis to remove waste products and excess fluids from the body. However, the cancer risk also consists of additional influences from environmental conditions, such as some improper medications, viral infections, food pollution or poison, toxic chemical, radiation, air and water pollution, hormonal treatment, etc.

All of the above-mentioned diseases fall into the category of "symptoms" which are the outcomes of "root-causes" of genetic conditions, unhealthy lifestyles, and poor living environments.

Note: For a more detailed description, please refer to the "consolidated method" section which is given at the beginning of the special issue.

3. RESULTS

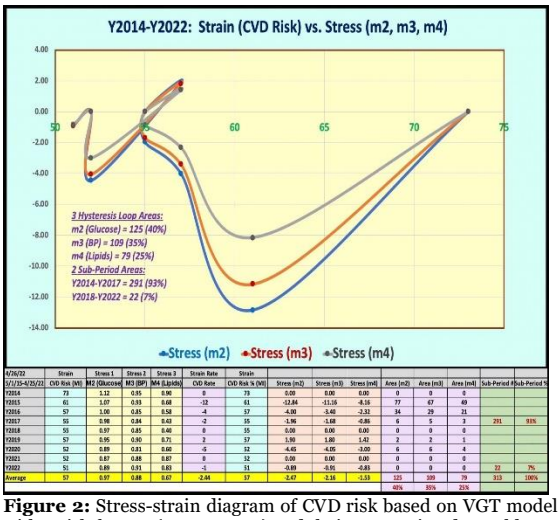
Figure 1 shows four biomarker curves in TD and their supporting data table.



	CVD/Stroke	M2 (Glucose)	M3 (BP)	M4 (Lipids)
Y2014	0.73	1.12	0.95	0.90
Y2015	0.61	1.07	0.93	0.68
Y2016	0.57	1.00	0.85	0.58
Y2017	0.55	0.98	0.84	0.43
Y2018	0.55	0.97	0.85	0.40
Y2019	0.57	0.95	0.9	0.71
Y2020	0.52	0.89	0.81	0.60
Y2021	0.52	0.87	0.88	0.87
Y2022	0.51	0.89	0.91	0.83
Average	0.57	0.97	0.88	0.67

Figure 1: Four biomarker curves in a time-domain (TD) and their supporting data table.

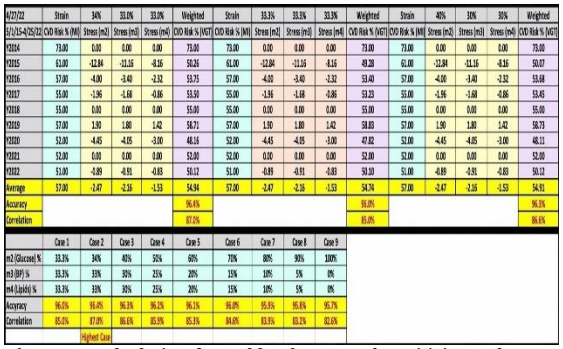
Figure 2 illustrates the stress-strain diagram of CVD risk based on the VGT model with three risk factors (m2, m3, and m4) and their supporting data table.



4/26/22	Strain	Stress 1	Stress 2	Stress 3	Strain Rate	Strain								
Y/1/Y-4/25/22	CVD Risk (MI)	M2 (Glucose)	M3 (BP)	M4 (Lipids)	CVD Rate	CVD Risk % (MI)	Stress (m2)	Stress (m3)	Stress (m4)	Area (m2)	Area (m3)	Area (m4)	Sub-Period #	Sub-Period %
Y2014	73	1.12	0.95	0.90	0	73	0.00	0.00	0.00	0	0	0		
Y2015	61	1.07	0.93	0.68	-12	61	-12.84	-11.16	-8.16	77	67	49		
Y2016	57	1.00	0.85	0.58	-4	57	-4.00	-3.40	-2.32	34	29	21		
Y2017	55	0.98	0.84	0.43	-2	55	-1.96	-1.68	-0.86	6	5	3	291	93%
Y2018	55	0.97	0.85	0.40	0	55	0.00	0.00	0.00	0	0	0		
Y2019	57	0.95	0.90	0.71	2	57	1.90	1.80	1.42	2	2	1		
Y2020	52	0.89	0.81	0.60	-5	52	-4.45	-4.05	-3.00	6	6	4		
Y2021	52	0.87	0.88	0.87	0	52	0.00	0.00	0.00	0	0	0		
Y2022	51	0.89	0.91	0.83	-1	51	-0.89	-0.91	-0.83	0	0	0	22	7%
Average	57	0.97	0.88	0.67	-2.44	57	-2.47	-2.16	-1.53	125	109	79	313	100%
										40%	35%	25%		

Figure 2: Stress-strain diagram of CVD risk based on VGT model with 3 risk factors (m2, m3, m4) and their supporting data table.

Figure 3 displays the calculation data table of 9 cases of sensitivity analyses to determine which combination of risk contribution is the most accurate one.



