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Predictive Monitoring for Improved Management of Glucose Levels

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Abstract

Background:
Recent developments and expected near-future improvements in continuous glucose monitoring (CGM) devices provide opportunities to couple them with mathematical forecasting models to produce *predictive monitoring* systems for early, proactive glycemia management of diabetes mellitus patients before glucose levels drift to undesirable levels. This article assesses the feasibility of data-driven models to serve as the forecasting engine of predictive monitoring systems.

Methods:
We investigated the capabilities of data-driven autoregressive (AR) models to (1) capture the correlations in glucose time-series data, (2) make accurate predictions as a function of prediction horizon, and (3) be made *portable* from individual to individual without any need for model tuning. The investigation is performed by employing CGM data from nine type 1 diabetic subjects collected over a continuous 5-day period.

Results:
With CGM data serving as the gold standard, AR model-based predictions of glucose levels assessed over nine subjects with Clarke error grid analysis indicated that, for a 30-minute prediction horizon, individually tuned models yield 97.6 to 100.0% of data in the clinically acceptable zones A and B, whereas cross-subject, *portable* models yield 95.8 to 99.7% of data in zones A and B.

Conclusions:
This study shows that, for a 30-minute prediction horizon, data-driven AR models provide sufficiently-accurate and clinically-acceptable estimates of glucose levels for timely, proactive therapy and should be considered as the modeling engine for *predictive monitoring* of patients with type 1 diabetes mellitus. It also suggests that AR models can be made *portable* from individual to individual with minor performance penalties, while greatly reducing the burden associated with model tuning and data collection for model development.

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Abbreviations: (AR) autoregressive, (BG) blood glucose, (BMI) body mass index, (CGM) continuous glucose monitoring, (HbA1c) glycated hemoglobin, (LS) least squares, (SD) standard deviation, (RMSE) root mean square error

Keywords: autoregressive model, diabetes, continuous glucose monitoring, predictive monitoring

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