Diabetes: What You Know and What You Don’t Know You Don’t Know

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Former Diabetes Outcome Manager, managed over 2000 diabetes patients, with education classes in private practices of primary care physicians and endocrinologists.

Editor in Chief – Diabetes In Control.com
Polling Question

What color is a yield sign?
### Objectives:

At the end of this presentation the attendees should be able to:

- Describe the increased incidence, severity and cost of diabetes, and complications and comorbidities associated with diabetes.
- Explain diagnosis criteria and methods of diagnosis, and how to identify diabetes sooner.
- Decipher the data to determine if Type 1 or Type 2 Diabetes.
- Understand how socio-economic factors and ethnic beliefs influence the concern and treatment of diabetes.
- Describe food and activity choices to help patients and explain how they affect diabetes.
- Describe the medications for diabetes and which ones to choose first or mix.
- Explain how combining products can improve care and reduce costs.
- Describe Insulin delivery technology and how to educate patients.
- Understand how the Pandemic has affected and will continue to affect diabetes patients.

### Conflict of Interest

- I have no conflict of interest and am receiving no funding from any company or product in the presentation.
- I may be making off-label claims.
- Permission to use the personal information presented in this presentation has been received and is available upon request.

### Questions

- Will the same food in same quantity have the same effect on glucose?
- Do Type 2 patients ever start on insulin the first day of diagnosis?
- What is the difference between a patient with Type 1 and Type 2?
- Can Type 2 patients become Type 1?
- Do patients typically stay on their diabetes medications?
- Can too much information for patients cause problems?
- Do older patients readily accept new technologies?
- Does activity always lower blood glucose?
- Can a patient reduce insulin resistance?
We Have an Epidemic

Average age of Type 2 Diabetes in 1990 was 57, in 2017 it was 45
A form of Type 1 called latent autoimmune diabetes in adults, or LADA occurs in patients 35 or older and is increasing in incidence yearly

Diabetes Is Serious Business

- Only 55% of people with diabetes remain on therapy after 12 months
- There are significant knowledge deficits in 50-80% of individuals with diabetes
- Most Hospitals and Clinics do not offer diabetes education
- Pharma support for diabetes care has all but disappeared
- Each $1 spent on outpatient diabetes education saves $2-3 in hospitalization costs
- Diabetes costs $327 billion/year* 12% from medications and supplies
- The cost of an average hypoglycemic or DKA hospitalization is over $17,000 after contract deductions
- Costs for diabetes patients are 230% greater than non-diabetes patients

ADA 2018-2020

Natural History of Type 2 Diabetes
Progression: Beta Cell Failure and Insulin Resistance
Know Your Numbers

A1c and SMBG

If you can’t measure it you can’t fix it

A1C level

Fasting/preprandial glucose

Postprandial glucose

*The A1C goal for patients in general is an A1C goal of 7%. The A1C goal for the individual patient is an A1C as close to normal (6%) as possible without significant hypoglycemia.


Recommendations for Patients With Diabetes

<table>
<thead>
<tr>
<th>Glucose Level</th>
<th>Normal</th>
<th>&lt;7%*</th>
<th>&lt;6.5%</th>
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<tr>
<td>Fasting/preprandial</td>
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<td>&lt;100</td>
<td>&lt;110</td>
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<tr>
<td>Postprandial glucose</td>
<td>&lt;180</td>
<td>&lt;140</td>
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*The A1C goal for patients in general is an A1C goal of 7%. The A1C goal for the individual patient is an A1C as close to normal (6%) as possible without significant hypoglycemia.

Lower-extremity amputation or fatal peripheral vascular disease

Cataract extraction

Heart failure

Myocardial infarction

Stroke

Cardiovascular complications

UKPDS: 1% A1C Decrease and Reduced Risk of Complications

43% 37% 19% 16% 14% 12%

Microvascular disease

Cataract extraction

Heart failure

Myocardial infarction

Stroke

UKPDS = United Kingdom Prospective Diabetes Study.

