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Katalyst Publishing Group

Research Article

Journal of Current Trends in Physics Research and Applications

The Influences of Medication on Diabetes Control Using TIR Analysis GH-Method: Math-Physical Medicine)

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Received Date: 25 May, 2020
Accepted Date: 30 May, 2020
Published Date: 06 June, 2020

Citation: Gerald C. Hsu (2020) The Influences of Medication on Diabetes Control Using TIR Analysis GH-Method: Math-Physical Medicine). J Cur Tre Phy Res App 1(1): 101

Introduction

The author applied the American Diabetes Association (ADA) 2020 Guidelines for TIR% to analyze the medication contribution on his diabetes control situation.

Method

A continuous glucose monitor (CGM) device has been placed on his left upper arm to collect 51,697 glucose data over 684 days (5/5/2018 - 3/20/2020) at a rate of 75.58 glucoses per day. During the same period, his HbA1C has been tested seven times on a quarterly basis.

Recently, the ADA published revised guidelines regarding CGM collected data [1,2] and included three new measurement terms: (1) TIR: time-in-range 70-180 mg/dL for "acceptable" diabetes glucose range; (2) TAR: time-above-range >180 mg/dL for severe diabetes concerns; and (3) TBR: time-below-range <70 mg/dL for insulin shock warning. After the ADA's announcement, several research papers have been written regarding this subject [3-5]. Some minor data differences existed in papers 3 and 4; however, those research papers are based on collected CGM data belonging to diabetes patients. Lacking clear evidence, the author would like to make a logical assumption that "most" of those tested data were collected from patients who were using medications.

Results

Figure 1 shows both percentages and average glucose values of TIR, TAR, TBR, and HbA1C during seven quarters for a period of 684 days. TIR is the most important parameter with an average value of 95%. It should be noted that his TAR is 5% only and his TBR is ~0%, i.e. no threat from insulin shock (Figure 2). His average glucose value for TIR is 127 mg/dL (Figure 3), while his daily average CGM sensor glucose is 135 mg/dL. His average HbA1C over these seven quarters is 6.7% without taking any diabetes medication (Figure 4).

The conclusive diagram is Figure 5 that shows the relationship between his TIR and his HbA1C. For the past two years (5/5/2018 - 3/20/2020), his diabetes conditions have been under control via a rigorous lifestyle management program without taking any diabetes medication. Therefore, both of his TIR and HbA1C curves are moderately smooth, i.e. without significant ups (glucose spikes) or downs (glucose valleys).

