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Using Four Clinical Cases to Examine the Accuracy of Predicted Postprandial Plasma Glucose Via AI Glucometer Tool (GH-Method: Math-Physical Medicine)

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Abstract

The author developed his GH-Method: math-physical medicine (MPM) by applying mathematics, physics, engineering modeling, and computer science (big data analytics and AI) to derive the mathematical metabolism model. In this study, he utilized his MPM approach to investigate four clinical cases to examine the accuracy of the predicted postprandial plasma glucose via artificial intelligence glucometer tool.

Keywords: *Type 2 diabetes, metabolism, metabolic conditions, lifestyle data, artificial intelligence, AI Glucometer tool, and math-physical medicine.*

Introduction

This paper describes the range of postprandial plasma glucose (PPG) prediction accuracy on four type 2 diabetes (T2D) patients using the same AI Glucometer tool developed by the first author. The GH-Method: Math-physical medicine (MPM) starts with the observation of the human body's physical phenomena (not biological or chemical characteristics), collecting elements of the disease related data (preferring big data), utilizing applicable engineering modeling techniques, developing appropriate mathematical equations (not just statistical analysis), and finally predicting the direction of the development and control mechanism of the disease.

Method

The first author spent his first two years (2011-2013) to build-up a large food database containing 6 million cleaned USDA food nutrition data and ~1.6 million re-organized franchise restaurants food menu nutritional database via different public sources. Furthermore, since 6/1/2015, he has kept all of his meal pictures with three, sometimes four (snacks and fruits) photos per day. Thus far, he has collected ~0.5 million personal meal nutritional data. In total, his food and meal database contains ~8 million data.

He then utilized physics concepts, engineering tools, and mathematics, including optical physics, wave theory, energy theory, and signal processing technique specifically to link meal photos with food nutrition ingredients in order to calculate PPG. By using this math-physical medicine approach, he could bypass the "traditional" route of studying botanic molecular structure and chemical interactions among molecules in order to focus on the physical phenomena observation and mathematical equations derivation. Based on this discovery and different approach, he finally developed a diabetes patient-oriented AI Glucometer product via computer software programming to contain as much information and conclusions from his 9-years diabetes research work. Of course, the author has also added the machine-learning, self-judging, and auto-correction capabilities into his AI software. T2D patients can use this tool on their smart phones or computers to control their disease conditions in their daily life (see Figure 1).

Fig 1. *AI Glucometer*

In this analysis, the "carbohydrate and sugar intake amount" is the primary influential factor, albeit a difficult factor as well, while post-meal exercise amount is also required to be entered by patients. Other variables such as sleep, stress, water drinking, etc. are kept as secondary factors within each case.

It should be noted that, except Case A from the first author, all other three cases have occasional miss-matched data situations, e.g. have finger measured value but missing meal photo or vice versa. Case C has the highest missing data rate of ~40 %. The author further developed a self-checking and correction algorithm to calculate accuracy for both situations: a total set with all of mis-matched data and without those mis-matched data.

Results and Discussion

The following are four clinical cases with different data collection periods, averaged Finger measured PPG, AI predicted PPG, and AI prediction accuracies (Table 1 & Figures 2, 3, 4). They are accuracy results of both daily data and 90-days moving averaged data without mis-matched data only.

(1) Case A: Male, age 72. 1,481 days (6/1/2015 - 6/20/2019) with 4,443 meals. Averaged Finger PPG is 118.05 mg/dL. Daily AI prediction accuracy is 99.6%, and 90-days moving average AI prediction accuracy is 99.7%.

(2) Case B: Female, age 71. 170 days (1/7/2019 - 6/20/2019) with 510 meals. Average Finger PPG is 113.34 mg/dL. Daily AI prediction accuracy is 98.4%, and 90-days moving average AI prediction accuracy is 95.5%.

(3) Case C: Male, age 75. 426 days (4/21/2018 - 6/13/2019) with 1,278 meals. Average Finger PPG is 157.54 mg/dL. Daily AI prediction accuracy is 89.3%, and 90-days moving average AI prediction accuracy is 91.1%.

(4) Case D: Female, age 46. 281 days (9/13/2018 - 6/14/2019) with 843 meals. Average Finger PPG is 133.18 mg/dL. Daily AI prediction accuracy is 98.5%, and 90-days moving average AI prediction accuracy is 98.4%.

It should be noted that the amazing diabetes control accomplishment of Case D has been under care and closed monitoring by using the AI Glucometer by both second author and third author.

