The GH-Method

A Summary Report on Partial Regeneration of the Pancreatic Beta Cells Insulin Regression Using Both Fasting Plasma Glucose, Postprandial Plasma Glucose, and HbA1C Data Using GH-Method: Math-Physical Medicine (No. 252)

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Abbreviations: T2D: type 2 diabetes; HbA1C: hemoglobin A1C; FPG: fasting plasma glucose; PPG: postprandial plasma glucose; MPM: math-physical medicine

1. INTRODUCTION

In this paper, the author describes his hypothesis on the "self-recovery" of partial insulin regeneration capacity of the pancreatic beta cells from a type 2 diabetes (T2D) patient (himself). By using the collected big data of postprandial plasma glucose (PPG) of both Finger piercing PPG and Synthesized PPG via Sensor PPG pattern, fasting plasma glucose (FPG of Finger piercing), and HbA1C for six years from 1/1/2014 to 12/31/2019.

2. METHODS

2.1 Background

The author has had T2D for 25 years and took various diabetes medications to control his elevated glucose levels starting in 1998. For the last 20 years, he has suffered from many complications from his diabetes, including five cardiac episodes, foot ulcer, bladder infection, renal complications, diabetic retinopathy, and hyperthyroidism; however, he did not have a stroke.

In 2013, he started different stages to reduce the dosages from his three prescribed diabetes medications. On 12/8/2015, he finally ceased his last one, the classic metformin HCL. For more than four years, his body has been free of any medications.

Since then, he has completely relied on a stringent lifestyle management program to control his diabetes conditions. As a result, his HbA1C has been reduced from 10% in 2010, while taking medications, to an average of 6.63% during 2016-2019 without any medication or use of insulin injection (Figure 1).

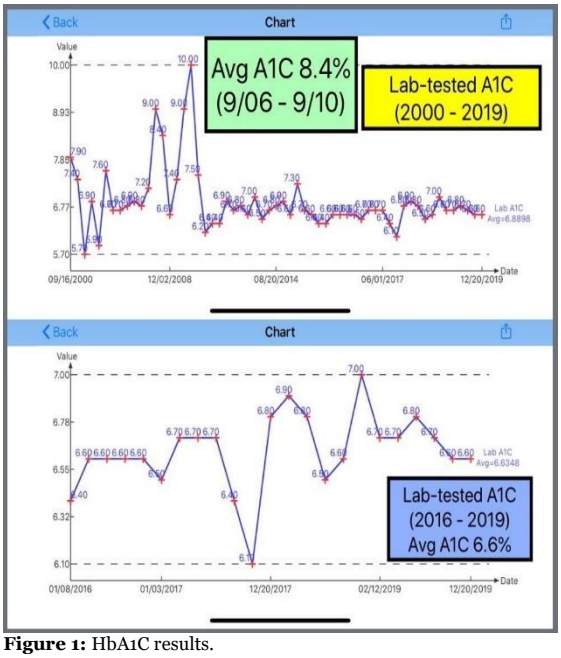

Figure 1: HbA1C results.

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Thus far, he has kept ~2 million data on his medical conditions and lifestyle details. He has also developed sophisticated computer software by using big data analytics, artificial intelligence, physics concepts and principles, mathematics equations and formulas, as well as some engineering modeling techniques to analyze, process, manage his massive health data, and even predict future development of certain important biomedical variables, such as HbA1C.

To summarize prominent findings from the glucose data analysis based on his observations for the past 4 to 6 years, he has noticed two "opposite" phenomena. The first observation, his peak PPG value around 60 minutes after the first bite of his meal, occasionally reaches 200-300 mg/dL when he does not follow his stringent diet and exercise guidelines. This explicitly shows the true status and severity of his existing T2D conditions in terms of insulin resistance or lack of insulin production supply. The second observation, from checking his massive data since 2014, his natural health state of pancreatic beta cells seems to be on a "slow" self-recovery path, even though its recovery rate might be on a small scale.

3. OTHER RESEARCH

Recently, he read an article online, "Diabetes: Can we teach the body to heal itself?" on Medical News Today, which was published on January 8, 2019.

