Insulin Pump Therapy and New Technologies in the Treatment of Patients with Diabetes.
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Objectives
- Promote understanding of existing and new technologies in the treatment and management of patients with diabetes including Insulin Pumps, Continuous Glucose Sensors, new meters and insulin calculators and Digital Applications.
- Identify components of an insulin pump and how it works
- Advantages and disadvantages of pump therapy
- Understand the alternate insulin delivery systems.
- What is in the future???

Times and Technology have Changed since Insulin was 1st used.

Insulin discovered in 1921 by Frederick Banting and Charles Best

Times and Technology have Changed Since insulin was 1st Developed.

This was from the 1960's

Times and Technology have Changed Since Insulin was 1st Developed.

Insulin Syringes

Sizes of Insulin Syringes available

Times and Technology have Changed Since Insulin was 1st developed.

Insulin Pumps

Types of Insulin Pumps available
INSULIN PUMP

- First insulin pump – late 1960’s/early 1970s
- Initial excitement waned off because of size, safety, efficacy and complications


Early Insulin Pumps circa 1977 and 1978

Insulin Pumps available in the US Today

- Animas
  - One Touch Ping
  - Animas Vibe System
  - Insulet Omnipod
- MiniMed
  - MiniMed Bevel
  - Medtronic 530G with Enlite
  - Medtronic 630G with Enlite
  - Medtronic 670G G Hybrid Closed Loop System—Available Spring 2017
  - Roche Accu-Chek Combo
- Tandem
  - T-Slim
  - T-Slim G4 with CGMS
  - T-Flex has a larger reservoir to allow for patients with insulin resistance and Type 2 diabetes
  - T-slim X2™ Pump schedule for release in Mid-October 2016

Components of Insulin pump

- Insulin pump
- Reservoir
- Infusion set or Pod
- Change every 2 to 3 days

Basics of Insulin Pump Therapy

- **Basal rate:**
  - Continuous flow of insulin from pump to patient.
  - Usually about 50% of total daily dose.
  - This is background insulin.
  - Controls blood glucose in a fasting state.
  - Different rates can be programmed throughout the day to deal with variable need.
  - It mimics the steady and small amount of insulin secreted by pancreas throughout day and night.
  - Very precise delivery.
  - Eliminates large insulin depots.
  - Greatly reduces risk of lows.
Basics of Insulin Pump Therapy

- **Bolus**:  
  - **Meal**: amount of insulin given before meal to "cover" food eaten. A.K.A. Insulin: CHO ratio  
  - **Correction/Sensitivity**: amount of insulin given to correct for high blood glucose levels. Think of it as the Sliding scale or correction scale with multiple daily injections  
  - **Targets**: the blood glucose level you are aiming for  
  - **Insulin Action**: Effects the amount of correction that can be given and helps to prevent 'stacking' of correction boluses that leads to lows. It will calculate how much active insulin is on board and not allow extra to be given. The usual setting is 3 to 4 hours. It may be longer if the patient has renal failure.

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Advantages

- Using an insulin pump means eliminating individual insulin injections  
- Pumps deliver insulin more accurately and precisely than injections  
- Decreased incidence of severe hypoglycemia  
- Can be programmed to increase or decrease to follow circadian rhythm  
- Ideal for athletes/exercise to decrease insulin delivery during an event or after  
- Meal time doses can be delivered over a period of time instead of all at once—i.e. if the patient has gastroparesis. Varied and prolonged bolusing for high-fat meals  
- Insulin pumps often improve A1C and glycemic control  
- Insulin can be billed thru Medicare Part B, rather that Part D and thus does not impact the pharmacy benefit/donut hole for Medicare patients and often provides a cost savings with only having to have 1 type of insulin.

