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ORIGINAL ARTICLE

Characterizing Blood Glucose Variability Using New Metrics with Continuous Glucose Monitoring Data

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Abstract

Objective:

Glycemic variability contributes to oxidative stress, which has been linked to the pathogenesis of the long-term complications of diabetes. Currently, the best metric for assessing glycemic variability is mean amplitude of glycemic excursion (MAGE); however, MAGE is not in routine clinical use. A glycemic variability metric in routine clinical use could potentially be an important measure of overall glucose control and a predictor of diabetes complication risk not detected by glycosylated hemoglobin (A1C) levels. This study aimed to develop and evaluate new automated metrics of glycemic variability that could be routinely applied to continuous glucose monitoring (CGM) data to assess and enhance glucose control.

Method:

Individual 24 h CGM tracings from our clinical diabetes research database were scored for MAGE and two additional metrics designed to compensate for aspects of variability not captured by MAGE: (1) number of daily glucose fluctuations >75 mg/dl that leave the normal range (70–175 mg/dl), or excursion frequency, and (2) total daily fluctuation, or distance traveled. These scores were used to train machine learning algorithms to recognize excessive variability based on physician ratings of daily CGM charts, producing a third metric of glycemic variability: perceived variability. Finger stick A1C (average) and serum 1,5-anhydroglucitol (postprandial) levels were used as clinical markers of overall glucose control for comparison.

Results:

Mean amplitude of glycemic excursion, excursion frequency, and distance traveled did not adequately quantify the glycemic variability visualized by physicians who evaluated the daily CGM plots. A naive Bayes classifier was developed that characterizes CGM tracings based on physician interpretations of tracings. Preliminary results suggest that the number of excessively variable days, as determined by this naive Bayes classifier, may be an effective way to automatically assess glycemic variability of CGM data. This metric more closely reflects 90-day changes in serum 1,5-anhydroglucitol levels than does MAGE.

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Abbreviations: (A1C) glycosylated hemoglobin, (AUC) area under the curve, (CGM) continuous glucose monitoring, (MAGE) mean amplitude of glycemic excursion, (PGF2) urinary 8-iso-prostaglandin F2 alpha excretion; (PV) perceived variability

Keywords: blood glucose measurement, continuous glucose monitoring, glycemic control, glycemic variability, machine learning, naive Bayes classifiers

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Abstract cont.

Conclusion:

We have developed a new automated metric to assess overall glycemic variability in people with diabetes using CGM, which could easily be incorporated into commercially available CGM software. Additional work to validate and refine this metric is underway. Future studies are planned to correlate the metric with both urinary 8-iso-prostaglandin F2 alpha excretion and serum 1,5-anhydroglucitol levels to see how well it identifies patients with high glycemic variability and increased markers of oxidative stress to assess risk for long-term complications of diabetes.

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