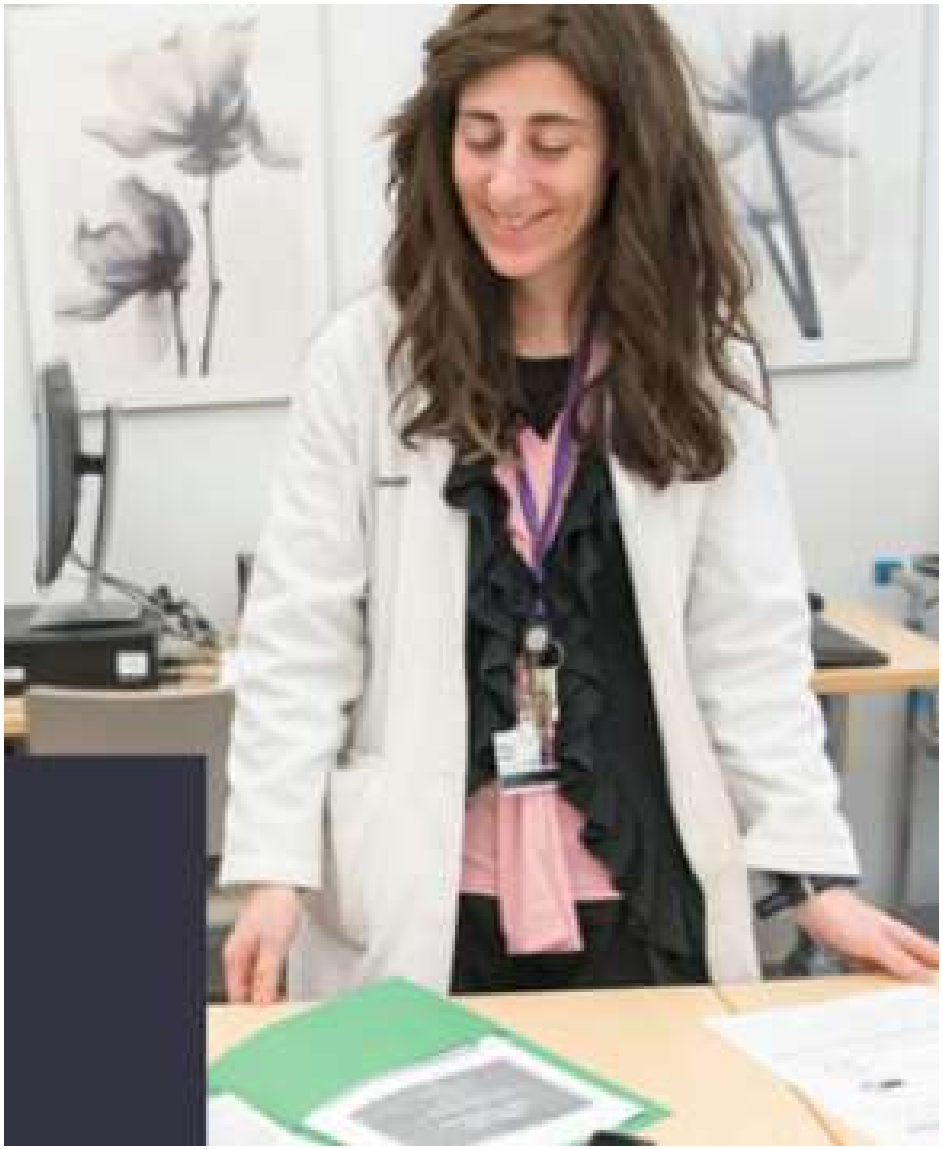
Insulin – Ultimate Hormone Replacement Therapy



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Disclosures for Dr. Isaacs

- Diana Isaacs, PharmD, BCPS, BCACP, CDCES, BC-ADM, FADCES, FCCP declares the following disclosures:
- Speaker: Abbott, Dexcom, Novo Nordisk, Insulet, Medtronic, Lilly, Cequr, Sanofi
- Consultant: Undermyfork, Sequel
- ADCES Board Member

Objectives – Insulin –The Ultimate Hormone Replacement Therapy

Objectives:

- Discuss the actions of different insulins
- Describe how to use the ADA algorithm for insulin management
- Counsel a person with diabetes on safe and effective insulin use
- Discuss strategies to determine and fine-tune basal and bolus insulin settings based on glucose pattern management
- Describe how insulin settings are used to program insulin pumps and connected insulin pens

History of insulin

- Insulin is produced by beta cells in the pancreas
- Discovered in 1921 by Frederick Banting and his assistant Charles Best from a dog's pancreas
- First used in a dog with diabetes and kept him alive for 70 days until they ran out of extract
- With the help of JB Collip and John Macleod, insulin was derived from the pancreas of cattle and in January 1922, given to a 14-year-old dying from diabetes in a Toronto hospital
- In 1923, Banting and Macleod received the Nobel Price in Medicine which they shared with Best and Collip
- Soon after, Eli Lilly started large-scale production of insulin

ADA. The history of a wonderful thing we call insulin (accessed 2020 Aug 29).

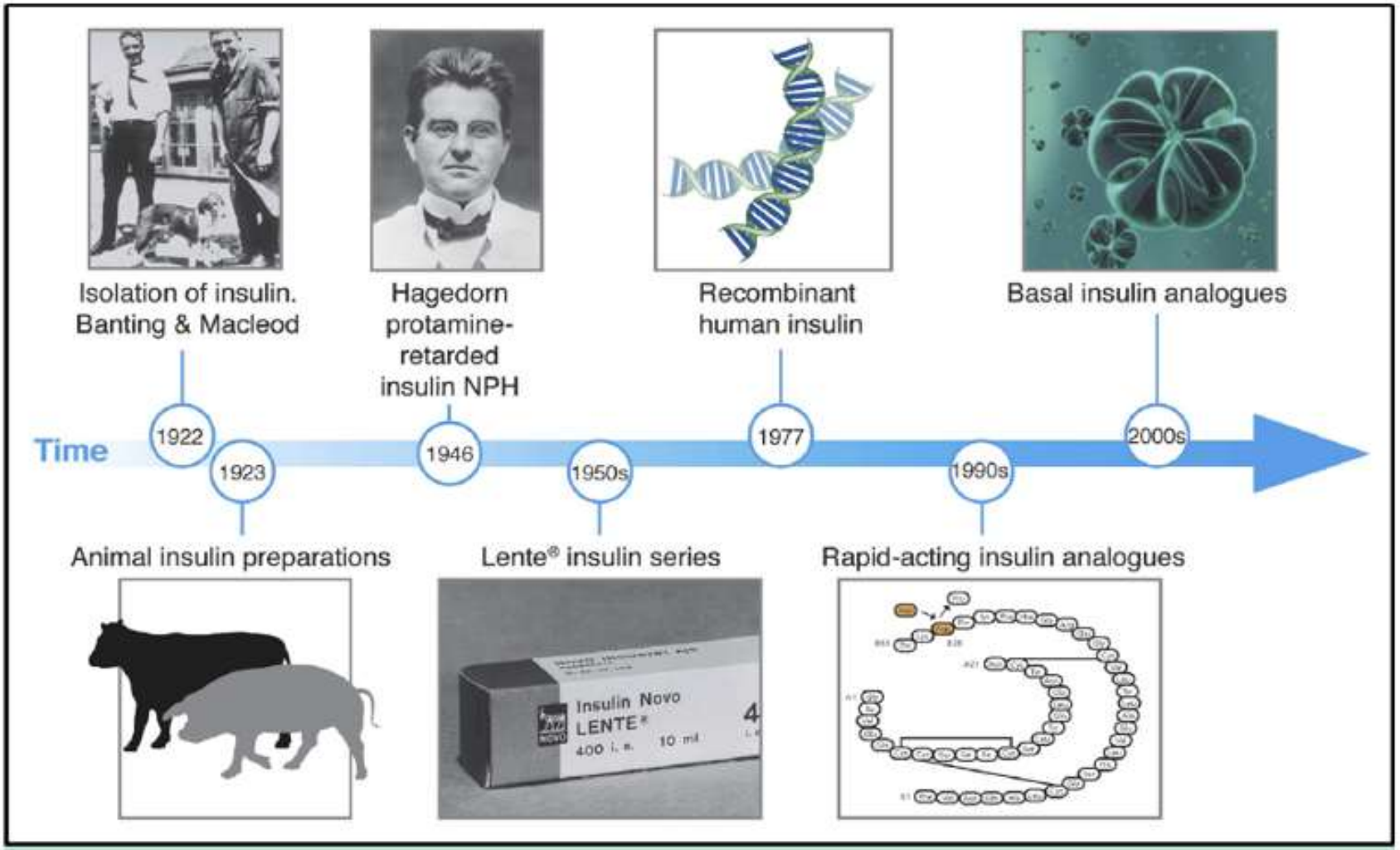
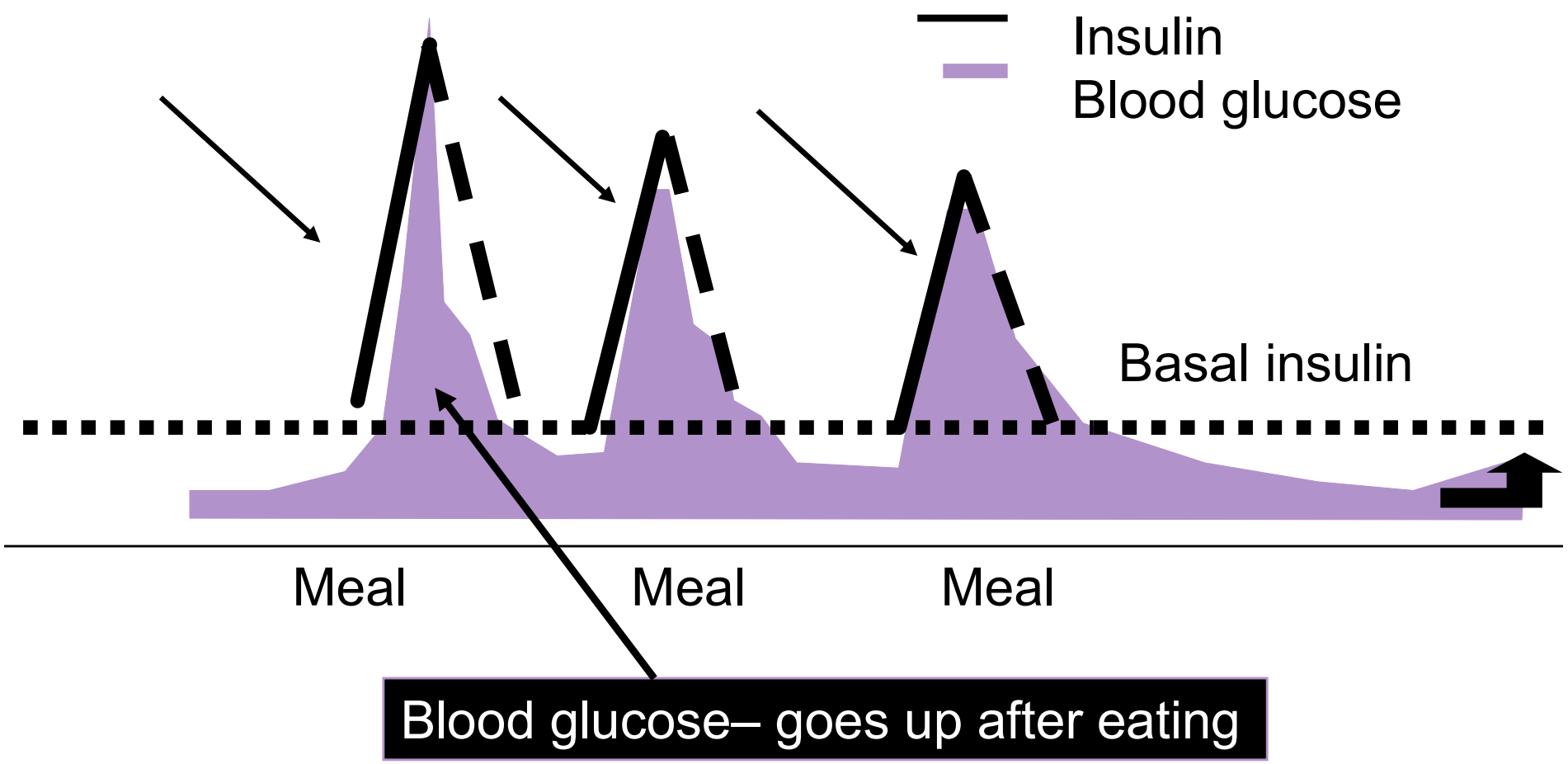