4/27/22	Strain	34%	33.0%	33.0%	Weighted	Strain	33.3%	33.3%	33.3%	Weighted	Strain	40%	30%	30%	Weighted
12/31-4/25/22	CVD Risk % (MI)	Stress (m2)	Stress (m3)	Stress (m4)	CVD Risk % (VGT)	CVD Risk % (MI)	Stress (m2)	Stress (m3)	Stress (m4)	CVD Risk % (VGT)	CVD Risk % (MI)	Stress (m2)	Stress (m3)	Stress (m4)	CVD Risk % (VGT)
Y2014	73.00	0.00	0.00	0.00	73.00	73.00	0.00	0.00	0.00	73.00	73.00	0.00	0.00	0.00	73.00
Y2015	61.00	-12.84	-11.16	-8.16	50.26	61.00	-12.84	-11.16	-8.16	49.28	61.00	-12.84	-11.16	-8.16	50.07
Y2016	57.00	-4.00	-3.40	-2.32	53.75	57.00	-4.00	-3.40	-2.32	53.40	57.00	-4.00	-3.40	-2.32	53.68
Y2017	55.00	-1.96	-1.68	-0.86	53.50	55.00	-1.96	-1.68	-0.86	53.23	55.00	-1.96	-1.68	-0.86	53.45
Y2018	55.00	0.00	0.00	0.00	55.00	55.00	0.00	0.00	0.00	55.00	55.00	0.00	0.00	0.00	55.00
Y2019	57.00	1.90	1.80	1.42	56.71	57.00	1.90	1.80	1.42	56.83	57.00	1.90	1.80	1.42	56.73
Y2020	52.00	-4.45	-4.05	-3.00	48.16	52.00	-4.45	-4.05	-3.00	47.82	52.00	-4.45	-4.05	-3.00	48.11
Y2021	52.00	0.00	0.00	0.00	52.00	52.00	0.00	0.00	0.00	52.00	52.00	0.00	0.00	0.00	52.00
Y2022	51.00	-0.89	-0.91	-0.83	50.12	51.00	-0.89	-0.91	-0.83	50.10	51.00	-0.89	-0.91	-0.83	50.12
Average	57.00	-2.47	-2.16	-1.53	54.94	57.00	-2.47	-2.16	-1.53	54.74	57.00	-2.47	-2.16	-1.53	54.91
Accuracy					96.4%					96.0%					96.3%
Correlation					87.0%					85.0%					86.6%

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
m2 (Glucose) %	33.3%	34%	40%	50%	60%	70%	80%	90%	100%
m3 (BP) %	33.3%	33%	30%	25%	20%	15%	10%	5%	0%
m4 (Lipids) %	33.3%	33%	30%	25%	20%	15%	10%	5%	0%
Accuracy	96.0%	96.4%	96.3%	96.2%	96.1%	96.0%	95.9%	95.8%	95.7%
Correlation	85.0%	87.0%	86.6%	85.9%	85.3%	84.6%	83.9%	83.2%	82.6%
		Highest Corr							

Figure 3: Calculation data table of 9 cases of sensitivity analyses to determine which combination of risk contribution is the best one.

4. CONCLUSION

The following four described biophysical characteristics have demonstrated behaviors of CVD risk based on the MI model under 3 chosen risk factors of m2 glucose, m3 blood pressure, and m4 blood lipids (a 3x1 model) with the viscoelastic or viscoplastic energy (VGT) tool:

(1) From the time-domain (TD) chart of 4 biomarkers, all 4 biomarkers (1 CVD risk plus 3 mi inputs) have visible improvements during the sub-period of Y2014-Y2017 and remain almost at constantly improved levels during the sub-period of Y2018-Y2022. In detail, CVD risk and m2 glucose are declining most visibly while m3 blood pressure remains at a constant level, but below 1.0 (healthy, SBP < 120 and DBP <80). His blood lipid m3 values are also below 1.0 (healthy) but with a rather "violent" fluctuation manner from year to year. All of these 4 biomarker values have been normalized according to a dividing line between healthy conditions versus unhealthy conditions. If the author uses those data with their original unit, they would either enlarge or shrink the values of stresses and hysteresis loop areas which would produce a twisted view of the conclusion. This scenario is similar to what Americans used to say: "comparison between orange and apple".

(2) From his strain values (MI-based CVD risks) as shown on the x-axis of the stress-strain diagram, his MI-based CVD risks have decreased from the high-end of 73% in Y2014 down to the low-end of 51% in Y2022. This observed trend is very encouraging for a patient who has suffered 5 heart episodes in the past.

(3) From his averages stress values (his MI-based CVD change rate over time multiplying with his m2, m3, m4, respectively) as shown on the y-axis of the stress-strain diagram are: stress (m2) = -2.47, stress (m3) = -2.16, stress(m4) = -1.53. On the other hand, his respective hysteresis loop areas are: area (m2) = 125 (40%), area (m3) = 109 (35%), area (m4) = 79 (25%). In addition, sub-period loop area of Y2014-Y2017 = 291 (93%) versus sub-period loop area of Y2018-Y2022 = 22 (7%). The above data and area percentages have depicted that the risk contributions follow the order of glucose (40%), blood pressure (35%), and blood lipids (25%). Furthermore, the sub-period of Y2014-Y2017 contributed the most of his CVD risks (93%).

