Special Issue 5
2022

The GH-Method

Viscoelastic or Viscoplastic Glucose Theory (VGT#52): Applying VGT and Using the Collected Annual Average Data from Y2015 to Y2022 to Study the Inter-Relationships Among Carbs/Sugar Intake Amount in Grams, Total Food Intake Quantity in Calories, Postprandial Plasma Glucose, and Body Weight in the Early Morning Based on the GH-Method: Math-Physical Medicine (No. 639)

Gerald C. Hsu*

eclaireMD Foundation, USA

Note: Readers who want to get a quick overview can read the abstract, results, and graphs.

Abstract

The author was a professional engineer working in the fields of the space shuttle, naval battleships, nuclear power plants, computer hardware and software, artificial intelligence, and semiconductor chips. After retiring from his work, he initiated self-study and research on internal medicine with an emphasis on biomarker relationship exploration and disease prevention. Since 2010, he has utilized these disciplines learned from 7 different universities along with various work experiences to formulate his current medical research work during the past 13 years. One thing he has learned is that in engineering or medicine, we are frequently seeking 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, i.e. a symptom of certain causes can become a cause of another different symptom. This phenomenon is a complex scenario with "chain effects". Engineering and biomedical complications are fundamentally mathematical problems that correlate or conform with many inherent physical laws or principles. Over the past 13 years, in his medical research work, he has encountered more than 100 different sets of biomarkers with almost equal amounts of cause/input variables versus symptom/output variables. For example, food and exercise influence both body weight and glucose level, where persistent high glucose can result in diabetes. When diabetes combines with hypertension (high blood pressure) and hyperlipidemia (high blood lipids), it can cause cardiovascular diseases. Furthermore, obesity and diabetes are also linked with various kinds of cancers. These multiple sets of biomedical input versus output have been researched by the author using different tools he has learned from academic fields of mathematics, physics, computer science, and engineering. Previously, he has applied signal processing techniques to separate 19 components from the combined postprandial plasma glucose (PPG) wave. He identified the carbs/sugar intake amount and post-meal exercise as the two most important contributing factors to PPG formation. Based on these findings, he then applied the theory of elasticity to develop a linear elastic glucose theory (LEGT) to predict PPG value with high prediction accuracy, using fasting plasma glucose (FPG), carbs/sugar grams, and post-meal walking k-steps as three major input components of predicted PPG formation. Furthermore, he took a specific PPG waveform in the time domain (TD) and applied Fourier transform technique to convert it into a waveform in the frequency domain (FD). The y-axis value in the frequency diagram indicates the magnitude of energy corresponding to a certain frequency component on the x-axis, while the total area underneath the frequency-energy curve is the total relative energy associated with the specific PPG wave. Recently, he has applied theories of viscoelasticity and viscoplasticity (VGT) in physics and engineering to various biomedical problems and has written more than 50 biomedical research papers. This VGT technique emphasizes the time-dependency