*P<0.05; †P<0.0001.
Glucose Monitoring Has Helped Identify Many of These Patients

- In 1500 B.C. High Glucose was identified by ants going to a person's urine
- In 400 B.C. Physicians were tasting urine to diagnose diabetes
- "Water testers" used to diagnose up until the 17th century.
- 1776 - sugar actually identified in the urine by Matthew Dobson
- Early 1800s: 1st chemical tests to detect sugar in urine
- 1915 - Benedict's reagent is used as a test for glucose in urine - testing becomes more common.
- 1941 - Clinistest tabs are available and you can boil urine and get a quantitative glucose value

Rite Aid TrueMatrix Meter

- Best for budget
- Basic and affordable
- Programs four reminders' alarms
- Process results in 4 seconds
- Stores up to 500 test results
- Cost $15.99
OneTouch Verio Reflect Blood Glucose Monitor

- Blood sugar mentor feature provides insights, guidance and encouragement
- Indicates when results are high, low or in range
- Connects wirelessly with OneTouch app
- Cost $34.49

Care Touch Blood Glucose Monitoring System

- Easy to use, affordable all-in-one kit
- Provides 14 days reading average
- Stores up to 300 readings at a time
- Process result in 5 seconds
- Cost $39.99

Software Applications for Diabetes Management

- These diabetes management apps help patients to:
  - Track
  - Analyze and
  - Share their diabetes data with their healthcare providers
- Diabetes data includes:
  - Blood glucose readings
  - Insulin intake information
  - Diet and exercise tracking,
  - A1c records.
Available Software Applications For Diabetes Management

- Some of the most popular apps available:
  1. Tidepool
  2. mySugr: Diabetes Tracker Log
  3. Dario
  4. Glucose Buddy
  5. OneDrop
- Others include:
  1. Glucose
  2. Glooko
  3. Sugarmate

The World of Connectivity

All at the touch of a button
Dario Capabilities
- Used with Dario glucose monitoring system
- Others: requires manual entry of blood sugar
- Integratable:
  - RunKeeper (exercise tracking app)
  - Apple Health
- Compactible:
  - Android
  - iPhone
- Free download

OneDrop Diabetes Capabilities
- Can synchronize with:
  - Dexcom
  - Fitbit
  - Google Fit
  - Apple Health data
- Diabetes Coaches:
  - 24 hours for $19.99/month
- Compactible:
  - iPhone
  - Android
- Free download

Tidepool Capabilities
- Synchronizes readings from:
  - Blood sugar meters
  - CGM
  - Bolus and basal insulin rates
  - Carbohydrates amount from insulin pumps
  - Share diabetes data
- Compatible with:
  - Abbott (FreeStyle Libre), Bayer, Dexcom, Medtronic (Guardian Connect), Omnipod, Tandem, Apple Health and more.
  - Tidepool Web, Tidepool Mobile, and Tidepool Uploader are available at no cost to you.
Glucose Monitor Accuracy Is Good, Sample Size Is Small And Coding Is Not Necessary
- Fast Test Time – most 5 seconds or less
- Small Blood Sample – 0.3-0.7 microliters
- Alternate Site Testing - Decreases pain associated with testing
- No Coding Needed - Accurate and precise tests
- Most monitors link to phones to provide information and recommendations

Why would patients even use them?
- Patients often have no reason to monitor
- Patients often never see the value of their testing
- Patients don’t know what to do with the readings if they take them
- The pain is not worth the effort

We know the reasons
- Evaluate food choices
- Evaluate exercise
- Evaluate medication
- Check for hypoglycemia
It all makes perfect sense to us but………

Do the patients care?

We need to give them reasons
Would they drive without these?

When do we look at these the most– When we are at 10 or at 80?
So where’s the comparison

• Most patients test when they get up and see the best reading.
• But they look at their speedometer when they are going the fastest.
• Testing post-prandial is like looking at your speedometer, you want to know the highest number.

So here’s the comparison

• Patients eat a meal and wonder what effect the food has.
• They check before they eat and 2 hours after.
• If the reading is too high, what could they do?

Why will this work?

• Everyone gets feedback on what they do.
  • Their check stub
  • How far they ride
  • How many sit-ups
  • Their bowling average
  • Their 401k

• So why not their food choices

Reading Food Labels to Manage Glucose

• How to read a food label in relation to Diabetes:
  
  Most important value
  Higher the value, slower glucose absorbed, can be slowly converted to glucose if no carbs are ingested for many hours
  Higher the value, slower glucose absorbed, can be slowly converted to glucose if no carbs are ingested for many hours

  No real effect on glucose
  Higher the value(s) larger rise in glucose
  Non-Digestible carbs may be subtracted from total

  Some foods have Sugar Alcohols which are non-digestible and can be subtracted from total carbs

https://www.youtube.com/watch?v=am6ga3tSnpk
Most people only eat 35-40 different foods
Most Similar foods have the same effect on glucose

- Fast Food Cheeseburgers
  - McDonalds 33g
  - Burger King 32g
  - Hardee’s 38g

- French Fries Small
  - McDonalds 29g
  - Burger King 38g
  - Hardee’s 37g
- The large size has 97g

Many Restaurants have added menu items that are low carb so the can be Keto-Friendly

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There is an Easier Way

- Patient checks in the morning before eating
- Patient eats breakfast and then checks 2 hours later, if glucose is more than 30mg/dl higher then they simply eat a smaller portion
- The smaller portions won’t be enough long term so we need to give them low carb choices.