(4) From the data table of his sensitivity study using 9 cases, the risk contribution with the combination of glucose 34%, blood pressure 33%, and blood lipids 33% would provide the highest compatibility between MI-based CVD risk and VGT- based CVD risk. This combination would have a prediction accuracy of 96.4% and a correlation coefficient of 87.0%.

In summary, this unique "time-dependency" characteristic study of CVD risk change amount over time, using glucose, blood pressure, and blood lipids as its causes (influential factors) can be applied to cardiology research and discover some more useful findings. Incidentally, this math-physical medicine research study has identified that a combination of 34% from glucose (artery integrity and strength), 33% from blood pressure (artery rupture), and 33% from blood lipid (artery blockage) would make the best sense regarding their respective damage contribution to build up the CVD situations.

This report on CVD risk probability versus normalized values of glucose, blood pressure, and blood lipids has demonstrated how the author utilizes the mathematics, physics, and engineering (VGT energy method) to construct his biophysical model and display his biomedical research findings on various cardiovascular diseases.

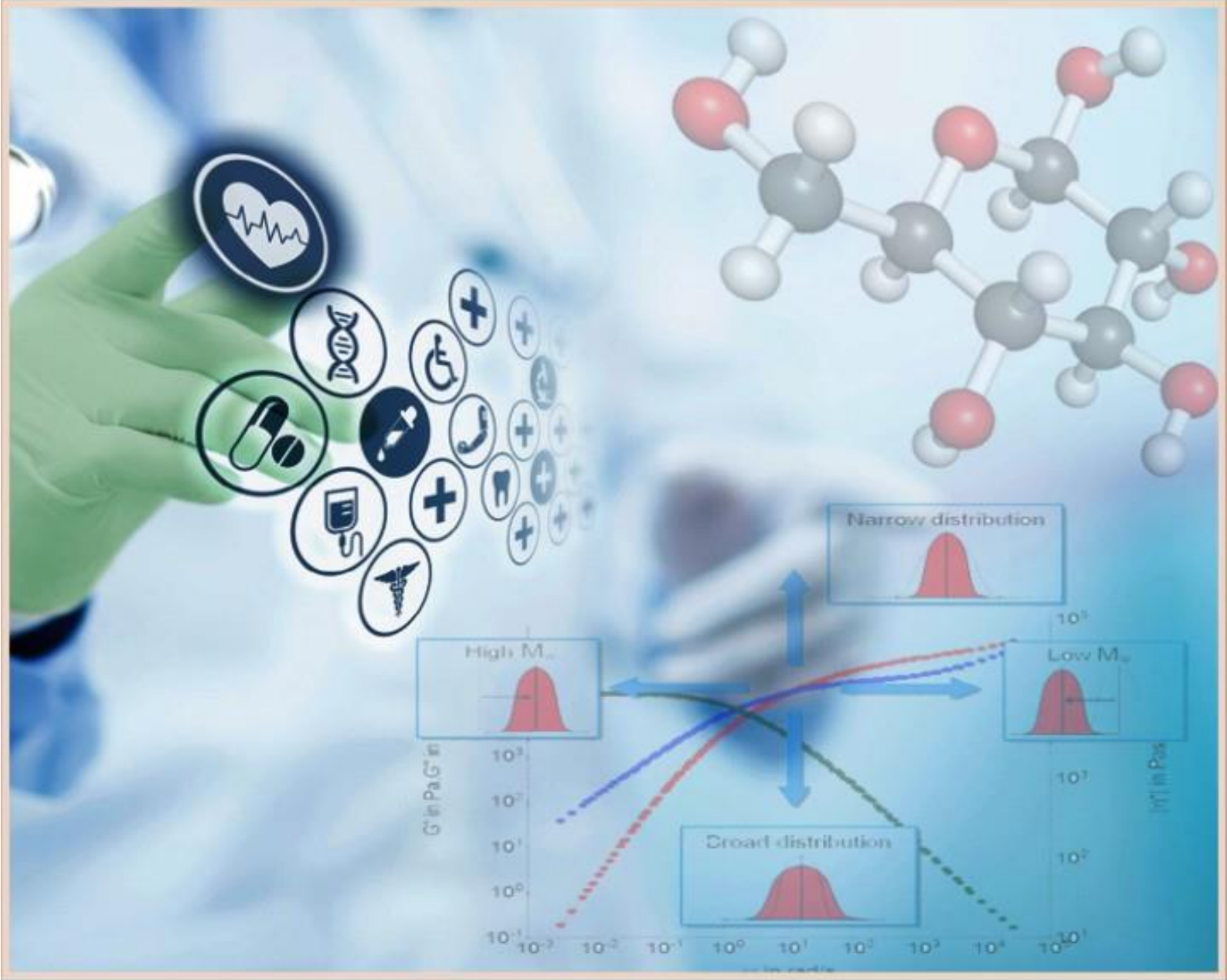
5. REFERENCES

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

Special Issue | Issue No. 5 The GH-Method

Viscoelastic and Viscoplastic Glucose Theory Application in Medicine

Gerald C. Hsu



https://theghmethod.com

2022