

The GH-Method

Investigating Glucose Changes of a Type 2 Diabetes Patient's Clinical Data for Three Selected Periods Based on GH-Method: Math-Physical Medicine (No. 443)

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Abstract

On 4/23/2021, the author, who has a 26-year history of multiple chronic diseases, had blood tests conducted at two different medical laboratories which provided varying HbA1C results of 6.79% vs. 7.0% along with a set of differing lipid results. He understands that different labs may yield contrasting test results due to some issues related to the testing environment, operating procedure, and performing technician. For example, one lab's triglycerides result of 380mg/dL is almost 4 times higher than the other result of 100mg/dL. The significant difference in readings performed on the same day from the two labs shocked him. Although the A1C varying results puzzled him, he already expected that his HbA1C level in the recent period would be higher than the previous period of 6.2% from 10/20/2020. This is a result of his recent food and meal experiment projects along with the on-and-off intermittent fasting (IF) experiments. During the period of 1/20/2021 to 4/20/2021, he has eaten more meals with higher amounts of carbohydrates and sugar, which included starchy foods made from white rice, white flour, potato, etc. Since 7/1/2015, he abstained from eating starchy foods and maintained an average carbs/sugar intake amount below 20 grams per meal. Lately, he decided to continue his research on both pancreatic beta cells recovery and IF impact on his health conditions. So, he changed his diet practice to some degree in order to determine the durability of his pancreatic beta cells. He should have been more cautious to monitor the impact on his overall HbA1C. These two recent lab-tested HbA1C results opened his eyes to refocus on his HbA1C situation. Not only does this report covers the difference in the A1C test results, but it focuses on the reasons and sources for his recent elevated A1C. It should be noted that the average A1C between 6.79% and 7.0% is 6.9, but he decided to use 7.0% as the base for this analysis. As a comparison, he chooses three periods of identical length consisting of three months each: Period A of 1/20/21-4/20/21, Period B of 9/20/20-12/20/20, and Period C of 9/20/19-12/20/19. Not only is he comparing their glucose magnitude, but he also evaluates the shape similarity of their related glucose waveforms. A glucose waveform can reveal certain external physical phenomena that contain much hidden biochemical information, where they can be discovered and illustrated through thorough mathematical

analysis. In summary, his increased A1C value of 0.8% from 6.2% to 7.0% is a combined result of the following: (1) The sleep time interval of 7 hours occupies 29% of daily total hours. His slight weight increase of ~2 lbs. have a very close relationship with his fasting plasma glucose (FPG) increase of 8 mg/dL. He must also be extra careful with the possibility of hypoglycemic situations (<70 mg/dL) during his sleep hours. (2) His defined total of three postprandial plasma glucose (PPG) time intervals of 9 hours occupies 38% of daily total hours. His food and meal experiment has caused his daily meal's PPG to increase by 13 mg/dL, 16 mg/dL, and 9 mg/dL for breakfast, lunch, and dinner, respectively. He should stop his food and meal experiment projects and continue to keep his carbs/sugar intake amount below 14 mg/dL. (3) The non-meal time interval hours occupy 33% of daily total hours. His increased fruits and snack intake during his non-meal time caused his non-meal time's glucose to increase by 13 mg/dL, 30 mg/dL, and 8 mg/dL for pre-lunch, pre-dinner, and pre-bed, respectively. He must remove all snacks between meals and include his necessary fruit portions in normal meals. (4) His higher PPG peak (usually around 60-minutes after the first bite of the meal) resulted from the starting time of his post-meal walking exercise around 60-minutes. This is a little bit too late for his energy consumption. He should start his post-meal walking around 30-minutes after the first bite of meals in order to burn off the fuel from food before it pushes his PPG wave upward. (5) He uses a continuous glucose monitoring (CGM) device to monitor his glucose levels at 15-minute time-interval and collects 96 glucose data each day. He should establish a new target for his daily average glucose at 105 mg/dL and also attempt to meet this target through GF reduction. In addition, the comparisons among these three periods have revealed the following two observations. First, in terms of the variety of glucose magnitudes, Period B is the lowest, Period A is in the middle, and Period C is the highest. Second, in terms of shape similarity of glucose waveforms, Periods A and B are highly similar to each other and possess a high correlation coefficient due to their adjacency on the time scale while Period C is not similar to either Periods A or B due to its different lifestyle and organ health conditions of one year apart on the time scale.