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Tidbits to Make it Easier

- If it is free to move or you have to chase it to catch it in nature it has no carbs
- A simple rule of thumb, the sweeter the fruit the higher the carbs. 1 grape equals 2 sugar cubes, think about that next time you grab a handful
- Vegetables, if you cook them and they are sweet then everything made from them is high in carbs. Corn is sweet, broccoli, spinach and asparagus is not.
- Beware of eating sugar free foods as they are not carb free. How could a cookie that is full of flour be okay if you take the sugar out of it, when flour is very high in carbs?
- Single serving foods are not always one serving. A 20 Oz Coke or Pepsi looks like 1 serving but is really 2.5 but Diet is zero.
Blood Glucose Testing

When to monitor
• There is no absolute recommendation
• Testing times may depend on:
  • medication regimen
  • age
  • stability of blood glucose
  • personal preference
  • finances

*Testing is to benefit the patient, not satisfy the medical practitioner!*

BUT WHY FINGERSTICK AT ALL??

**Continuous Glucose Monitoring Systems**
• Years in the making
• Long road to accuracy
• Never expected to be mainstream
• Will insurers pay
• Will patients Use
• Is too much knowledge a bad thing.

Guardian Connect CGM
• Provides detailed data tracking
• Compiles time in range data
• For age 14 and above
• Sensor change every 14 days
• Customizable predictive alerts (10-60 minutes before a high or low)
• Cost $279.99
CGMS
Continuous Glucose Monitoring Systems
Medtronic Guardian Connect

Continuous readings, low or high glucose alarms, predicts trends, works directly with phones, last 7 days, must be calibrated with finger sticks q12h.

https://www.youtube.com/watch?v=eaT7dD7yH2U

Dexcom G6 CGM

• Most reliably accurate CGM
• Transmits data automatically every 5 minutes
• Share your data with up to 5 people
• Customizable alerts and alarms
• Downloadable app for smartphone, tablet, or smartwatch
• Complements other devices like insulin pumps
• Cost $319.99

https://www.youtube.com/watch?v=ozoVpPULySo

Continuous readings, low or high glucose alarms, predicts trends, works directly with phones and watches, last 10 days, no finger sticks required, readings shared with others via phone app.

https://www.youtube.com/watch?v=eo0vP5UvSg
CGMS
Dexcom G6
Continuous readings, low or high glucose alarms, predicts trends, works directly with phones and watches, last 10 days, No finger sticks required.

FreeStyle Libre CGM
• Best CGM
• Use interstitial fluids
• Need to reapply new sensor every 14 days
• Optional alarms for out-of-range glucose level
• Stores up to 90 Days of glucose reading
• Cost $299.95 for reader with 28 days sensor kit

Eversense CGM
• Long lasting CGM
• Applied at the doctor's office
• Sensor implanted subcutaneously for 90 days
• Sends data to smart device automatically every 5 minutes
• Vibrates if blood glucose falls out of range
• Eversense Bridge program cost patients $99 initially
Ultimate CGM Users - Team Novo Nordisk

The all-diabetes men’s professional cycling team races on the International Cycling Union (UCI) Professional Continental tour, competing in major professional races around the world.

Diabetes Drug Combinations Now and into the Future
From 1950 to 1995 only 1 oral medication available

Now with 11 classes of Drugs:
Possible combinations: **853,207**

There are 4 new classes that have moved past phase 2 testing and will likely be available in the next 5 years
Possible combinations: **1,544,320**
Medications we have available
Can You Name Them????

