Tracking Glucose Excursions with a Multisensor Platform for Non Invasive Glucose Monitoring

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Introduction: Impedance spectroscopy (IS) is a promising approach for non invasive glucose monitoring (NIGM). However, a number of external and physiological factors can affect the measurement, and some of these factors may even be considered as generic perturbations to NIGM in general. In order to be able to compensate for such factors a multisensor platform including sensors for broad band IS, optical, moisture, conductance, acceleration and temperature has been developed.
Methods: Blood glucose excursions were induced by an oral glucose load in 4 patients with Type 1 Diabetes (T1DM, age 40±13 y, BMI 23.9±1.6 kg/m^2, duration of diabetes 19±14 y; HbA1c 7.6±1.0%) and 4 T2DM patients (60±11 y; 25.9±4.4 kg/m^2; 11±4 y; 7.6±0.5%). In another series of experiments the effect of drinking 3 L of water (while blood glucose remained stable) was studied in 4 healthy subjects (23±2 y; 22.2±1.6 kg/m^2). Our multisensor platform held all sensors on one single substrate and was attached to the upper arm of the subjects by an expandable band. For data evaluation a multiple regression analysis was performed to establish a universal model including all subjects. The models generated a) aimed at simplicity, taking great care to avoid potential over fitting and b) allowed investigating the effect of excessive water intake on the dielectric characteristics and hence on the overall performance of the platform.
Results: Using the impedance parameters only, including one individual baseline parameter, glucose excursions could be tracked by our multisensor approach with an R^2 value of 0.7. A Clark Error Grid analyses showed that 96.1% of all data points were in zone A+B, 1.2% in C, 2.7% in D and 0% in D. Taking into account all sensor signals leads to an improvement of R^2 to 0.763.
Conclusions The results indicate that an improvement of non-invasive monitoring by IS can be achieved by a multisensor approach. Whether a calibration strategy of such a multisensor platform in a larger clinical setting will need to consider separate patients groups rather than a universal calibration approach remains to be seen.

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