Figure 1 Milestones in the evolution of insulin therapy. NPH = neutral protamine Hagedorn.

Evolution of Insulin: From Human to Analog. Joseph M. Tibaldi, MD American Journal of Medicine, 2014

Physiologic Insulin Release:
Individuals without diabetes



Physiologic Insulin at Meals

- **1st phase:** peak 1-2 minutes, duration 10 minutes, suppresses hepatic glucose production
- **2nd phase:** duration 1-2 hours

The perfect insulin would be fast enough to match the absorption of carbohydrates

Freeman JS. J Am Osteopath Assoc. 2009;109:26-36.

Insulin Overview

- None of the commercially available insulins are as fast as true physiologic insulin
- Almost all insulin is injected (SC or IV) with 1 inhaled option
- All people with T1D require basal + bolus insulin or insulin pump therapy
- Many people with T2D require insulin due to the progressive nature of the condition

Basal aka "Background" Insulin

- The liver plays a major role in maintaining glucose levels by regulating the process of gluconeogenesis and glycogenolysis
- Excessive hepatic glucose release leads to hyperglycemia
- In a person without diabetes, there is a low level of insulin to keep glucose homeostasis from glucose produced by the liver (**basal insulin**)
- People with type 1 diabetes lack the ability to produce insulin to counteract the liver's effects
- In people with type 2 diabetes, there may not be enough insulin due to insulin resistance
- Long-acting insulins or intermediate-acting insulins serve as a basal or "background insulin"
- In an insulin pump, a regular or rapid-acting insulin can be given continuously to serve as the basal

Everyone with T1D need basal insulin and many with T2D may need it

Sharabi K et al. Mol Aspects Med. 2015; 46:21-22.

Bolus Insulin

- Glucose rises in response to carbohydrates
- A regular or rapid-acting insulin is given as a bolus to prevent the glucose from rising too much
- A regular or rapid-acting insulin can also be given to “correct” or bring down a high glucose

Everyone with T1D needs bolus insulin, some people with T2D may need it to achieve glycemic targets

Insulin PocketCard™

Diabetes Education Services 25

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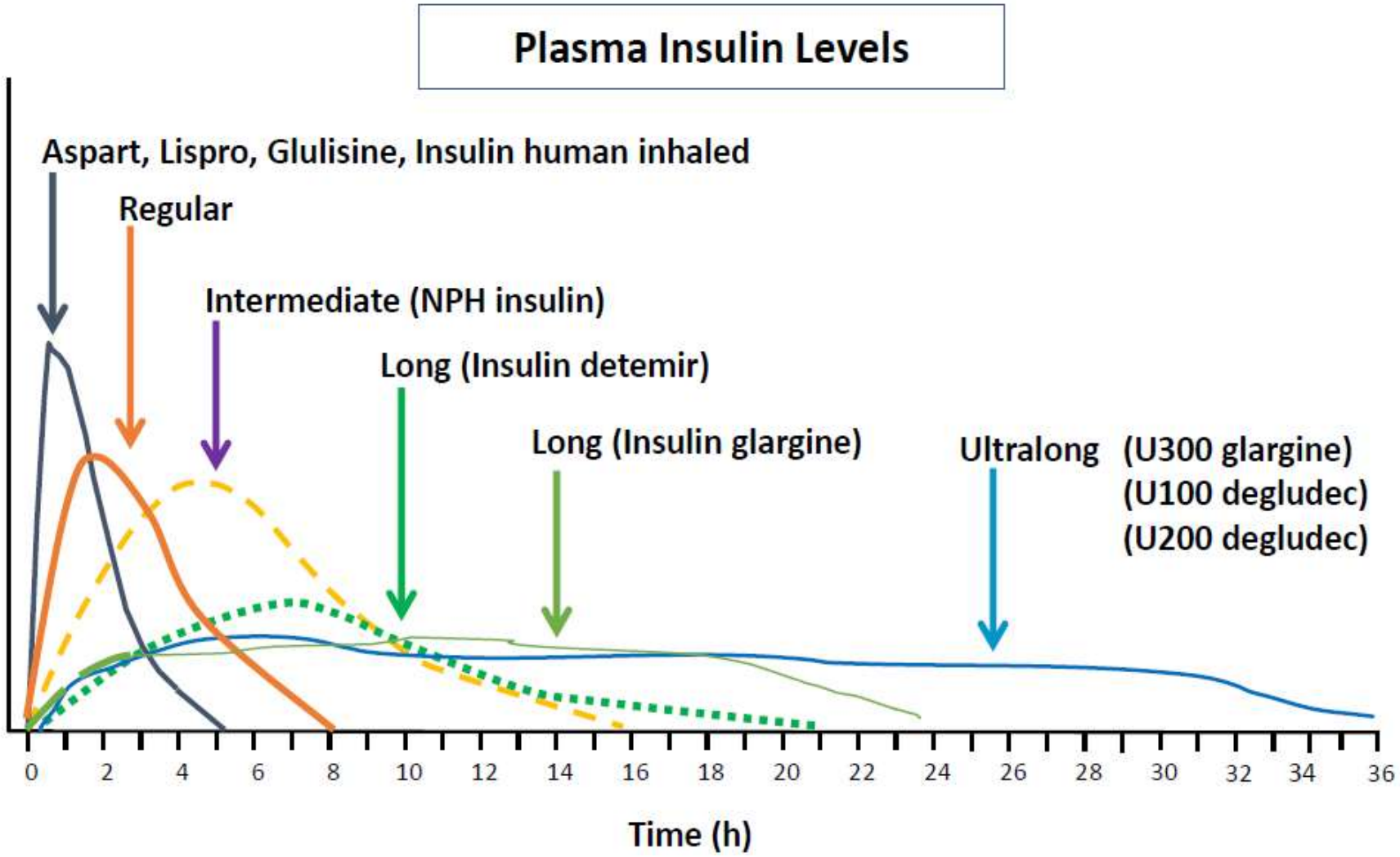
Action		Insulin Name	Effective Onset	Peak	Duration	Considerations
Bolus	Very Rapid Acting Analogs	Aspart (Fiasp)	16 - 20 min	1 - 3 hrs	5 - 7 hrs	Bolus insulin lowers after-meal glucose. Post meal BG reflects efficacy. Basal insulin controls BG between meals and nighttime. Fasting BG reflects efficacy. Side effects: hypoglycemia, weight gain. Typical dosing range: 0.5-1.0 units/ kg body wt/day. Discard most open vials after 28 days. For pen storage guidelines, see package insert.
		Lispro-aabc (Lyumjev)	15 - 17 min	2 - 3 hrs	5 - 7 hrs	
	Rapid Acting Analogs	Aspart (Novolog)	20 - 30 min	1 - 3 hrs	3 - 7 hrs	
		Lispro (Humalog*/ Admelog)	30 min	2 - 3 hrs	5 - 7 hrs	
		Glulisine (Apidra)	15 - 30 min	1 - 3 hrs	3 - 4 hrs	
	Short Acting	Regular*	30 - 60 min	2 - 4 hrs	5 - 8 hrs	
Basal	Intermediate	NPH	2 - 4 hrs	4 - 10 hrs	10 - 16 hrs	
	Long Acting	Glargine (Lantus*/Basaglar/Semglee/Rezvoglar)	2 - 4 hrs	No Peak	20 - 24 hrs	
		Degludec (Tresiba)*	~ 1 hr		< 42 hrs	
Basal + Bolus	Intermediate + short	Combo of NPH + Reg 70/30 = 70% NPH + 30% Reg 50/50 = 50% NPH + 50% Reg	30 - 60 min	Dual peaks	10 - 16 hrs	
	Intermediate + rapid	Novolog® Mix - 70/30 Humalog® Mix - 75/25 or 50/50	5 - 15 min		24 hrs	

