GlucoReg: An Algorithm for the Infusion Rate of Glucose During an Insulin Clamp

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Problem Statement

- Hyperinsulinemic clamp studies are used to measure insulin sensitivity in diabetics and those with endocrine and metabolic disorders
- Dr. Luther adjusts GIR on the fly based on his judgment
- This can affect subject safety and data validity
- We will develop an algorithm that allows researchers to perform these studies in a more controlled manner

Needs Assessment

Patient: Provide utmost safety and maintain plasma glucose levels between 85 - 105 mg/dL
Provider: Provide a simple interface for inputting predictor values and outputting predicted glucose infusion rates. The researcher can also override predictions.
System: Wide applicability should lower future healthcare costs, specifically within endocrinology & pharmacology.

Device Overview

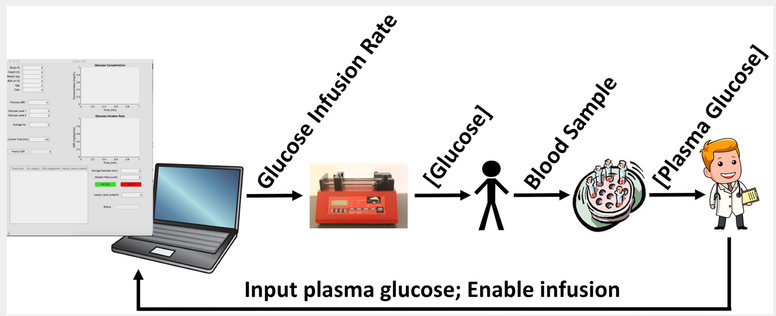

Figure 1: Schematic of device overview
Predicted GIR iis communicated via PC to pump, which delivers glucose to patient at specified rate. Plasma glucose is measured, which the physician inputs to the PC. Subsequent predictions and iterations follow.

Results: Algorithm

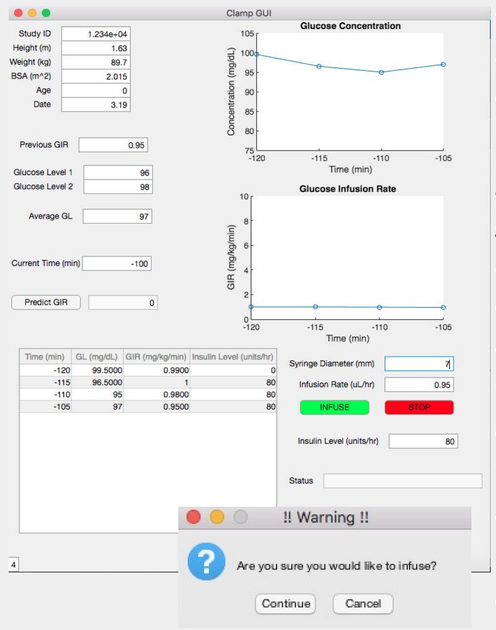

Figure 2: Graphic User Interface (GUI)
Our GUI allows for inputs, and then outputs a predicted GIR. The physician can infuse this GIR, but is first prompted with a warning box that must be confirmed before infusion

- A multiple regression analysis of demographic parameters identified <u>height</u>, <u>weight</u>, <u>body surface area</u>, and <u>age</u> as significant predictors of GIR
- Our algorithm can take these inputs and generate a predicted GIR
- Linear regression kernels in Python have optimized predictions via machine learning
- Data is outputted to an Excel file that can be uploaded to RedCap

Results: Pump

- Our algorithm can directly control a Kent Scientific Genie syringe pump
- Communication occurs from MATLAB to pump via serial communication
- Can monitor pump controls and detect errors

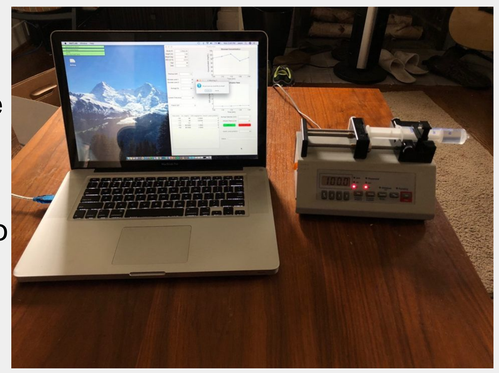

Figure 3: PC-pump interface
GIR communicated via serial communication

Results continued

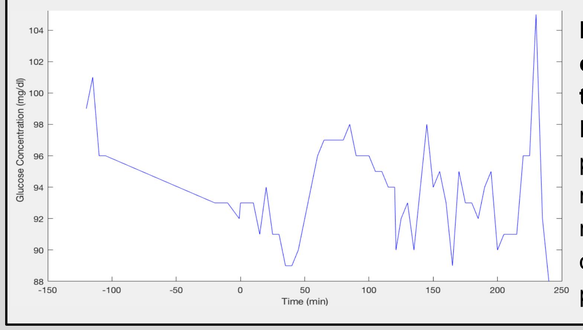

Figure 4: Glucose concentration over time
Fluctuations of plasma glucose remain within 90-101 mg/dL (with one outlier) using predictions

Conclusion

- Currently, our algorithm can predict glucose infusion rate given demographic parameters and previous GIRs for a certain subject as it is run alongside a clinical study
- This is useful to Dr. Luther, however, he still finds himself relying on his clinical judgment in some cases
- With an improved algorithm, we could accurately predict GIR without any necessary physician intervention

Future Directions

- Improve machine learning algorithm using such tools as Python inverse reinforcement
- Optimize algorithm with more data from an increase in clinical studies
- Test algorithm and pump in animal studies

Acknowledgements & Refs.

- Defronzo et al., 1979
- We would also like to thank Dr. James Luther, Dr. Matthew Walker, & Dr. Andre Diedrich for their guidance and technical support