Table 1. *Summary of Cases A, B, C, and D (without missing data)*

Cut-off Missing Data			T2D						Daily	Daily	Daily	90-days	90-days	90-days
Case	Age	Gender	years	Nation	From	To	Days	Meals	PPG (AI)	PPG (Finger)	Accuracy (%)	PPG (AI)	PPG (Finger)	Accuracy (%)
A	72	Male	25	A	6/1/15	6/20/19	1481	4443	118.55	118.05	99.6%	119.35	118.94	99.7%
B	71	Female	22	A	1/2/19	6/20/19	170	510	111.50	113.34	98.4%	106.93	111.95	95.5%
C	75	Male	20	T	4/21/18	6/20/19	426	1278	174.46	157.54	89.3%	169.3	155.53	91.1%
D	46	Female	10	M	9/13/18	6/20/19	281	843	133.10	131.18	98.5%	130.06	132.15	98.4%

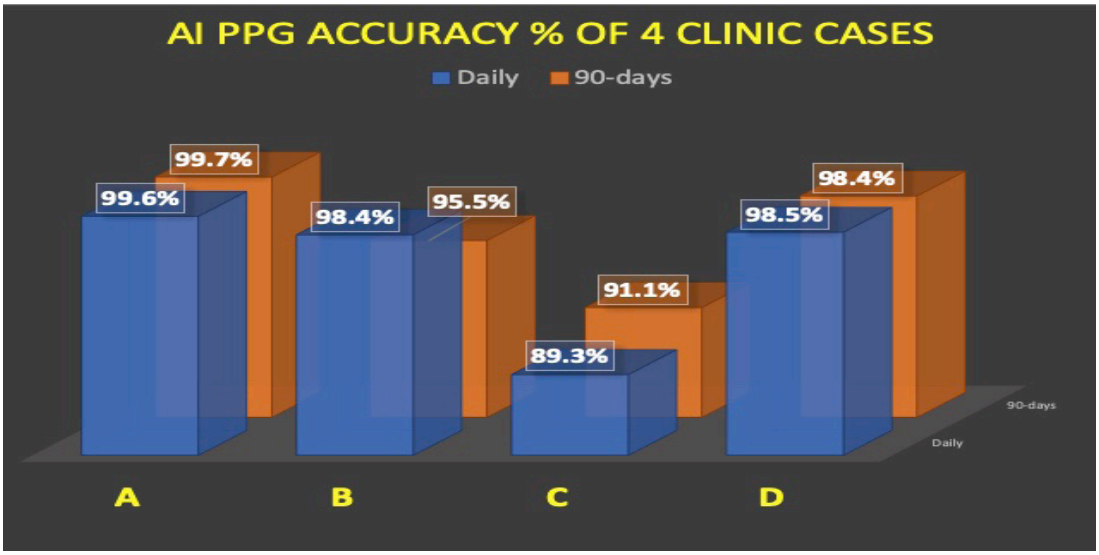

Fig 2. *Comparison for 4 clinical cases*

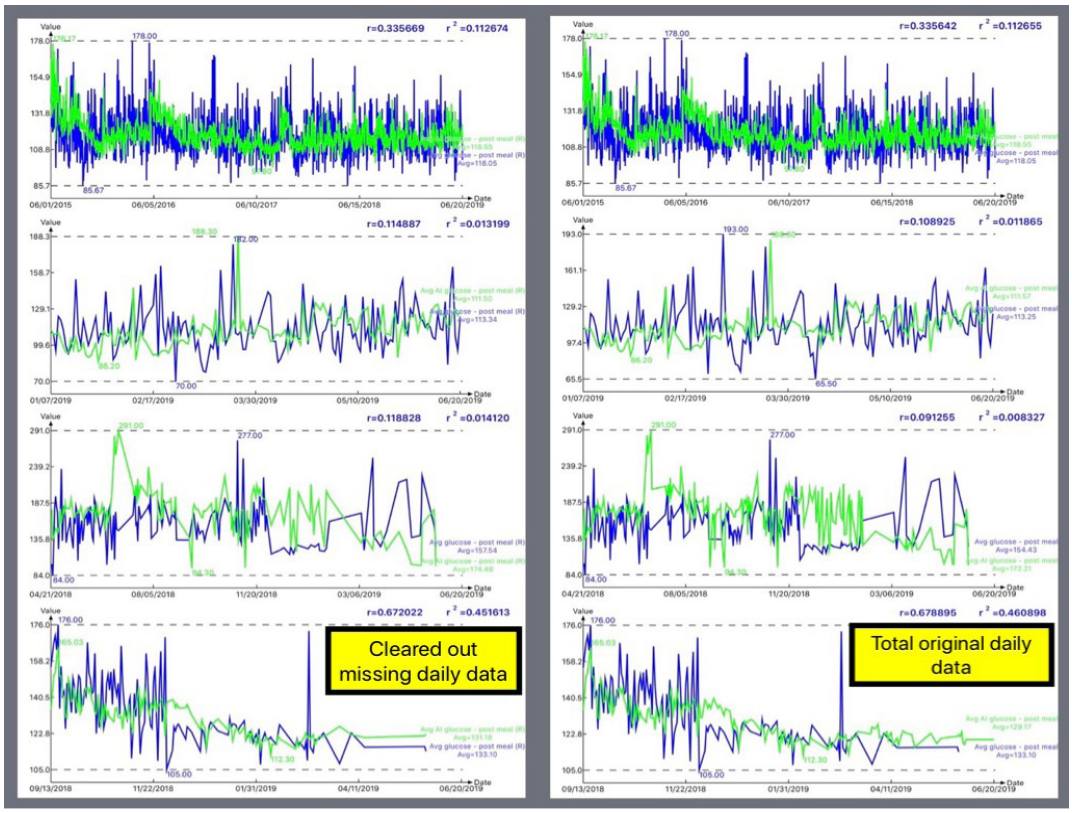