Concentrated insulins available - see Concentrated Insulin Card for details. Insulin action times vary; time periods are general guidelines only.
All PocketCard content is for educational purposes only. Please consult prescribing information for detailed guidelines. © 2024

Insulin Profiles



Hirsch IB. NEJM 2005;352:174-183.
Lexicomp Online, Lexi-Drugs Online, Hudson, Ohio: UpToDate, Inc; 2020; Last updated August 21, 2020.

Insulin Concentration

- Most insulin is U100: 100 units/mL
- There is also concentrated insulin
  - U500 insulin, 500 units/mL, U300, 300 units/mL, and U200, 200 units/mL
- Insulin is available in a vial, pen, or cartridge
- U100 insulin:
  - 1 vial =10mL = 1000 units
  - 1 pen =3 mL = 300 units
  - 1 cartridge = 3 mL = 300 units
  - 1 box of pens = 5 pens = 1500 units
- Inhaled insulin
  - 4, 8, 12 units cartridges

Afrezza, Novolog, Humalog, Lantus, Levmir (package inserts) 2022

Image: :Blausen.com staff (2014). Medical gallery of Blausen Medical 2014. WikiJournal of Medicine 1 (2).

Concentrated and Inhaled Insulin

Concentrated & Inhaled Insulins

Name/Concentration	Insulin/Action	Considerations
Humulin Regular U-500 • 500 units insulin/mL • KwikPen or Vial	Regular Bolus / Basal	Indicated for those taking 200+ units daily. 3 mL pen holds 1,500 units. Max dose 300 units. Once opened, good for 28 days. 20 mL vial holds 10,000 units. Max dose 250 units using U-500 syringe. Once opened, good for 40 days.
Humalog KwikPen U-200 200 units insulin/mL.	Lispro (Humalog) Bolus	3 mL pen holds 600 units. Max dose 60 units. Once opened good for 28 days.
Lyumjev KwikPen U-200 200 units insulin/mL.	Lispro (Lyumjev) Bolus	3 mL pen holds 600 units. Max dose 60 units. Once opened good for 28 days.
Toujeo Solostar U-300 Pen 300 units insulin/mL.	Glargine (Lantus) Basal	1.5 mL pen holds 450 units. Max dose 80 units. 3 mL Max Solostar pen holds 900 units. Max dose 160 units. Once opened good for 56 days.
Tresiba FlexTouch U-200 Pen 200 units insulin/mL.	Degludec (Tresiba) Ultra basal	3 mL pen holds 600 units. Max dose 160 units. Once opened good for 56 days.
All concentrated insulin pens and the U-500 syringe automatically deliver correct dose (in less volume). No conversion, calculation or adjustments required. For example, if order reads 30 units, dial the concentrated pen to 30 units or draw up 30 units on the U-500 syringe. **Important – never withdraw concentrated insulin from the pen using a syringe.**		

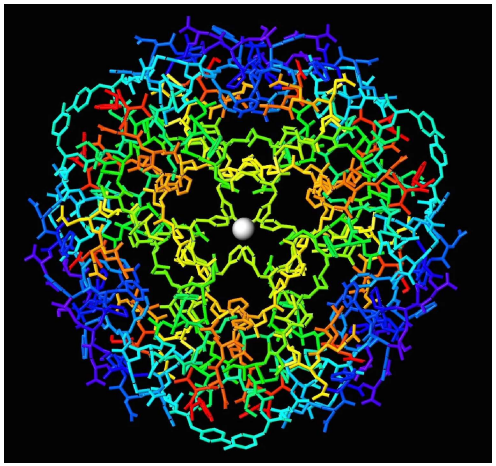
Inhaled Insulins

Action	Insulin Name	Dose Range	Onset	Peak	Duration	Considerations
Bolus – Rapid-acting	Afrezza Inhaled regular human insulin	4, 8, and 12 unit cartridges before meals	~ 12 min	35 - 45 mins	1.5 - 3 hrs	Assess lung function. Avoid in lung disease — bronchospasm risk. Side effects: hypo, cough, throat irritation.

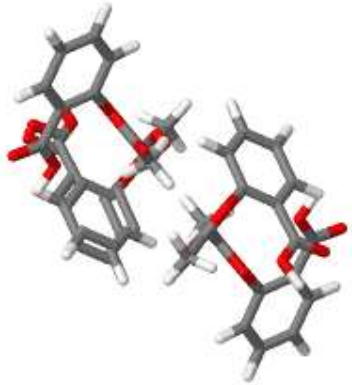
The information listed here are not guidelines. Please consult prescribing information for details.

Follow-On Insulin

- Follow-on insulin products requires a separate prescription (not directly interchangeable)
  - Examples:
    - Insulin glargine (Lantus), follow-on product (Basaglar)
    - Insulin lispro (Humalog), follow-on product (Ademlog)
- Semglee and Rezvoglar can be interchangeable with Lantus (insulin glargine)



Insulin – Large Molecule



Aspirin – Small Molecule

Generic Insulins

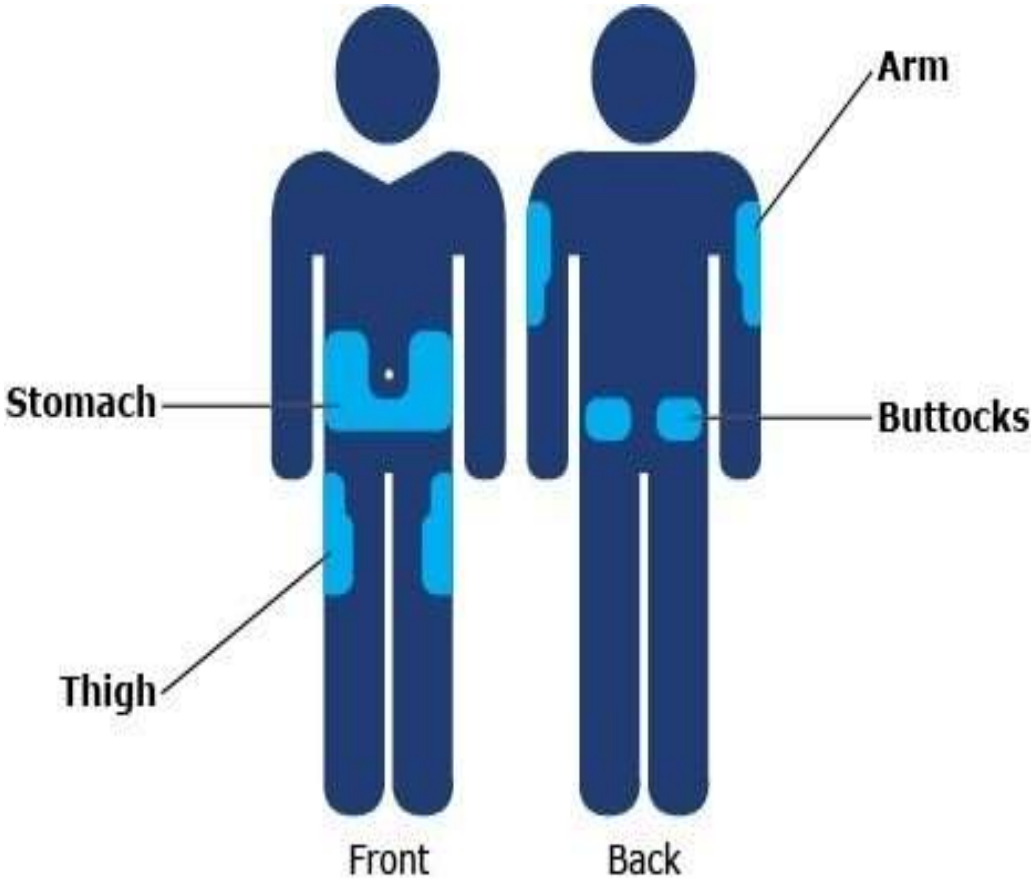
- Insulin aspart
- Insulin lispro
- Insulin glargine

