A Near-Infrared Fluorescence Detector for Glucose Monitoring

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Minimally-Invasive Glucose Detection

We seek to design a portable near-infrared (NIR) fluorescence detection unit that will interface with an implantable glucose sensor previously developed and published by BioTex, Inc. The device will provide a simple, minimally-invasive alternative to current glucose monitors.

Diabetes: A Looming Epidemic

• Approximately 20 million Americans, 300 million worldwide suffer diabetes.
• Glucose levels are monitored to determine the appropriate insulin treatment.
• Most monitors involve self-administered, invasive, frequent blood withdrawals (“finger-prick” method).
• Minimally-invasive designs measure interstitial glucose.

Current Non-invasive Device Limitations

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<tr>
<th>Method</th>
<th>How it Works</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Dermal Trans-</td>
<td>Draws interstitial glucose through skin using</td>
<td>• Pads last only 13 hours.</td>
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<td>phosphoresis</td>
<td>electrostatic charge.</td>
<td>• Each pad requires calibration.</td>
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<td>Glucose Oxidase</td>
<td>Measures glucose oxidase activity with trans-dermal implant.</td>
<td>• Gels cause skin irritation.</td>
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<td>Activity</td>
<td>• Calibration required every 12 hours.</td>
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<td>• Implant must be replaced every 3 days.</td>
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BioTex Optical FRET Sensor

The BioTex sensor.

• Small, subcutaneously implantable sensor.
• The sensor is excited at 650 nm and emits a 675 nm glucose-dependent signal and a 715 nm reference signal.
• Emission of the NIR radiation occurs when fluorescence resonance energy transfer (FRET) between dyes is impaired by glucose binding.
• The fluorescence signal intensity ratio is dependent on interstitial glucose concentration.
• Allowing for real-time monitoring of glucose concentration.

BioTex Sensor's emission spectrum.

• Allowing for real-time monitoring of glucose concentration.

BioTex – Dr. Ralph Ballerstadt, Dr. Bill Jackson, Dr. Ashok Gowda, Dr. Roger McNichols, and Colton Evans
Rice University – Dr. Maria Oden, Carlos Amaro, Joseph Gesenhues, Tim Muldoon, Mark Pierce, and Margaret Bate

Conclusions

• Our current device can differentiate between fluorescence intensities of model dyes.
• Our detector is capable of measuring fluorescence at the wavelengths associated with the FRET glucose sensor.
• Increased sensitivity is needed to adequately determine dye concentrations.
• Future work includes calibration and personalization models, in vivo animal testing and FDA and FCC approval.

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References