Keywords: Glucose; Intermittent fasting; Postprandial plasma glucose; Fasting plasma glucose; Glucose waveform

Abbreviations: HbA1C: hemoglobin A1C; IF: intermittent fasting; FPG: fasting plasma glucose; PPG: postprandial plasma glucose; CGM: continuous glucose monitoring; MPM: math-physical medicine

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1. INTRODUCTION

On 4/23/2021, the author, who has a 26-year history of multiple chronic diseases, had blood tests conducted at two different medical laboratories which provided varying HbA1C results of 6.79% vs. 7.0% along with a set of differing lipid results. He understands that different labs may yield contrasting test results due to some issues related to the testing environment, operating procedure, and performing technician. For example, one lab's triglycerides result of 380mg/dL is almost 4 times higher than the other result of 100mg/dL. The significant difference in readings performed on the same day from the two labs shocked him.

Although the A1C varying results puzzled him, he already expected that his HbA1C level in the recent period would be higher than the previous period of 6.2% from 10/20/2020. This is a result of his recent food and meal experiment projects along with the on-and-off intermittent fasting (IF) experiments. During the period of 1/20/2021 to 4/20/2021, he has eaten more meals with higher amounts of carbohydrates and sugar, which included starchy foods made from white rice, white flour, potato, etc. Since 7/1/2015, he abstained from eating starchy foods and maintained an average carbs/sugar intake amount below 20 grams per meal. Lately, he decided to continue his research on both pancreatic beta cells recovery and IF impact on his health conditions. So, he changed his diet practice to some degree in order to determine the durability of his pancreatic beta cells. He should have been more cautious to monitor the impact on his overall HbA1C. These two recent lab-tested HbA1C results opened his eyes to refocus on his HbA1C situation.

Not only does this report covers the difference in the A1C test results, but it focuses on the reasons and sources for his recent elevated A1C. It should be noted that the average A1C between 6.79% and 7.0% is 6.9, but he decided to use 7.0% as the base for this analysis.

As a comparison, he chooses three periods of identical length consisting of three months each: Period A of 1/20/21-4/20/21, Period B of 9/20/20-12/20/20, and Period C of 9/20/19-

12/20/19. Not only is he comparing their glucose magnitude, but he also evaluates the shape similarity of their related glucose waveforms. A glucose waveform can reveal certain external physical phenomena that contain much hidden biochemical information, where they can be discovered and illustrated through thorough mathematical analysis.

2. METHODS

The author conducted his glucose research by applying the developed GH-method: math-physical medicine (MPM) approach along with the following eight contribution factors of HbA1C:

- (1) A1C variances contributed by fasting plasma glucose (FPG) between 15% to 35%, where he used 25% in his calculation for this article.
- (2) FPG variance due to weight change with ~77% contribution.
- (3) Colder weather impact on FPG with a decrease of each Fahrenheit degree caused 0.3 mg/dL decrease of FPG.
- (4) A1C variances contributed by postprandial plasma glucose (PPG) between 65% to 85%, where he used 75% in his calculation for this article.
- (5) PPG variance due to carbs/sugar intake with ~39% weighted contribution on PPG.
- (6) PPG variance due to post-meal walking with ~41% weighted contribution on PPG.
- (7) Warm weather impact on PPG with an increase of each Fahrenheit degree caused 0.9 mg/dL increase of PPG.
- (8) All of the other three-time intervals, including pre-lunch, pre-dinner (i.e., between meals), and pre-bed, have occupied 33% of the total continuous glucose monitoring (CGM) sensor collected glucose⁽¹⁻⁴⁾.