Available online: 30 July 2022

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

characteristics of certain 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 (in physics, it is called the "hysteresis loop"), in which area size can be used to estimate the relative energy created during the uploading (digesting carbs/sugar) and unloading (walking exercise) process over the timespan of a PPG wave. In this article, he initially selects a dataset containing 2 key biomarkers, carbs/sugar intake amount of grams as the symptom (output) and daily total food quantity in calories as the cause (input) to conduct his VGT analysis. He then chooses a dataset containing 3 key biomarkers, postprandial plasma glucose (PPG) as the symptom (output), along with carbs/sugar intake amount of grams and daily total food quantity in calories as the causes (inputs) to perform another VGT analysis. Finally, he selects a dataset containing another 2 key biomarkers, body weight in the early morning as the symptom (output) and daily total food quantity in calories as the cause (input) to conduct the final VGT analysis. These data are collected over ~8 years from Y2015 to Y2022. He has already discovered this observation from earlier research results that his PPG is related to the carbs/sugar intake amount and body weight is closely related to the daily food intake quantity. Now, he applies VGT specifically to construct three stress-strain diagrams with three hysteresis loops corresponding to the energy status of the research topics. 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 present. VGT stress = σ (based on the change rate of strain, symptom, multiplying with one or more viscosity factors or causes) = η * (dε/dt) = η * (d-strain/d-time) = (viscosity factor η using normalized cause at present time) * (symptom at present time - symptom at a previous time). However, the original measurement units are grams for carbs/sugar intake amount and calories for the total food quantity. Therefore, he uses the formula of 1 gram equals 4 calories to convert his carbs/sugar amount into the calories unit. To place them on even ground with a sufficient biomedical value, he normalizes these two viscosity factors η of both carbs/sugar and total food quantity calories using the following 2 formulas: Normalized Carbs/Sugar = Carbs&Sugar (calories) / 1600; Normalized walking k-steps = Food quantity (calories) / 1600. To control the word size of this article, he omits the repetitive background introduction regarding LEGT, VGT, Fourier transformation, frequency domain analysis, and energy theory in the research method section. In summary, by conducting the three VGT analyses, the author uncovers the following 3 observations: (1) From the VGT analysis of carbs/sugar (symptom) versus food quantity calories (cause), their correlation is a mere 53% with a viscoplastic behavior and hysteresis loop area of 45. In this case, carbs/sugar uses grams and food quantity uses calories as their respective units. This conclusion shows that if we consume more food calories, most likely our carbs/sugar grams will be higher. (2) From the VGT analysis of finger-pieced PPG (symptom) versus both carbs/sugar and food quantity calories (causes), their correlation is a lower 61% between PPG and carbs/sugar grams and a higher 85% between PPG and food calories. It has a viscoplastic behavior and two hysteresis loop areas of 12 for PPG versus carbs calories and 110 for PPG versus food calories. In this case, carbs/sugar and food quantity use calories as their units. This conclusion indicates that if we consume more food calories, i.e. carbs/sugar or food quantity, most likely our PPG level will be higher. Again, eating more food quantity will have a higher probability of consuming increased carbs/sugar food unless we are knowledgeable and careful with the carbs/sugar food consumption. In this case, his carbs/sugar food consumption only occupies 11% of his total quantity of food consumption which is a "low-carb diet". (3) From the VGT analysis of body weight (symptom) versus food quantity calories (cause), their correlation is 75% with a viscoplastic behavior and hysteresis loop area of 8. In this case, body weight uses pounds, and food quantity uses calories as their respective units. This conclusion demonstrates that if we consume more food calories, most likely our body weight will be increased. Furthermore, this hysteresis loop area of 8 cannot be used to compare with the other two cases since the strain unit (symptom) is the pound. In conclusion, food consumption (what to eat and how much to eat) is the most important element for our overall health maintenance and disease prevention. This article offers a quantitative demonstration of this statement.

Keywords: Carbs/sugar; Viscoelastic; Viscoplastic; Body weight; Linear elastic glucose theory; Glucose; Fasting plasma glucose; Postprandial plasma glucose

Abbreviations: FPG: fasting plasma glucose; PPG: postprandial plasma glucose; LEGT: linear elastic glucose theory; TD: time domain; SD: space domain; MPM: math-physical medicine

1. INTRODUCTION

The author was a professional engineer working in the fields of the space shuttle, naval battleships, nuclear power plants, computer hardware and software, artificial intelligence, and semiconductor chips. After retiring from his work, he initiated self-study and research on internal medicine with an emphasis on biomarker relationship exploration and disease prevention. Since 2010, he has utilized these disciplines learned from 7 different universities along with various work experiences to formulate his current medical research work during the past 13 years.

One thing he has learned is that in engineering or medicine, we are frequently seeking 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, i.e. a symptom of certain causes can become a cause of another different symptom. This phenomenon is a complex scenario with "chain effects". Engineering and biomedical complications are fundamentally mathematical problems that correlate or conform with many inherent physical laws or principles.