Here is an excerpt:

"A new study by researchers from the University of Bergen in Norway, Maria Cohut, Ph.D. and Luiza Ghoul, suggests that, with just a small "push," we may be able to train the body to start producing adequate levels of insulin once more, on its own. The researchers were able, for the first time, to uncover some of the key mechanisms that allow cells to "switch" identity, looking specifically at pancreatic alpha- and beta-cells in a mouse model. They found that alpha-cells respond to complex signals they receive from neighboring cells in the context of beta-cell loss. Approximately 2 percent of alpha-cells can thus "reprogram" themselves and start producing insulin. By using a compound able to influence cell signaling in the pancreas, the researchers could boost the number of insulin-making cells by 5 percent.

The author's research methodology is a "math-physical medicine" approach, rather than a "biochemical medicine" approach as used in the article above. Furthermore, he uses his own body, instead of a "mouse model" cited in Norway's lab test.

4. METHODOLOGY

Math-physical medicine approach has three key steps of research methodology. The first step starts with observing the physical phenomena of some prominent biomedical characteristics from collected data. All of the biological and chemical work including their actions and chain reactions in the human body and organs would show or expose some sort of physical phenomena in terms of exterior appearances because both biology and chemistry are applied physics. In the second step, he then forms a hypothesis based on physics theories or concepts from these specific physical observations. In the third step, if possible, he utilizes existing mathematical equations (along with their given constraints) or derives his mathematical equations and constraints based on both original physics concepts and engineering models (engineering is applied physics and physics is applied mathematics), to verify or prove his hypothesis. Finally, once his hypothesis is proven using his collected data, he can apply these mathematical prediction equations to recreate future outcomes or reproduce the final results based on future input data. It should be noted that computer science techniques, such as artificial intelligence and big data analytics, only served as convenient and useful "tools" for his simulation model work and massive data processing.

5. THIS RESEARCH WORK

This project started in July 2019 and lasted through May 2020. During these 10 months, he has already written 10 medical papers (No. 103, 108, 112, 133, 138, 139, 241, 242, 243, 244) regarding the subject of beta cells [1-10]. In those referenced papers, he has described his suspicion and hypothesis regarding the probability of his pancreatic beta cells' "self-recovery". He will try to summarize his efforts on how he determined

the annualized self-recovery rate of his damaged pancreatic beta cells due to either insufficient insulin production and/or insulin resistance.

6. RESULTS

6.1 Baseline PPG: lower-bound

Applying the signal processing technique of wave theory from electronics and earth science, the author was able to successfully decompose his PPG waveform into 19 sub-waves of carbs/sugar intake (39%) and post-meal walking exercise (41%) plus other 17 secondary factors and "left-over" or remaining insulin's biological functionality (a total of ~20%). He developed a linear equation for a newly termed "Baseline PPG" which is further defined as follows:

Baseline PPG
= measured PPG + PPG adjustment

Where,

PPG adjustment
= (diet * B - walking/1000 * C)
B and C are different multipliers

We can observe from Figure 2 that both increased PPG amount by food intake and decreased PPG amount by walking steps are almost equal and cancel each other for both periods (6/1/2015-5/3/2020 and 1/1/2017-5/3/2020). However, the PPG moving average curves still have noticeable variances due to some of the remaining secondary factors, and mostly the "left-over" insulin functionalities of the pancreatic beta cells.

He then calculated these Baseline PPG values using the above equation and segregated the Baseline PPG data into annualized average Baseline PPG datasets for the 6 years between 2014 and 2019 (Figure 3). Finally, he computed the baseline PPG's change rate (%) for each year as well as the average change rates of these 6 years. For this lower-bound case of Baseline PPG, the annualized change rate is 1.5%.

6.2 Segment turning points PPG: medium

During the period of ~5 years (June 2015 through April 2020), there are 7 "turning-points" PPG values (i.e. peaks or bottoms of a wave). By connecting these turning points and then calculating the decline rate of each segment, he was able to get the overall average dropping rate (see Figure 4). If we include the first PPG peak of 141 mg/dL, the overall average declining rate is 3.8%; if we exclude the first peak, then the overall average declining rate is 2.3%. For this medium case of Segment Turning-point PPG, the annualized change rate is 2.3%. The author choose this conservative rate of 2.3% to remove the perturbation caused by the first peak data).