- About half the cost of the brand name
- Exact same formulation, produced by same manufacturer, interchangeable at pharmacy

Which Insulin is Interchangeable with Lantus (Insulin glargine U100)?

A. Toujeo (Insulin glargine U300)
B. Basaglar (Insulin glargine U100)
C. Semglee (Insulin glargine U100)
D. Insulin degludec U100
E. All of the above

Insulin Injection Sites



Sites should be rotated

Insulin Key Counseling Points

- Do not shake insulin
- Cloudy insulin (NPH or pre-mixed) should be rolled before use so suspension is uniform
- Skin thickness is usually 2mm regardless of person's size, so shortest needles (4mm) work well for most
- Take outer and inner covering off for pen needles
- Leave the needle/syringe in the body for 5-10 seconds
- Change needle or syringe with each injection
- Dispose of needles/syringes in a sharps container or per local regulations

Dang DK. Taking medication. In: Cornell S et al, eds. The art and science of diabetes self-management education desk reference. 5th ed.

Priming insulin

- Pens should be primed before every use to get air bubbles out
- Hold vertically with needle at the top
- Turn dial to 2 units
- Push plunger
- Repeat until insulin comes out of the top
- May have to do multiple times for a new pen
- This will ensure all air is out and that pen needle works
- Do this every time an insulin pen injection is given

Storage Options

Insulin Storage and Expiration Cheat Sheet Available

Insulin Storage and Dispensing Info

Diabetes Education SERVICES

Product Name/Type	Expiration when opened, stored at room temp up to 86 F	Pens per Box Or Vial	Units per Pen/Vial	Max Dose / Notes
Rapid Acting Insulins				
Aspart (Fiasp) -Vial -Pen -Pump	 28 Days 28 Days 6 Days	 1 Vial 5 Pens per Box	 1000 units 300 units in 3 mL	 80 Units
Aspart (Novolog) -Vial -Cartridge -Flexpen - Pump	 28 Days 28 Days 28 Days 6 Days	 1 Vial 5 cartridges 5 Pens per Box	 1000 units 300 units in 3 mL 300 units in 3 mL	 60 Units
Glulisine (Apidra) -Vial -SoloStar Pen -Pump	 28 Days 28 Days 2 Days	 1 Vial 5 Pens per Box	 1000 units 300 units in 3 mL	 80 Units
Lispro (Humalog/Admelog) -Vial -Cartridge -Pen -Pump	 28 Days 28 Days 28 days Up to 7 Days	 1 Vial 5 cartridges 5 Pens per Box	 1000 units 300 units in 3mL 300 units in 3mL	 80 Units (Admelog) 60 Units (Humalog)
Lispro -aabc (Lyumjev) - Vial -Cartridge -KwikPen	 28 Days 28 Days 28 days	 1 Vial 5 cartridges 5 Pens per Box	 1000 units 300 units in 3mL 300 units in 3mL	 60 units

Side Effects of Insulin

Weight Gain

Lipodystrophy/
Lipohypertrophy

Hypoglycemia

Dang DK. Taking medication. In: Cornell S et al, eds. The art and science of diabetes self-management education desk reference. 4th ed.

Sharps Disposal: Product and Info

- Search for household hazardous waste listing for your city or county.
- Call 1-800-CLEANUP (1-800-253-2687)

Polling Question 1

- After how many days should an open vial of insulin degludec be discarded?

A. 28 days
B. 30 days
C. 42 days
D. 56 days

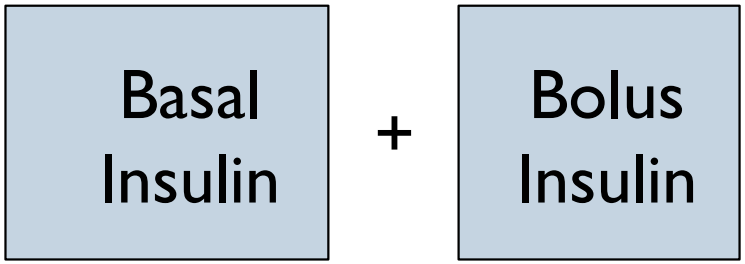
DiaBingo - I

- Inhaled insulin
- Glargine, detemir, NPH, degludec are types of
- Breakdown of glycogen into glucose
- Anabolic hormone made by pancreatic beta cells
- Insulin is released when glucose levels are low – T or F
- In which injection site is insulin most rapidly absorbed?
- Elevated post-prandial glucose indicate need for pre-meal
- Epinephrine increases insulin resistance
- Creation of glucose from amino acids and lactate
- Decreasing renal function for people on insulin can cause
- Bolus insulins
- A hormone that increases blood glucose

How to Dose Insulin

Type 1 Diabetes (T1D)

- Absolute deficiency in endogenous insulin
- Exogenous insulin is required
- The regimen should include:

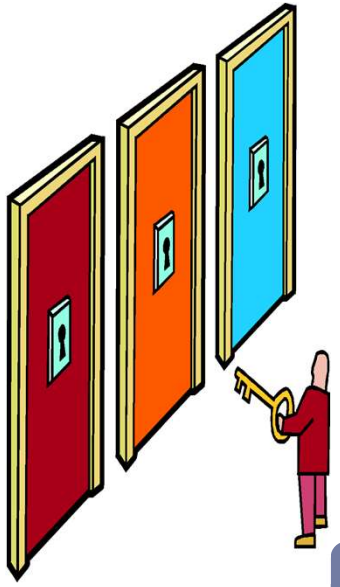


How to Dose Insulin? T1D

- Newly diagnosed T1D
  - Total insulin dose: 0.5-1.0 units/kg/day
  - 50% basal
  - 50% bolus
- Bolus can initially start with set doses or calculations can be used to determine initial carbohydrate ratio and correction factor

Pamagluapatai LG et al. In: Cornell S et al., Pharmacolotherapy for Glucose Management. The art and science of diabetes self-management education desk reference. 5th ed.