Over the past 13 years, in his medical research work, he has encountered more than 100 different sets of biomarkers with almost equal amounts of cause/input variables versus symptom/output variables. For example, food and exercise influence both body weight and glucose level, where persistent high glucose can result in diabetes. When diabetes combines with hypertension (high blood pressure) and hyperlipidemia (high blood lipids), it can cause cardiovascular diseases. Furthermore, obesity and diabetes are also linked with various kinds of cancers. These multiple sets of biomedical input versus output have been researched by the author using different tools he has learned from academic fields of mathematics, physics, computer science, and engineering.

Previously, he has applied signal processing techniques to separate 19 components from the combined postprandial plasma glucose (PPG) wave. He identified the carbs/sugar intake amount and post-meal exercise as the two most important contributing factors to PPG formation. Based on these findings, he then applied the theory of elasticity to develop a linear elastic glucose theory (LEGT) to predict PPG value with high prediction accuracy, using fasting plasma glucose (FPG), carbs/sugar grams, and post-meal walking k-steps as three major input components of predicted PPG formation.

Furthermore, he took a specific PPG waveform in the time domain (TD) and applied Fourier transform technique to convert it into a waveform in the frequency domain (FD). The y-axis value in the frequency diagram indicates the magnitude of energy corresponding to a certain frequency component on the x-axis, while the total area underneath the frequency-energy curve is the total relative energy associated with the specific PPG wave.

Recently, he has applied theories of viscoelasticity and viscoplasticity (VGT) in physics and engineering to various biomedical problems and has written more than 50 biomedical research papers. This VGT technique emphasizes the time-dependency characteristics of certain 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 (in physics, it is called the "hysteresis loop"), in which area size can be used to estimate the relative energy created during the uploading (digesting carbs/sugar) and unloading (walking exercise) process over the timespan of a PPG wave.

In this article, he initially selects a dataset containing 2 key biomarkers, carbs/sugar intake amount of grams as the symptom (output) and daily total food quantity in calories as the cause (input) to conduct his VGT analysis. He then chooses a dataset containing 3 key biomarkers, postprandial plasma glucose (PPG) as the symptom (output), along with carbs/sugar intake amount of grams and daily total food quantity in calories as the causes (inputs) to perform another VGT analysis. Finally, he selects a dataset containing another 2 key biomarkers, body weight in the early morning as the symptom (output) and daily total food quantity in calories as the cause (input) to conduct the final VGT analysis. These data are collected over ~8 years from Y2015 to Y2022.

He has already discovered this observation from earlier research results that his PPG is related to the carbs/sugar intake amount and body weight is closely related to the daily food intake quantity. Now, he applies VGT specifically to construct three stress-strain diagrams with three hysteresis loops corresponding to the energy status of the research topics.

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 present

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

However, the original measurement units are grams for carbs/sugar intake amount and calories for the total food quantity. Therefore, he uses the formula of 1 gram equals 4 calories to convert his carbs/sugar amount into the calories unit. To place them on even ground with a sufficient biomedical value, he normalizes these two viscosity factors η of both carbs/sugar and total food quantity calories using the following 2 formulas:

Normalized Carbs/Sugar
= Carbs&Sugar (calories) / 1600

Normalized walking k-steps
= Food quantity (calories) / 1600

To control the word size of this article, he omits the repetitive background introduction regarding LEGT, VGT, Fourier transformation, frequency domain analysis, and energy theory in the research method section.

