Algorithm for the Infusion Rate of Glucose During an Insulin Clamp

Jason Blohm, Nicholas Diehl, Joe Jeffrey, Sheng-Yau Lim
GlucoReg

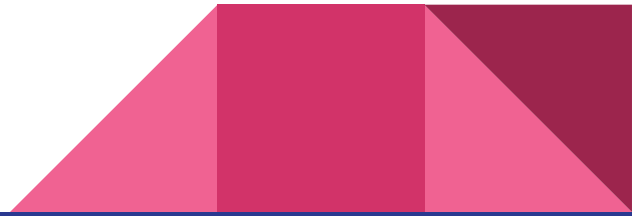
Refresher: Problem Statement

- In hyperinsulinemic clamp studies, Dr. Luther adjusts GIR on the fly based on his clinical judgment
- This can lead to inaccurate adjustments which can affect subject safety and data validity
- Some people claim that an algorithmic approach works, but no one Dr. Luther has talked to has been successful
- We will develop an algorithm that allows researchers to perform these studies in a more controlled manner

Refresher: Needs Assessment → Provider

Interface

1. Should be simple to understand
2. Should include inputs for all possible variables the physician may want to change: target glucose level, insulin clamp level, demographic data, time of experiment
3. Given patient demographics and history, should simulate the glucose level over time, prior to clinical testing



Refresher: Needs Assessment → Provider

Algorithm

1. Should calculate the amount of glucose uptake based on the constant insulin infusion rate the physician specifies
2. Depends on accurate glucose infusion rate
3. Should output a recommended glucose infusion rate that accounts for the time delay in measuring glucose level from blood sample (t-1)

Refresher: Needs Assessment → Provider

Timing

1. Runtime -- should provide physician with proper glucose infusion rate (GIR) within 10 seconds of inputting the current glucose level
2. Should include an easy to navigate UI for immediate data entry

Refresher: Needs Assessment → Patient

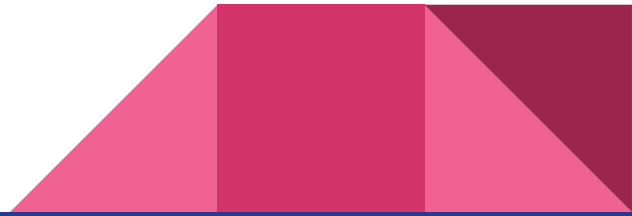
Safety

1. Ensure that glucose levels do not exceed or drop below safe levels, as determined by the physician
2. Measurements need to be taken every 5 minutes to ensure glucose levels are where they should be. If not, the program should alert the physician (future iteration)
3. Must run smoothly so that no bugs interrupt the program