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Disadvantages

- DKA- pump only delivers short acting insulin so there is a potential for rapid onset of significant hyperglycemia and diabetic ketoacidosis if insulin delivery is interrupted  
- Catheter site infection  
- Contact dermatitis  
- Something is always attached to the person  
- Cost (pump $4500-$8500+; yearly supplies ~ $1,500.) That does not include the cost of sensors. Some of the pump companies have patient assistance plans. Sensors are generally not covered by Medicare. Often covered by Medical Assistance.  
- Sometimes a pump is cheaper that MDI as supplies are Durable Medical Equipment and may be covered well by insurance and only 1 type of insulin is needed

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Medtronic Insulin Pump Therapy Today

**MiniMed Paradigm® REAL-Time Revel™**

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Insulin Pump Therapy Today

**Medtronic MiniMed 530G with Enlite Sensor**
Medtronic MiniMed 530 G Pump and Enlite Sensor and Connect Transmitter

Medtronic MiniMed 630 G

Medtronic Glucose Sensor and Transmitter

Medtronic Enlite Glucose Sensor

Insulin Pump Therapy Today
Medtronic MiniMed 670 G
Available in the spring of 2017

- It is a Hybrid closed loop system
- Available in the Spring 2007
- Has the Smart Guard technology with the low suspend capabilities
- Allows patient and Health Care provider to choose from increasing levels of automation that best fit their diabetes management needs
- Features the Guardian Sensor 3, Medtronic’s newest sensor with a longer 7 day life

THE MINIMED® 670G SYSTEM
THE WORLD’S FIRST HYBRID CLOSED LOOP SYSTEM

Maximizes time in target range
- SmartGuard HCL Technology
- Automated basal delivery
- Predictive low glucose suspension
- Displays on low
- More consumer-friendly design
The Medtronic MiniMed 670G is considered a “hybrid closed loop” system because it is not fully automated – it still requires manual food and correction insulin boluses, as it only automates basal insulin. This means the 670G will take care of insulin dosing in the background (on top of boluses), which is particularly valuable at night, and can help mitigate many highs and lows during the day. Food boluses will also benefit from an automated system that works between meals. For example, if a user took too much or too little insulin for a meal, the system might reduce or increase insulin delivery to keep glucose in range.

The pivotal study suggested that this hybrid closed loop approach significantly improves blood sugars and safety. Adolescents and adults spending three months on the Medtronic 670G saw:

- 0.5% reduction in A1c, bringing participants from a low initial A1c of 7.4% to 6.9%;
- 44% less time spent with low blood glucose (under 70 mg/dl);
- 11% less time spent over 180 mg/dl and an 8% improvement in time-in-range (71-180 mg/dl);
- Much better overnight glucose levels.

Of the 124 people in the trial, 80% opted to continue using the device through the FDA’s continued access program – encouraging enthusiasm for the system plus FDA comfort with real-world use of the device.
Insulin Pump Therapy Today
Animas One Touch Ping

- Approved for use in all ages, pediatric through elderly

Insulin Pump Therapy Today
Animas Vibe with Dexcom G4 Sensor

- Approved for use in ages 2 and older

Dexcom sensor

Animas Insulin Pump Therapy In the Future

- Animas has a Hybrid Closed Loop Hypo/Hyper system with built-in Hypoglycemia-Hyperglycemia Minimizer algorithm before the FDA at this time.
- Animas pump - Dexcom CGM
- Approval is pending
**Insulin Pump Therapy Today**

**Insulet Omnipod Tubeless Insulin Pump**

- Tubeless device
- Waterproof
- Auto-Cannula insertion, Hands free
- Approved in all ages, Pediatric through elderly

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**Insulet’s Commitment to Meaningful Innovation**

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**Insulin Pump Therapy Today**

**Roche Accu-Chek Combo**

- Approved in all ages, Pediatric through elderly

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**Future Plans for Roche**

Working internally on a new CGM, with future potential application to an artificial pancreas device.

