

The GH-Method

Investigating the HbA1C Changes Between Adjacent Periods for Two Clinical Cases Based on GH-Method: Math-Physical Medicine (No. 442)

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Abstract

On 4/23/2021, the author had blood tests conducted at two different labs which provided differing HbA1C results of 6.79% vs. 7.0%. There were also two sets of different lipid results for HDL, LDL, total cholesterol, and triglycerides. He understands that different labs may yield varying test results due to issues related to the testing environment, operating procedure, and performing technician. However, one set of lipid results exceeded the normal expected range of tolerance or margin of difference, for example, his triglycerides were 100 vs. 380. Of course, these findings puzzled him but he expected his HbA1C level would be higher than his previous test result of 6.2% due to his recent food and meal experiment projects along with the on-and-off intermittent fasting (IF) experiment conducted on himself since 11/8/2020. During the period of 1/20/2021 to 4/20/2021, he has eaten more meals with high carbohydrates, 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. He should have been more careful in watching his overall HbA1C. The 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 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. In summary, his increased A1C value of 0.8% from 6.2% to 7.0% is a 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 of 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 cut off 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 intervals and collects 96 glucose data each day. He should establish a new target for his daily average glucose (eAG) at 105 mg/dL and also make an effort to meet this target through glucose fluctuation (GF) reduction.

Keywords: Glucose; Glucose fluctuation; Postprandial plasma glucose; Fasting plasma glucose; Diabetes

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

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1. INTRODUCTION

On 4/23/2021, the author had blood tests conducted at two different labs which provided differing HbA1C results of 6.79% vs. 7.0%. There were also two sets of different lipid results for HDL, LDL, total cholesterol, and triglycerides. He understands that different labs may yield varying test results due to issues related to the testing environment, operating procedure, and performing technician. However, one set of lipid results exceeded the normal expected range of tolerance or margin of difference, for example, his triglycerides were 100 vs. 380.

Of course, these findings puzzled him but he expected his HbA1C level would be higher than his previous test result of 6.2% due to his recent food and meal experiment projects along with the on-and-off intermittent fasting (IF) experiment conducted on himself since 1/8/2021. During the period of 1/20/2021 to 4/20/2021, he has eaten more meals with high carbohydrates, 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. He should have been more careful in watching his overall HbA1C. The 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 for his recent elevated A1C.

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 the HbA1C prediction model research, he utilized his CGM collected glucose from the previous 3-months prior to the day of the lab-test. 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 included glucose fluctuation (GF) as one of the influential factors of his estimated HbA1C. From studying his CGM sensor-collected glucose data, he discovered a higher average daily glucose which usually contains higher GF i.e., higher vibration magnitude between maximum glucose and minimum glucose.

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 (eAG) between 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 between-meals and pre-bed average glucose levels for a detailed comparison.

(4) Finally, he uses his developed equation of predicted HbA1C to obtain his estimated A1C in order to compare against his lab-tested A1C^(5,6).

3. RESULTS

Figure 1 shows a data table containing his input glucose and calculated average glucose values for each time interval. He has found that the Male's glucose difference between the two periods is +13% which is the same difference of his HbA1C between the two periods if 17.5 is used as his conversion factor. With a similar method, the Female's glucose difference between the two periods is -6% which is the same difference of her HbA1C between the two periods if 17.5 is used as her conversion factor.

	9/20/20-12/20/20		1/20/21-4/20/21		9/20/20-12/20/20		9/20/20-12/20/20		1/20/21-4/20/21		1/20/21-4/20/21	
Male	2020	2021	Hours	2020	2020	2021	2021					
FPG	95	111	7	662	26%	779	27%					
Pre-Lunch	122	135	2	243	9%	270	9%					
Pre-Dinner	104	134	2	208	8%	269	9%					
Pre-Bed	116	124	4	465	18%	495	17%					
PPG	111	124	9	1000	39%	1112	38%					
AverageSum	107	122	24	2579	100%	2924	100%					
A1C Conversion		113%	17.5			113%						
HbA1C	6.2	7.0	7.0									
Female	2020	2021	Hours	2020	2020	2021	2021					
FPG	105	103	7	737	29%	724	25%					
Pre-Lunch	125	105	2	251	10%	209	7%					
Pre-Dinner	109	100	2	218	8%	199	7%					
Pre-Bed	112	107	4	449	17%	427	15%					
PPG	112	104	9	1009	39%	938	32%					
AverageSum	111	104	24	2665	103%	2498	85%					
A1C Conversion		94%	17.5			94%						
HbA1C	6.2	5.8	5.9									

Figure 1: Input data of different time segments within a day and calculations of daily glucose contributions of two periods for two clinic cases (both male and female).

Figure 2 depicts the Male patient's eAG of two adjacent periods. The Y2020 period was 107 mg/dL and the Y2021 period is 120 mg/dL which is 113% of Y2020.