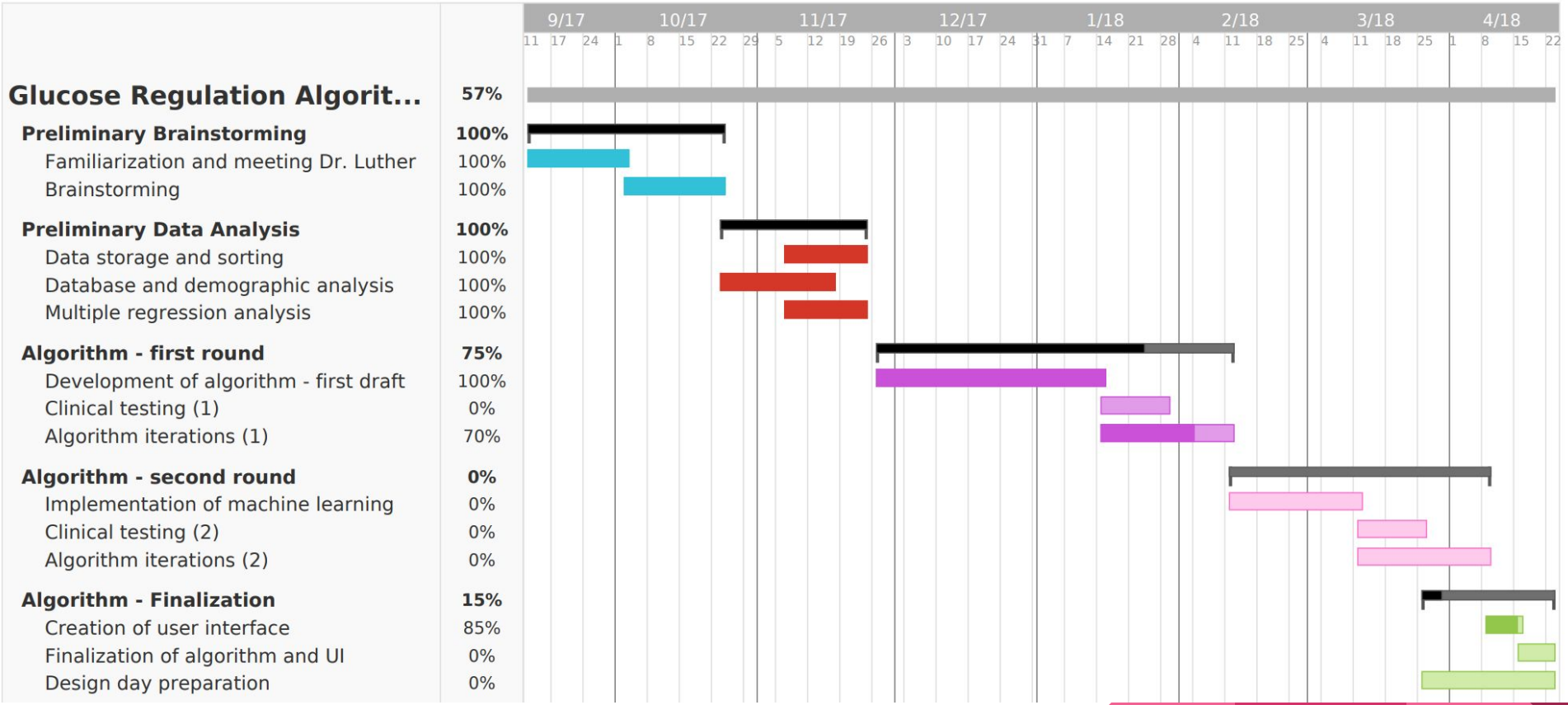
Refresher: Needs Assessment → System

Applicability and cost

1. Should be applicable to different physicians and different hospitals performing the same studies
2. Should be open source
3. Results from these studies should lower healthcare costs in the future



Gantt Chart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Glucose Regulation Algorit... 57%
Preliminary Brainstorming 100%
Familiarization and meeting Dr. Luther 100%
Brainstorming 100%
Preliminary Data Analysis 100%
Data storage and sorting 100%
Database and demographic analysis 100%
Multiple regression analysis 100%
Algorithm - first round 75%
Development of algorithm - first draft 100%
Clinical testing (1) 0%
Algorithm iterations (1) 70%
Algorithm - second round 0%
Implementation of machine learning 0%
Clinical testing (2) 0%
Algorithm iterations (2) 0%
Algorithm - Finalization 15%
Creation of user interface 85%
Finalization of algorithm and UI 0%
Design day preparation 0%

Progress: Multiple Regression Analysis

Linear regression model:

GIR ~ 1 + Height + Weight + BSA + Age + Gender + Race

Estimated Coefficients:

