GH-Method: Math-Physical Medicine
Special Issue

Comparison Study of PPG Characteristics from Candlestick Model Using GH-Method: Math-Physical Medicine (No. 261)

Hsu GC*

eclaireMD Foundation, USA

***Correspondence:** Gerald C Hsu, eclaireMD Foundation, USA

Received on 21 October 2020; Accepted on 04 January 2021; Published on 20 January 2021

Keywords: glucose, insulin, medicine, sugar

Abbreviations: CGM: continuous glucose monitoring; PPG: postprandial plasma glucose; MPM: math-physical medicine

Introduction

This paper describes the author's investigation results of his glucose behaviors based on a continuous glucose monitoring (CGM) sensor collecting postprandial plasma glucose (PPG) data from breakfast, lunch, and dinner, using candlestick charting techniques from Wall Street and his developed GH-method: math-physical medicine (MPM) approach.

Methods

A Japanese merchant, who traded in the rice market in Osaka, Japan, started the candlestick charting around 1850. An American fellow, Steve Nison brought the candlestick model concept and method to the western world in 1991. These techniques are largely used in today's stock market to predict the stock price trend.

On 4/17/2018, the author had an idea to study glucose behavior by using the candlestick chart (aka K-Line) and subsequently developed customized software to analyze his big data of glucose. The analogies between fluctuations of stock price and glucose value are described as follows:

- Stock prices are closely related to the psychology of the buyers and sellers, which is similar to the glucose related to a patient body's biochemical interactions and behavior psychology.
- Stock price wave of a public traded company is dependent upon its product line, internal management, marketing efforts, and public events and perception. This is remarkably similar to the PPG wave of a diabetes patient being dependent on his/her complex food and diet (buying stock), exercise pattern and amount (selling stock), weather temperature (buying stock), and pancreatic beta-cell insulin function (SEC regulations). From a trained mathematician's eyes, both waves are just two similar mathematical representations.
- When there are more buyers than sellers, the price goes up, which is similar to the glucose value rising when carbs/sugar intake increases (more buyers) or lack of exercise (less sellers).
- When there are more sellers than buyers, the price goes down, which is similar to the glucose value decreasing when carbs/sugar intake decreases (less buyers), or exercise increases (more sellers).

During his period of using CGM sensor to collect his glucose data (5/5/2018–5/19/2020), he has compiled a total of 56,730 data *via* a CGM sensor placed on his upper left arm with an average of 76.25 measurements per day approximately every 15 min. His standard PPG wave covers a period of 180 min or 3 h from the first bite of his meal. Each PPG waveform contains the following five key characteristic data:

1) Open value as his PPG at first-bite, 0 min
2) Close value as PPG at 180 min
3) Minimum value as the lowest PPG
4) Maximum value as the highest PPG
5) Average glucose - average value of 12 recorded PPG data per meal over 3 h

Based on his 2,232 meal candlestick bars, glucose patterns, and moving trends can be observed and analyzed through further mathematical and statistical operations. Finally, he interpreted these operational results with his acquired knowledge of biomedical phenomena of his body to discover some hidden medical truth or potential health dangers *via* TIR analysis.

Since the stock market is much more lucrative than the medical research field, it attracts more talented mathematicians and engineers to work in the highly rewarded financial industry. They even call themselves finance engineers. On the contrary, most financial rewards in the medical community are distributed to pharmaceutical companies, healthcare institutions, and clinical medical doctors. From the author's personal observation, a large number of medical research scientists are self-motivated through their interests and dedication and are mostly associated with either universities or research institutions. They are rarely rewarded financially.

The author is a professionally trained mathematician, physicist, engineer, computer scientist, and a successful entrepreneur. He accidentally wandered into the medical research field due to his strong motivation of saving his own life after suffering many diabetes complications, such as 5 cardiovascular episodes, chronic kidney disease (CKD) complications, and faced the possibility of death. As a result, he thought about how to import his learned physics principles and mathematical analysis methods from his academic educations and professional experiences, as well as his accumulated knowledge regarding stock price and other financial analyses techniques, such as the candlestick model, from his position as the CEO of a public traded corporation and apply them to his medical research activities. This allowed him to learn and gain from financial world intellectuals' knowledge and professional experiences.