- Biguanides. $
- Sulfonylureas. $
- TZDs’ $
- Alpha-glucosidase inhibitors $
- Dopamine receptor agonists $$$
- GLP-1 mimetics $$$
- SGLT-2 Inhibitors $$$
- DPP-4 inhibitors $$$
- Bile acid sequestrant $
- Insulins $ to $$$$
Medications we have available

• TZDs’ $  

Medications we have available

• Alpha-glucosidase inhibitors $  

Medications we have available

• Dopamine receptor agonists $$$
Medications we have available

- Bile acid sequestrant $58

SGLT-2 INHIBITOR
Sodium-glucose co-transporter 2 (SGLT2) inhibitor

What does it do?
SGLT-2 inhibitor is an oral medication used for treating type 2 diabetes

How does it work?
- Preventing kidneys from reabsorbing sugar back into the blood; excess sugar will be removed from the body through urine

Available agents

Canagliflozin (Invokana)
- Dosage form: 100mg and 300mg tablet
- Price:
  - $21.74 per 100 mg tablet; $577 for 30 tablets (GoodRx)
  - $21.74 per 300 mg tablet; $577.34 for 30 tablets (GoodRx)
Dapagliflozin (Farxiga)
- Dosage form: 5mg and 10mg tablet
- Price:
  - $21.31 per 5 mg tablet; $514.30 for 30 tablets (GoodRx)
  - $21.31 per 10 mg tablet; $514.30 for 30 tablets (GoodRx)

Empagliflozin (Jardiance)
- Dosage form: 10mg and 25mg tablet
- Price:
  - $21.94 per 10mg tablet; $529.30 for 30 tablets (GoodRx)
  - $21.94 per 25mg tablet; $529.30 for 30 tablets (GoodRx)

Ertugliflozin (Steglatro)
- Dosage form: 5mg and 15mg tablet
- Price:
  - $12.38 per 5mg tablet; $334.36 for 30 tablets (GoodRx)
  - $12.38 per 15mg tablet; $334.26 for 30 tablets (GoodRx)
• Efficacy: 1% A1C reduction
  o Weight loss 1 – 5 kg
• Additional perks:
  o Jardiance and Invokana: cardiovascular, heart failure and renal benefit
• Dosing:
  o Geriatric: Farxiga not recommended in ages > 65; Invokana or Jardiance have diminished effect in ages > 65

DPP-4 INHIBITORS
Dipeptidyl peptidase-4 (DPP4) inhibitor

What does it do?
DPP4 inhibitor is an oral medication used for treating type 2 diabetes; second-line therapy after metformin failure

How does it work?
Make the body to secrete more incretins (substances that help producing more insulin) to break down the amount of sugar in the blood

Available agents (Brand only)

Sitagliptin (Januvia)
• Dosage form: 25mg, 50mg and 100 mg tablet
• Price:
  • $17.87 per 25mg tablet; $528.66 for 30 tablets (GoodRx)
  • $17.87 per 50mg tablet; $528.66 for 30 tablets (GoodRx)
  • $17.87 per 100mg tablet; $528.66 for 30 tablets (GoodRx)
Saxagliptin (Onglyza)
- Dosage form: 2.5mg and 5mg
- Price:
  - $14.29 per 2.5mg tablet; $432.40 per 30 tablets (GoodRx)
  - $14.29 per 5 mg tablet; $432.40 per 30 tablets (GoodRx)

Linagliptin (Tradjenta)
- Dosage form: 5 mg
- Price:
  - $14.42 per 5mg tablet; $420.10 for 30 tablets (GoodRx)

Alogliptin (Nesina)
- Dosage form: 6.25mg, 12.5mg and 25mg
- Available as generic Alogliptin
- Price:
  - $5.70 per 6.25mg tablet; $171.30 for 30 tablets (GoodRx)
  - $5.70 per 12.5mg tablet; $171.30 for 30 tablets (GoodRx)
  - $5.70 per 25mg tablet; $171.30 for 30 tablets (GoodRx)
GLP-1 Agonists

- GLP-1 agonists are antidiabetic drugs that work by mimicking the effects of the glucagon-like peptide. GLP-1 agonists and endogenous GLP-1 can lower blood glucose levels and help T2DM patients achieve glycemic control by binding and activating GLP-1 receptors.
- These anti-diabetic drugs enhance beta cell proliferation by increasing glucose-dependent insulin secretion from functional beta cells, decreasing glucagon release after meals, lowering hepatic glucose synthesis, delaying stomach emptying, and suppressing hunger.
- A1C reduction of 0.78% to 1.9%

Dulaglutide (Trulicity)

- Injected once weekly
- May cause weight loss in some patients (Up to 10 lbs)
- Price for 4 pens: $734.81
Exenatide extended release (Bydureon)
- Injection once weekly
- Weight reduction up to 3 lbs
- Price for 4 pens: $732.44

Exenatide (Byetta)
- Injection twice daily
- Must use within one hour before eating
- Price for 1 pen: $773.77