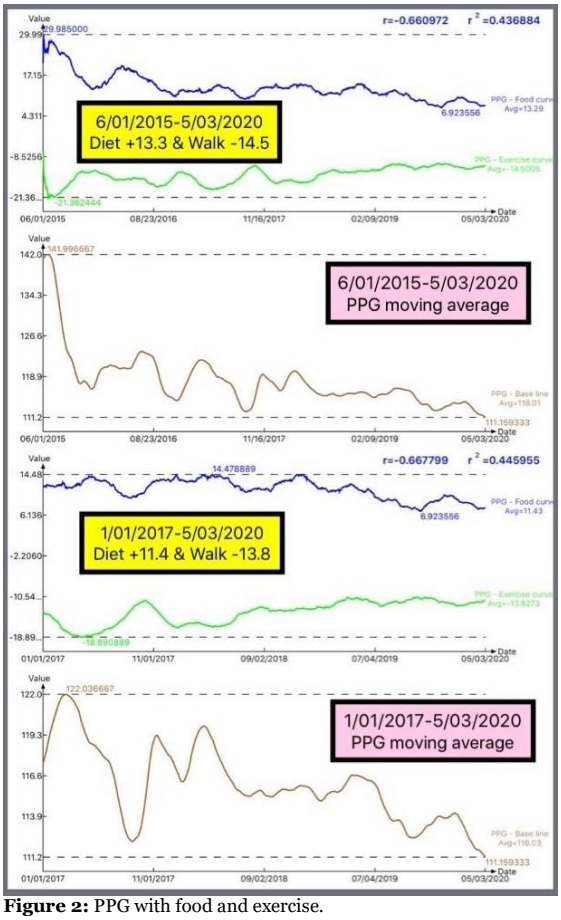
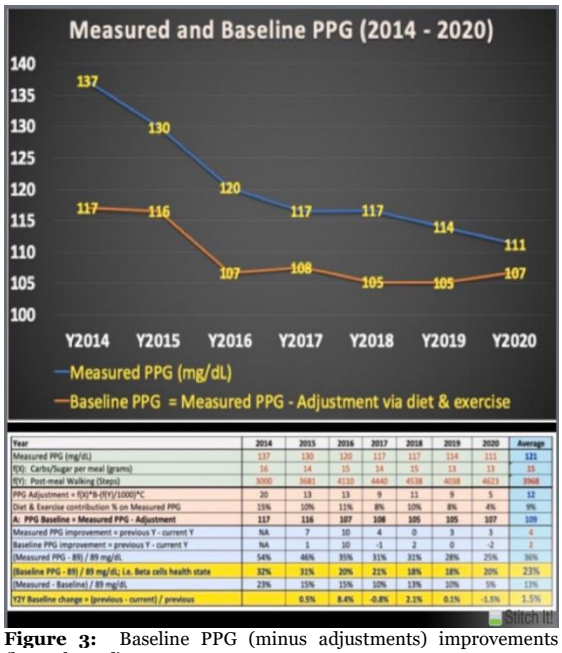


Figure 2: PPG with food and exercise.

6.3 Synthesized PPG via OHCA model: upper-bound

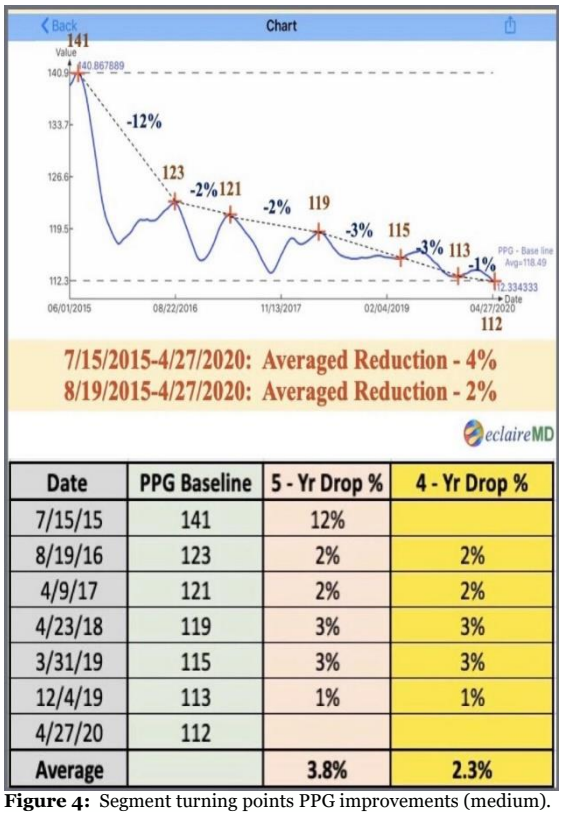
The author has applied his created OHCA (Open, High, Close, and Average) Model of the CGM Sensor PPG data from 5/5/2018 to 4/5/2020 to build a hypothetical synthesized sensor PPG model for the pre-CGM period of 1/1/2014 - 5/4/2018 (see Figure 5). Since the average sensor, PPG value is about 18% higher than the Finger PPG value, this is the reason he created the "synthesized PPG" value, which would serve as an upper bound of his research results. Following the same