Figure 3 reflects the Male's case of glucose components' contributions on both eAG and A1C for the two adjacent periods. The summarized information is listed below:

- Pre-lunch difference = 13 mg/dL
- Pre-dinner difference = 30 mg/dL
- Pre-bed difference = 8 mg/dL

- Non-PPG difference = 15 mg/dL
- FPG difference = 13 mg/dL
- PPG difference = 16 mg/dL
- Daily average difference = 15 mg/dL

It is evident that all of the three segments including FPG, PPG, and non-meal are contributing an almost equal amount of ~15 mg/dL glucose increase. The increased glucose values are resulted from his food and meal experimental projects, eating fruits and snacks during non-meal intervals, along delayed post-meal walking exercise.

His estimated HbA1C equation is listed below:

$$\text{Estimated HbA1C} = (\text{daily glucose}) / 17.5$$

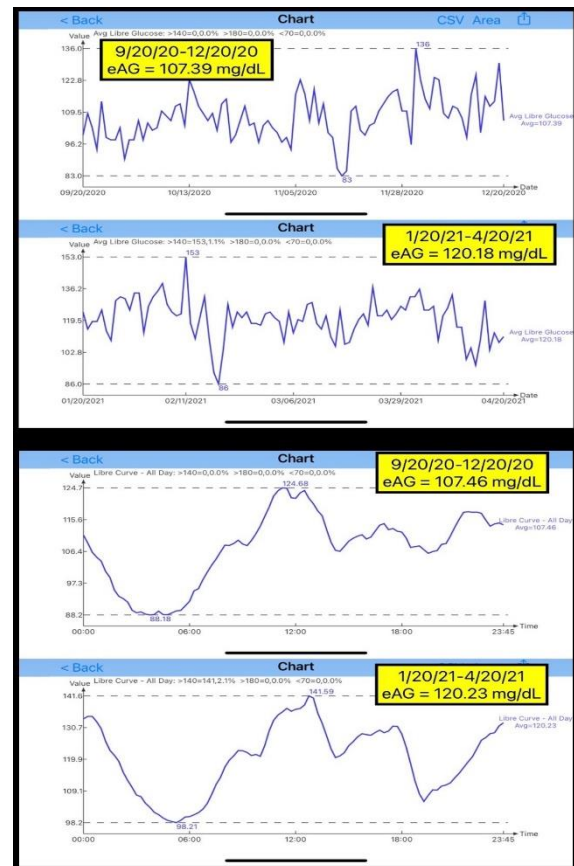


Figure 2: Average data and wave pattern of daily glucose for male case.

Figure 4 reveals his daily glucose profile with illustrations of his future plan on how to reverse his elevated HbA1C for his next lab-test. The conclusive segments are outlined in the conclusion section.

Figure 5 illustrates the Female case's daily glucose data and glucose curve which have two missing sub-periods (red-circle) from

9/20/2020 to 4/20/2021. Therefore, these missing glucose data and their related information would sacrifice the desired prediction accuracy on her estimated HbA1C value.

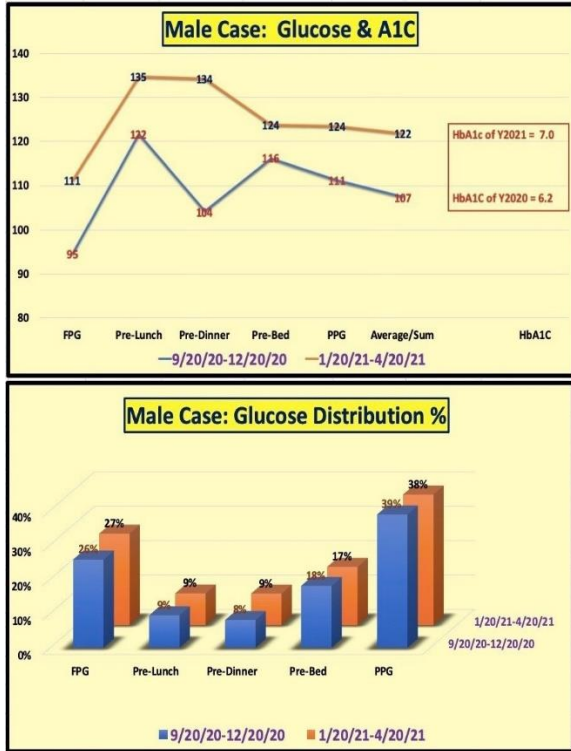


Figure 3: Average glucose for each time segment and their contribution to daily average glucose and HbA1C values for male case.

