POINT OF VIEW

Glycemia Risk Index—A Novel Glycemic Parameter: A Composite Metric to Better Quantify Glycemic Risk Beyond Time-in-range

Abhijit Anil Trailokya[1*], Suhas Erande[2]

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Abstract

The glycemia risk index (GRI) was developed in 2022. This novel metric is designed to provide a single, comprehensive value that encapsulates the overall quality of a patient's glycemic control. Unlike conventional indicators such as HbA1c or time-in-range (TIR), the glycemia risk index places greater emphasis on severe glycemic fluctuations and more closely reflects clinicians' understanding of glycemic risk. It integrates hypoglycemia and hyperglycemia into a single numerical value, placing greater weight on hypoglycemia and extreme glycemic excursions. In this article, we highlight the clinical rationale behind GRI, its calculation, and its potential utility in diabetes management compared to traditional metrics such as TIR.

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Introduction

Continuous glucose monitoring (CGM) systems have emerged as vital technologies for evaluating glycemic control, offering round-the-clock measurement of glucose levels in the interstitial fluid beneath the skin.[1] According to the American Diabetes Association (ADA) guidelines, time-in-range (TIR) derived from continuous glucose monitoring (CGM) is a recognized parameter for evaluating glycemic control. While widely adopted by clinicians as a summary indicator of glycemic quality, TIR has limitations—particularly its insufficient sensitivity to hypoglycemic events—thereby making it suboptimal as a standalone metric.[2]

The Glycemia Risk Index

The glycemia risk index (GRI), introduced in 2022, is a novel composite metric designed to quantify the overall quality of glycemic control by integrating the frequency and severity of both hypo- and hyperglycemic excursions into a single, interpretable score.

Development of GRI

The GRI was developed by a team of over 330 international diabetes experts, including Dr David Klonoff, Dr Rich Bergenstal, Dr Anne Peters, Dr Roy Beck, Dr Jane Seley, Dr Boris Kovatchev, and many more.[3]

The glycemia risk index is an integrated scoring system designed to evaluate the overall quality of glycemic control by factoring in the potential risks associated with both hypoglycemia and hyperglycemia. Developed by a global panel of 330 diabetes experts using CGM data from 225 individuals receiving insulin therapy, the GRI addresses the need for a more holistic approach to glucose management. By consolidating various CGM-derived metrics, it aids clinicians in making informed treatment decisions. As a singular metric, the GRI places greater weight on clinically significant hypoglycemia and shows a strong alignment with TIR, making it a valuable tool for monitoring and adjusting glucose levels effectively.[4]

About Glycemia Risk Index

The glycemia risk index is a novel composite parameter that quantitatively captures the frequency and severity of both hypoglycemic and hyperglycemic events, enabling a comprehensive evaluation of glycemic control in individuals with type 1 or type 2 diabetes. It serves as a valuable tool for longitudinal patient monitoring, population-level diabetes management, and outcome prediction in interventional research.

The expert assessments were primarily influenced by two key components: the duration of hypoglycemia, referred to as the hypoglycemia component (CHypo), and the duration of hyperglycemia, referred to as the hyperglycemia component (CHyper). Greater weight was assigned to hypoglycemia relative to hyperglycemia, with additional emphasis placed on extreme deviations in glucose levels—both severely low and high. The GRI is computed as a weighted sum of these two components using predefined coefficients. This composite score showed a strong correlation (r = 0.95) with expert ratings of glycemic profiles in the original validation study. The GRI is expressed as a percentile (Pc) ranging from 0 to 100, where lower scores indicate better glycemic control, reflecting minimal time spent in hypo- and hyperglycemic ranges.[3]

Glycemia Risk Index Calculation

The glycemia risk index is derived from CGM data and provides a quantitative measure of the overall glycemic risk. It assigns greater weight to hypoglycemic episodes compared to hyperglycemic ones, with particular emphasis on extreme glucose values—specifically, levels below 54 mg/dL and above 250 mg/dL.

$$GRI = 3.0 \times [TBR < 54 + (0.8 \times TBR\ 54–70)] + 1.6 \times [TAR > 250 + (0.5 \times TAR\ 180–250)]$$

Glycemic Risk Estimation Tool

To calculate the GRI using CGM data, enter the percentage of time glucose readings are within the very low, low, high, and very high ranges into the respective input fields (Fig. 1).

The GRI can be calculated for individual patients or cohorts using the online GRI calculator, accessible at www.diabetestechnology.org/gri.