Choice of Basal Insulin



1. NPH

Lowest Cost

2. Detemir

Glargine

3. Glargine U-300

Delgudec U-100

Degludec U-200

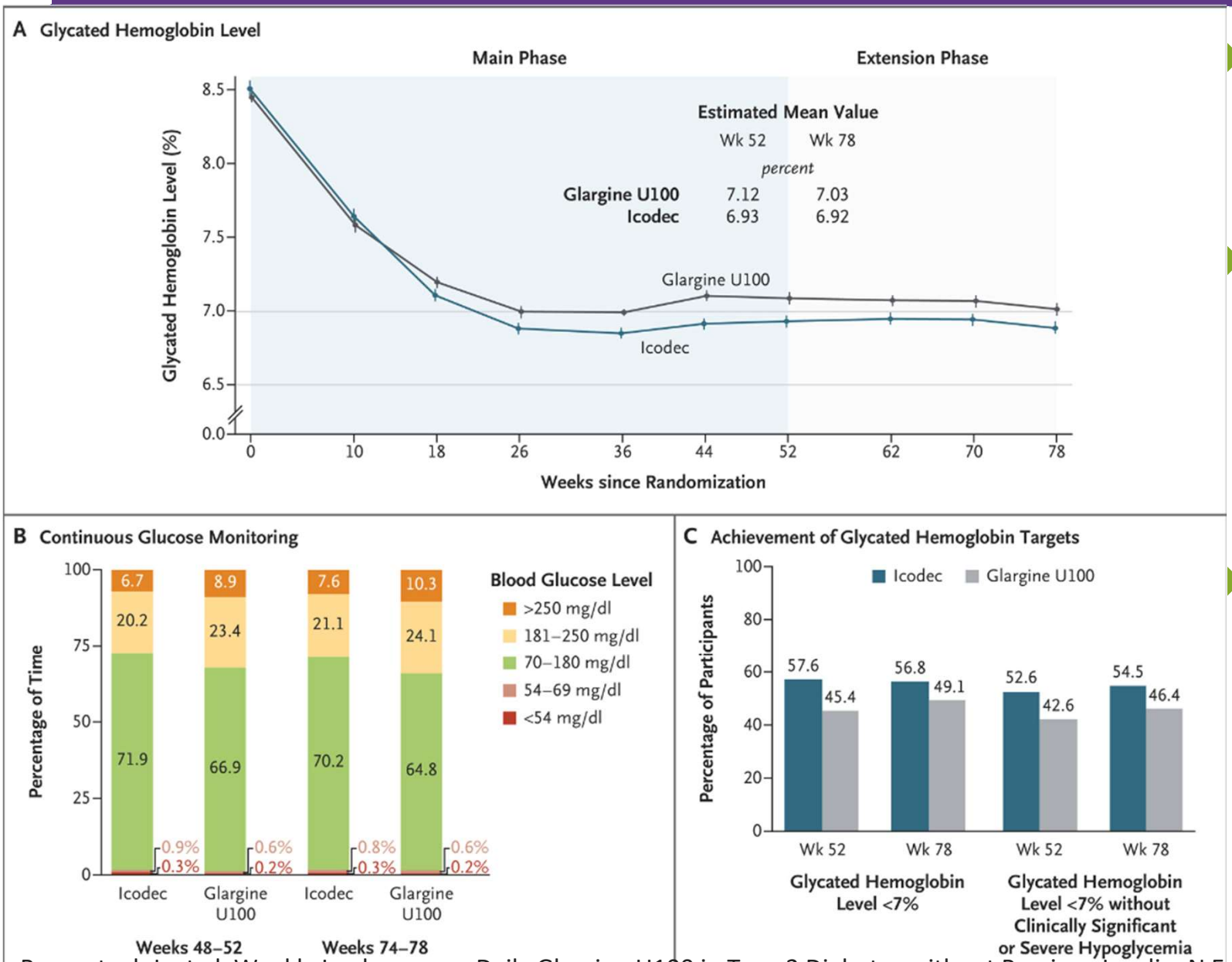
1. Shortest duration, 2. Medium duration, 3. Longest duration

Weekly Insulin

- Awiqli® (once-weekly basal insulin icodec) approved for use in the EU
- Anticipated US approval in the near future
- Half-life: 196 hours ~8 days
- U700 insulin, 3mL pen = 2100 units/pen
- 70 units icodec weekly = 10 units glargine daily

Rosenstock J, et al. Weekly Icodec versus Daily Glargine U100 in Type 2 Diabetes without Previous Insulin. N Engl J Med. 2023 Jul 27;389(4):297-308.

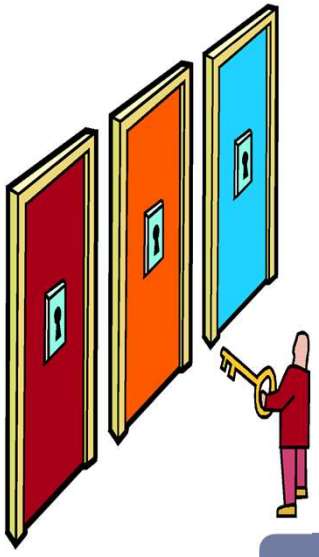
Glargine vs. Icodec in T2D



- 492 pts in each group
- Primary outcome: change in A1C
- Conclusion: glycemic control better with icodec

Rosenstock J, et al. Weekly Icodec versus Daily Glargine U100 in Type 2 Diabetes without Previous Insulin. N Engl J Med. 2023 Jul 27;389(4):297-308.

Choice of Bolus Insulin



1. Regular

Lowest Cost

2. Lispro (Humalog®, Admelog®)

Aspart (Novolog®)

3. Glulisine (Apidra®)

Aspart (Fiasp®)

Lispro (Lyumjev®)

Inhaled (Afrezza®)

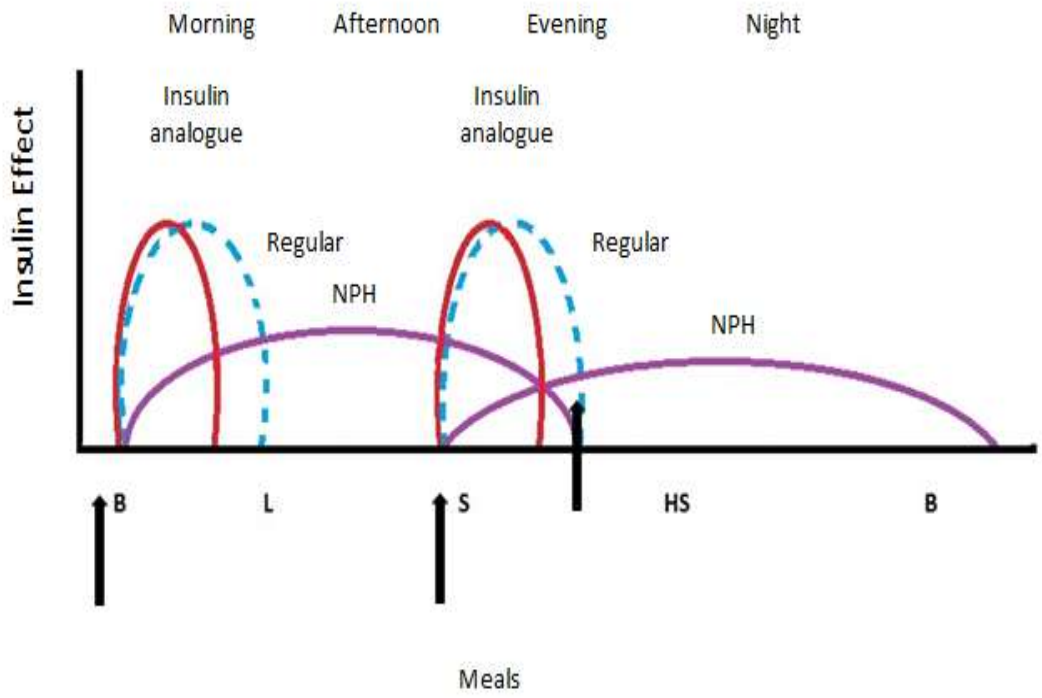
1. Slowest, 2. Medium, 3. Quickest

T1D: Insulin Dosing Regimens

Time of Insulin Administration	Before breakfast	Before lunch	Before dinner	Bedtime
Method 1	Intermediate: Regular (2/3 TDD) 2:1 ratio		Intermediate: Regular (1/3 TDD) 2:1 ratio	
Method 2	Regular/ analog (1/2 TDD ÷ by 3)	Regular/ analog (1/2 TDD ÷ by 3)	Regular/ analog (1/2 TDD ÷ by 3)	Long-acting (1/2 TDD)

***These are starting regimens and are adjusted based on ability to carbohydrate count and glycemic management as determined by A1C, BGM and/or CGM