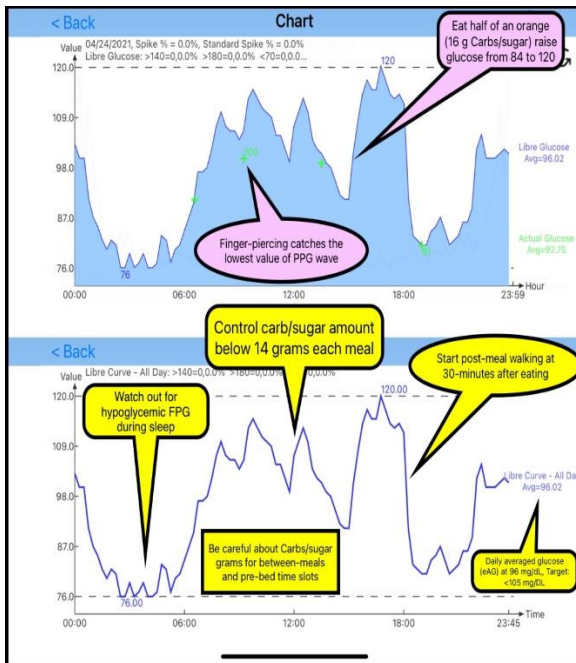


Figure 4: Male case's future plan on how to lower his HbA1C on his next laboratory check-up using his glucose data and waveform on 4/24/2021 for illustration.

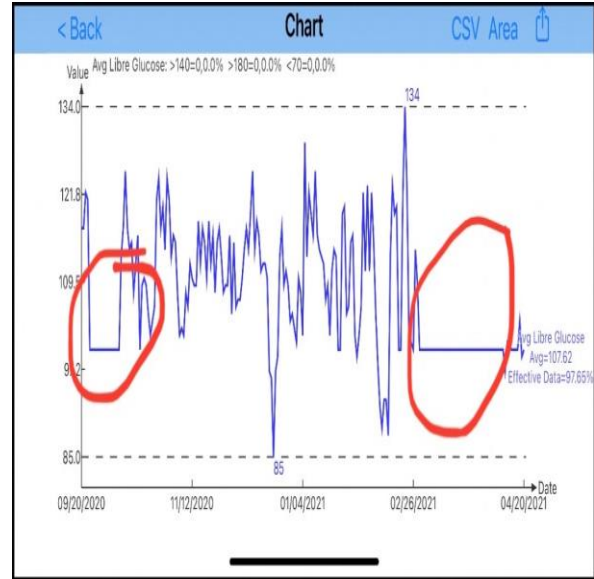


Figure 5: Female case's daily glucose data and curve which have two missing sub-periods (red circle) within 9/20/2020-4/20/2021 which would sacrifice the desired prediction accuracy on her estimated HbA1C value.

Figure 6 demonstrates the Female case of glucose components' contributions on both eAG and A1C for two adjacent periods. The summarized information is listed below:

Pre-lunch difference = -20 mg/dL
Pre-dinner difference = -9 mg/dL
Pre-bed difference = -5 mg/dL

Non-PPG difference = -10 mg/dL
FPG difference = -2 mg/dL
PPG difference = -8 mg/dL
Daily average difference = -7 mg/dL

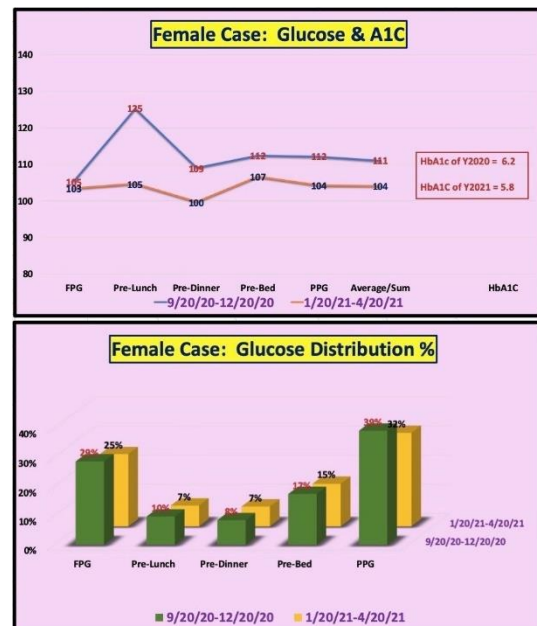


Figure 6: Average glucose for each time segment and their contribution to daily average glucose and HbA1C values for female case.

It is obvious that all of the three segments including FPG, PPG, and non-meal are contributing an amount within the range of -2 mg/dL to -10 mg/dL and with a -7 mg/dL for daily glucose change.

Her estimated HbA1C equation is listed below:

Estimated HbA1C = (daily glucose) / 17.5

4. CONCLUSION

In summary, his increased A1C value of 0.8% from 6.2% to 7.0% is a 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 FPG increase of 8 mg/dL. He must also be extra-careful of the possibility of hypoglycemic situations (<70 mg/dL) during his sleep hours.

(2) His defined total of three 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 cut off 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 CGM device to monitor his glucose levels at 15-minute time-intervals and collects 96 glucose data each day. He

should establish a new target for his eAG at 105 mg/dL and also make an effort to meet this target through GF reduction⁽⁷⁻⁹⁾.

He would also advise the female patient with diabetes to follow a similar set of guidelines but with a different set of target numbers.

5. REFERENCES

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