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SYMPOSIUM

Modeling the Error of Continuous Glucose Monitoring Sensor Data: Critical Aspects Discussed through Simulation Studies

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Abstract

Background:

Knowing the statistical properties of continuous glucose monitoring (CGM) sensor errors can be important in several practical applications, e.g., in both open- and closed-loop control algorithms. Unfortunately, modeling the accuracy of CGM sensors is very difficult for both experimental and methodological reasons. It has been suggested that the time series of CGM sensor errors can be described as realization of the output of an autoregressive (AR) model of first order driven by a white noise process. The AR model was identified exploiting several reference blood glucose (BG) samples (collected frequently in parallel to the CGM signal), a procedure to recalibrate CGM data, and a linear time-invariant model of blood-to-interstitium glucose (BG-to-IG) kinetics. By resorting to simulation, this work shows that some assumptions made in the Breton and Kovatchev modeling approach may significantly affect the estimated sensor error and its statistical properties.

Method:

Three simulation studies were performed. The first simulation was devoted to assessing the influence of CGM data recalibration, whereas the second and third simulations examined the role of the BG-to-IG kinetic model. Analysis was performed by comparing the "original" (synthetically generated) time series of sensor errors vs its "reconstructed" version in both time and frequency domains.

Results:

Even small errors either in CGM data recalibration or in the description of BG-to-IG dynamics can severely affect the possibility of correctly reconstructing the statistical properties of sensor error. In particular, even if CGM sensor error is a white noise process, a spurious correlation among its samples originates from suboptimal recalibration or from imperfect knowledge of the BG-to-IG kinetics.

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Abbreviations: (ACF) autocorrelation function, (AR) autoregressive, (BG) blood glucose, (CGM) continuous glucose monitoring, (IG) interstitial glucose, (LTI) linear time invariant, (PACF) partial autocorrelation function, (PSD) power spectral density, (SCGM) simulated continuous glucose monitoring, (SIG) surrogate interstitial glucose

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Abstract cont.

Conclusions:

Modeling the statistical properties of CGM sensor errors from data collected *in vivo* is difficult because it requires perfect calibration and perfect knowledge of BG-to-IG dynamics. Results suggest that correct characterization of CGM sensor error is still an open issue and requires further development upon the pioneering contribution of Breton and Kovatchev.

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