Insulin Pumps, Sensors, and Bluetooth

Angela Temm-McBane, BSN, RN, CDE
Erica Page, BSN, RN, CDE
John Devlin, MD, MPH, FACP
History of Pumps
iLet
Spectrum of closed-loop systems

Full OL  Auto-  Hybrid CL  Full CL
SAP     Suspend

Automation
System Complexity
Sensor-augmented pump therapy
MiniMed CSII + Enlite CGM
Sensor-augmented pump
Auto-suspend

• Threshold suspend

• Predictive low glucose suspend (PLGS)
MiniMed 530G + Enlite CGM
Threshold suspend
Predictive Low Glucose Suspend (PLGS) reduces nocturnal hypoglycemia

Reduction in hypoglycemia > 2 hours

- Ages 15-45: 74% reduction
- Ages 11-14: 62% reduction
- Ages 4-10: 53% reduction

Messer L. ADA Annual Meeting, 2015; Maahs D. Diabetes Care 2014;37:1885-91
Bihormonal closed-loop

• Glucagon

• Other
  – liraglutide
  – Amylin-like peptide
Outpatient Glycemic Control with a Bionic Pancreas in Type 1 Diabetes


A Mean Glucose Levels in Adults

B Mea Glucose Levels in Adolescents
Bionic Pancreas
Bionic Pancreas
Sensor Glucose Levels and Insulin Delivery.

A  Adults

B  Children and Adolescents

Bionic Pancreas: Feedback from the interviews

- Improved BG control
- Decreased glycemic variability
- Nice to wake up in good control
- Less time missing out on things to treat lows
- No longer thinking about what/how much to eat
- Decreased time thinking about diabetes

- Struggles with calibration
- Frustration with alarms
- Frustration with size of devices/discomfort when sleeping
- Too many devices to manage

Weissberg-Benchell J. ADA Annual Meeting, 2015
<table>
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<tr>
<th>Group/Company</th>
<th>Product</th>
<th>Expected timing of a commercially available device</th>
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| Medtronic     | - MiniMed 670G hybrid CL (with Enlite 3)  
               - Fully automated | - US launch expected by April 2017  
               - Following 670G |
| Tandem        | Predictive low glucose suspend of basal CL | Potential launch in 2017 |
| MGH/BU         | Bionic Pancreas (24-hr, hybrid CL, insulin + glucagon, Dexcom G4) | ~ 2018 launch |
| UVA           | DiAs (24-hr or overnight-only, hybrid CL. Dexcom, Roche/Tandem) | Large-scale clinical trials are planned for 2015 and 2016 |
| Animas        | PLGS with Dexcom | Unknown |
| Insulet (OmniPod) | Developing strategies | Unknown |
| Cambridge     | Abbott Navigator CGM | Unknown |
| Roche         | Working internally | Unknown |

http://diatribe.org/taking-artificial-pancreas-home-24-hours-day#sthash.8sn39fyg.dpuf
Why is understanding human factors important?

- Technology holds the promise of less lows, improved glycemic excursion and reduced patient burden.

- But CSII discontinuation rates are high
  - Poor glycemic control
  - Poor body image
  - Frustration with daily regimen demands
  - Diabetes-specific emotional distress
  - Annoyance with alarms/site insertion challenges

- But CGM discontinuation rates are high
  - Alarms don’t prevent lows (ignoring, delayed response, sleeping through)
  - Data is overwhelming
  - Need to use 6 days/week to be useful. Most do not use it that long.

Weissberg-Benchell J. ADA Annual Meeting, 2015