It should be noted that in his research work using his developed glucose prediction model and HbA1C prediction model, he utilized his CGM collected glucose from the previous 3-months prior to the day of lab-testing. It is

common knowledge that HbA1C is closely connected to the average glucose for the past 90 days. Actually, the average human red blood cells (RBC), after differentiating from erythroblasts in the bone marrow, are released into the blood and survive in circulation for approximately 115 days.

In this study, he applied the following thought process to calculate and analyze the hidden reasons for the recent elevated HbA1C phenomenon:

- (1) He compares his daily average glucose between the two tested periods first.
- (2) He then segregates his weight, FPG, carbs/sugar amount, post-meal walking steps, and PPG for a detailed comparison.
- (3) He then segregates his meal's PPG from breakfast, lunch, and dinner for a detailed comparison.
- (4) He then segregates his between-meals and pre-bed average glucose levels for a detailed comparison.
- (5) Finally, he uses his developed equation of predicted HbA1C to obtain his estimated A1C in order to compare against his lab-tested A1C.

(6) Using both correlation coefficients from statistics and graphic representation, he can quickly evaluate the shape similarities among different glucose waveforms^(5,6).

3. RESULTS

Figure 1 shows a data table and two diagrams with his calculated results which contain his input glucose data of all different glucose components, his measured daily glucose, and his calculated glucose values for each period.

He has identified that all of the glucose components and the overall glucose situations associated with Period B are the lowest among these three periods. Period C is the worst one and Period A is situated in the middle position. Furthermore, his glucose components contributions on daily glucose are listed below:

- FPG: 29%
- Each meal's PPG: 13%
- PPG: 38%
- Between-meal: 17%
- Pre-bed: 17%

The new targets he established for himself after 4/23/2021 are as follows:

- Weight: 165 lbs.
- FPG: 100 mg/dL
- Each meal's PPG: 107 mg/dL
- PPG: 107 mg/dL
- Between-meal: 105 mg/dL
- Pre-bed: 105 mg/dL
- Daily glucose: 105 mg/dL
- Carbs/sugar: 14.0 grams
- Post-meal walking: 4,400 steps

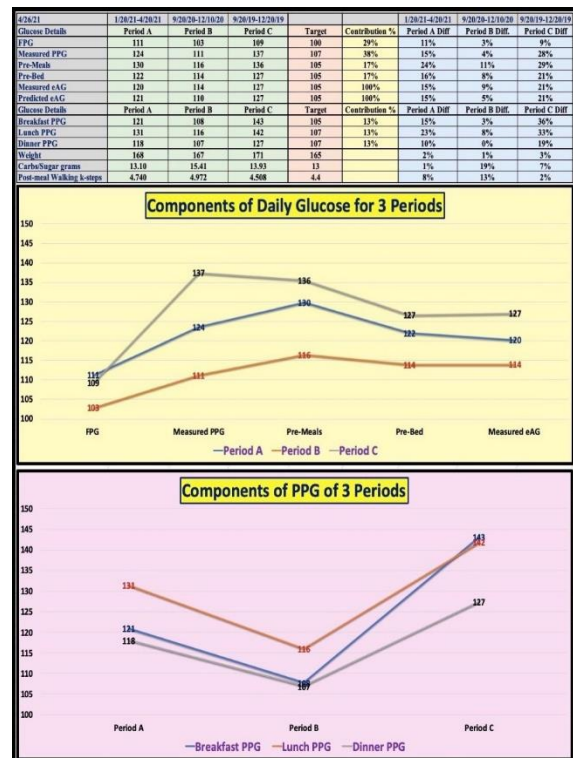


Figure 1: Input data of different glucose segments and calculation of their contributions on daily glucose of three periods.