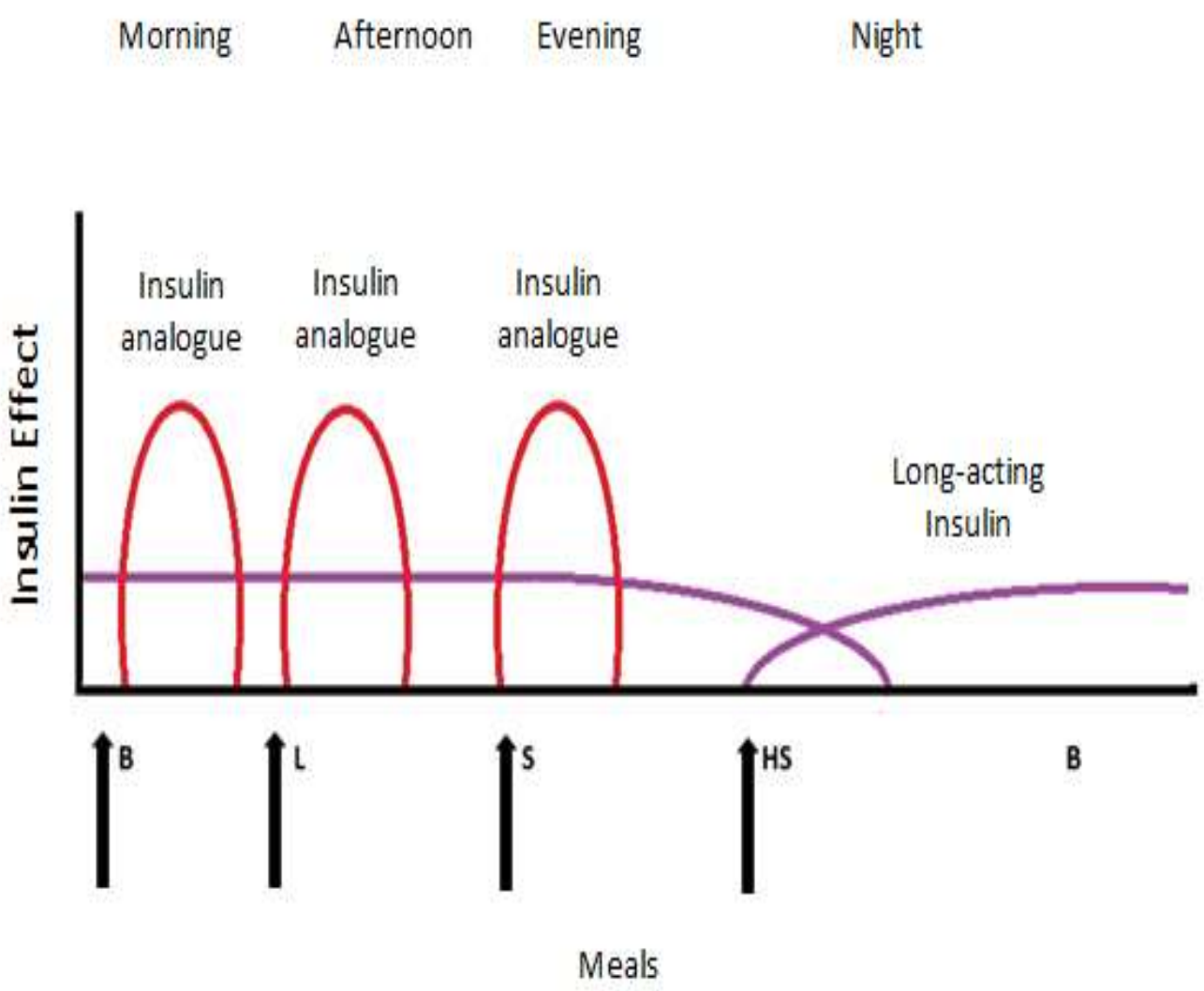
Intermediate-acting Insulin + Regular Insulin or Insulin Analog



Intermediate insulin serves as basal while regular or insulin analog serves as bolus

Regular insulin: Novolin R, Humulin R
Intermediate insulin: Novolin N, Humulin N
Insulin analogue: aspart, lispro, glulisine

Long-acting Insulin with Insulin analog



Long-acting serves as basal insulin analog serves as bolus

Carbohydrate Ratio

- Insulin to carbohydrate ratio (ICR)
  - 1 unit of insulin is expected to cover X grams of carbohydrates
- Rule of 450 or 500 can be used
  - 500/TDD = estimated carbohydrate ratio

Trujillo J et al. Diabetes mellitus. In: Dipiro JT et al., eds. Pharmacotherapy: a pathophysiologic approach. 11th ed.

Correction Factor

- Insulin correction factor (ICF)
  - Often returned to as insulin sensitivity
  - 1 unit of insulin is expected to lower glucose by Y points
- Rule of 1700 or 1800 can be used
  - 1700/TDD = estimated ICF
- For regular insulin, the rule of 1500 is typically used

Trujillo J et al. Diabetes mellitus. In: Dipiro JT et al., eds. Pharmacotherapy: a pathophysiologic approach. 11th ed.

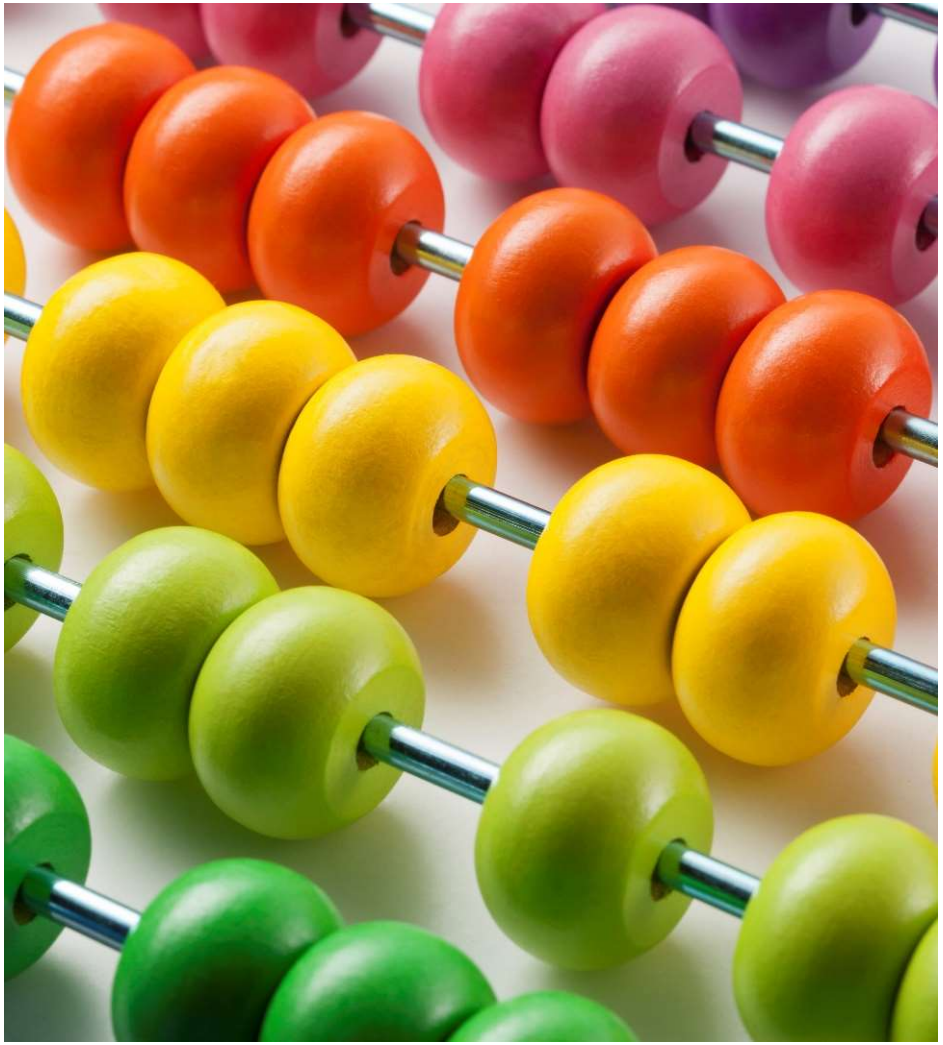
An Example: Meet Austin

- Austin is a 12-year-old newly diagnosed with T1D, he weighs 40kg
- He is started on 0.5 units/kg/day of total insulin
  - 40*0.5=20 units
  - 50% basal=10 units
  - 50% bolus=10 units
- Austin is prescribed 10 units of long-acting insulin and 3 units of rapid-acting insulin at meals
- The insulin doses will be adjusted based on glucose data

Austin Calculation cont'd

- Austin is ready for carbohydrate counting

- Based on the rule of 500 and rule of 1700, what should his ICR and ICF be?



Poll Question 2

- Based on the rule of 500 and rule of 1700, what should Austin's ICR and ICF be? (TDD=20 units/day)

A. ICR=25, ISF=85
B. ICR=20, ISF=60
C. ICR=15, ISF=50
D. ICR=30, ISF=75
E. I am not sure

Answer and Explanation

- ICR=500/20=25
  - This means that 1 unit of insulin covers 25 grams of carbohydrate
  - If Austin eats 50 grams of carbohydrate, he should inject 2 units
- ISF=1700/20=85
  - This means that 1 unit of insulin is expected to lower glucose by 85 mg/dL
  - Austin's glucose target is 100
  - If his current glucose is 185, he should take 1 extra unit of insulin

Correction Scale 1

Rapid/Fast Acting Insulin (1 unit:50 mg/dl>150)

Less than 70	Subtract 1 unit
70-150 mg/dl	0 units
151-200 mg/dl	1 unit
201-250 mg/dl	2 units
251-300 mg/dl	3 units
301-350 mg/dl	4 units
351-400 mg/dl	5 units

Correction Scale 2

Rapid/Fast Acting Insulin (2 units:50 mg/dl>150)

Less than 70	Subtract 1 unit
70-150 mg/dl	0 units
151-200 mg/dl	2 unit
201-250 mg/dl	4 units
251-300 mg/dl	6 units
301-350 mg/dl	8 units
351-400 mg/dl	10 units

