ISSN: 2573-9565

Review Article

Journal of Clinical Review & Case Reports

Using Two Clinical Glucose Measurement Datasets, Finger Glucose As Lower Bound and Sensor Glucose As Upper Bound, to Establish A Rational Range of HbA1c Values for Type 2 Diabetes Patients (GH-Method: Math-Physical Medicine)

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Submitted: 20 Apr 2020; **Accepted**: 24 Apr 2020; **Published**: 01 May 2020

Introduction

This paper describes a rational range of HbA1C for type 2 diabetes (T2D) conditions based on big data analytics of a lower bound from finger-piercing and glucose testing strip method (Finger) and an upper bound from a continuous glucose monitoring sensor device (Sensor). It uses the "eAG" concept defined by ADA to conduct this comparison study.

The American Diabetes Association is recommending the use of a new term known as the "estimated average glucose" or "eAG" for diabetes management (see following quotes from ADA literature).

"Health care providers can now report A1C results of patients by using the same units (mg/dl or mmol/l) that patients routinely see in blood glucose measurements. Although the A1C test is an important tool, it can't replace the daily self-monitoring of blood glucose (SMBG). A1C tests don't measure a person's day-to-day control. People with diabetes can't adjust their insulin on the basis of their A1C tests. That's why blood glucose checks and log results are so important to stay in good control. From 1994, the goal for most people with diabetes has been less than 7%. ADAG Study was conducted by ADA, EASD, and IDF with 507 recruited people, including 268 patients with type 1 diabetes (53%), 159 with type 2 diabetes (31%), and 80 people without diabetes (16%) from 10 international centers."

Methods

The author conducted four glucose measurements per day by using the Finger method over the past 7.5 years, 2,745 days from 1/1/2012 - 7/7/2019 with 10,980 measured glucose data. Furthermore, by applying a Sensor on his upper arm and measuring 74 times per day, he has collected additional 31,672 measured glucose data over 428 days (5/5/2018 - 7/7/2019).

He then conducted a detailed big data analytics of glucose results comparison with both Finger and Sensor data (Figures 1 and 2). In summary, the average sensor results are 13% higher than the average finger results. These two sets of self-monitoring of blood glucose (SMBG) data include both fasting plasma glucose (FPG), postprandial plasma glucose (PPG), and the glucoses in other periods throughout the day from the Sensor method (a total of 74 data per day). From the testing results, it is obvious that the finger results serve as the lower bound and the sensor result serve as the upper bound of SMBG.

The following ADA's equation for the eAG conversion to A1C is also used in this calculation except the term of eAG is replaced by *Finger glucose* and *Sensor glucose* in two separated bound analyses.

eAG (mg/dL) = (A1C × 28.7) – 46.7
Or
A1C (%) = (eAG + 46.7) ÷ 28.7

Based on his research findings, he decided to establish a more rational range of HbA1C with lower and upper bounds instead of using a single value of A1C % to determine a T2D patient's "more realistic" disease condition.

Results

Table 1 shows the summarized results of his glucose study. It includes daily glucose, FPG, and PPG. He compares not only the average glucoses, but also two high glucosas at both 60-minutes peak and 120-minutes (traditional knowledge) in order to provide a realistic sense of understanding this glucose wave fluctuation. It should be noted here that, through his research, he has identified the peak PPG occurring approximately 60 minutes after the first bite of meal, not the traditional belief and practice of measuring PPG around two hours after a meal.

Table 2 lists a range of Glucose versus HbA1C from 100 mg/dL to 160 mg/dL. Furthermore, it lists all of 113% upper bound of glucoses and their corresponding HbA1C values utilizing the "modified" ADA recommended conversion equation.

Conclusion

This big data analytics derived a range of measured glucose values and their corresponding HbA1C with both lower bound at 100% by using the Finger method and upper bound at 113% by using the Sensor method. With this rational *Range of HbA1C*, a medical professional and a T2D patient can easily depict a more accurate picture of his or her diabetes conditions [1-5].