Quick interpretation of GRI

The glycemia risk index can be visualized using the GRI grid, a graphical tool that plots the hypoglycemia component on the X-axis and the hyperglycemia component on the Y-axis. The grid is segmented into five percentile-based zones, ranging from optimal glycemic control (Pc: 0–20) to poor control (Pc: 80–100). This visual representation facilitates rapid identification of predominant glycemic disturbances and aids healthcare professionals in targeting specific areas for therapeutic intervention. The GRI scale extends from 0, indicating minimal risk,

[1]Head Medical Affairs, Department of Medical Affairs, Indoco Remedies Limited, Mumbai; [2]Senior Diabetologist and Physician, Department of Medicine, Akshay Hospital, Pune, Maharashtra, India; *Corresponding Author

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% Very Low (<54 mg/dL; <3.0 mmol/L)
% Low (54–<70 mg/dL; 3.0–< 3.9 mmol/L)
% Very High (>250 mg/dL; > 13.9 mmol/L)
% High (>180–250 mg/dL;>10.0–13.9 mmol/L)
Hypoglycemia Component = Very Low + (0.8 x Low)
Hyperglycemia Component = Very High + (0.5 x High)

GRI = (3.0 x Hypo-Component) + (1.6 x Hyper-Component)
Equivalently,
GRI = (3.0 x Very Low) + (2.4 x Low) + (1.6 x Very High) + (0.8 x High)

GRI

Fig. 1: Glycemia risk index calculator

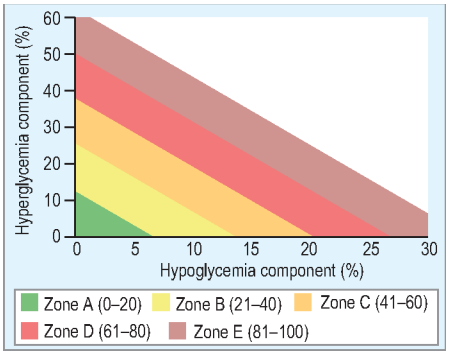

Fig. 2: Visual (graphical) depiction of the glycemia risk index (GRI) using a grid format

No	TIR	Vlow	Low	Vhigh	High	Results →	Hypo-component	Hyper-component	GRI	Zone
1	59%	2	10	5	24		10	17	57	C
2	85%	0	0	1	14		0	8	13	A
3	74%	0	0	1	24		0	13	21	B
4	91%	0	1	0	8		0.8	4	9	A
5	92%	0	8	0	0		6.4	0	19	A
6	80%	0	14	0	6		11.2	3	38	B

Fig. 3: Analysis using CGM and GRI (online tool) (https://www.diabetestechnology.org/gri/)

to values exceeding 100, reflecting severe glycemic risk, thereby enhancing clinical interpretation of glucose variability.

The GRI grid displays the hyperglycemia component along the vertical (Y) axis and the hypoglycemia component along the horizontal (X) axis. Glycemic control is categorized into five distinct zones (A–E) based on percentiles, ranging from optimal control (Pc: 0–20) to poor control (Pc: 80–100) (Fig. 2).

Need for GRI

With broader access to continuous glucose monitoring (CGM) data among nonspecialist healthcare providers, there is a growing need for simplified yet effective tools to interpret glycemic patterns. The glycemia risk index (GRI) represents a valuable advancement in this context, offering a practical means to assess the overall quality of glycemic control in individuals with diabetes. Its applicability in both clinical trials and real-world settings makes it a useful parameter for monitoring the impact of emerging therapeutic interventions. Unlike traditional metrics such as HbA1c or time-in-range, the GRI provides a more nuanced view of glycemic variability, serving as both an early warning signal and a guide for therapeutic optimization. It empowers healthcare professionals to make informed decisions regarding treatment adjustments by highlighting specific areas of glycemic risk.[3]

The glycemia risk index offers distinct advantages over conventional metrics such as HbA1c and TIR by emphasizing extreme glycemic fluctuations and better reflecting clinical assessments of glycemic risk. It shows strong concordance with other CGM-based measures and has demonstrated utility across diverse clinical contexts, including among individuals utilizing hybrid closed-loop insulin delivery systems. Notably, in patients with HbA1c ≤ 7%, the GRI can uncover residual glycemic risk not evident through HbA1c alone, underscoring its added value in comprehensive glycemic evaluation.[5]

Limitations of GRI

Despite its potential, the GRI has certain limitations. Its development was based on CGM data from healthy adults undergoing intensive insulin therapy, which may restrict its applicability to broader patient populations. Additionally, unlike established measures such as HbA1c and TIR, the GRI has not yet been validated against definitive clinical outcomes. Nonetheless, with ongoing advancements in CGM technology, the GRI remains a promising tool, contingent on further validation and integration into clinical practice through future research.[4]

Our Experience with CGM and GRI

We analyzed CGM data from six patients using the GRI calculator alongside traditional metrics such as TIR. The GRI tool provided immediate classification of glycemic control into zones A to E, using a color-coded system. This visual representation proved to be highly intuitive and time-efficient, particularly beneficial for clinicians and paramedical staff with limited time to review comprehensive CGM reports. Moreover, the GRI facilitated straightforward tracking of patient progress over time, offering a practical approach for monitoring and guiding diabetes management (Figs 3 and 4).