Poll Question 3

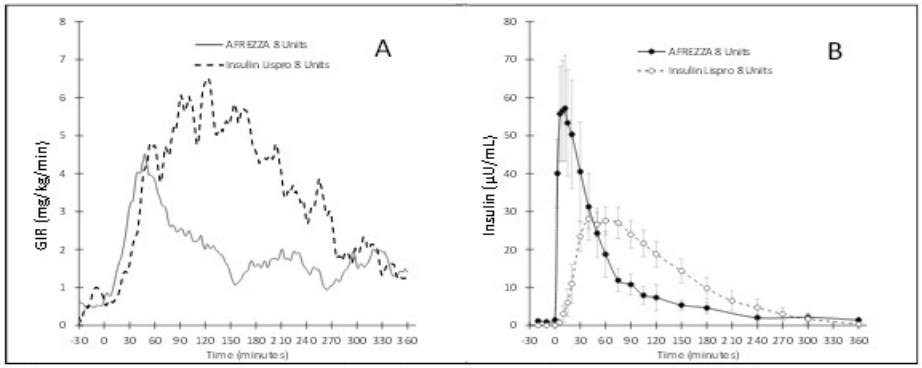
- How much insulin does a person with type 1 diabetes need a day?
  a. 1 to 2 units/kg per day
  b. No more than 0.5 units/kg per day
  c. 5 to 10 units/kg per day
  d. 0.5 to 1 units/kg per day

Inhaled Insulin

Injected Meal Time Dose	Inhaled Insulin Dose
Up to 4 units	4 units
5-8 units	8 units
9-12 units	12 units
12-16 units	16 units
17-20 units	20 units
21-24 units	24 units

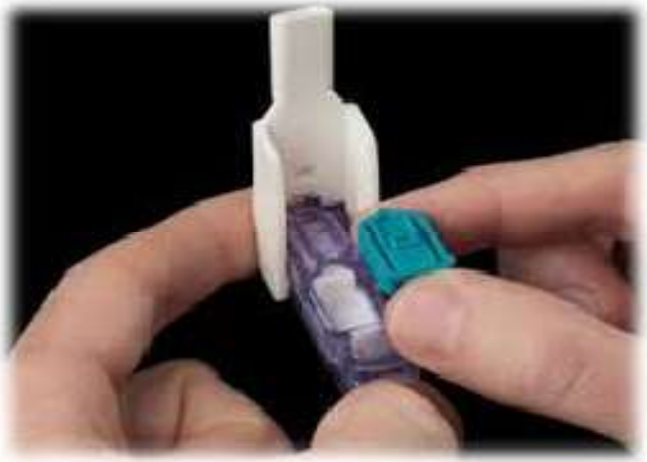
- **FDA approved for adults over 18yo**
- **Not indicated for pregnancy, while breastfeeding**

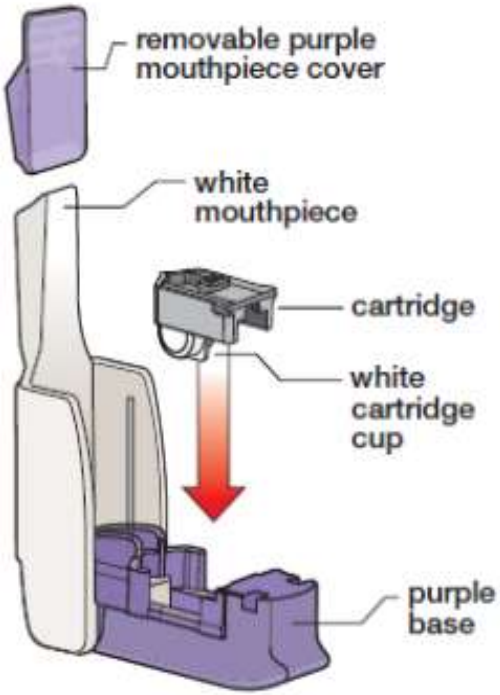
Figure 3. Baseline-Corrected Glucose Infusion Rate (A) and Baseline-Corrected Serum Insulin Concentrations (B) after Administration of AFREZZA or Subcutaneous Insulin Lispro in Type 1 Diabetes Patients*

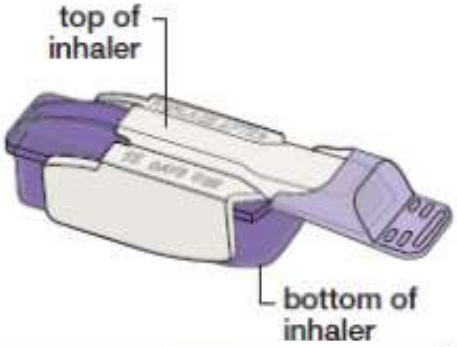


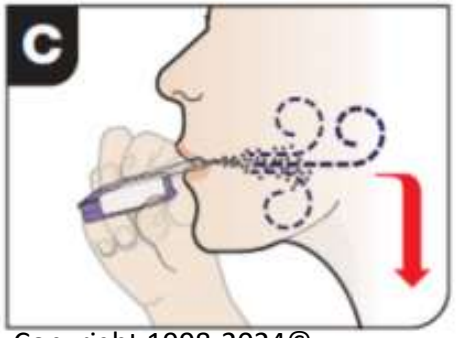
* Despite the faster absorption of insulin (PK) from Afrezza, the onset of activity (PD) was comparable to Insulin lispro.

Inhaled Insulin









Inhale Deeply and Hold Breath

With your mouth closed around the mouthpiece, **inhale deeply through the inhaler**.

Hold your breath for as long as comfortable and at the same time remove the inhaler from your mouth. After holding your breath, exhale and continue to breathe normally.

Inhaled Insulin Storage

- Opened inhaler: use in 15 days
- Sealed foil packages: refrigerate until expiration date on package
- Sealed blister card strips: room temp-use within 10 days, fridge-30 days
- Opened strips: room temperature, use within 3 days
- Before using, inhaler and strips should be at room temperature for at least 10 minutes

https://afrezza.com/wp-content/uploads/2020/01/Afrezza-Storage-and-Handling-Guide.pdf

Inhaled Insulin Dosing and Counseling

- Bolus insulin – inhaled before meals
- Dosing: 4, 8 and 12 unit cartridges
- Lung function test before start (FEV1)
  - Not for pts w/ chronic lung issues
    - Asthma, COPD, history of lung cancer, smoking within past 6 months
    - Can cause acute bronchospasm – Black box warning
- Side effects:
  - Sore throat, cough
  - Less hypoglycemia than injected insulin

Bolus Insulin Timing

- How is the effectiveness of bolus insulin determined?
  - 1-2 hours post meal
  - Before next meal blood glucose

- Glucose goals may be modified by HCP/pt
  - 1-2 hours peak post meal <180 (ADA)
  - 2 hour post meal <140 (AACE)
  - Before next meal 80 - 130

Poll Question 5

- Mary takes 4 units of insulin lispro (Humalog) before breakfast. Which BG result reflects that the dose was the right dose?

1. Before breakfast BG of 97
2. 1 hour post lunch BG of 160
3. Before lunch BG of 87
4. 2 hour post breakfast BG of 185

More than 200 units a day?

DRUG NAME	AVAILABILITY	PEN UNITS	EXPIRATION	ONSET	PEAK EFFECT	DURATION OF ACTION	CLINICAL PEARLS
INSULIN HUMAN REGULAR (HUMULIN R U500)	Pen, Vial	5 unit	Vial: 40 days Pen: 28 days	0.25-0.5 hours	4-8 hr	13-24 hr	This insulin is 5 time as concentrated. If using a vial, use the special U500 syringe.

DailyMed: https://dailymed.nlm.nih.gov/dailymed/index.cfm

Stahnke AM et al. ADCES in Practice. March, 2020. https://doi.org/10.1177/2633559X20896414

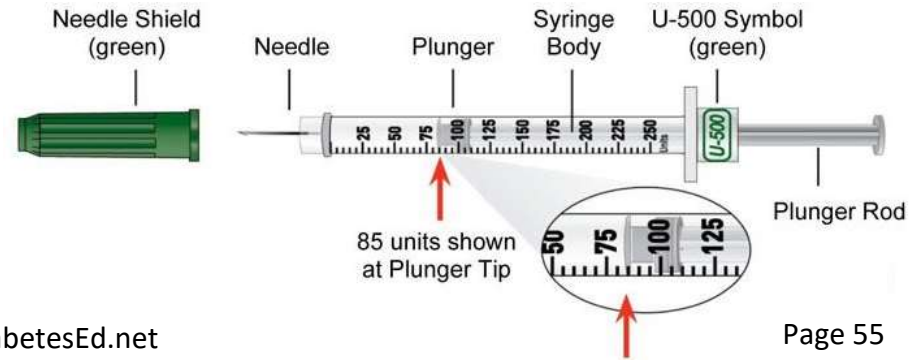
Switching to u500 insulin

- Typically reserved for people requiring insulin >200 units/day
- U500 acts like an intermediate acting insulin but replaces both the basal and bolus doses
  - If A1C< 8%, recommend to reduce TDD by 10-20%
  - If A1C≥ 8%, consider 1:1 conversion
- Typically dosed 2-3 times daily
- It should be taken 30 minutes prior to meals
- Often initiated as a 60/40 or 40/30/30 split

Reid TS, et al. Postgrad Med. 2017;129(5):554-562.