Semaglutide (Ozempic), (Rybelsus)
- Injection once weekly
- Reduces the risk of major cardiovascular events, such as stroke, heart attack or death
- Rybelsus taken by mouth once daily
  - Price for 30 tabs of 3 mg: $813.31
  - Price for 30 tabs of 7 mg: $823.68
  - Price for 30 tabs of 14 mg: $ 813.31
  - Price for 2 pens: $846.37
Liraglutide (Victoza)
• Injection once daily
• Reduces the risk of major cardiovascular events, such as stroke, heart attack or death
• Price for 3 pens: $1,061.44

Lixisenatide (Adlyxin)
• Injection once daily
• Must use within one hour before the first meal of the day
• Price for 2 pens: $676.08

Lixisenatide and Insulin Glargine (Soliqua)
• Injection once daily
• Must use within one hour before the first meal of the day
• Price for 5 pens: $769.28

Simple Dosing Algorithm - Adjust Weekly

https://www.soliqua100-33.com/hcp
Liraglutide and Insulin Degludec (Xultophy)

- Injection once daily at any time
- Reduces the risk of major cardiovascular events, such as stroke, heart attack or death
- Price for 5 pens: $1135.44

![Image of Liraglutide and Insulin Degludec (Xultophy)](https://www.xultophy.com/dosing-and-prescribing/dosing.html)

Side Effects - Lessened in the Weekly Dose

- Nausea/vomiting
- Abdominal pain
- Decreased appetite
- Injection site redness
- Diarrhea
- Headache

**Warning s**

- Risk of thyroid C-cell tumors
- Pancreatitis

Insulin Management a Challenge for Clinicians

- Type 1 - maximizing therapy
  - Mixed insulins
  - Basal/ Bolus
- Type 2 — when to start — why start
  - How intense
  - Patient Knowledge
  - Patient Ability
  - Patient buy-in
Overview

- Insulin is a hormone produced by the beta cells of the pancreas. The human body possesses sensors that measure the blood glucose.
- Insulin released is necessary all the time irrespective of the glucose level because it helps move fuel into the muscles. Cells that have insulin receptors are termed insulin-dependent.
- Some cells like the brain, kidney digestive cells, and red blood cells can absorb glucose without insulin production and are called insulin-independent.
- Diabetes
  - deficiency in insulin production,
  - insulin utilization, or
  - glycogen formation
  - Excess carbohydrate absorption

https://www.medicinenet.com/insulin/definition.htm

<table>
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<tr>
<th>Name</th>
<th>Manufacturer</th>
<th>Strength (units/mL)</th>
<th>Onset (min)</th>
<th>Peak (min)</th>
<th>Quantity</th>
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<td>Aspart</td>
<td>Novo Nordisk Inc</td>
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<td>3-5 h</td>
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</tr>
<tr>
<td>Insulin Human</td>
<td>MannKind Corporation</td>
<td>4, 8, or 12 units</td>
<td>1-4 h</td>
<td>12 min</td>
<td>5 pens of 3 mL each</td>
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<tr>
<td>Regular Insulin</td>
<td>Humulin R</td>
<td>100 units/mL</td>
<td>6-10 h</td>
<td>30-60 min</td>
<td>one vial of 10 mL</td>
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<td>Humulin, Eli Lilly</td>
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<td>12-18 h</td>
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<td>Sanofi</td>
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<td>2 h</td>
<td>No peak</td>
<td>324 - 390</td>
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<td>100 units/mL</td>
<td>&gt; 42 h</td>
<td>1 h</td>
<td>No peak</td>
<td>508 - 608</td>
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Some Facts about Insulin Glargine Lantus and Toujeo

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<thead>
<tr>
<th></th>
<th>Toujeo</th>
<th>Lantus</th>
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<tbody>
<tr>
<td>Patient Age</td>
<td>18 years or older</td>
<td>6 years or older</td>
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<tr>
<td>Form</td>
<td>Pen only</td>
<td>Pen and Vial</td>
</tr>
<tr>
<td>Dosage</td>
<td>300 units/mL for high doses</td>
<td>100 units/mL</td>
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<tr>
<td>Shelf life</td>
<td>42 days at room temperature after opening</td>
<td>28 days at room temperature after opening</td>
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<tr>
<td>Dosing</td>
<td>Dial to Lantus dose on pen Same units less volume</td>
<td>Dial to Lantus Dose on Pen</td>
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https://www.healthline.com/health/diabetes/toujeo-vs-lantus#table
### Initiating insulin:

The dose administered is proportional to the patient weight. In general, depending on the severity of the uncontrolled blood sugar, initial dosage for insulin naïve patients:
- Normal weight patients (BMI between 18.5 and 25 kg/m²), 0.2 to 0.4 u/kg/day.
- Overweight patients (BMI between 25 and 30) take a dose of 0.5 u/kg/day.
- Obese patients (BMI > 30) take at least 0.6 u/kg/day.

