Hypoglycemia Avoidance in Patients During and Post-exercise with a Fuzzy Logic Controller (FLC)

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Introduction

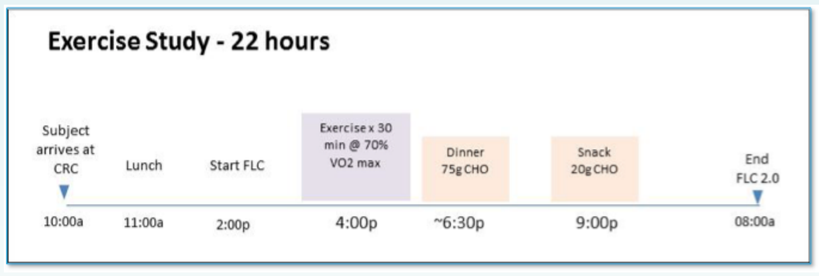
One of the challenges of T1 diabetes is controlling blood glucose levels during and following exercise. Becoming hypoglycemic during, and several hours following exercise is common. This situation is difficult to address with a fully automated pancreas system (APS) which has no exercise acknowledgement. Here we put a fully automatic APS controller to the challenge of dealing with this difficult situation. The algorithm is based on Fuzzy Logic which does not rely on predictive models nor require meal or exercise announcements or manual boluses. The fuzzy logic controller (FLC) calculates doses using only the three previous 5-min CGMS readings.

Objective

This eighteen-hour study evaluated the acute and late effectiveness of our fully automated closed loop FLC artificial pancreas controller with adult patients during and post exercise followed overnight.

Methods

Eleven studies were conducted using 8 different subjects having HbA1C < 8.5%. 100% of the insulin used in this study was commanded by the FLC. Three repeated the study with the controller set to a more aggressive personalization factor. The FLC was initialized using total daily basal insulin and the physician-set PF. The controller operated autonomously from 2pm until 8am; with no announcements for exercise or meals.



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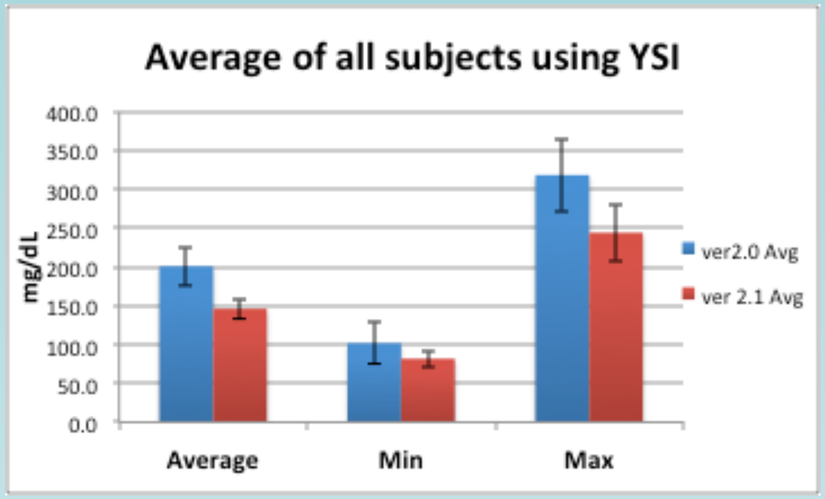
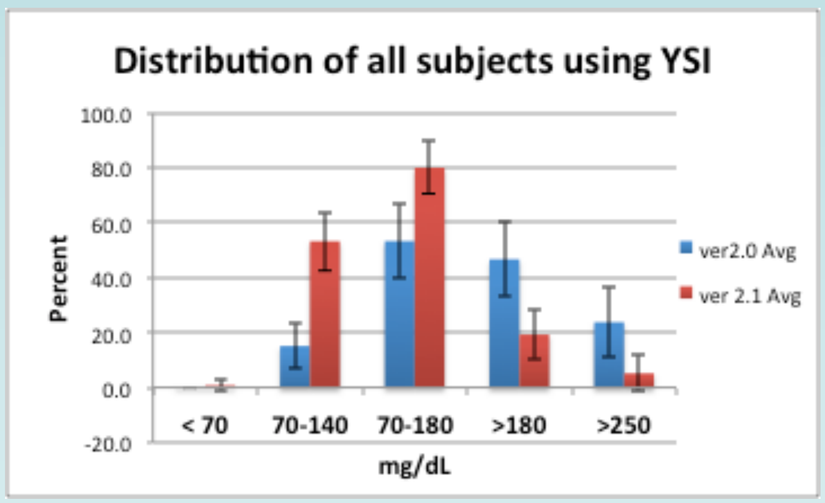
Results



