Non-invasive glucose monitoring in patients with type 1 diabetes: repeatability in the same subjects

Author Block A. Caduff[1], W. A. Stahel[2], C. Bull[3], M. S. Talary[1], J. Klisic[1], M. Donath[4], L. Heinemann[5];
[1]R&D, Solianis Monitoring, Zurich, Switzerland, [2]Seminar for Statistics, ETH Zurich, Zurich, Switzerland, [3]Centre for clinical research, University Hospital Zurich, Zurich, Switzerland, [4]Clinic for Endocrinology and Diabetes, University Hospital Zurich, Zurich, Switzerland, [5]Research, Profil Institute for Metabolic Research, Neuss, Germany.

Abstract: A non-invasive multisensor system for continuous glucose monitoring (multisensor glucose monitoring system MGMS), based on dielectric spectroscopy, combined with additional sensors for optical, sweat/moisture and temperature measurement has been developed. The motivation for the MGMS is based on the understanding that various temporal fluctuations of the biophysical properties of skin, can introduce significant perturbations to the actual glucose related measurement. The aim of this study was to measure glucose excursions on different study days in the same subjects using an identical set of calibration parameters.
The multisensor system was worn on the upper right arm by 10 patients with Type 1 Diabetes (age 44 ± 14 y, BMI 25.1 ± 2.5 kg/m^2, duration of diabetes 21.8 ± 10.7 y, HbA1c 6.9 ± 0.5%). Glucose was administered orally to induce two consecutive hyperglycemic excursions (12-15 mmol/L) within 8 hours. Euglycemia was re-established by i.v. insulin administration. Based on the sensor signals registered after the first study day, a global model was derived, and the respective coefficients of the model for the individual sensor signals were determined. The model included one coefficient specific to each run. On the second study day, 5 of these patients were again administered glucose orally to induce a glucose profile with one hyperglycemic excursion. The coefficients derived using the global model of the first study days were re-applied to the 5 test runs of the second study day with the same coefficients in order to study the prediction power of the model. Both study days for all subjects were performed within a period of two months. Application of the calibration model from day one to day two yielded an $R^2 = 0.68$ and MARD= 27.3%. These data indicate that a global model can be derived using training runs and successfully applied to a set of test runs with a different glucose profile for external model validation. The global parameterisation is shown to be transferable between subjects and additional study day data, leading to a successful tracking of glucose variations. Repeating this in a larger study group and under less experimentally controlled conditions, will be another important step towards non-invasive glucose monitoring.