Journal of Diabetes Science and Technology
Volume 1, Issue 5, September 2007
© Diabetes Technology Society

SYMPOSIUM

Hypoglycemia Detection and Prediction Using Continuous Glucose Monitoring—A Study on Hypoglycemic Clamp Data

Cesar C. Palerm, Ph.D.,[1,2] and B. Wayne Bequette, Ph.D.[3]

Abstract

Motivation:
The fear of hypoglycemia remains an important limiting factor in the ability of an individual with type 1 diabetes to tightly regulate glycemia. Continuous glucose monitors provide important feedback to improve glycemic control, but there remains a need for these devices to better alarm of possible impending hypoglycemia, particularly overnight or other periods when the individual is engaged in activities that take their focus away from glucose monitoring.

Methods:
We have previously proposed an algorithm, based on the use of real-time glucose sensor signals and optimal estimation theory (Kalman filtering), to predict hypoglycemia; the algorithm was validated in simulation-based studies. In this article we further refine and validate the prediction algorithm based on the analysis of clinical hypoglycemic clamp data from 13 subjects. The sensitivity and specificity of the predictions are calculated with respect to reference blood glucose values obtained at the same sampling rate of the sensor.

Results:
For a 30-minute prediction horizon and alarm threshold of 70 mg/dl, the sensitivity and specificity were 90 and 79%, respectively, indicating that a 21% false alarm rate must be tolerated to predict 90% of the hypoglycemic events 30 minutes ahead of time. Shorter prediction horizons yield a significant improvement in sensitivity and specificity.

Discussion:
Sensitivity and specificity data as a function of prediction horizon and alarm threshold enable an individual to adjust the alarm to best meet their needs. Such decisions can be made depending on the subject's risk for hypoglycemia, for example.

J Diabetes Sci Technol 2007;1(5):624-629

Author Affiliations: [1]Department of Chemical Engineering & Biomolecular Science and Engineering Program, University of California Santa Barbara, Santa Barbara, California; [2]Sansum Diabetes Research Institute, Santa Barbara, California; and [3]Isermann Department of Chemical & Biological Engineering, Rensselaer Polytechnic Institute, Troy, New York

Abbreviations: (CGM) continuous glucose monitoring, (LBGI) low blood glucose index, (RAD) relative absolute differences, (ROC) receiver operating characteristic

Keywords: glucose monitoring, hypoglycemia prediction, Kalman filtering, hypoglycemic clamp

Corresponding Author: B. Wayne Bequette, Ph.D., Isermann Department of Chemical & Biological Engineering, Rensselaer Polytechnic Institute, Troy, NY 12180-3590; email address *bequette@rpi.edu*