In vivo studies for the development of a nocturnal hypoglycemic alarm algorithm using near-infrared spectroscopy

Noninvasive glucose monitoring has been the subject of considerable research because of the high number of diabetes patients who must monitor their glucose levels daily by taking blood samples. Among methods being evaluated for possible use in this application, near-infrared spectroscopy has received significant attention because of available glucose absorption bands that can be observed in the presence of the large aqueous background found in tissue spectra. The objective of the research presented here is to evaluate the potential for implementing a noninvasive nocturnal hypoglycemic alarm with near-infrared spectroscopy. Such an alarm would be used by a diabetic to detect potentially dangerous occurrences of hypoglycemia during sleep. The approach used is to collect spectra continuously from the patient during the sleep period, followed by the application of pattern recognition methods to determine if a spectrum represents a blood glucose level that exceeds a hypoglycemic threshold. A reference spectrum is collected and a conventional finger-stick glucose concentration measurement is made at the start of the sleep period. The ratio is then taken of each subsequent spectrum to the collected reference, forming a differential spectrum corresponding to the signed difference in concentration relative to the reference. The identification of these differential spectra as “alarm” or “non-alarm” is performed with a classification model computed with piecewise linear discriminant analysis (PLDA).

This methodology was tested with in vivo data that simulate the glucose excursions that occur during sleep. The performance of this methodology was tested with data collected from a non-survival single day experiment with an anesthetized rat. The prediction data for the rat clearly demonstrates that the alarm methodology works well with the in vivo data collected in a single day. Ongoing work is focusing on expanding testing of the methodology to multiple-day experiments with a single rat.