2. METHODS

2.1 Viscoelasticity/plasticity glucose theory (VGT)

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 present

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

However, the original measurement units are grams for carbs/sugar intake amount in grams and calories for total food quantity in calories. Therefore, he uses the formula of 1 gram equals 4 calories to convert his carbs/sugar amount into the calories unit. Furthermore, to place them on even ground with a sufficient biomedical sense, he has to normalize these two viscosity factors η of both carbs/sugar calories and total food quantity calories using the following 2 formulas:

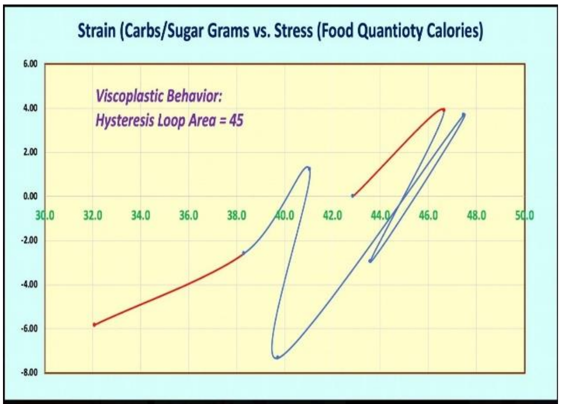
Normalized Carbs/Sugar
= Carbs&Sugar (calories) / 1600

Normalized walking k-steps
= Food quantity (calories) / 1600

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 the stress-strain diagram of carbs/sugar grams (symptom) versus total food quantity in calories (cause) and the data table.



4/2/22			Daily grams	Total Calories	1 g = 4 calories	1600	
PPG vs. Carbs, Calories	Carbs (raw data)	Food (raw data)	Strain (Carbs g)	eTa (Food Calorie)	Strain (Carbs g)	Stress (Calories)	Area (Steps)
Y2015	14.3	55	42.8	1651	42.8	0.00	0
Y2016	15.5	55	46.6	1650	46.6	3.91	7
Y2017	14.5	52	43.6	1547	43.6	-2.96	-1
Y2018	15.8	51	47.5	1523	47.5	3.70	1
Y2019	13.2	50	39.7	1514	39.7	-7.31	14
Y2020	13.7	50	41.0	1501	41.0	1.23	-4
Y2021	12.8	50	38.3	1504	38.3	-2.58	2
Y2022	10.7	50	32.1	1500	32.1	-5.83	26
Average or Sum	13.8	51.6	41.5	1548.7	41.5	-1.2	45
Correlation	100%	53%					

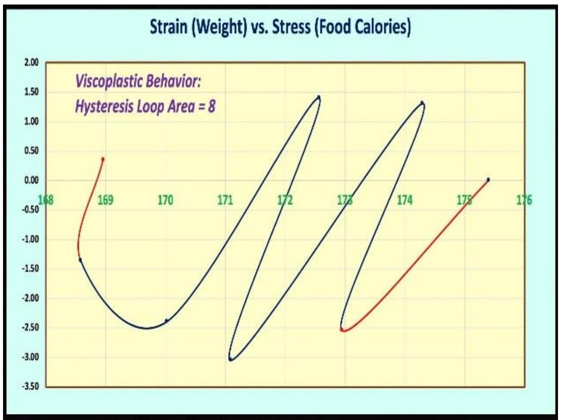
Figure 1: A stress-strain diagram of carbs/sugar grams (symptom) versus total food quantity in calories (cause) and data table.

Figure 2 displays the stress-strain diagram of PPG (symptom) versus carbs/sugar grams (Cause A) and total food quantity in calories (Cause B) and the data table.

4/2/22				Calories (*3*4)	Calories (*30)		1 g = 4 calories	1600	1600		
PPG vs. Carbs, Calories	Strain (eAG)	Carbs (raw data)	Food (raw data)	eta (Carbs Cal.)	eTa (Food Cal.)	Ratio: Carbs/Total	Strain (eAG)	Stress (Carbs)	Stress (Food)	Area (Carbs)	Area (Food)
Y2015	129	14.3	55	171	1651	10%	129	0.0	0.0	0	0
Y2016	119	15.5	55	187	1650	11%	119	-1.1	-9.0	5	41
Y2017	117	14.5	52	174	1547	11%	117	-0.2	-2.1	1	11
Y2018	116	15.8	51	190	1523	12%	116	-0.1	-1.0	0	2
Y2019	114	13.2	50	159	1514	10%	114	-0.2	-2.1	0	3
Y2020	106	13.7	50	164	1501	11%	106	-0.8	-8.7	4	44
Y2021	105	12.8	50	153	1504	10%	105	-0.2	-1.7	1	8
Y2022	107	10.7	50	128	1500	9%	107	0.2	2.1	0	0
Average or Sum	114	13.8	51.6	166	1549	11%	114	-0.3	-2.8	12	110
Correlation	100%	61%	85%					Carbs/Food	11%	Carbs/Food	11%