CGM expected to launch in Europe in 2016
**Tandem T:Slim X2™ Pump**

- **COMING SOON!** Slated for mid October
- Next-generation
- T:slim X2™ Pump
- Compatible with Tandem Device Update

**Tandem Launching in mid October**

- The Tandem Device Updater is a tool for the remote update of Tandem insulin pump software, allowing users to update their pump from a personal computer as new features are cleared by the FDA. This tool allows patients access to new and enhanced features faster than the industry has been able to in the past, and separate from the typical multi-year warranty cycle.
- Just like you update the software on your cell phone or other electronics, you will be able to update the operating system of your pump.
Tandem Insulin Pump Therapy Today

- Tslim Approved ages 6 and up
- TslimX2 Approved in ages 12 and up
- Tslim G4 Approved ages 12 and up
- Tflex Approved ages 12 and up

Tandem Therapy in the Future

- The first software update, planned for FDA submission later this year, will be integration with the Dexcom G5® Mobile CGM system which they anticipate rolling out in mid-2017.
- Tandem and Type Zero Technologies have a license agreement to accelerate development and commercialization of closed loop system. They are partnering with Stanford for “AP” (artificial pancreas) development. Another term is “automated insulin delivery”.

Tandem Future Plans

- Tandem t:slim pump with built in predictive low glucose suspend algorithm; Dexcom CGM
  - Pivotal trial in 2016, potential launch in 2017
- Tandem t:slim pump with built in Hypoglycemia-Hyperglycemia Minimizer algorithm; Dexcom CGM
  - Pivotal study in 2017, potential launch by end of 2018

Insulin pump therapy in the future

- There are at least 18 systems in various stages of development that are addressing the hybrid closed loop or artificial pancreas technology with the goal for a truly closed loop automated system.

The Artificial Pancreas

- The development of automated insulin delivery comes with many names like:
  - Artificial pancreas
  - Bionic Pancreas
  - Closed-loop device
- While the name “artificial pancreas” may bring to mind the dream of an implanted pancreas-substitute that works just like a biological pancreas would, we are still not there yet.
- Current systems involve the use of devices - insulin pumps, Continuous Glucose Monitors (CGM) and software algorithms that decide how much insulin (and in some cases, glucagon) to deliver.

International Diabetes Closed Loop (IDCL) Consortium (TypeZero, UVA, and nine other academic institutions), Cellnovo, Beta Bionics, Bigfoot Biomedical and Cambridge

All of these companies are in various stages of pump, sensor, dual chamber, hybrid or closed loop systems and may be available from 2017 through 2019 often using pumps, sensors, patch devices or smartphone applications.
Insulin-only or insulin+glucagon?
- Ultimately it may come down to patient preferences.
- There will be some patients who may want the extra glycemic control offered by the dual hormone approach and will be willing to accept a bit more risk or a more aggressive algorithm.
- Bionic Pancreas could be especially helpful for those with hypoglycemia unawareness, a sizeable percentage of patients.
- Ultimately, cost considerations may present the largest factor in adoption. The Bionic Pancreas certainly brings multiple cost elements to consider – glucagon, a dual-chambered pump, custom infusion sets, potentially higher training, etc. It's hard to know at this point how the relative costs/benefits will exactly compare.

Continuous Glucose Monitoring (CGM) Components
- Glucose sensor
- Transmitter
- Small external monitor (may be built into an insulin pump or a stand-alone device)
- A monitor may not be needed as it may connect to the patient's smart phone.

Continuous Glucose Monitoring (CGM) Components

Dexcom G4 Glucose Sensor and Transmitter
- Allows the sensor data to be shared remotely with up to five people to follow a patient's glucose data and trends from their compatible smart devices.

