LETTER TO THE EDITOR

Corrections of Equations on Glycemic Variability and Quality of Glycemic Control

Irina Gaynanova, PhD,¹ Jacek Urbanek, PhD,² and Naresh M. Punjabi, MD, PhD²

Dear Editor-in-Chief,

We write to draw attention to potential errors in formulas for calculating various metrics from continuous glycemic profiles that were published in the article by Rodbard¹. The determination of Low Blood and High Blood Glucose Indexes (LBGI and HBGI) was described as follows:

$$\text{the average of } 27.695 \cdot (\log_e(\text{Glucose}))^{1.084} - 5.381$$

where for LBGI glucose values less than 112.5 mg/dL are used and for HBGI glucose values greater than 112.5 mg/dL are used. The correct formulas should be:

$$f(\text{Glucose}_i) = \left\{ (\log_e(\text{Glucose}_i))^{1.084} - 5.381 \right\}$$

If $\text{Glucose}_i < 112.5 \text{ mg/dL}$,

$$r_l(\text{Glucose}_i) = 22.77 \cdot f(\text{Glucose}_i)^2$$

$$r_h(\text{Glucose}_i) = 0$$

If $\text{Glucose}_i \geq 112.5 \text{ mg/dL}$,

$$r_l(\text{Glucose}_i) = 0$$

$$r_h(\text{Glucose}_i) = 22.77 \cdot f(\text{Glucose}_i)^2$$

$$\text{LBGI} = \sum r_l(\text{Glucose}_i) / n$$

$$\text{HBGI} = \sum r_h(\text{Glucose}_i) / n$$

The values $f(\text{Glucose}_i)$ are calculated for all (n) glucose values, then truncated at zero (either $\text{MIN}(f, 0)$ or $\text{MAX}(f, 0)$ depending on the Index), then squared and multiplied by 22.77 before the average is determined.

The average is calculated for all glucose values (with some of them treated as zeroes due to truncation) rather than just for the values within the hypo- or hyperglycemic ranges.²⁻⁴

MODD and MODD_d should be calculated as the mean of absolute rather than raw differences.

The formula for GRADE provided in Rodbard¹ is:

MEAN, for $i = 1$ to n , of

$$\left\{ \text{MIN} \left[50, 42.5 \cdot \left\{ \log_{10}(\log_{10}(\text{Glucose}_i/18) + 0.16)^2 \right\} \right] \right\}$$

This formula has an incorrect constant and incorrect positioning of the brackets. The correct equation should be:⁵

GRADE = MEAN, for $i = 1$ to n , of

$$\left\{ \text{MIN} \left[50, 425 \cdot \left\{ \log_{10} [\log_{10} (\text{Glucose}_i/18)] + 0.16 \right\}^2 \right] \right\}$$

The discrepancies in the presented formulas lead to dramatic differences in resulting values, potentially creating confusion in interpretation of the derived metrics.

References

1. Rodbard D: Interpretation of continuous glucose monitoring data: glycemic variability and quality of glycemic control. *Diabetes Technol Ther* 2009;11(Suppl 1):S-55-S-67.
2. Service FJ: Glucose variability. *Diabetes* 2013;62:1398-1404.
3. Clarke W, Kovatchev B: Statistical tools to analyze continuous glucose monitor data. *Diabetes Technol Ther* 2009; 11(Suppl 1), S-45-S-54.
4. Kovatchev B, Cobelli C: Glucose variability: timing, risk analysis, and relationship to hypoglycemia in diabetes. *Diabetes Care* 2016;39:502-510.
5. Hill NR, Hindmarsh PC, Stevens RJ, Stratton IM, Levy JC, Matthews DR: A method for assessing quality of control from glucose profiles. *Diabet Med* 2007;24:753-758.

¹Texas A&M University

²Johns Hopkins University