Noninvasive Glucose Monitoring: Increasing Accuracy by Combination of Multi-Technology and Multi-Sensors

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Abstract

Background:

The main concern in noninvasive (NI) glucose monitoring methods is to achieve high accuracy results despite the fact that no direct blood or interstitial fluid glucose measurement is performed. An alternative approach to increase the accuracy of NI glucose measurement was previously suggested through a combination of three NI methods: ultrasonic, electromagnetic, and thermal. This paper provides further explanation about the nature of the implemented technologies, and multi-sensors are presented, as well as a detailed elaboration on the novel algorithm for data analysis.

Methods:

Clinical trials were performed on two different days. During the first day, calibration and six subsequent measurements were performed. During the second day, a "full day" session of about 10 hours took place. During the trial, type 1 and 2 diabetes patients were calibrated and evaluated with GlucoTrack[®] glucose monitor against HemoCue[®] (Glucose 201+).

Results:

A total of 91 subjects were tested during the trial period. Clarke error grid (CEG) analysis shows 96% of the readings (on both days 1 and 2) fall in the clinically accepted A and B zones, of which 60% are within zone A. The absolute relative differences (ARDs) yield mean and median values of 22.4% and 15.9%, respectively. The CEG for day 2 of the trial shows 96% of the points in zones A and B, with 57% of the values in zone A. Mean and median ARD values for the readings on day 2 are 23.4% and 16.5%, respectively. The intervals between day 1 (calibration and measurements) and day 2 (measurements only) were 1–22 days, with a median of 6 days.

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Abbreviations: (ARD) absolute relative difference, (BG) blood glucose, (CEG) Clarke error grid, (EM) electromagnetic, (EMC) electromagnetic channel, (HT) heat transfer, (MU) main unit, (NI) noninvasive, (PEC) personal ear clip, (SMBG) self-monitoring of blood glucose, (TH) thermal, (US) ultrasonic

Keywords: combination methodology, ear clip, electromagnetic, GlucoTrack, glucose monitor, multi-sensors, multi-technology, noninvasive glucose monitoring, self-monitoring of blood glucose, thermal, ultrasonic

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Abstract cont.

Conclusions:

The presented methodology shows that increased accuracy was indeed achieved by combining multi-technology and multi-sensors. The approach of integration contributes to increasing the signal-to-noise ratio (glucose to other contributors). A combination of several technologies allows compensation of a possible aberration in one modality by the others, while multi-sensor implementation enables corrections for interference contributions.

Furthermore, clinical trials indicate the ability of using the device for a wide range of demography, showing clearly that the calibration is valid for long term.

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