Fig 3. *Both total original data and cleared out missing data of daily PPG for 4 cases*

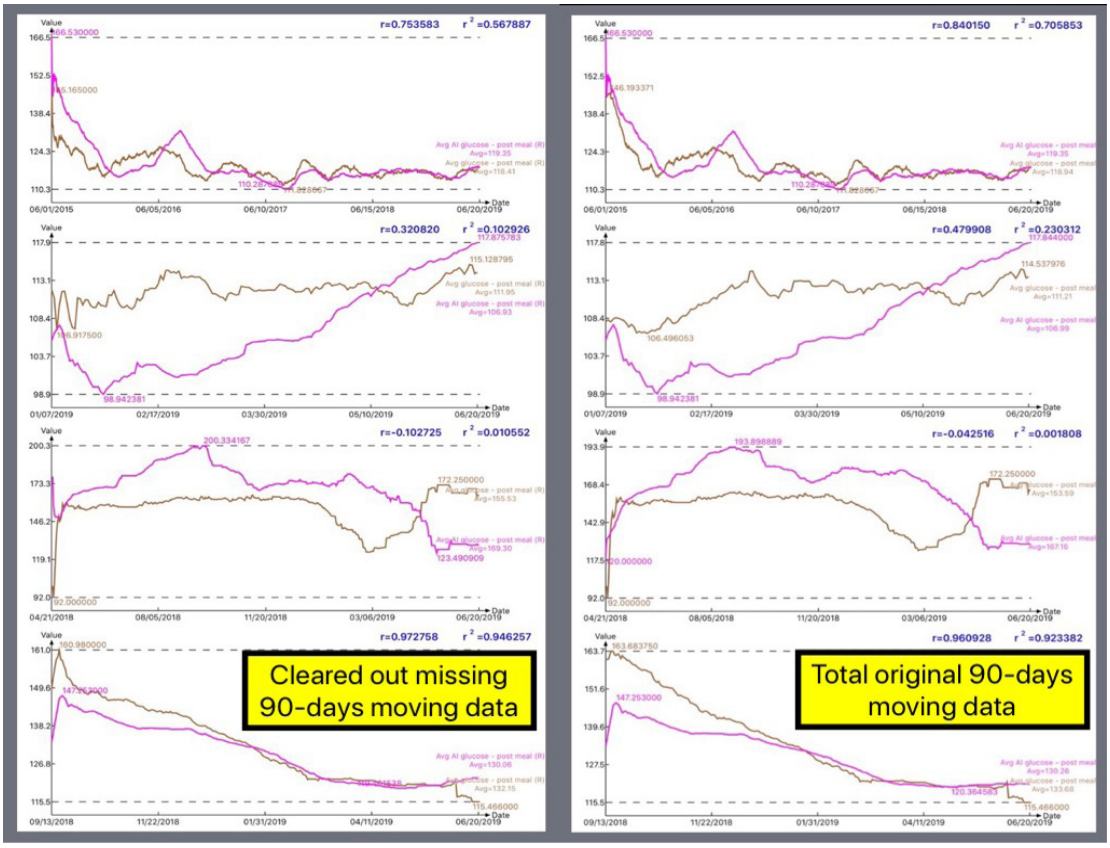

Fig 4. *Both total original data and cleared out missing data of 90-days moving average PPG for 4 cases*

Conclusion

This AI-based PPG prediction technology are used by four different T2D patients, who live in three different nations with varying diet selections. Nevertheless, it still demonstrates its high PPG AI prediction accuracies, ranging from 89.3% to 99.7%. Therefore, the authors have a high degree of confidence that this AI-based Glucometer can be used by a large pool of T2D patients to control their diabetes conditions effectively.

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