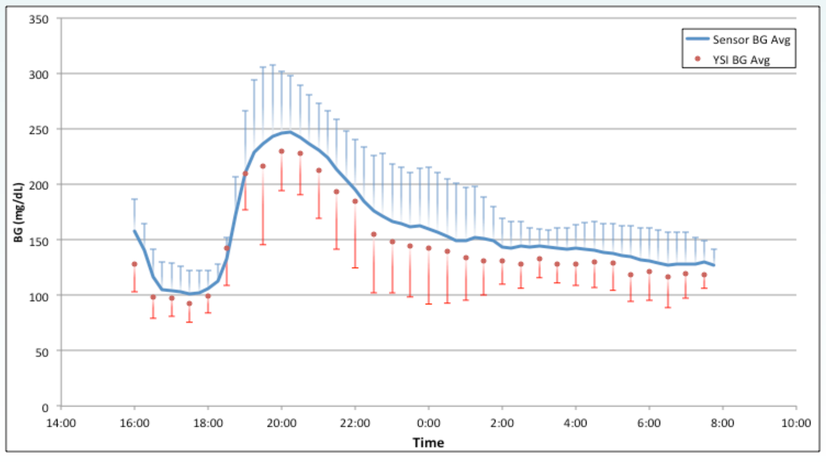


Changes to the fuzzy logic rules matrix (from version 2.0 to 2.1) had these results:

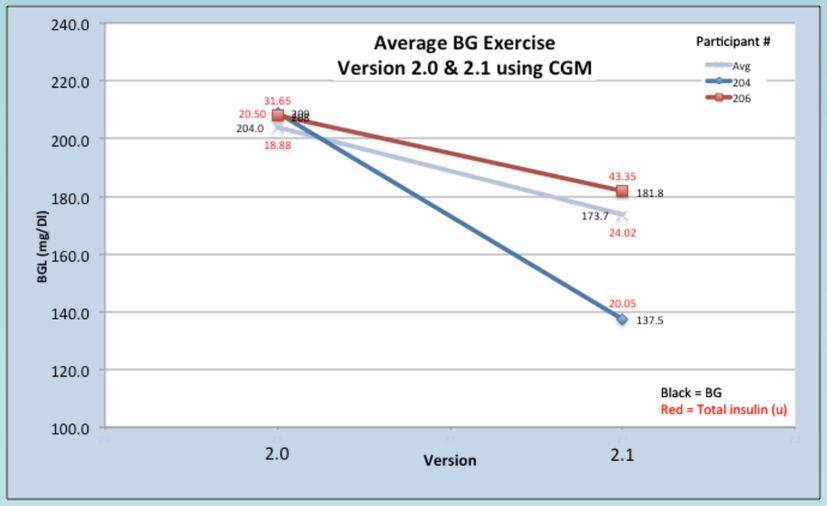
- The average blood sugar decreased by 54 mg/dL
- Max average blood sugar decrease by 74 mg/dL
- Time 70-180 mg/dL increased from 53% to 80%
- Time > 180 mg/dL decreased from 47% to 19%
- Time > 250 mg/dL decreased from 24% to 5%

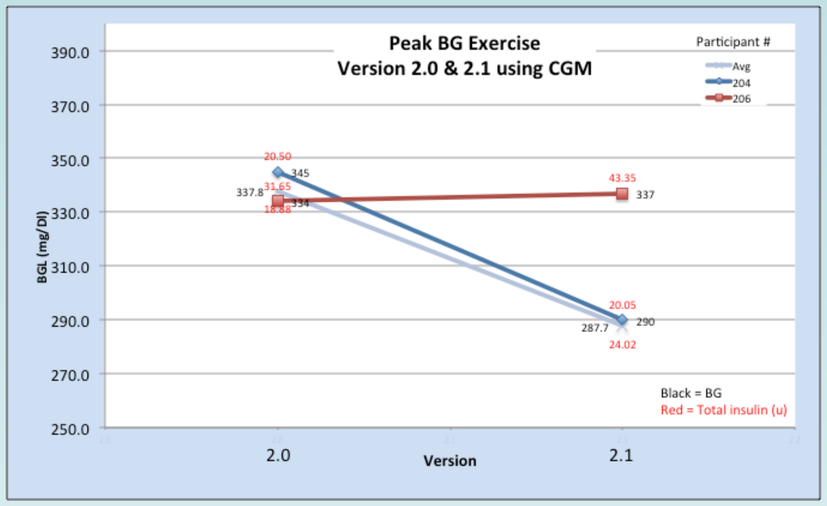
Also, correlation of lower PF values (causing more aggressive dosing) to decreases in both average and peak BG levels was apparent in version 2.1.

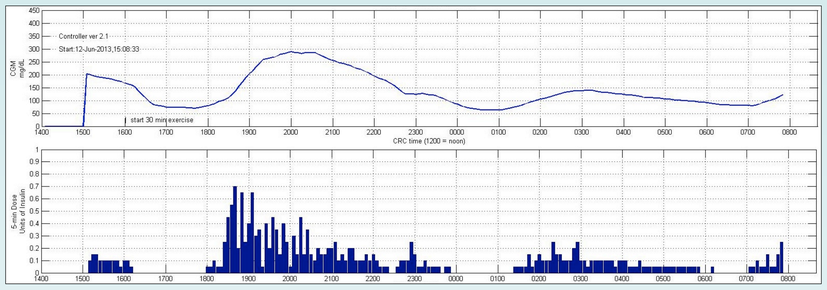
Avg. Time Histories Ver. 2.1



Results (continued)







Conclusion

This fully automated closed loop FLC provides safe and effective glucose control in response to exercise, meals and an overnight period in the CRC.

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