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ORIGINAL ARTICLES

Using Support Vector Machines to Detect Therapeutically Incorrect Measurements by the MiniMed CGMS®

Jorge Bondia, Ph.D.,[1] Cristina Tarín, Ph.D.,[2] Winston García-Gabin, Ph.D.,[3] Eduardo Esteve, M.D.,[4] José Manuel Fernández-Real, M.D.,[4] Wifredo Ricart, M.D.,[4] and Josep Vehí, Ph.D.[3]

Abstract

Background:

Current continuous glucose monitors have limited accuracy mainly in the low range of glucose measurements. This lack of accuracy is a limiting factor in their clinical use and in the development of the so-called artificial pancreas. The ability to detect incorrect readings provided by continuous glucose monitors from raw data and other information supplied by the monitor itself is of utmost clinical importance. In this study, support vector machines (SVMs), a powerful statistical learning technique, were used to detect therapeutically incorrect measurements made by the Medtronic MiniMed CGMS®.

Methods:

Twenty patients were monitored for three days (first day at the hospital and two days at home) using the MiniMed CGMS. After the third day, the monitor data were downloaded to the physician's computer. During the first 12 hours, the patients stayed in the hospital, and blood samples were taken every 15 minutes for two hours after meals and every 30 minutes otherwise. Plasma glucose measurements were interpolated using a cubic method for time synchronization with simultaneous MiniMed CGMS measurements every five minutes, obtaining a total of 2281 samples. A Gaussian SVM classifier trained on the monitor's electrical signal and glucose estimation was tuned and validated using multiple runs of k-fold cross-validation. The classes considered were Clarke error grid zones A+B and C+D+E.

Results:

After ten runs of ten-fold cross-validation, an average specificity and sensitivity of 92.74% and 75.49%, respectively, were obtained (see **Figure 4**). The average correct rate was 91.67%.

Conclusions:

Overall, the SVM performed well, in spite of the somewhat low sensitivity. The classifier was able to detect the time intervals when the monitor's glucose profile could not be trusted due to incorrect measurements. As a result, hypoglycemic episodes missed by the monitor were detected.

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Author Affiliations: [1]Instituto Universitario de Automática e Informática Industrial, Universidad Politécnica de Valencia, Valencia, Spain; [2]Instituto de Telecomunicaciones y Aplicaciones Multimedia, Universidad Politécnica de Valencia, Valencia, Spain; [3]Institut d'Informàtica i Aplicacions, Universitat de Girona, Girona, Spain; [4]Unidad de Diabetes, Endocrinología y Nutrición, Hospital Dr. Josep Trueta, Girona, Spain

Abbreviations: (CEG) Clarke error grid, (CGM) continuous glucose monitor, (ISIG) input signal for glucose, (MMH) maximum margin hyperplane, (SVM) support vector machine, (VCTR) voltage counter transfer ratio

Keywords: continuous glucose monitor, fault detection, statistical learning, support vector machine

Corresponding Author: Jorge Bondia, Ph.D., Departamento de Ingeniería de Sistemas y Automática, Universidad Politécnica de Valencia, Camino de Vera s/n, E-46022 Valencia, Spain; email address *jbondia@isa.upv.es*