In Silico Testing of a Fuzzy Logic Insulin Pump Controller's Ability to Address Variable Daily Eating Patterns with Use of Personalization

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Objective

To evaluate the use of a Fuzzy Logic Controller (FLC) in various age groups under relatively normal circumstances and meal scenarios, and to evaluate the use of personalization factors to customize insulin dosing.

Introduction

Fuzzy logic controllers have been used for many years in several different applications. These controllers are very good at handling noisy data. We have been interested in using it for the possibility of an artificial pancreas. Traditional Proportional Integral Derivative (PID) and Model Predictive Control (MPC) blood glucose controllers have been tested and found lacking. They rely upon high fidelity mathematical equations defining the human glucoregulatory system. The resulting control is then only as good as the ability of the model to mimic this complex system. Fuzzy Logic Control systems do not require a model defining the glucoregulatory system, but instead capture the physician's expertise in treating diabetes in a format that is readily understood, and defined by, the medical professional. FL systems are also inherently robust and can be modified in the manner the medical professional deems most appropriate, because they are not bound by the constraints imposed by a mathematical model that attempts to mimic the human glucoregulatory system.

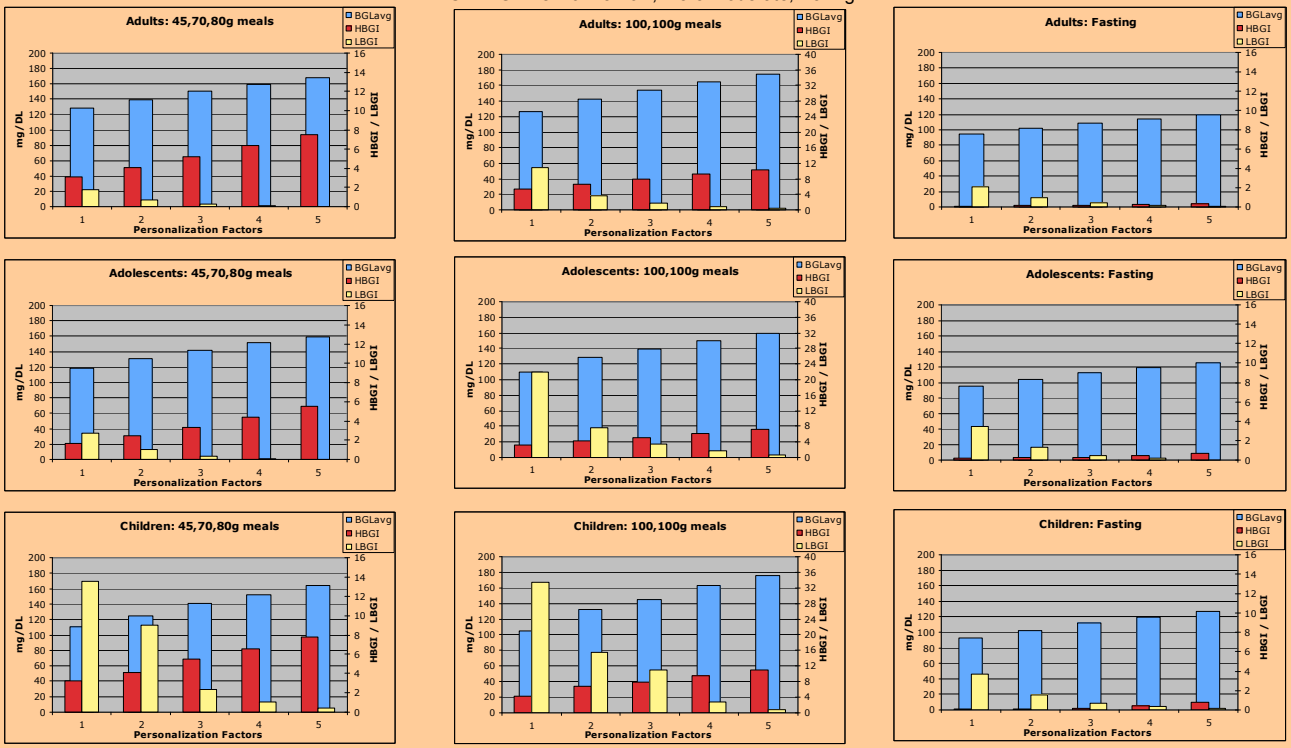
Scenario

An in silico test was run on 10 adult, 10 adolescent & 10 child subjects for 24-hours from the FDA-accepted UVa/Padova diabetes simulator [Kovatchec et al., 2009]. Endpoints included average blood glucose (BGavg, mg/dL), low blood glucose risk index (LBGI), high blood glucose risk index (HBGI), and seven others. Personalization was done by scaling of our original FLC matrix. There were three scenarios:

1.Standard day meal {45g, 70g, 80g}
2.Fasting condition
3.Large day meal {100g, 100g}; (7:00, 18:00)

In Silico Results

LBGI/HBGI Risk: 0-2.5 Low, 2.5-5 Moderate, >5 High



Conclusions

Data was developed which will allow a physician to ascertain the risk of hypoglycemia and weigh this against the risk of hyperglycemia. This would allow the physician to set the amount of aggressiveness of the controller for each "individual" patient. This potentially could be used to allow patients to adjust the degree of dosing aggressiveness on a day to day basis.

Acknowledgments

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