CGM vs. Finger stick

<table>
<thead>
<tr>
<th>Features of testing method</th>
<th>Finger stick testing</th>
<th>CGM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of glucose readings done per day</td>
<td>2 to 4</td>
<td>Up to 24/7</td>
</tr>
<tr>
<td>Shows direction glucose is headed?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Shows speed of glucose changes?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Has low and high glucose alerts?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Displays real-time glucose readings over numerous time spans?</td>
<td>No</td>
<td>Yes — graphs showing your trend over the past 1, 3, 6, 12, or 24 hours</td>
</tr>
</tbody>
</table>

Dexcom G4 Glucose Sensor and Transmitter

CGM vs. Finger stick

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Dexcom G4 Glucose Sensor and Transmitter

CGM vs. Finger stick
Dexcom G5 Mobile CGM System
Glucose Sensor/Receiver/Transmitter

The Dexcom G5 Mobile app is an application for compatible smart devices. View real-time glucose data and trends on your phone and choose to share your data with loved ones and caregivers.

Dexcom G5

The Dexcom G5 Mobile app

The Dexcom G5 Mobile app is an application for compatible smart devices. View real-time glucose data and trends on your phone and choose to share your data with loved ones and caregivers.

Dexcom Follow app

Allow up to five people to remotely follow your glucose data and trends from their compatible smart devices.

Dexcom CLARITY®

The Dexcom CLARITY® web-based software platform simplifies diabetes data reporting and management for patients, caregivers and healthcare professionals—providing relevant glucose insights in minutes. Access and track data, anywhere, anytime. Email and download PDF reports. Timesaving tools (like sending and reviewing data before a doctor’s appointment).

Dexcom

A US Food and Drug Administration (FDA) advisory panel in July, 2016 voted in favor of allowing the Dexcom G5 Mobile continuous glucose monitoring (CGM) system to be used as a replacement for fingerstick glucose monitoring in patients with diabetes, based on safety, efficacy, and that the benefits of the proposed new indication would outweigh the risks.

Dexcom continued....

Currently, the Dexcom G5 CGM is indicated for adjunctive use along with self-monitoring of blood glucose (SMBG), done using a fingerstick test, to provide trend information and alert the patient of high and low blood glucose values. If the FDA follows the panel’s advice, the new indication would allow patients to skip the premeal fingersticks and instead use the CGM’s data to determine their insulin doses, as well as make other lifestyle decisions such as whether to exercise.
Dexcom in the Future

- DexCom is sharing its technology with various insulin pump makers that are developing their own artificial pancreases, including Insulet, Animas, Tandem, as well as other companies.
- Insulet (Omnipod) plans to begin clinical trials for its artificial pancreas this year, and potential commercialization in 2018;
- Tandem also hopes to begin clinical trials this year, and it's targeting a launch in late 2017.

Who Benefits from CGM

- People who want to decrease their A1C without increasing risk for lows
- People with frequent lows or hypoglycemic unawareness
- People with fluctuating BG levels
- Are pregnant or thinking about becoming pregnant

CGM Continued...

- Sensors can be used in 1 of 2 ways
  1) Personal - Purchased for day to day use at home. Reports may be sent to providers office for review
  2) Professional - Sensor is placed in the clinic and worn for 3-7 days. Reports printed out and reviewed with patient. There is now a recently approved Professional Sensor that can give 14 days of continuous data.

Newly approved by the FDA--Abbott’s FreeStyle Libre Pro™ System

- FREESTYLE LIBRE PRO IS A CONTINUOUS GLUCOSE MONITORING (CGM) SYSTEM DESIGNED TO PROVIDE A CLEAR, VISUAL SNAPSHOT OF A PATIENT’S GLUCOSE LEVELS, TRENDS AND PATTERNS FOR UP TO 14 DAYS
- REQUIRES NO FINGERSTICKS TO CALIBRATE THE SYSTEM – THIS IS DIFFERENT FROM OTHER PROFESSIONAL USE CGM DEVICES
- LOWER COST THAN OTHER PROFESSIONAL CGM SYSTEMS
- CONSUMER VERSION OF THE TECHNOLOGY, FREESTYLE LIBRE™, IS CURRENTLY UNDER REVIEW BY THE FDA

Abbott’s FreeStyle Libre Pro™ System
Abbott’s FreeStyle Libre Pro™ System

- The FreeStyle Libre Pro is a blinded (non-real-time) system.
- Place a small round sensor on the arm of a person with diabetes, and following two weeks of wear, use a reader device in the office to download 14 days of glucose data.
- While wearing the sensor at home, users do not need to enter any fingerstick data or carry around a receiver – Libre Pro collects all glucose data automatically.
- Once the sensor is downloaded in the office, healthcare providers receive a visual report (called an “Ambulatory Glucose Profile”) that shows trends and patterns in glucose levels, time-in-range, high and low blood sugars, and glucose variability from the two weeks during which the sensor was worn.