**Administration route:** subcutaneous

**Site of administration:**
- upper arm,
- the thigh or
- the abdomen

![Insulin Action Curves](https://www.google.com/search?q=insulin+action+curves)

### Table of Insulin Information

<table>
<thead>
<tr>
<th>Name</th>
<th>Manufacturer</th>
<th>Strength (units/mL)</th>
<th>Duration</th>
<th>Onset</th>
<th>Peak</th>
<th>Price ($)</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humulin 70/30</td>
<td>Ely Lilly</td>
<td>100</td>
<td>18–24 h</td>
<td>30 min</td>
<td>30 min</td>
<td>96</td>
<td>1 vial, 10 mL</td>
</tr>
<tr>
<td>Novolin 70/30</td>
<td>Ely Lilly</td>
<td>100</td>
<td>18-24h</td>
<td>30 min</td>
<td>30 min</td>
<td>140 - 150</td>
<td>1 vial, 10 mL</td>
</tr>
<tr>
<td>Humalog 75/25</td>
<td>Ely Lilly</td>
<td>100</td>
<td>14-24h</td>
<td>15-30 min</td>
<td>30 min</td>
<td>140 - 280</td>
<td>1 vial, 10 mL</td>
</tr>
<tr>
<td>Humalog 50/50</td>
<td>Ely Lilly</td>
<td>100</td>
<td>14-24h</td>
<td>15-30 min</td>
<td>30 min</td>
<td>140 - 280</td>
<td>1 vial, 10 mL</td>
</tr>
<tr>
<td>Novolog 70/30</td>
<td>Novo Nordisk</td>
<td>100</td>
<td>18-24h</td>
<td>10-20 min</td>
<td>60-90 min</td>
<td>240-275</td>
<td>5 flexpens, 3 mL each</td>
</tr>
</tbody>
</table>

![Insulin Dosing Chart](https://www.aafp.org/afp/2011/0715/p183.html)
InPen Smart Insulin Delivery System

InPen Reports

When You Don't Have Diabetes
Your Pancreas Works Like This.
Typical Starting Point
Basal Treatment Program with Peakless Long-Acting Analogs Alone

Clinicians often increase long acting insulin to address meal related glucose

Clinicians continue increase long acting insulin to address meal related glucose

Verbal communication from Bode, BW. Atlanta, Ga; Feb. 2003.
Clinicians then finally add prandial insulin to address meal related glucose.

Verbal communication from Bode, BW. Atlanta, Ga; Feb. 2003.

Basal/Bolus Treatment Program with Rapid-Acting and Peakless Analogs.

Verbal communication from Bode, BW. Atlanta, Ga; Feb. 2003.

Basal/Bolus Treatment Program with Fast Acting R and Peakless Analogs.

Verbal communication from Bode, BW. Atlanta, Ga; Feb. 2003.
Making it easier for the patient

- Mixed Insulins - simple to use
- But
  - How do you accommodate food
  - How do you accommodate missed meals
  - How do you accommodate low or high glucose
  - How do accommodate physical activity

Basal/Bolus Affect of Insulin Absorption with Regular and NPH Insulin Preparations injecting 45 minutes before a meal

Increased risk for severe hypoglycemia if food not eaten on time

Increased risk for hypoglycemia especially at night
Fixing life’s affects on Glucose

- Many Causes
  - Different food choices
  - Different affects of foods on different people
  - Times of food consumption
  - Combinations of foods
  - Stress, injury, infection affect glucose
  - Medications
  - Exercise
**Sliding Scale Insulin**

### Types of Sliding Scales

#### Pre Set Dose

**Pros:**
- Easy to use
- No Patient Calculations Necessary
- Increased patient Compliance

**Cons:**
- No Correlation with Current Glucose Readings
- Decreases importance of SMBG
- Does not account for meal consumption
- Very High likelihood of hypoglycemia

<table>
<thead>
<tr>
<th>Meal or Time</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breakfast</td>
<td>7 units</td>
</tr>
<tr>
<td>Lunch</td>
<td>5 units</td>
</tr>
<tr>
<td>Dinner</td>
<td>6 units</td>
</tr>
<tr>
<td>Bedtime</td>
<td>2 units</td>
</tr>
</tbody>
</table>