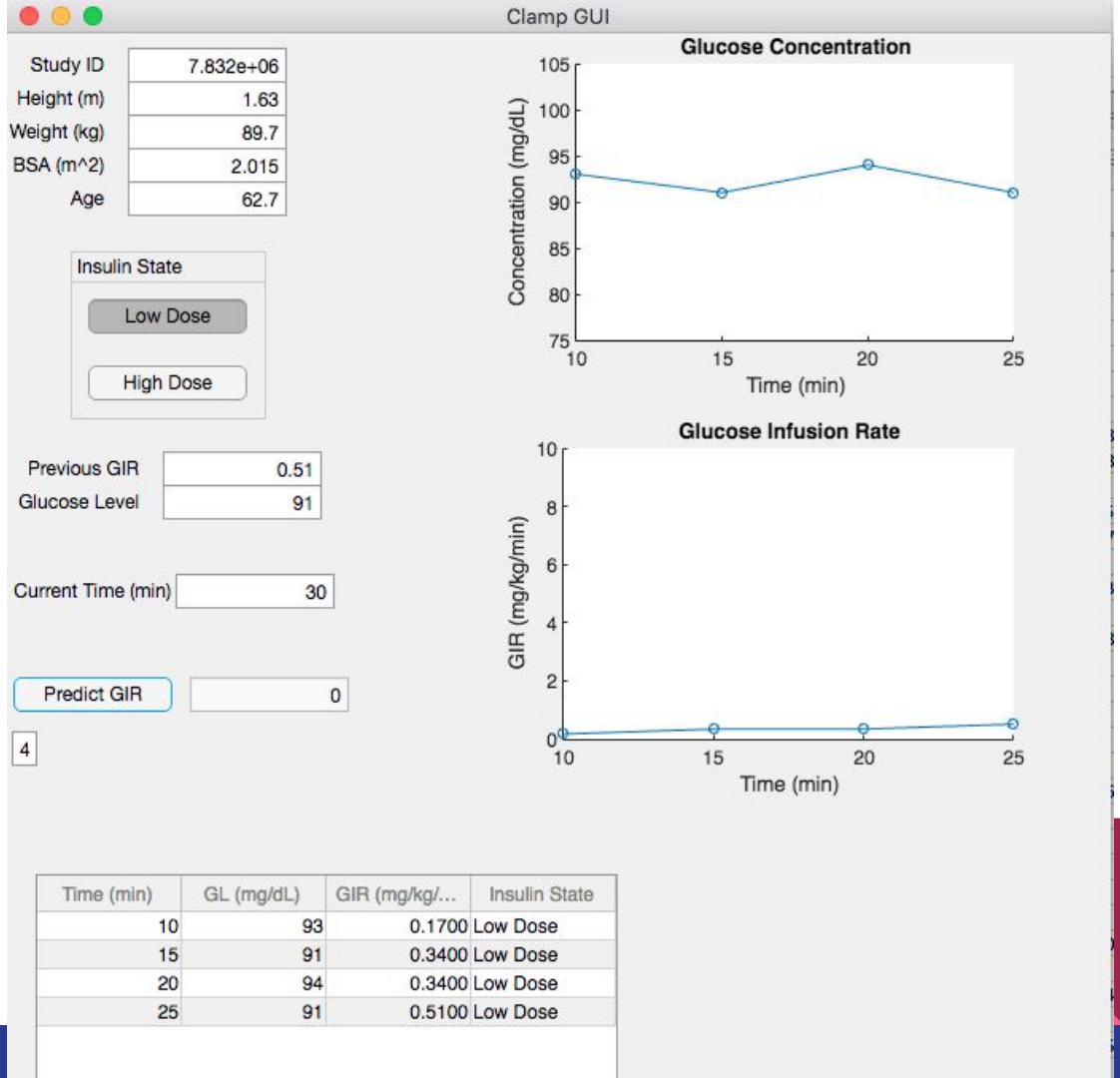
	Estimate	SE	tStat	pValue
(Intercept)	3.2236	2.011	1.603	0.11325
Height	15.35	5.7597	2.6651	0.0094679
Weight	0.19485	0.083456	2.3348	0.022309
BSA	-20.895	8.0997	-2.5797	0.0119
Age	-0.014226	0.0054871	-2.5927	0.011498
Gender	0.14254	0.16286	0.87521	0.38433
Race	-0.32696	0.22619	-1.4455	0.15261

Progress: First Iteration

- Relying on current algorithm for first iteration of algorithm
  - GIR = ((Gd-Gi)(10)((0.19)(body weight))/((Ginf)(15)) + (((SMi-2)(Gd)(FMi-1))/Gi)
    - Gd = desired plasma glucose concentration (mg/dL), 95
    - Gi = actual plasma glucose concentration (mg/dL)
    - Body weight in kg
    - Ginf = glucose concentration in infusate (mg/mL)
    - SMi = metabolic component: SMi = (SMi-2)(FMi)(FMi-1)
    - FMi = Gd/Gi
  - Will use our linear regression model to set the initial GIR

Progress: GUI

- Will take inputs and generate a predicted GIR
- Once closed, file will save to MATLAB workspace and an excel file



Example of first iteration along with GUI

MATLAB

Next Steps

- Familiarization with machine learning
  - Resources online such as the Stanford Machine Learning Course
  - Set up a meeting with professor Maithilee Kunda
- Finalize development of first iteration of algorithm
- Obtain new sources of data
- Obtain Dr. Luther’s patient schedule to test algorithm

Questions?