The GH-Method

Changes in Relative Health State of Pancreas Beta Cells Over Eleven Years Using GH-Method: Math-Physical Medicine (No. 112)

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Abbreviations: PPG: postprandial plasma glucose; FPG: fasting plasma glucose

1. INTRODUCTION

The purpose of this paper is to discuss the methods and results of estimating the relative health state (i.e. degree of damage) of the author's pancreatic beta cells resulted from his long-term type 2 diabetes conditions.

2. METHODS

The author uses big data analytics and signal processing technique to decompose his postprandial plasma glucose (PPG) data to separate them into two groups: (1) stimulator induced glucose by external factors and (2) naturally produced glucose by the human body. He then remove or strip off those external stimulated glucose components and then analyze those leftover body naturally produced glucose component via three different analysis approaches. This leftover glucose represents the combination of three biological effects: (1) liver produced glucose, (2) pancreatic alpha cells produced glycogen to increase low glucose level, and (3) pancreas beta cells produced insulin to decrease high glucose level. The author's "low-glucose" segment of less than 70 mg/dL occupies only 0.2% of his total PPG data while "high-glucose" segment of higher than 140 mg/dL is 32% and higher than 180 mg/dL is 5%. This discovery is also consistent with findings from most diabetes patients. The beta cell's insulin production quality and capacity are the most prominent elements of severity of diabetes conditions. That is why the author chose the term of "relative" health state, rather than use the term of "absolute" health state since there are some unknown but small contribution comes from both liver and pancreas alpha cells.

The glucose data are collected during a period of 483 days (from 5/5/2018 to 8/30/2019). Sensor data are collected at 74 times per day with a total of 35,842 sensor data. Finger data are collected at four times per day with a total of 1,932 finger data.

Each day has one sensor FPG waveform (i.e. a curve set) from 00:30 midnight to 7:45 am and three sensor PPG waveforms covering a three-hour period. There are a total of 483 FPG waveforms and 1,449 PPG waveforms in his pancreas analysis.

Each PPG waveform includes five key data points:

Open glucose (at 0 minute);
Maximum glucose (usually around 60 minutes);
Minimum glucose (could happen at any instant);
Close glucose (at 180 minutes);
Averaged glucose (over this 180 minutes period).

Furthermore, a "Baseline" glucose is defined as the glucose value at 1/3 distance from the open glucose on the line connecting both open glucose and close glucose.

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(A) The first approach uses the baseline value of PPG waveform to figure out the relative health state of pancreas beta cells. Through this particular approach, most of the major influential factors (i.e. external stimulators) of PPG are removed or stripped off from the measured PPG value. As shown in Figure 1 of the PPG's OHCA (Open, High, Close, Average) Model, the first stimulator of carb/sugar intake pushed PPG upward from open to maximum position, and then the second stimulator of exercise brings PPG downward from maximum to close position. The baseline which connects open and close glucoses is indicating the glucose status associated with post-removal of stimulators.

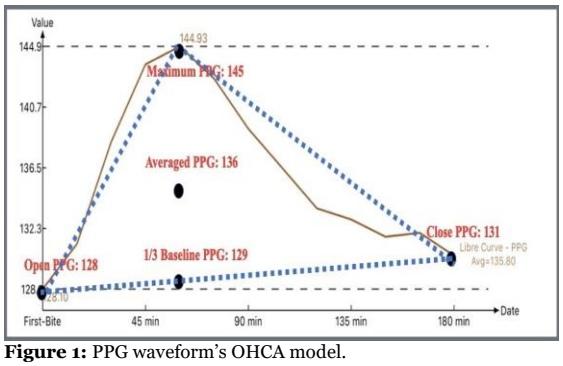

Figure 1: PPG waveform's OHCA model.

(B) The second approach uses the "pre-periods" glucose to estimate those naturally produced glucose by liver and also regulated by both alpha and beta cells of the pancreas. These pre-periods include both pre-meals period (from 3 hours after first bite of a meal and before the next meal) and pre-bed period (from 3 hours after dinner and before 12:00 midnight). Within these pre-periods, the most prominent stimulators such as food and exercise are not included, except occasional fruits intake, although it could be very sweet. Influences from some other secondary stimulators may still be there if they happen to exist during that time period such as hot weather temperature, higher stress, physical illness, emotional disturbance, etc. However, under most statistical situations, these secondary stimulators are insignificant factors. That is why a big glucose dataset has to be collected and analyzed carefully in order to obtain a better estimation. Based on biological domain-knowhow, we could assume that the baseline value obtained from approach A should be quite close to the average glucose value of pre-periods (averaged value of a both pre-meal and pre-bed).

(C) The third approach uses FPG values from both sensor (11 measurements throughout night, usually between 00:30 midnight through 07:45 am) and finger (only 1 measurement in early morning before breakfast). The averaged value of averaged sensor FPG and finger FPG still can provide a picture of where our internal organ's natural glucose production level is during our sleep period while external stimulators have least influences.

By combining results from above-mentioned three different analysis approaches, we now could have a rather complete glance of the relative health state of the pancreas, specifically its beta cells' insulin production quality and capacity.

