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Accuracy of three predicted HbA1C results from 12 lab-tested dates within a 38-month period based on GH-Method: math-physical medicine (No. 487)

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Abstract

Since 7/1/2015, the author has utilized his collected data of finger pierced glucose readings 4 times daily, carbs/sugar intake amount, and post-meal walking steps for each meal to calculate the predicted glucose values. He then utilized his developed software calculated daily HbA1C values (the "daily finger A1C").

Starting from 5/5/2018, along with finger glucose levels, he has been collecting 96 glucose data each day using a continuous glucose monitoring (CGM) sensor device until present day. Based on the collected CGM sensor glucoses, he further developed two extra HbA1C prediction models, the "sensor-1" A1C model using the combination of both average sensor glucoses and daily glucose fluctuations, and the "sensor-2" A1C model using the average sensor glucoses (eAG). Both sensor-1 and sensor-2 Predicted A1C models have utilized a simple but different conversion factor (CF) of the value for eAG/A1C.

This article presents the Comparison between the lab-tested A1C versus three predicted A1C: finger, sensor-1, and sensor-2.

In conclusion, both finger A1C and sensor-2 A1C models have yielded the same predicted HbA1C values of 6.6% as the lab-tested HbA1C value. However, the sensor-1 model produces a slightly higher A1C of 6.8% (103%) compared to the lab-tested A1C of 6.6% due to its heavy contribution (71%) from glucose fluctuation (GF).

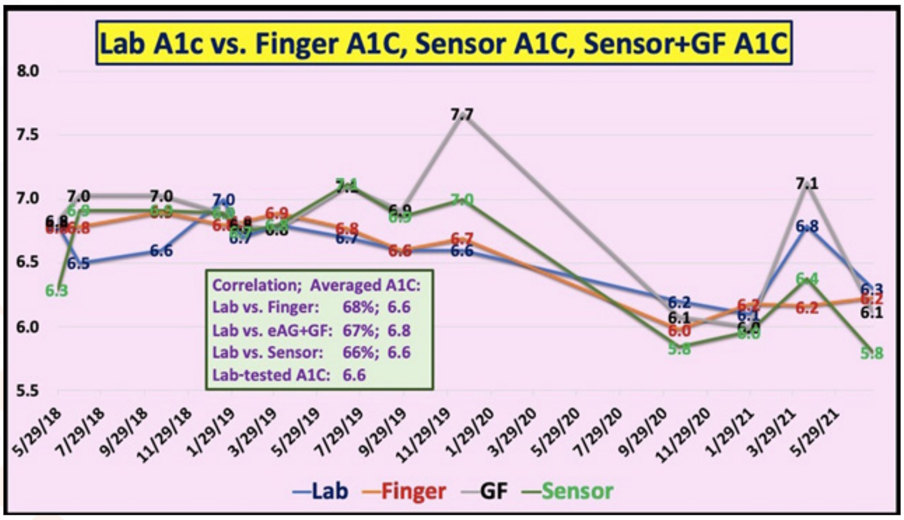
In addition, all of these three predicted A1C datasets have reasonable high correlation (66%-68%) versus the lab-tested A1C dataset.

The objective is to provide some simple yet useful A1C prediction tool to other diabetes patients for their diabetes control efforts. If we can predict the future outcomes of A1C on a daily basis, then diabetes control will not be a difficult task.

Both glucose and HbA1C involve many influential factors. Although the medical community lacks a precise definition for the term HbA1C (mathematically), it loosely defines HbA1C as being the 90-days average glucose value. However, the actual life-span of red blood cells (RBC) range between 90 to 120 days, where some documents even stated as 115 days. In reality, a lab-tested HbA1C is also affected by many other non-biomedical influential factors, including but not limited to its operational procedures, possible human errors, testing environment differences (even the altitude of the laboratory), etc.

The author spends his time and efforts on developing several highly accurate HbA1C prediction models in order to provide an "early and preventive warning" to diabetes patients on a daily basis. Therefore, they do not have to wait until the actual lab-test day to find out their HbA1C value. By that time, it will be too late to make any modifications for past behaviors in order to control their diabetes.

The author strongly believes that an accurate prediction offers a better chance in preventing the disease, which is always superior to treating it, including medications, injections, surgeries, chemotherapy, or radiation.



Introduction

Since 7/1/2015, the author has utilized his collected data of finger pierced glucose readings 4 times daily, carbs/sugar intake amount, and post-meal walking steps for each meal to calculate the predicted glucose values. He then utilized his developed software calculated daily HbA1C values (the "daily finger A1C").

Starting from 5/5/2018, along with finger glucose levels, he has been collecting 96 glucose data each day using a continuous glucose monitoring (CGM) sensor device until present day. Based on the collected CGM sensor glucoses, he further developed two extra HbA1C prediction models, the "sensor-1" A1C model using the combination of both average sensor glucoses and daily glucose fluctuations, and the "sensor-2" A1C model using the average sensor glucoses (eAG). Both sensor-1 and sensor-2 Predicted A1C models have utilized a simple but different conversion factor (CF) of the value for eAG/A1C.

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Method

Using signal processing techniques, the author identified more than 20 influential factors of physical behaviors for glucose. From these 20+ factors, he further outlined the following six most prominent conclusions for his glucose and HbA1C values:

1. The CGM sensor based A1C variances have the following contributions: 29% from fasting plasma glucose (FPG), 38% from postprandial plasma glucose (PPG), and 33% from between-meals and pre-bedtime periods. Therefore, **all three segments contributed to the HbA1C value almost equally (approximately one-third each).**
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. PPG variance due to carbs/sugar intake with ~39% weighted contribution on PPG.
5. PPG variance due to post-meal walking with ~41% weighted contribution on PPG.
6. Warm weather impact on PPG with an **increase** of each Fahrenheit degree caused 0.9 mg/dL increase of PPG.