Results

The figure (Figure 1) shows the normal time-series analysis results of the finger-piercing tested PPG, CGM sensor collected PPG, meal's carbs/sugar intake amount in grams, and post-meal walking steps for the period from 5/5/2018–5/19/2020.

The figure (Figure 2) depicts 3 candlestick models for breakfast, lunch, and dinner, respectively during the same period. It is rather difficult to identify useful and significant characteristics from these candlestick charts directly without further pattern analysis. This situation is similar to analyzing a publicly listed company's stock performance *via* its candlestick charts without a detailed analysis of its product lines, internal management, marketing programs, and market perception.

We can extract more PPG associated values from the candlestick charts of 3 meals regarding 5 key values of opening, maximum, minimum, closing, and average; then, put them into one consolidated table as shown in the figure (Figure 3). The figure also includes a "blow-up view" of different types of candlestick bars (Figure 3).

It is obvious that the lunch data is higher than both the breakfast and dinner data. In this table, his carbs/sugar intake amount and post-meal walking steps are also listed. The average PPG values from both finger and sensor are only listed here for a reference purpose. It is important to mention that the author normally eats a simple breakfast with high-quality protein and small amount of carbohydrates (average PPG 135 mg/dL and maximum PPG 160 mg/dL)

and a very light dinner due to weight control purposes (average PPG 129 mg/dL and maximum PPG 153 mg/dL). Both post-breakfast and post-dinner walking amounts are within the range of 4,400–4,500 steps. His heaviest meal is his lunch which contains a higher carbs/sugar intake amount from a plant-based diet (17 g for lunch in comparison with 12 g for breakfast and 16 g for dinner) and the lowest post-lunch exercise level (4,150 walking steps) due to hot weather temperature around noon time. These are the reasons for his high lunch results with the highest average PPG (139 mg/dL) and the highest maximum PPG (166 mg/dL). The data in this section also describe the tight relationship between lifestyle and metabolism.

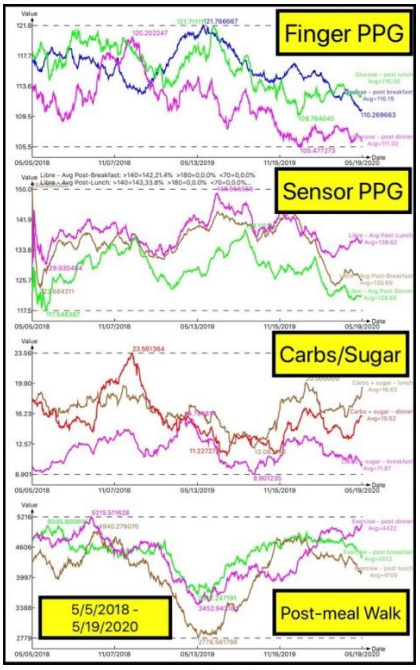

Figure 1: PPG (finger and sensor), carbs/sugar, and post-meal walking.

Candlestick	Breakfast	Lunch	Dinner
Max	160	166	153
Close	133	131	126
Average	135	139	129
Open	122	134	129
Min	115	115	108

Candlestick	Breakfast	Lunch	Dinner
Carbs/Sugar (g)	12	17	16
Walking (steps)	4512	4105	4422
Finger avg PPG	116	116	111
Sensoe avg PPG	136	139	129

Figure 2: Candlestick chart of 3 meals.

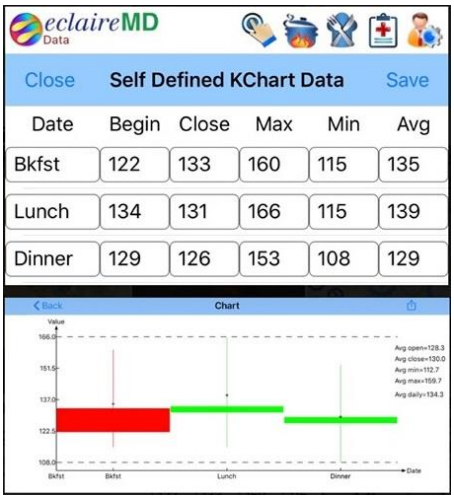

Figure 3: Data table of 5 key PPG characters, carbs/sugar, walking, and a blowup view of candlestick.