3. RESULTS

As shown in Table 1 (synthesized from time-series results in Figure 2), the results of relative health state of pancreas beta cells from three different analysis approaches are:

(A) OHCA baseline approach: 129
(B) Pre-periods approach: 121
(C) FPG approach: 113

It should be noted that both of the differences between A vs. B and B vs. C are "8" unit. From this case study, A represents the high-end value, B represents the medium value, and C represents the low-end value.

The "bandwidth" spread between 113 and 129 with a variance of +/- 6.6% (8/121=6.6%) indicates the author's current relative health state (or degree of damage) of his pancreas beta cells insulin production quality and capacity.

(5/5/2018-8/30/2019)	Daily Data Count	PPG mg/dL
Libre (mg/dL)	Sensor	Sensor
Avg Open (0 minute)		128
Avg Close (180 minute)		131
Avg 1/3 Baseline (60 minute)		129
Avg Pre-Meals	14	118
Avg Pre-bed	10	124
Pre-Periods (Avg of Meals & Bed)	24	121
FPG	11	113
PPG	36	135

Table 1: Pancreas beta cell's health state via glucose without stimulators.

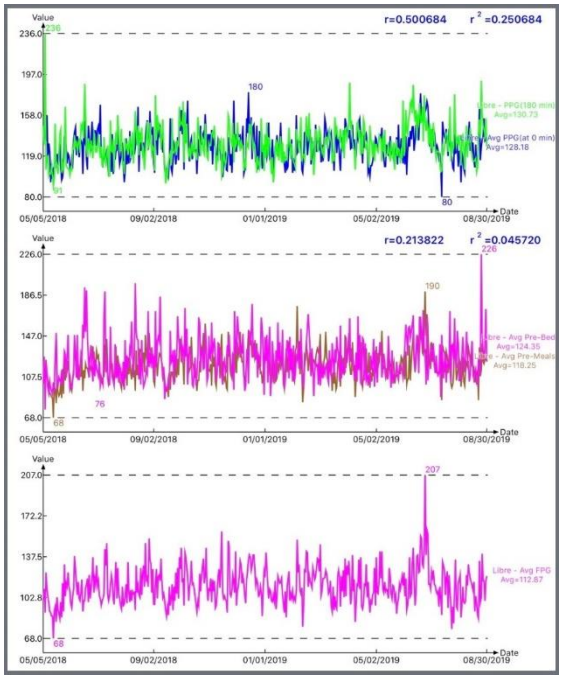

Figure 2: Detailed glucose from PPG waveform's baseline, pre-periods (pre-meals and pre-bed), and FPG.

The author has conducted a similar pancreas relative health state analysis for other three clinic cases. The results are summarized and compared as follows:

Case A (age 72, male): 113-129
Case B (age 71, female): 98-125
Case C (age 75, male): 127-170
Case D (age 46, female): 112-142

4. CONCLUSION

The author's averaged finger PPG values was above 240 mg/dL (HbA1C at 10%) in 2010. While lacking available sensor data back then, but utilizing this created analysis approach, the author estimates that his pancreas beta cell's relative health state should be around 200 in 2010. Does this indicate that his beta cell's insulin production capability damage was somewhat "restored" by his stringent and persistent lifestyle management program over the past nine years?

Incidentally, his dangerous renal conditions have also experienced a similar "self-restoration" process. His ACR value dropped from 116 in 2010 down to 8 in 2019 (the maximum of healthy urination protein range is 30) without taking any medications. Therefore, he would like to post here with his question: "Can beta cells be able to repair or restore themselves to some degree?" He would like to seek other medical expertise's opinions, discussions, or valuable inputs.

Human organs are extremely complex biochemical systems. However, by observing their natural physical behavior, recording their performance carefully, and collecting relevant bio mark data as much as possible, medical research scientist can then make careful but bold hypothesis to presume certain organ's behavior and also be able to predict its behavior. After creating some hypothesis and then following by careful proof of the validity of these hypotheses via physics theories and mathematical equations (sometimes applying engineering modeling techniques), scientists can ascertain and find hidden facts in our bodies and also be able to predict their future behaviors and performance of the human organs and certain diseases. Computer science and statistics are merely analysis tools to be utilized for data manipulation and calculation. It is insufficient if we only rely on some simple statistical operations to draw important conclusions since statistics has many tricks regarding its usage and applications. The precision and predictability actually rely on the power and applications of both mathematics and physics. Many past human accomplishments such as aerospace exploration, defense technology, nuclear power, and semiconductor technology were exactly based on the power of both mathematics and physics, which are the foundations of many branches of nature science. Actually, both biology and chemistry originated from physics which is further derived from mathematics. Most of the medical studies utilize biology and chemistry only. Once you have the complete understanding of the basic fundamental level of sciences, the more powerful and deeper knowledge you are going to have in order to solve higher-hierarchical problems. This is what the "GH-Method: math-physical medicine" is about.

The author wrote this paper by using his own glucose data and his developed math-physical medicine approach to provide an additional but a practical way on exploring the relative health state of the pancreatic beta cells.