It is common knowledge that HbA1C is closely connected to the average glucose for the past 90 days. Actually, the average human RBCs, after differentiating from erythroblasts in the bone marrow, are released into the blood and survive in circulation for approximately 115 days. The author has adopted the 120-days finger glucose model with different weight-factor for each month. In addition, he uses the CGM collected average sensor glucose (eAG) data with the daily glucose fluctuation data for this HbA1C study. It should be reemphasized that the lab-tested HbA1C value should not be considered as the "golden standard" since it contains a large margin of error due to various possible causes.

Here, he is listing his three arithmetic equations to be used for the predicted HbA1C of this study period. These three predicted HbA1C formulas with three associated CF are as follows:

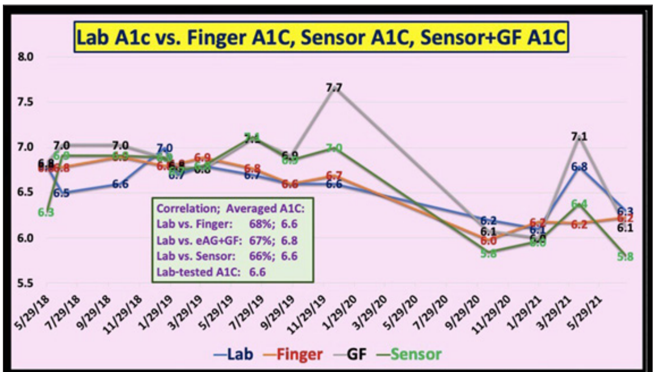
(a) Finger A1C = (weighted finger eAG) / CF
(b) New A1C-1 = (29% * sensor eAG +71% * GF) / CF
(c) New A1C-2 = (sensor eAG) / CF

The CF values are selected to achieve high accuracy and can vary from patient to patient or from one time period to another. This CF value can be different for a specific patient dependent on significant changes occurring in a certain time period or with special health conditions. However, for a general case, they do not vary too much.

It should be noted that the Sensor-1 A1C model includes the influences from the daily glucose fluctuation (GF) factor. GF can influence the outcomes of diabetes complications such as stroke, atherosclerosis, cardiovascular disease, chronic kidney disease, diabetic retinopathy, neuropathy, etc. Furthermore, by choosing a high weighted-factor of 71% for GF, it will modify the basic characteristics of the traditionally defined HbA1C.

Results

This paper is a simple demonstration of 3 predicted A1C models that achieved ~100% prediction accuracy with 12 lab-tested results over a long period of 38 months from 5/29/18 to 7/22/2021.



Date	Lab	Finger	GF	Sensor
5/29/18	6.8	6.8	6.8	6.3
6/29/18	6.5	6.8	7.0	6.9
10/22/18	6.6	6.9	7.0	6.9
1/18/19	7.0	6.8	6.9	6.9
2/12/19	6.7	6.8	6.8	6.7
4/4/19	6.8	6.9	6.8	6.8
7/11/19	6.7	6.8	7.1	7.1
9/25/19	6.6	6.6	6.9	6.9
12/20/19	6.6	6.7	7.7	7.0
10/21/20	6.2	6.0	6.1	5.8
1/28/21	6.1	6.2	6.0	6.0
4/19/21	6.8	6.2	7.1	6.4
7/21/21	6.3	6.2	6.1	5.8
Average	6.6	6.6	6.8	6.6
Correlation with Lab	100%	68%	67%	66%

Figure 1: Three predicted A1C versus lab-tested A1C on Lab-test dates and supporting data table

Figure 1 shows the combination of the four A1C curves with their supporting data table. The following lists the average A1C values with 12 data in each set:

Lab A1C	:	**6.6%**
Finger A1C	:	**6.6%**
Sensor+GF A1C	:	**6.8%**
Sensor A1C	:	**6.6%**

The following three correlation coefficients are three predicted A1C versus the lab-tested A1C:

Finger vs. Lab	:	**66%**
Sensor+GF vs. Lab	:	**67%**
Sensor vs Lab	:	**68%**

It should be pointed out that there were A1C spikes during a 6-month duration from October 2020 through April 2021. The 6-month A1C spike was caused by food experiments he conducted on his own body for research on the subject of pancreatic beta cells self-recovery. During that period, he consumed high-carbohydrates food, while maintaining the same level of exercise as other periods, and then recorded his hyperglycemic phenomena for medical research purpose. After April 23, 2021, he decided to revert to his usual diet in order to control his glucoses; therefore, he was able to bring his HbA1C from 6.8% on 4/23/2021 down to 6.3% on 7/22/2021. Again, for readers who are interested in learning more about his pancreatic beta cell research subject, they can visit the author's website at: www.eclairemd.com.

The straight lines connecting 12/20/2019 and 10/21/2020 are a result of the non-existent lab data due to COVID-19 quarantine life. He initiated his self-quarantined life on 1/19/2020 until present. For safety concerns, other than vaccine injections and absolutely necessary blood work, he does not leave his home at all.

Conclusion

In conclusion, both finger A1C and sensor-2 A1C models have yielded the same predicted HbA1C values of 6.6% as the lab-tested HbA1C value. However, the sensor-1 model produces a slightly higher A1C of 6.8% (103%) compared to the lab-tested A1C of 6.6% due to its heavy contribution (71%) from glucose fluctuation (GF) [1-19].

In addition, all of these three predicted A1C datasets have reasonable high correlation (66%-68%) versus the lab-tested A1C dataset.

The objective is to provide some simple yet useful A1C prediction tool to other diabetes patients for their diabetes control efforts. If we can predict the future outcomes of A1C on a daily basis, then diabetes control will not be a difficult task.

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