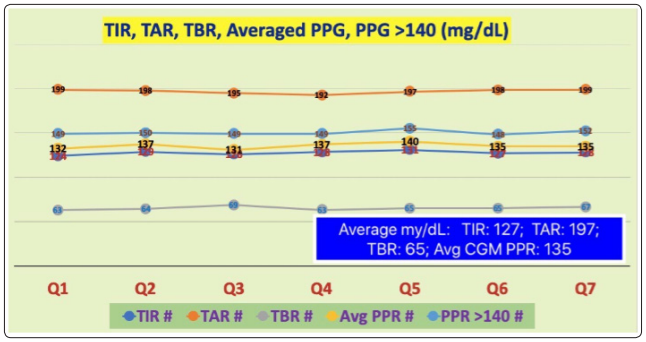

Figure 1: Measurement data

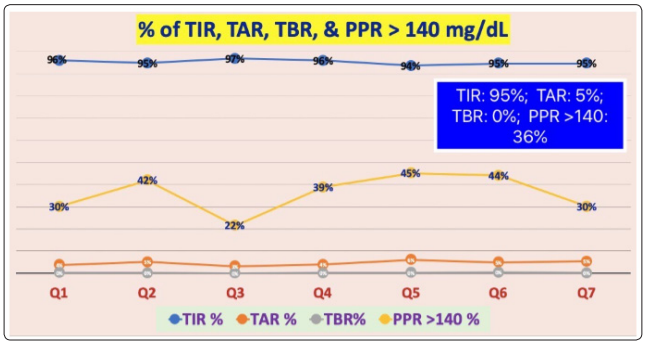

Figure 2: % of TIR, TAR, and TBR

%	May18 - Aug18	Aug18 - Nov19	Nov18 -Feb19	Feb19-May19	May19 - Aug19	Aug19 - Nov19	Nov19 - Feb20	May18 - Feb20
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Average
TIR %	96%	95%	97%	96%	94%	95%	95%	95%
TAR %	4%	5%	3%	4%	6%	5%	5%	5%
TBR%	0%	0%	0%	0%	0%	0%	0%	0%
PPR >140 %	30%	42%	22%	39%	45%	44%	30%	36%
# (mg/dL)	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Average
TIR #	124	129	126	128	131	127	128	127
TAR #	199	198	195	192	197	198	199	197
TBR #	63	64	69	63	65	65	67	65
Avg PPR #	132	137	131	137	140	135	135	135
PPR >140 #	149	150	149	149	155	148	152	150
HbA1C %	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Average
CGM's TIR %	96%	95%	97%	96%	94%	95%	95%	95%
TIR: Should be %	70%	72%	64%	68%	70%	72%	72%	70%
TIR: Medicine Factor %	26%	23%	33%	28%	24%	23%	23%	26%
HbA1C %	6.7%	6.6%	7.0%	6.8%	6.7%	6.6%	6.6%	6.7%

Figure 3: Values of TIR, TAR, and TBR

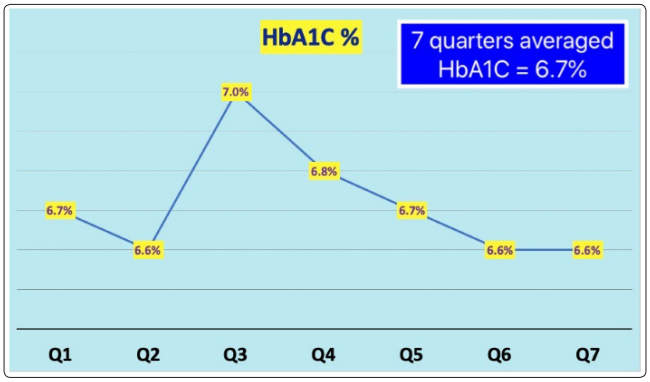

Figure 4: HbA1C curve

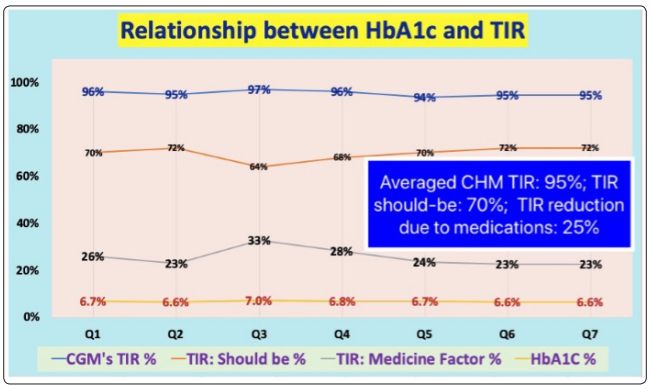

Figure 5: Relationship between HbA1C and TIR

Figure 6 reflects the corresponding values between TIR% and HbA1C% based on the research results cited in references 3 and 4. Since the author's HbA1C values are within the range of 6.6% to 7.0% with an average HbA1C of 6.7%, his TIR% range should be located between 64% to 72% with an average value of 70%. However, his CGM measured and then calculated TIR% based on ADA guidelines are located within the range of 94% to 97 % with an average value of 95%.

The crucial question is how to explain the TIR% difference of 25% existing between 70% from the ADA guidance table (Figure 6) and his measured and then calculated 95% from his CGM sensor data?

Time-in-range	*HbA1c (%)*
0%	12.1
10%	11.4
20%	10.6
30%	9.8
40%	9.0
50%	8.3
60%	7.5
70%	6.7
80%	5.9
90%	5.1
100%	4.3

Figure 6: Corresponding values of TIR% and HbA1C (ADA table)

Assuming that the ADA table's recommended TIR% is "most likely" based on patients who are on medications, the author's measured TIR% are his CGM glucose data without any medication contribution or influence. Therefore, we can safely draw a "probable" conclusion that the author's high TIR of 95% has an amount of 25% directly affected by medication. In other words, if the author takes medications for his diabetes, his TIR% would "most likely" be maintained at ~70% as indicated in the ADA table of guidelines which is corresponding to the average HbA1C of 6.7%.

Hypothetically, if the author takes medication as most of other diabetes patients, but continuing his same stringent lifestyle management, his HBA1C may further be lower to 5.8% based on the ADA chart in Figure 6. In other words, for patients who solely depend on lifestyle changes, they have to work 25% harder in order to achieve the same level of HbA1C as a patient who takes medication.

Conclusions

This research paper demonstrates that the CGM glucose data provides an overall detailed comprehensive picture of a diabetes patient's glucose profile. After reviewing his own case, the author accidentally discovered how much the medication affects diabetes patient's HbA1C level by investigating deeper into the observed TIR% result.

References

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