The Artificial Pancreas
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- Ryan Tanner - CS
- Aurimas Vinckevicius –
Diabetes

- Body does not make or properly use insulin
- Insulin is a hormone required for the metabolism of sugars
- It is estimated that 20 million Americans have diabetes
Types of Diabetes

**Type 1**
- “Juvenile”
- The body produces little or no usable insulin

**Type 2**
- “Adult Onset”
- Insulin resistance causes insulin to be less useful
Adverse Effects of Diabetes

Hyperglycemia
- High blood glucose
- Effects develop slowly
- Include: ocular neuropathy, poor circulation, and heart problems

Hypoglycemia
- Low blood glucose
- Medical emergency called ‘Insulin Shock’
- Results very quickly in slowed breathing, coma and even death
Monitoring and Delivering

- Blood glucose/insulin levels
- Venepuncture
- Painful and patient compliance suffers
- Non-Invasive techniques must be developed
Steve Almburg
Project Design and Goals

Phase 1
- Research
- Prototype Design
- Market Analysis

Phase 2
- Aesthetics
- Patents
- Customer Analysis
Previous Work

*Spring 2004 - Spring 2005*

- Focused primarily on monitoring
- Combined vacuum, ultrasound, and reverse iontophoresis
Our Work

- “Possibility to Actuality”
- True Artificial Pancreas
  - Monitoring
  - Delivery
  - “The Link”
How it Works

1. Monitor Blood/Glucose Level
2. Determine Amount of Insulin Needed
3. Deliver Insulin
Let B be the basal amount given every 10 minutes.
Let x be the glucose points in the blood at a certain time
Let y be the small amount of bolus given (0.05?)
Let z be the amount of points lowered by y \((X_0 - X_1) = z\)
Let A be the number of points that must be lowered \((A = X-100)\)
Let C be the number of boluses needed to lower the glucose level to normal \((A/z = C)\)

1. Administer B
2. measure X after ten minutes
3. store value of X in an array
   a. if X is between 100-110,
      i. administer y
      ii. calculate A
      iii. measure X every minute for next ten minutes
      iv. store each X in array
      v. average or RMS X values for ten minute interval
      vi. calculate z
      vii. calculate C
      viii. administer C units of y
      ix. store C + 1 in an array
   b. if X is less than 60,
      i. administer glucose injection (Jude)
      ii. measure X after ten minutes
      iii. store X in array
      iv. loop
   c. If other, start program over at step 1
The Artificial Pancreas

- Better Control
- Flexibility
- More Freedom
- Outward signs of Diabetes
Other Insulin Delivery Methods

- Insulin pens
- Inhaled delivery
- Jet injectors
Ideal Pump Candidates

- Have realistic expectations
- Ability to problem solve
- Accepting of the disease
- Self motivated
- Mature
<table>
<thead>
<tr>
<th>Feature</th>
<th>Deltec</th>
<th>MiniMed</th>
<th>IPRO 308 - Artificial Pancreas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Invasive</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Glucose Monitoring System and Insulin Pump together</td>
<td>Can be attached to the pump</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Waterproof</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Can be used on airplanes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
## Comparison of Insulin Pumps

<table>
<thead>
<tr>
<th></th>
<th>MiniMed’s Paradigm</th>
<th>MiniMed’s Guardian</th>
<th>Dexcom STS</th>
<th>IPRO 308 Artificial Pancreas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batteries for monitor</td>
<td>No separate monitor</td>
<td>2 AAA batteries</td>
<td>Chargeable batteries that need recharging every 5 days</td>
<td>Lithium ion rechargeable</td>
</tr>
<tr>
<td>Communicate With the insulin pump</td>
<td>Yes, with Paradigm 522 &amp; 722</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
The Past, The Present, The Future

Past
- Non-Invasive Glucose Monitoring

Present
- Non-Invasive Glucose Monitoring and Insulin Delivery

Future
- Aesthetics, Features, Patents and Grant Proposals, BME Competition
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