CONSUMER VERSION OF THE FREESTYLE LIBRE

- Not available at this time. Currently on review with the FDA
- FreeStyle Libre includes a glucose sensor worn under the skin and connected to a water resistant, plastic on-body patch the size of a one-dollar coin. The sensor remains inserted for 14 days and does not require fingerstick calibrations (it’s “factory calibrated”). After putting it on the upper arm and waiting one hour, it immediately begins reading glucose and trend information. FreeStyle Libre is approved for dosing insulin except in three cases when a fingerstick is recommended: when hypoglycemic, when glucose is changing rapidly, or when symptoms don’t match the system’s readings.

CONSUMER VERSION OF THE FREESTYLE LIBRE

- To use FreeStyle Libre, users take a touchscreen reader device, hold it near (within 1.5 inches) the sensor patch, and wait for it to beep. In less than a second, they can see their real-time glucose value (e.g., 102 mg/dl), a glucose trend arrow (e.g., rising), and a trend graph showing the last eight hours of data. The reader device displays reports on its screen that can be downloaded to Mac and PC-compatible software. The system is currently available in Europe for people with both type 1 and type 2 diabetes.

Other Devices to Deliver Insulin

V-Go Disposable Insulin Delivery Device

Smart Meters and Calculators

Accu-Chek Expert

Smart Meters and Calculators

Accu-Chek Connect
Accu-Chek Connect combines three products into one system:
- The Accu-Chek Aviva Connect blood glucose (bG) meter,
- The Accu-Chek Connect mobile app;
- The Accu-Chek Connect online web portal.

Accu-Chek Connect app

Main features
The Accu-Chek Connect diabetes management app is a key component of the Accu-Chek Connect system, providing seamless connectivity of diabetes information from the meter to the cloud.

- Accu-Chek Bolus Advisor - update coming Nov. 2016 *Expanded for use with both carb counting and fixed meal dose patients
- Structured testing reports and reminders
- Logbook and trend graph
- Automatically text bG results to caregiver
- Ability to add images to bG results

Digital Diabetes Management Tools: There’s an App for that!

- Glooko
- Glucose Buddy
- mySugr Diabetes Logbook
- Weight Loss Coach by Fooducate

Digital Diabetes Management Tools: There’s an App for that!

- Diabetic Connect
- Calorie Counter PRO
- My Fitness pal
- Accu-Chek Connect

- Go meals
- On Track
- Carb Counting with Lenny
- American Diabetes Association
Other new products
- GLP-1 and GLP-1/Basal Combos
  - Lyxumia (lixisenatide) a new GLP-1-approved by the FDA
  - Lixilan, (Lyxumia+Lantus/lixisentatide+glargine) Pending FDA approval. Set for review in November
  - Xultophy (Victoza+Tresiba/Liraglutide+Degludec) received a positive 16-0 vote in favor of approval from FDA Advisory Committee. Full approval is pending.

Other new products
- Lilly’s new basal insulin, Basaglar – a form of insulin glargine was approved by the FDA and will be available in December.
- Other companies are preparing for a rollout of their own forms of insulin glargine, we hope that choice in basal insulin therapy will increase for patients and that prices...perhaps...decrease.

Other new products
- A Canadian company, Locemia is studying nasal glucagon. Easy to carry, easy to dose, easy to implement, it could be a life-saving, every-second-counts emergency treatment fairly fool-proof to administer.
- Eli Lilly has acquired the rights to Locemia’s novel nasal glucagon.

Questions???