ANALYSIS AND DEVELOPMENT OF A MEAL DETECTION ALGORITHM FOR THE ARTIFICIAL PANCREAS

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EUREKA

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Type 1 Diabetes

- **Cause and Effects of Type 1**
  - Autoimmune destruction of pancreatic beta cells
  - No control of blood glucose
  - Exogenous insulin required

- **Current disease therapy**
  - Self monitoring
  - Multiple daily insulin injections
Future of Disease Therapy: Artificial Pancreas

CGM - transmitter
RF signal
CSII pump
RF signal

CGM (DexCom STS-Seven)

CSII Controller (Insulet OmniPod system)

Communication Signal

Artificial Pancreas System (APS)
Effect of a Meal on Glucose

Lunch

Detection < 30 min

2 Hours
Project Goals

- Implementing basic meal detection algorithm

- Establish metrics that represent desired qualities
  - Alarms faster than current controller response
  - Very few false alarms
  - True positive alarms
Data from Clinical Trials (12 subjects)

- Breakfast and dinner given with NO meal announcement

- Unannounced meal (50 g CHO)
- Unannounced breakfast (40 g CHO)
- Snack (16 g CHO)
Algorithm and System Alarming

- Slope predicted at each point
  - Threshold
  - Max and min slope

- Algorithm Parameters
  - Subsequent Alarms Required (SAR)
Hypotheses

- **Hypothesis 1**: with SAR 1, the reaction time for detecting a meal will be the fastest, however there will be more false positive alarms.

- **Hypothesis 2**: by using SAR 3, we anticipate a longer reaction time with a greater number of false negative alarms, but less false positive alarms present.
Determining the Best Parameter Settings: SAR

![Graph showing time from meal to alarm for different meals with categories: From meal to alarm 1, From meal to alarm 2, From meal to alarm 3, and Undetected Meals. The graph highlights faster responses and meal numbers from 1 to 24.]
## Results: The Better Detector

<table>
<thead>
<tr>
<th>Number of Alarms Required</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>True Positive Ratio</td>
<td>21/24</td>
<td>21/24</td>
<td>19/24</td>
</tr>
<tr>
<td># of False Positives</td>
<td>1/24</td>
<td>1/24</td>
<td>1/24</td>
</tr>
<tr>
<td>Average Time Difference from Alarm to Insulin Delivery</td>
<td>-11 ± 1 min</td>
<td>-6 ±17 min</td>
<td>3 ± 14 min</td>
</tr>
</tbody>
</table>
Conclusions & Future Work

- Hypothesis 1 unconfirmed: SAR 1 should have had more false positive alarms

- Hypothesis 2 confirmed: SAR 3 had more false negative alarms

- Future Work: Using the basic algorithm as a benchmark for an advanced system
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dedicated to finding a cure
Questions?