Figure 2: A stress-strain diagram of PPG (symptom) versus carbs/sugar grams (cause A) and total food quantity in calories (cause B) and data table.

Figure 3 depicts the stress-strain diagram of body weight (symptom) versus total food quantity in calories (cause) and the data table.



4/2/22				0 g = 4 calories		1600	
PPG vs. Carbs, Calories	Weight	Food (raw data)	Weight	eTa (Food Calorie)	Weight	Stress (Calories)	Area (Steps)
Y2015	175.4	55	175.4	1651	175	0.00	0
Y2016	172.9	55	172.9	1650	173	-2.54	3
Y2017	174.3	52	174.3	1547	174	1.30	-1
Y2018	171.1	51	171.1	1523	171	-3.05	3
Y2019	172.6	50	172.6	1514	173	1.40	-1
Y2020	170.0	50	170.0	1501	170	-2.39	1
Y2021	168.6	50	168.6	1504	169	-1.35	3
Y2022	169.0	50	169.0	1500	169	0.36	0
Average or Sum	171.7	51.6	171.7	1549	172	-0.8	8
Correlation	100%	75%					

Figure 3: A stress-strain diagram of body weight (symptom) versus total food quantity in calories (cause) and data table.

4. CONCLUSION

In summary, by conducting the three VGT analyses, the author uncovers the following 3 observations:

(1) From the VGT analysis of carbs/sugar (symptom) versus food quantity calories (cause), their correlation is a mere 53% with a viscoplastic behavior and hysteresis loop area of 45. In this case, carbs/sugar uses grams and food quantity uses calories as their respective units. This conclusion shows that if we consume more food calories, most likely our carbs/sugar grams will be higher.

(2) From the VGT analysis of finger-pieced PPG (symptom) versus both carbs/sugar and food quantity calories (causes), their correlation is a lower 61% between PPG and carbs/sugar grams and a higher 85% between PPG and food calories. It has a viscoplastic behavior and two hysteresis loop areas of 12 for PPG versus carbs calories and 110 for PPG versus food calories. In this case, carbs/sugar and food quantity use calories as their units. This conclusion indicates that if we consume more food calories, i.e. carbs/sugar or food quantity, most likely our PPG level will be higher. Again, eating more food quantity will have a higher probability of consuming increased carbs/sugar food unless we are knowledgeable and careful with the carbs/sugar food consumption. In this case, his carbs/sugar food consumption

only occupies 11% of his total quantity of food consumption which is a “low-carb diet”.

(3) From the VGT analysis of body weight (symptom) versus food quantity calories (cause), their correlation is 75% with a viscoplastic behavior and hysteresis loop area of 8. In this case, body weight uses pounds, and food quantity uses calories as their respective units. This conclusion demonstrates that if we consume more food calories, most likely our body weight will be increased. Furthermore, this hysteresis loop area of 8 cannot be used to compare with the other two cases since the strain unit (symptom) is the pound.

In conclusion, food consumption (what to eat and how much to eat) is the most important element for our overall health maintenance and disease prevention. This article offers a quantitative demonstration of this statement.