---

#### Based on Pre-Meal Readings

**Pros:**
- Easy to use
- No Patient Calculations Necessary
- Increased patient Compliance
- Increased Reason for SMBG

**Cons:**
- Chasing High Readings
- Does not account for meal consumption
- Higher likelihood of hypoglycemia

<table>
<thead>
<tr>
<th>Reading</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>150mg/dl</td>
<td>4 unit</td>
</tr>
<tr>
<td>200mg/dl</td>
<td>6 units</td>
</tr>
<tr>
<td>250</td>
<td>8 units</td>
</tr>
<tr>
<td>300</td>
<td>10 units</td>
</tr>
<tr>
<td>400</td>
<td>12 units</td>
</tr>
</tbody>
</table>

---

### Physiological Insulin Dosing

**Pros:**
- Tightest, best control, best A1c
- Least Chance of Hypoglycemia once titrated
- Increased patient Compliance
- Increased Reason for SMBG

**Cons:**
- Most Difficult to calculate
- Requires Carb counting
- Higher likelihood of hypoglycemia during start up
Establishing Starting Basal and Bolus Dosing

Total Daily Dose
Split to mimic euglycemic control

50% Basal
50% Bolus

INSULIN-TO-CARBOHYDRATE RATIO (ICR)
Definition: The number of carb grams covered by one unit of insulin
Purpose: To calculate the number of units needed for a food bolus
Goal: Deliver correct amount of insulin to cover carbs and keep post-meal BGs within target range

Insulin sensitivity factor (ISF)
Definition: The number of mg/dL 1 unit of insulin lowers glucose
Purpose: To determine the amount of insulin needed to return a high glucose back to selected target
Goal: Provide the correct dose needed to correct a high or low glucose values back to target range

Calculated using standard industry formulas

Estimating an Insulin-to-Carbohydrate Ratio

500 Rule: 500 divided by TDD

Example: 500 / 50 = 10
Insulin to carb ratio = 1u for 10g
Insulin Sensitivity Factor-Correction Factor

- 1800 rule Humalog/Novolog/Apidra
  1800 divide by TDD= mg/dl drop in BG
  Example: 1800 / 50 = 36
- 1500 rule Regular Insulin
  1500 divide by TDD=mg/dl drop in BG
  Example: 1500 / 50 = 30

Calculating the Ratios

- Ms. Smith is currently taking 65 units of Lantus qam and
  14 units of Humalog at each meal
- What would be her Carb Ratio and Correction Factor

Estimating an Insulin-to-Carbohydrate Ratio

500 Rule: 500 divided by TDD which is 107 units
500 / 107 = 5
Insulin to carb ratio = 1u for 5 carbs
Insulin Sensitivity Factor-Correction Factor

1800 divide by TDD which is 107

\[ \frac{1800}{107} = 18 \]

Insulin Correction factor is 1u will lower glucose 18 mg/dl

Calculating the dose

Correction Factor 1 unit will lower BG 18 mg/dl
Correction Goal Pre-Meal Goal 120 mg/dl
Carb Ratio 1 unit will cover 5 carbs
So:
If the patient's pre lunch reading is 270 mg/dl
and they are going to eat 90 carbs what dose of Lispro would they need?
Dose for Correction:
Dose for Carbohydrates:
Total Dose of Lispro:

If the patient's pre lunch reading is 270 mg/dl
and they are going to eat 90 carbs what dose of Lispro would they need?
Dose for Correction: 8u
Dose for Carbohydrates: 18
Total Dose of Lispro: 26
Onboard Insulin the Forgotten Factor
98% Of All Primary Care Physicians Have Never Heard Of This

- Rapid acting insulin such as Lispro or Aspart has an onset of action of 15 minutes.
- Patients inject at mealtimetime
- Patients check 2 hours post meal and re-administer to bring PPG levels in line.
- But how long till the insulin is gone?
  - Studies have shown that
    - after 1 hour 75% of bolus remaining
    - After 2 hours 44% of bolus remaining
    - After 3 hours 22% of bolus remaining

Patient takes reading 2 hours after lunch and reading is 240, so based on 1u= 18mg/dl the patient should deliver how many units to get to goal of 120mg/dl?
Onboard Insulin the Forgotten Factor
98% Of All Primary Care Physicians Have Never Heard Of This

Patient takes reading 2 hours after lunch and reading is 240, so based on 1u=18mg/dl the patient should deliver how many units to get to goal of 120mg/dl
7 units ..... But

The on board insulin from the lunch correction bolus is 11 units, so if the patient gave 7 more units they would be hypoglycemic 2 hours later.