calculation scheme, we get a higher bound of the PPG change rate result. This effect is due to the observation of a CGM sensor monitoring the entire 3-hour time span of a PPG wave, while Finger PPG measures around 2 hours after the first bite of food, usually catching a much lower PPG value. For this upper-bound case of Synthesized PPG via the OHCA Model, the annualized change rate is 3.5% (see Figure 6).



Year	2014	2015	2016	2017	2018	2019	2020	Average
Measured PPG (mg/dL)	137	130	120	117	117	114	111	121
f(X): Carbs/Sugar per meal (grams)	16	14	15	14	15	13	13	15
f(Y): Post-meal Walking (Steps)	3000	3681	4110	4440	4538	4038	4623	3904
PPG Adjustment = f(X)*B-(f(Y)/1000)*C	20	13	13	9	11	9	5	12
Diet & Exercise contribution % on Measured PPG	15%	10%	11%	8%	10%	8%	4%	9%
A: PPG Baseline = Measured PPG - Adjustment	117	116	107	108	105	105	107	109
Measured PPG improvement = previous Y - current Y	NA	7	10	4	0	3	3	4
Baseline PPG improvement = previous Y - current Y	NA	1	10	-1	2	0	-2	2
(Measured PPG - 89) / 89 mg/dL	54%	46%	35%	31%	31%	28%	25%	36%
(Baseline PPG - 89) / 89 mg/dL i.e. Beta cells health state	32%	31%	20%	21%	18%	18%	20%	23%
(Measured - Baseline) / 89 mg/dL	23%	15%	15%	10%	13%	10%	5%	13%
Y2Y Baseline change = (previous - current) / previous		0.5%	8.4%	-0.8%	2.1%	0.1%	-1.5%	1.5%

Figure 3: Baseline PPG (minus adjustments) improvements (lower-bound).



Date	PPG Baseline	5 - Yr Drop %	4 - Yr Drop %
7/15/15	141	12%	
8/19/16	123	2%	2%
4/9/17	121	2%	2%
4/23/18	119	3%	3%
3/31/19	115	3%	3%
12/4/19	113	1%	1%
4/27/20	112		
Average		3.8%	2.3%

Figure 4: Segment turning points PPG improvements (medium).

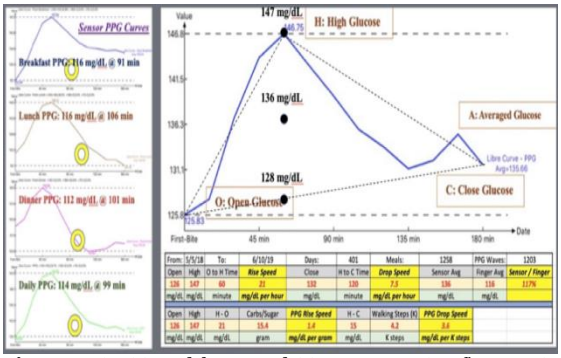
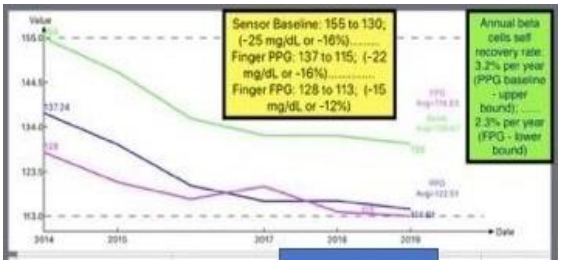


Figure 5: OHCA model to extend CGM sensor PPG to finger PPG.