The figure (Figure 4) shows candlestick bars for breakfast, lunch, dinner respectively, using each meal's 5 key values.

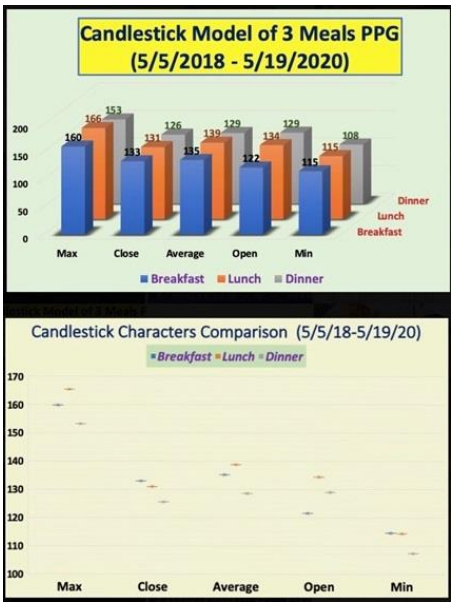

Figure 4: Candlestick bars of breakfast, lunch, and dinner.

The figure (Figure 5) uses graphic presentations of both bar chart and point chart to clearly demonstrate the same data as shown in figure 3.

Similar to the study of a publicly traded company's stock performance *via* its stock candlestick charts, we must study and understand why its stock price is trending upward, in what speed, and how high it reaches to; why is the stock price trending downward, in what speed, and how low it reaches to; and what is the average price for that trading day. When we connect their daily candlesticks together into a complete waveform, we can then investigate the wave's past performance and future trend to predict the wave moving direction and its future performance. We can also analyze the reasons of sudden significant changes of glucose candlesticks similar to COVID-19 did on Wall Street trading candlesticks.

We can apply the same concept and a similar method to analyze the glucose waveforms since, in nature, both waves of the stock price and blood sugar are two similar waves with the identical mathematical form. Based on this fundamental understanding, the author further calculated 10 more different values which are derived from these 5 key

candlestick characters, *i.e.*, open, max, average, min, and close. These 10 different values are listed in the table and shown by the line chart in the given figure (Figure 6). Due to the complexity of each key character difference and their secondary significance, he will not put these detailed findings and their meanings in this article.

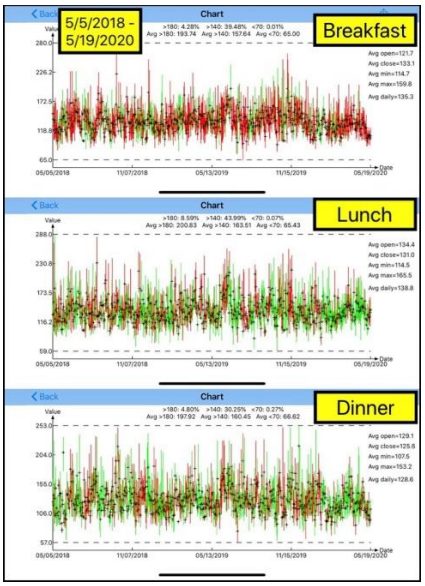

Figure 5: Bar and point charts of 5 key PPG waveforms.

Candlestick	Breakfast	Lunch	Dinner
Max	160	166	153
Close	133	131	126
Average	135	139	129
Open	122	134	129
Min	115	115	108

Candlestick	Breakfast	Lunch	Dinner
Max - Min	45	51	46
Max - Open	38	31	24
Max - Close	27	35	28
Max - Avg	25	27	25
Avg - Open	14	4	-1
Avg - Close	2	8	3
Avg - Min	21	24	21
Close - Open	11	-3	-4
Close - Min	18	17	18
Open- Min	7	20	22

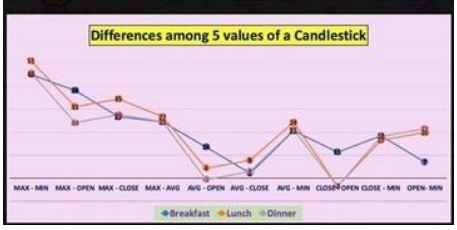

Figure 6: 10 differences among 5 key characters of 3 meal PPG.