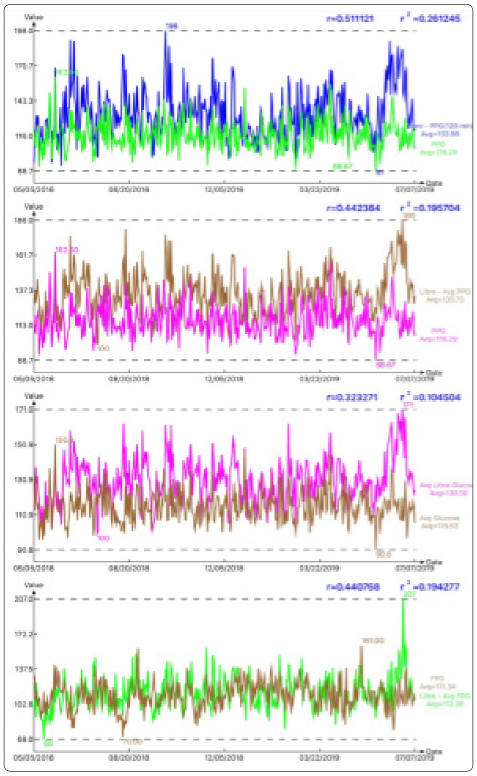

Figure 1: Glucose data of Daily average, FPG, and PPG

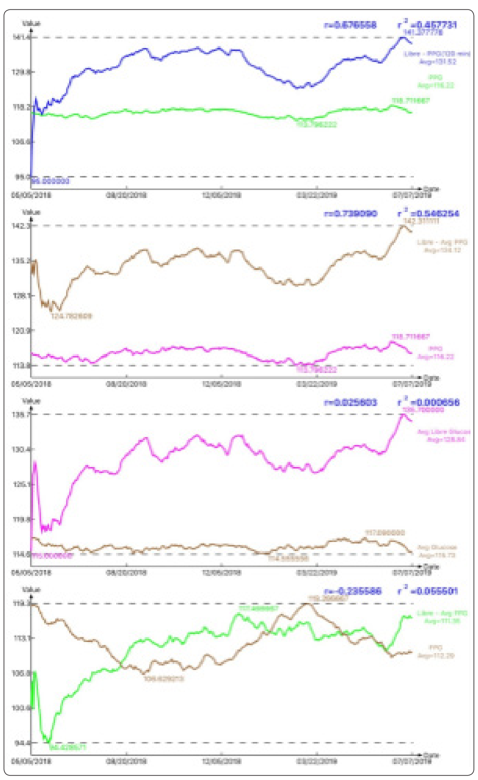

Figure 2: 90-days moving average glucose data of Daily average, FPG, and PPG

Finger Daily Glucose	115.53	100%
Sensor Daily Glucose	130.50	113%
Finger FPG	111.34	100%
Sensor Average FPG	113.39	102%
Sensor Peak FPG	133.37	120%
Finger PPG	116.29	100%
Sensor Average PPG	135.75	117%
Sensor (120 min) PPG	133.86	115%
Sensor Peak PPG	160.13	138%

Table 1: Comparison between Finger glucose and Sensor glucose

eAG (mg/dL) at 100%	A1C at 100%	eAG (mg/dL) at 113%	A1C at 100%	A1C Delta
110	5.46%	124	5.96%	0.50%
111	5.49%	125	6.00%	0.50%
112	5.53%	127	6.04%	0.51%
113	5.56%	128	6.08%	0.51%
114	5.60%	129	6.12%	0.52%
115	5.63%	130	6.16%	0.52%
116	5.67%	131	6.19%	0.53%
117	5.70%	132	6.23%	0.53%
118	5.74%	133	6.27%	0.53%
119	5.77%	134	6.31%	0.54%
120	5.81%	136	6.35%	0.54%
121	5.84%	137	6.39%	0.55%
122	5.88%	138	6.43%	0.55%
123	5.91%	139	6.47%	0.56%
124	5.95%	140	6.51%	0.56%
125	5.98%	141	6.55%	0.57%
126	6.02%	142	6.59%	0.57%
127	6.05%	144	6.63%	0.58%
128	6.09%	145	6.67%	0.58%
129	6.12%	146	6.71%	0.58%
130	6.16%	147	6.75%	0.59%
131	6.19%	148	6.79%	0.59%
132	6.23%	149	6.82%	0.60%
133	6.26%	150	6.86%	0.60%
134	6.30%	151	6.90%	0.61%
135	6.33%	153	6.94%	0.61%
136	6.37%	154	6.98%	0.62%
137	6.40%	155	7.02%	0.62%
138	6.44%	156	7.06%	0.63%
139	6.47%	157	7.10%	0.63%
140	6.51%	158	7.14%	0.63%
141	6.54%	159	7.18%	0.64%
142	6.57%	160	7.22%	0.64%
143	6.61%	162	7.26%	0.65%
144	6.64%	163	7.30%	0.65%
145	6.68%	164	7.34%	0.66%
146	6.71%	165	7.38%	0.66%
147	6.75%	166	7.41%	0.67%
148	6.78%	167	7.45%	0.67%
149	6.82%	168	7.49%	0.67%
150	6.85%	170	7.53%	0.68%
151	6.89%	171	7.57%	0.68%
152	6.92%	172	7.61%	0.69%
153	6.96%	173	7.65%	0.69%
154	6.99%	174	7.69%	0.70%
155	7.03%	175	7.73%	0.70%
156	7.06%	176	7.77%	0.71%
157	7.10%	177	7.81%	0.71%
158	7.13%	179	7.85%	0.72%
159	7.17%	180	7.89%	0.72%
160	7.20%	181	7.93%	0.72%

Table 2: Range of HbA1C corresponding with both lower bound of eAG (Finger) and upper bound of eAG (Sensor)

References

1. Hsu Gerald C (2018) Using Math-Physical Medicine to Control T2D via Metabolism Monitoring and Glucose Predictions. Journal of Endocrinology and Diabetes 1: 1-6.
2. Hsu Gerald C (2018) Using Math-Physical Medicine to Analyze Metabolism and Improve Health Conditions. Video presented at the meeting of the 3rd International Conference on Endocrinology and Metabolic Syndrome 2018, Amsterdam, Netherlands.
3. Hsu Gerald C (2018) Using Signal Processing Techniques to Predict PPG for T2D. International Journal of Diabetes & Metabolic Disorders 3: 1-3.
4. Hsu Gerald C (2018) Using Math-Physical Medicine and Artificial Intelligence Technology to Manage Lifestyle and Control Metabolic Conditions of T2D. International Journal of Diabetes & Its Complications 2: 1-7.
5. Hsu Gerald C (2018) A Clinic Case of Using Math-Physical Medicine to Study the Probability of Having a Heart Attack or Stroke Based on Combination of Metabolic Conditions, Lifestyle, and Metabolism Index. Journal of Clinical Review & Case Reports 3: 1-2.

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