	PPG	BaseL	FPG
Avg	122.51	138.67	118.83
2014	137.24	155	128
2015	129.88	147	121
2016	120.19	136	117
2017	116.53	132	120
2018	116.60	132	114
2019	114.61	130	113

Figure 6: Synthesized PPG improvements (upper-bound).

6.4 Combined average PPG

When we add the above three PPG models' change rates we then get the combined average PPG change rate of 2.3% per year.

6.5 FPG

By applying the signal processing technique similar to the PPG case, we can identify the most significant contributing factor of FPG is the body weight in the morning (> 90% of influence). The remaining 4 other secondary factors and "left-over" or "remaining" insulin functionalities contribute only ~10% or less. As shown in Figure 7, the correlation between the annualized body weight vs. annualized FPG is as high as 93%. The author notices that for the past 6 years, his weight dropped moderately from 177 lb. in 2014 down to 173 lb. (- 2.3%) in 2019.

However, his FPG decreased more noticeably from 128 mg/dL down to 113 mg/dL (- 11.7%). This observation is another indirect proof that his pancreatic beta cells have been self-repairing over the past 6 years. For this FPG case, the FPG change rate is 2.3% per year.

Currently, we can see that both his combined average PPG change rate and FPG change rate are at 2.3% per year (see Figure 8).

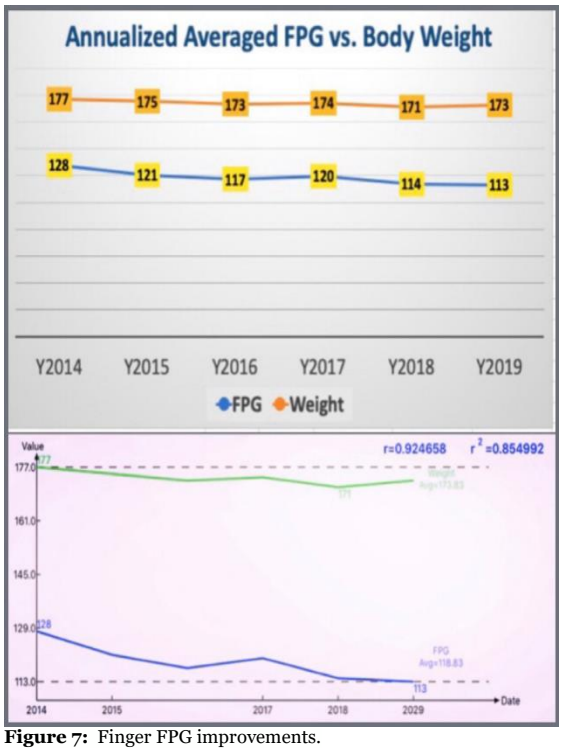


Figure 7: Finger FPG improvements.

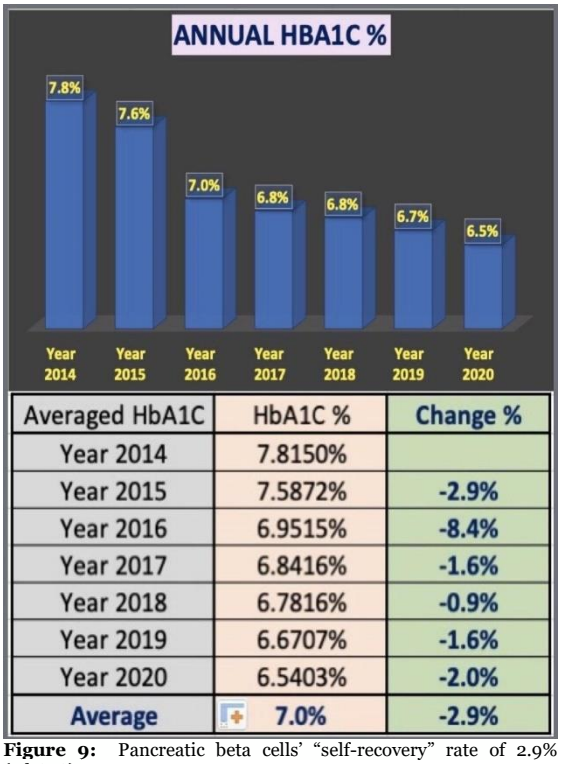
Entry Point of Analysis	Repaire Rate
PPG: Baseline (Measured - Adjustments)	1.5%
PPG: Segment Peaks	2.3%
PPG: Synthesized via OHCA Sensor Model	3.2%
PPG: Average of above 3	2.3%
FPG: Correlated with Weight	2.3%

Pancreatic Beta Cells are "self-recovering" at a rate of 2.3% per year

Figure 8: Summary table of pancreatic beta cells' "self-recovery" rate of 2.3% (PPG & FPG).