5. REFERENCES

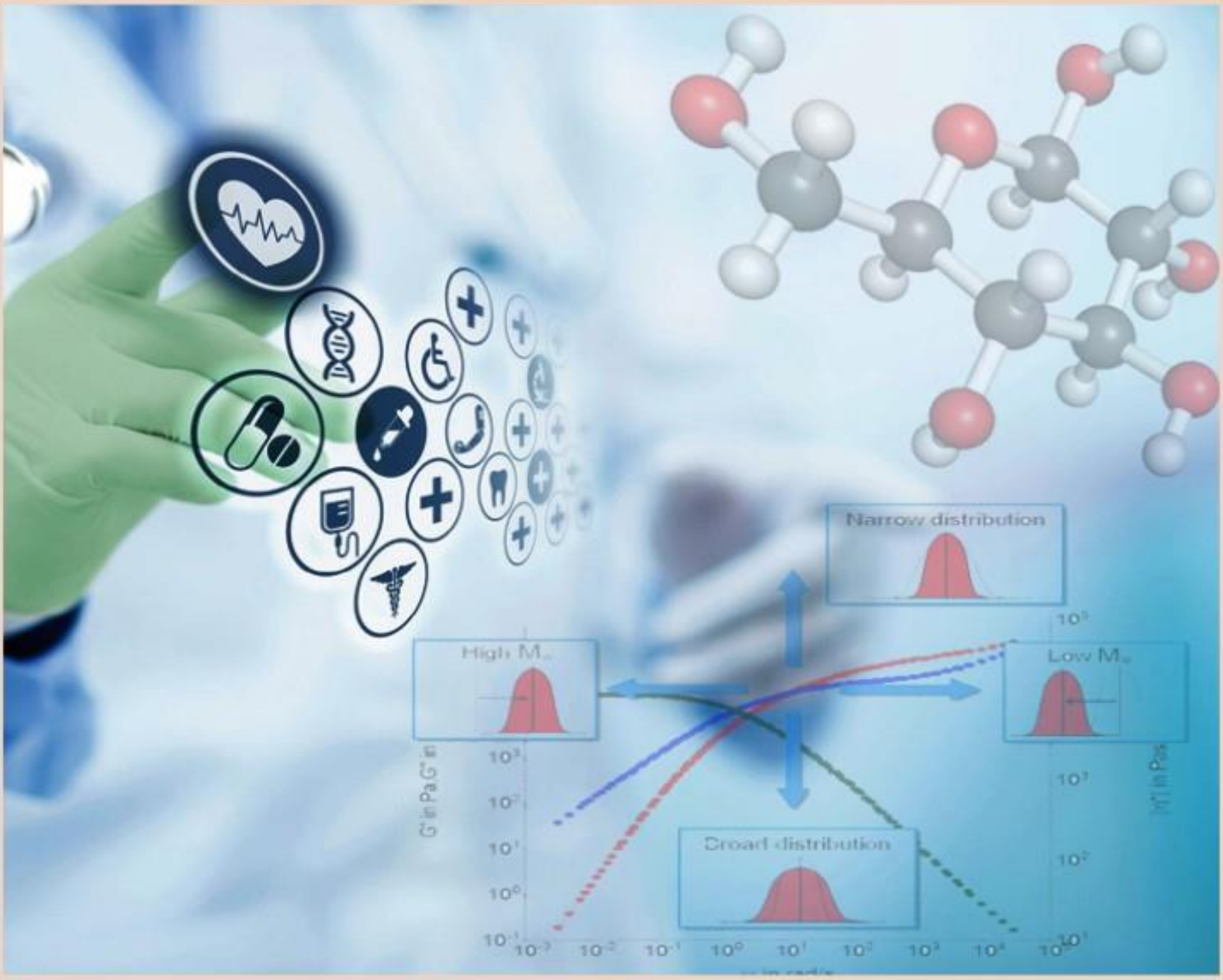
For editing purposes, the majority of the references in this paper, which are self-references, have been removed. Only references from other authors' published sources remain. The bibliography of the author’s original self-references can be viewed at www.eclairemd.com.

Special Issue | Issue No. 5

The GH-Method

Viscoelastic and Viscoplastic Glucose Theory Application in Medicine

Gerald C. Hsu



https://theghmethod.com

2022