Through the figure (Figure 7), one correlation behavior of the meal overall patterns from their 10 different characteristics (Figure 5) can be observed. The breakfast is similar but has differences from lunch (R = 84%) and from dinner (R = 79%), where R is the correlation coefficient. However, lunch and dinner are highly correlated with each other (R = 98%). This phenomenon is similar to the stock price situation of three hypothetical publicly listed

companies with different names of breakfast, lunch, and dinner. Two company performances, lunch, and dinner are quite similar companies with similar product lines and belong to the same market. The lunch values are higher than dinner values probably due to some differences that existed in their product quality (such as carbs/sugar amount). However, the breakfast pattern is quite different from both lunch and dinner which is similar to a third company with a vastly diverse product line to serve a different market. Indeed, the author's breakfast nutritional ingredients are vastly different from his lunches and dinners.

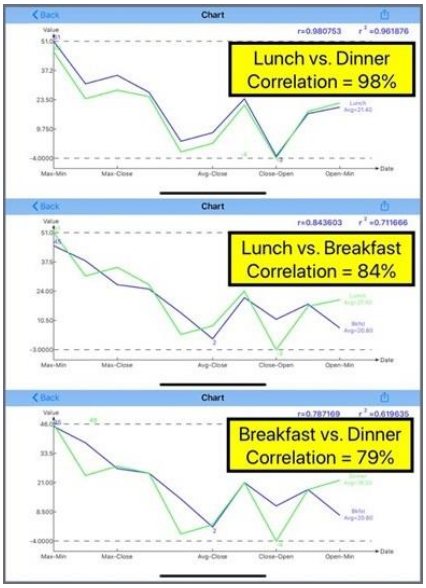

Figure 7: Correlation study among 3 meal character differences.

Finally, the figure (Figure 8), illustrates his TIR analysis demonstration based on the American Diabetes Association's new guideline regarding TAR (> 180 mg/dL), TIR (70–180 mg/dL), and TAR (< 70 mg/dL). His TIR percentages are in the range of 91–96% which means his type 2 diabetes (T2D) conditions control has been highly effective during this reporting period. His TAR percentages are in the low range of 4.3–8.6% (lunch) which means his chances of having hyperglycemia damage is quite low. His TBR percentages are in the smallest range of 0.01–0.27% which means his chance of having insulin shock is near zero. It should be emphasized that the author has ceased taking any diabetes medication since 12/8/2015. Therefore, all the above discovered biomedical phenomena are under medicine-free conditions. The figure (Figure 7) has graphically summarized his overall diabetes safety analysis.

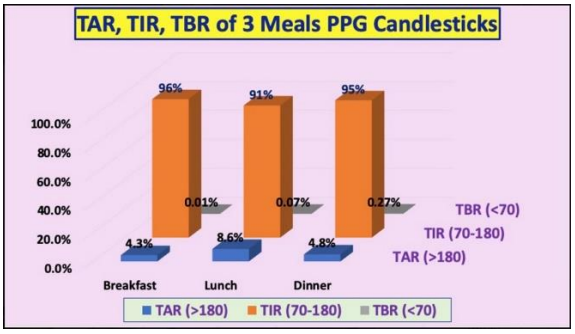

Figure 8: TAR, TIR, TBR safety study of candlesticks of 3 meals.

Conclusion

This paper has further demonstrated the power of using both the Wall Street candlestick model and GH-method: MPM approach to observe and analyze the PPG phenomena. The methodology of observation for the physical phenomena,

derivation of mathematical equations, utilization of various computational tools, and finally combined with the discovery of biomedical interpretations have been proven repeatedly in the author's previous 260 medical papers.

References

1. Hsu GC. Using candlestick charting techniques to investigate glucose behaviors (GH-Method: Math-Physical Medicine). J Biotechnol Immunol. 2020;2(3):1-3.

2. Hsu GC. The influences of medication on diabetes control using TIR analysis (GH-Method: Math-Physical Medicine). eclaireMD Foundation. 2020:238.