Figure 2 depicts the comparison of his major glucose of these three periods which include daily glucose, PPG, FPG, and weight (directly impact on FPG).

Figure 3 reflects the comparison of his three different minor glucose components of PPG for these three periods which include breakfast, lunch, and dinner. Generally, his dinner PPG is the lowest, lunch PPG is the highest, and breakfast is in the middle.

It is evident that the glucose waveform shapes are remarkably similar for Periods A and B. However, in general, Period C is different and has a lower degree of shape similarity compared to Periods A and B.

From the daily glucose curve, we can also observe the general glucose movement and hourly pattern which are a result of the combined influences from both diet and exercise.

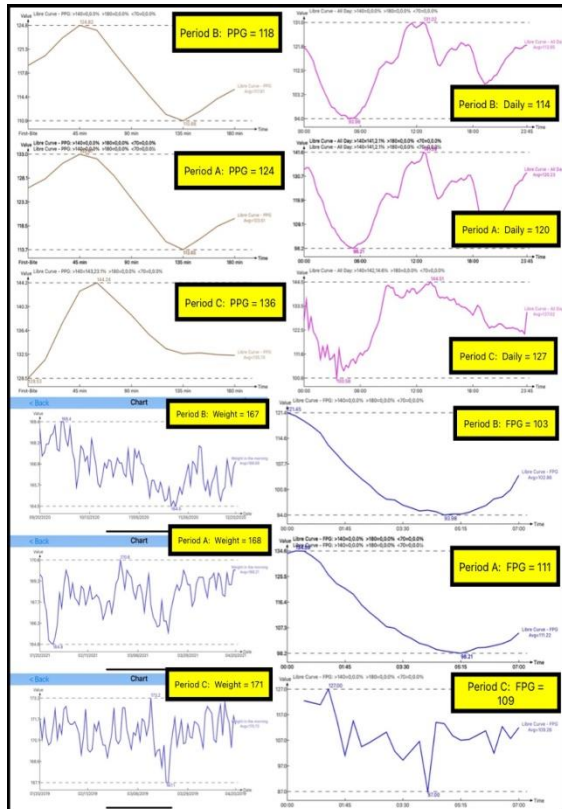


Figure 2: Average glucose data of daily glucose, PPG, FPG, and weight.

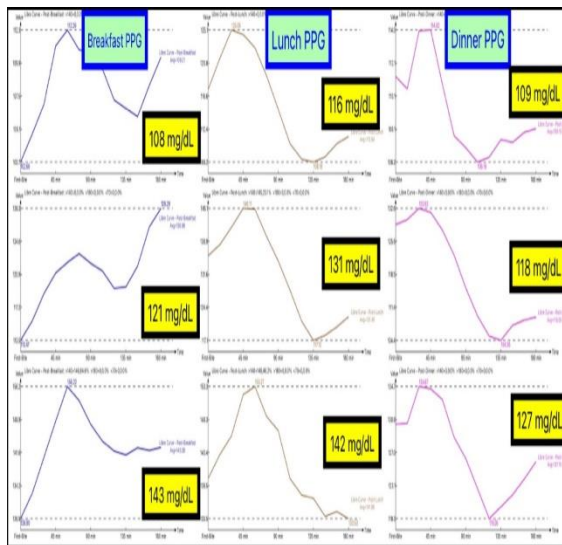


Figure 3: Three PPG components from breakfast, lunch, and dinner.

4. CONCLUSION

In summary, his increased A1C value of 0.8% from 6.2% to 7.0% is a combined result of the following:

(1) The sleep time interval of 7 hours occupies 29% of daily total hours. His slight weight increase of ~2 lbs. have a remarkably close relationship with his FPG increase of 8 mg/dL. He must also be extra careful with the possibility of hypoglycemic situations (<70 mg/dL) during his sleep hours.

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