Use of GRI

The glycemia risk index has gained considerable attention within the diabetes care research community, with a growing body of evidence supporting its application across various patient populations, including pediatric and adult groups, individuals on continuous subcutaneous insulin infusion (CSII), and those with type 2 diabetes. Notably, the GRI offers superior sensitivity in detecting hypoglycemic episodes compared to TIR, enhancing its clinical utility. Its ability to capture extreme glucose excursions also makes it a valuable tool in managing insulin-treated pregnancies. As a single, easy-to-calculate, and actionable metric, the GRI streamlines the interpretation of CGM data—particularly benefiting clinicians with limited experience in data analysis. Furthermore, it supports efficient clinical decision-making by helping prioritize patients with poor glycemic control and informing targeted therapeutic strategies based on its CHypo and CHyper components. These features position the GRI as a highly promising tool in the context of precision medicine and big data analytics in diabetes care.[1]

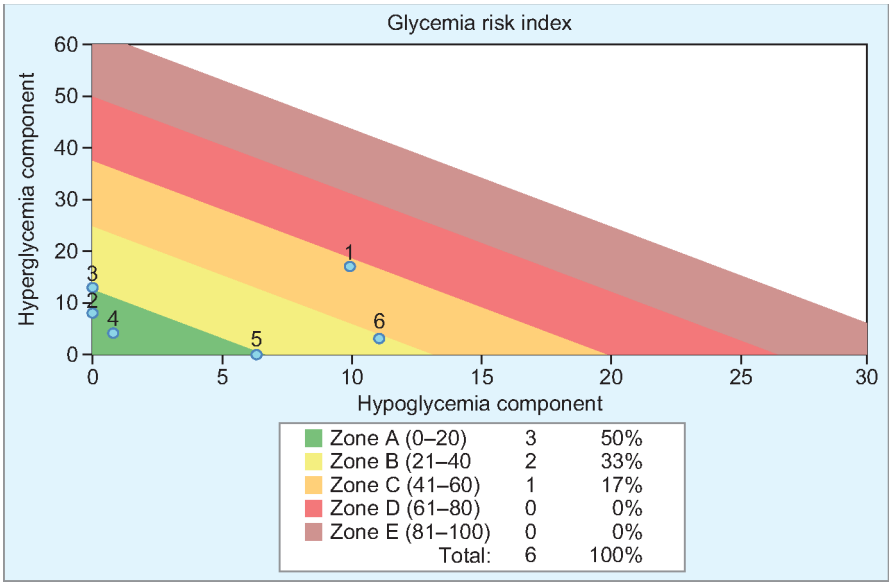

Fig. 4: GRI plot (online tool) (https://www.diabetestechnology.org/gri/)

Conclusions

The glycemia risk index is an emerging metric designed to provide a comprehensive assessment of an individual's glycemic control by integrating both hypoglycemic and hyperglycemic components into a single, quantifiable value. Its key advantage lies in its simplicity, ease of calculation, and clinical actionability, enabling healthcare professionals to efficiently identify patients at higher risk and tailor interventions accordingly. Compared to TIR, the GRI offers enhanced sensitivity in capturing hypoglycemia and extreme glycemic excursions, which makes it especially useful for certain groups, including children and individuals using CSII. Moreover, the GRI has shown associations with chronic diabetes-related complications and quality-of-life outcomes, underscoring its potential as a meaningful tool in routine diabetes management. As an adjunct to TIR and HbA1c, GRI may offer a more holistic and risk-sensitive glycemic assessment, particularly in individuals with frequent hypoglycemia or high glycemic variability.

Clinical Recommendation

Given its comprehensive nature and clinical relevance, GRI should be routinely used by all physicians, diabetologists, and endocrinologists involved in diabetes care. It enables better identification of patients at risk, supports personalized treatment adjustments, and complements existing metrics such as TIR and HbA1c.

Future Directives

The glycemia risk index represents a novel and meaningful advancement in CGM-based glycemic assessment. Further real-world studies are warranted to validate its predictive value and integrate it into routine diabetes care.

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Orcid

Abhijit Anil Trailokya https://orcid.org/0009-0002-7657-8119
Suhas Erande https://orcid.org/0000-0003-1566-6350

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