Other Considerations
- Physical Activity
- Illness
- Stress
- Medications
- Injury
- Obesity
- High Fat Meals
- Rebound
- Dawn Phenomenon
- Gastroparesis
- Liver Failure
- Visceral Fat
- Large Volume of Insulin

The Special Patient
- High insulin user
  - Over 75 units/day
  - Highly Insulin Insensitive
  - Large Abdomen
What can we do
U-500 Insulin
- Regular Insulin made by Lilly
- 5x as potent as U-100
- 20ml vial (equals 10 vials of U-100 insulin)
- Pens make dosing easier and safer
- Not stocked by most pharmacies
- May need prior auth for some plans

Human Regular U-500 Pen
- Can deliver up to 300 units in a single injection
- No dose conversion for pen
- Vials/syringes will need dose conversion
- Dials in 5-unit increments
- Holds 1500 units of insulin in every pen
- For severely insulin-resistant patients
- When daily insulin requirements are in excess of 200 units/day
Goal of Every Insulin Regimen:
MIMIC INSULIN DELIVERY OF HEALTHY PANCREAS

Rate and time of insulin secretion varies based on changing glucose levels:

12am  3am  7am  12pm  6pm
9pm  12am

Lunch  Breakfast  Dinner  Snack


Insulin Pumps Use U100 Rapid-Acting Insulin
LOWEST PHARMACODYNAMIC VARIABILITY

Pharmacodynamic Variability of Insulin Types*

Intermediate-acting insulin  46%
Long-acting insulin  36%
Rapid-acting insulin  16%

Pumps deliver insulin in two ways
BASAL & BOLUS

Schematic of Basal and Bolus Insulin Delivery

Concept: Match insulin delivery to more closely mimic a healthy pancreas.
Pumps Are Designed for Varied Basal Rates

TO MEET INDIVIDUALIZED PATIENT NEEDS


Basal rates can be

decreased

Basal rates can be

programmed to increase for
dawn phenomenon

Higher rate can be

programmed if needed

after dinner

12am

Insulin Infusion

Rate

2am

4am

6am

8am

10am

12pm

2pm

4pm

6pm

8pm

10pm

12am

Time of Day

Schematic of basal rate needs over 24 hours

Average Hourly Basal Rate by Age Group

PUBLISHED 2005

% Difference Between Peak and Non-peak Basal Rates, by age

• 3-10: 72%  
• 11-20: 52%  
• 21-60: 57%  
• >60: 81%

Average type 1 patient needs ~5 basal rates/day

Average type 2 patient needs 1-2 basal rates/day

Mimic Physiological Release

Insulin Infusion Devices

- Deliver basal insulin slowly over 24 hours at multiple rates.
- Allows a patient to bolus or correction dose whenever they want. Accurate down to 1/100 of a unit.
- Only one needle stick every 3 days.
- Calculates Correction bolus
- Calculates Meal Bolus
- Considers On-Board Insulin
- Allows Instant Basal Adjustments
They All Have

- Multiple basal patterns
- Extended and Combination Bolus
- Bolus Calculation Software (some with additional equipment needed)
- Low reservoir warning
- Occlusion alarms
- 24hr support
- Exchange policy
- Battery Alarm

https://www.youtube.com/watch?v=AQyWjCS-47w

Some Have

- Direct link to CGM
- Current Glucose on screen
- Ability to automatically suspend basal or bolus dosing when low glucose

https://www.youtube.com/watch?v=ADUDwM1SxeE

Life In The Real World
Tidbits Learned

- There is a natural progression in intensification.
- Patients need to be advised about results they can obtain.
- Patients learn from use:
  - Less insulin use with pump
    - Prior to insulin pump with CGM: Daily Dose 36 units basal 19 units bolus Total 54 units/day
    - With pump and CGM: 15 basal 9 bolus Total 24 units a day

In Conclusion

- Diabetes care is very difficult because so much is the patient's responsibility.
- Patients do better when diabetes care becomes part of their daily routine.
- Patients appreciate easy explanations and information.
- Patients react to new technology for diabetes care just as they do for other aspects of their life.
- We need to find the things that are important to a patient to help them be successful.
- Pharmacists are in a unique position to explain the benefits of food choices, medications, and technology.
Questions??
Comments??