6.6 HbA1C

He developed a mathematical model to predict his HbA1C level on daily basis. He utilized his past 4-month glucose data, including both FPG and PPG, and then assigned different weighting factors for each month's input data. Combining with some other assumptions and adjustments, this daily HbA1C model becomes a "nonlinear" mathematical model which he named the "N-2 model" inside of his computer software program. Due to this difficulty, it is not easy to decompose his HbA1C wave similar to his PPG wave using a signal processing technique. For this HbA1C case, the HbA1C change rate is 2.9% per year (see Figure 9), which is higher than 2.3% for both FPG and PPG cases.



Averaged HbA1C	HbA1C %	Change %
Year 2014	7.8150%	
Year 2015	7.5872%	-2.9%
Year 2016	6.9515%	-8.4%
Year 2017	6.8416%	-1.6%
Year 2018	6.7816%	-0.9%
Year 2019	6.6707%	-1.6%
Year 2020	6.5403%	-2.0%
Average	7.0%	-2.9%

Figure 9: Pancreatic beta cells' "self-recovery" rate of 2.9% (HbA1C).

7. CONCLUSION

The author has spent 10 months researching the self-recovery of his pancreatic beta cells via different entry points and various methods. He has written a total of 10 medical articles regarding this specific subject (see References). Finally, after summarizing all of his past findings at different research stages, he has confirmed that, via his continuous and stringent lifestyle management efforts, he has seen a self-recovery rate of 2.3% to 2.9% per year. This percentage range is actually quite close to the cited Norwegian Lab's mouse result of ~2% conversion rate from alpha cells into beta cells to produce insulin.

Although this is only a moderate improvement, it is still promising. If his self-

recovery rate is 2.3% to 2.9%, then for the past 6 to 7 years, his beta cells insulin functionalities have been repaired by 13% to 20%. This solid evidence of "glucose improvement" for nearly 7 years is a non-arguable fact. Most medical professionals stated that diabetes is an "irreversible" or "non-curable" disease. At least, the author has now proven that not only has he stopped the "deterioration" of his T2D conditions, but he may have "reversed" his damaged pancreatic beta cells. Hopefully, by sharing his lifestyle program, research methods, and positive results, other T2D patients can also be encouraged to achieve similar positive results in their battles against diabetes.

8. REFERENCES

Hsu, Gerald C., eclaireMD Foundation, USA

1) (103) Using GH-Method: math-physical medicine methodology and four clinical cases to study type 2 diabetes patients' liver and pancreas baseline conditions.

2) (108) Changes in the relative health state of pancreas beta cells over eleven years using GH-Method: math-physical medicine.

3) (112) Changes in the relative health state of pancreas beta cells over eleven years using GH-Method: math-physical medicine.

4) (133) Probable partial recovery of pancreatic beta cells insulin regeneration using annualized fasting plasma glucose (GH-Method: math-physical medicine).

5) (138) Probable partial self-recovery of pancreatic beta cells using calculations of annualized fasting plasma glucose (GH-Method: math-physical medicine).

6) (139) Guesstimate probable partial self-recovery of pancreatic beta cells using calculations of annualized glucose data using GH-Method: math-physical medicine.

7) (241) Using signal processing techniques to decompose PPG waveform and investigate the regeneration of pancreatic beta cells insulin production (GH-Method: math-physical medicine).

8) (242) Probable self-recovery of pancreatic beta cells insulin regeneration using annualized PPG, postprandial plasma glucose (GH-Method: math-physical medicine).

9) (243) Probable partial self-recovery of pancreatic beta cells using various glucose data (GH-Method: math-physical medicine).

10) (244) Using GH-Method: math-physical medicine approach and various glucose data to investigate the health state of a type 2 diabetes patient's pancreatic β- cells.