U500 example

- A woman with obesity, T2D, and insulin resistance takes insulin glargine 120 units BID and insulin aspart 60 units TID a.c. Her most recent A1C=9%. How would she switch to U500?
  - 1:1 conversion since A1C ≥ 8%
  - TDD=180+240=420 units split as 40/30/30
- New Dose:
  - U500 165 units QAM, 125 units at lunch, 125 units at dinner
  - Must round to nearest 5 unit increment
  - Inject 30 minutes before each meal
  - Use U500 syringe or U500 pen
  - Do not use U100 syringes!



Reid TS, et al. Postgrad Med. 2017;129(5):554-562.

Poll Question 6

- AJ tells you she doesn't want to start on insulin. What is your best response?

a. The needles are so small, you won’t even feel it.

b. Lots of people are afraid of insulin.

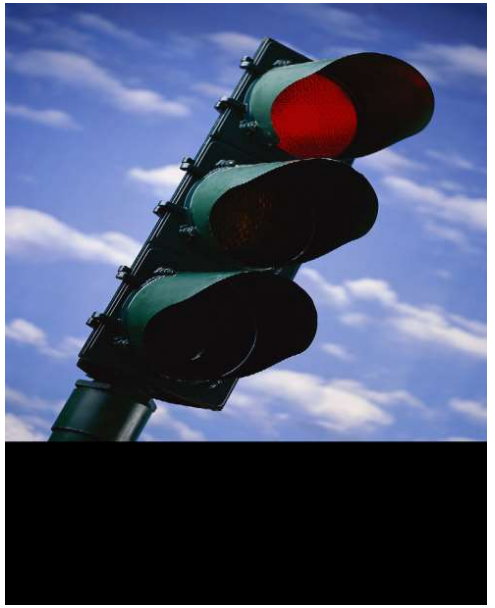
c. It sounds like you are refusing to take insulin?

d. I’m sorry, but there is a doctors' order to start insulin.

e. What concerns do you have about taking insulin?

Psychological Insulin Resistance (PIR)

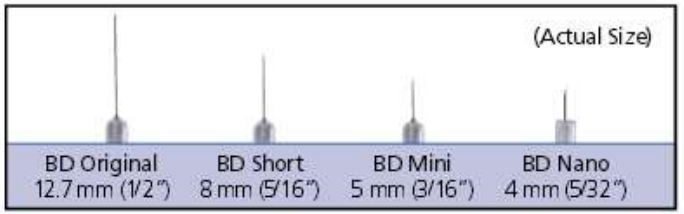
- 50% of providers in study threatened pts “with the needle”.
- Less than 50% of providers realized insulins’ positive effect on type 2 DM
- Most pts don’t believe that insulin would “better help them manage their diabetes”.
- Solutions: Find the root of PIR and address it



Diabetes Attitudes, Wishes, Needs Study - Rubin

Needle Size often a Barrier: Size Matters

- Use shortest needles – 4 mm
- Effective for almost ALL patients
- Keeps it subq
- If thin, inject at angle
- To avoid leakage, count to 10 before withdrawing needle
- For needle phobias, consider insulin pumps, patches, iport, and inhaled insulin



BD Nano 4mm and BD Mini 5mm only available in pen needles

How To's of Adding Insulin in Type 2 DM

Injectable Therapy for Type 2 Diabetes

- Use GLP-1 RA as first injectable when possible
- Start basal insulin 10 units or 0.1 to 0.2 units/kg day
- Titrate up 2 units every 3-4 days, until FBG at goal
- If hypo, decrease insulin 20% or 4 units
- If basal insulin is >0.5 unit/kg day, add bolus insulin (avoid overbasalization)
- Adding bolus
  - Start with 4 units bolus at largest meal or
  - Start 1-2 injections with 10% of basal or
  - Switch to 70/30 twice or three times daily.

Intensifying Injectable Footnotes 9.2

- Consider insulin as the first injectable if evidence of ongoing catabolism A1C levels (>10%) or BG levels ≥300mg/dL or a diagnosis of type 1 diabetes is a possibility.
- For those on GLP-1RA and basal insulin combination, consider using a fixed-ratio combination product (iDegLira or iGlarLixi).
- Consider switching from evening NPH to a basal analog if there is hypoglycemia and/or the individual frequently forgets to administer NPH in the evening. In this case, an AM dose of a long-acting basal insulin could be a better choice.
- If adding prandial insulin to NPH, consider initiation of a self-mixed or premixed insulin regimen to decrease number of injections.

Insulin/Injectable Combos

PocketCards are updated twice yearly.
Scan QR code to download or order the latest version.

SCAN ME

Name	Combines	Considerations
IDegLira* Xultophy 100/3.6	Insulin degludec (IDeg or Tresiba) Ultra long insulin + Liraglutide (Victoza) GLP-1 Receptor Agonist (GLP-1 RA)	**Xultophy 100/3.6 pre-filled pen** = 100 units IDeg / 3.6 mg liraglutide per mL Once daily injection – Dose range 10 to 50 = 10 – 50 units IDeg + 0.36 -1.8 mg liraglutide **Recommended starting dose:** • 16 IDegLira (= 16 units IDeg + 0.58 mg liraglutide) Titrate dose up or down by 2 units every 3-4 days to reach target. Supplied in package of five single-use 3mL pens. Once opened, good for 21 days.
iGlarLixi* Soliqua 100/33	Insulin glargine (Lantus) Basal Insulin + Lixisenatide (Adlyxin) GLP-1 Receptor Agonist	**Soliqua 100/33 Solostar Pen** = 100 units glargine / 33 µg lixisenatide per mL Once daily injection an hour prior to first meal of day. Dose range 15 – 60 = 15-60 units glargine + 5 – 20µg lixisenatide **Recommended starting dose:** • 15 units if not meeting glucose target on 30 units basal insulin or GLP-1 RA • 30 units if not meeting glucose target on 30-60 units basal insulin or GLP-1 RA Titrate dose up or down by 2-4 units every week to reach target. Supplied in package of five single-use 3mL pens. Once opened, good for 14 days.

***Discontinue basal insulin /GLP-1 RA therapy before starting. If dose missed, resume with next usual scheduled dose.**

Observe precautions of each component drug.

DiabetesEd.net ©2024

INTENSIFYING INJECTABLE THERAPY IN TYPE 2 – ADA STANARDS Figure 9.4

Including reinforcement of behavioral interventions (weightmanagement and physical activity) and provision of DSMES to meet individualized treatment goals.

To Avoid Therapeutic Inertia - Reassess and modify treatment regularly (3-6 months)

If injectable therapy is needed to reduce A1C[1]

Consider GLP-1 RA or GIP/GLP-1 RA in most individuals prior to insulin[2]

INITIATION: Initiate appropriate starting dose for agent selected (varies within class)

TITRATION: Titration to maintenance dose (varies within class)

If already on **GLP-1 RA or GIP/GLP-1 RA** or if these are not appropriate OR if insulin is preferred:

If above A1C target

Add basal insulin[3]

Choice of basal insulin should be based on person-specific considerations, including cost. Refer to **Table 9.4** for insulin cost information.

Add basal analog or bedtime NPH insulin

INITIATION: Start 10 IU a day **OR** 0.1-0.2 IU/kg a day

TITRATION:

- Set FPG target (see Section 6: Glycemic Targets)
- Choose evidenced-based titration algorithm, e.g., increase 2 units every 3 days to reach FPG target without hypoglycemia
- For hypoglycemia determine cause, if no clear reason lower dose by 10-20%

INTENSIFYING INJECTABLE THERAPY IN TYPE 2 – ADA STANARDS Figure 9.4

Including reinforcement of behavioral interventions (weightmanagement and physical activity) and provision of DSMES to meet individualized treatment goals.

Assess adequacy of basal insulin dose

Consider clinical signals to evaluate for overbasalization and need to consider adjunctive therapies (e.g., basal dose >0.5 IU/kg, elevated bedtime-morning and/or post-preprandial differential, hypoglycemia [aware or unaware], high variability)

If above A1C target and not on GLP-1/GIP, consider adding to treatment plan. If A1C still elevated:

Add prandial insulin[5]

Usually, one dose with the largest meal or meal with the greatest PPG excursion; prandial insulin can be dosed individually or mixed with NPH as appropriate

INITIATION:

- 4 IU a day or 10% of basal insulin dose
- If A1C <8% (64 mmol/mol) consider lowering the basal dose by 4 IU a day

TITRATION:

- Increase dose by 1-2 IU or 10-15% twice weekly
- For hypoglycemia determine cause, if no clear reason lower corresponding dose by 10-20%

INTENSIFYING INJECTABLE THERAPY IN TYPE 2 – ADA STANARDS Figure 9.4
Including reinforcement of behavioral interventions (weightmanagement and physical activity) and provision of DSMES to meet individualized treatment goals.

American Diabetes Association.

If on bedtime NPH, consider converting to twice-daily NPH regimen

Conversion based on individual needs, glycemic control. The following is one possible approach:

INITIATION:

- Total dose= 80% of current NPH dose
- 2/3 given in the morning
- 1/3 given at bedtime

TITRATION: Titrate based on individualized needs

If above A1C target

Stepwise additional injections of prandial insulin

(i.e., two then three additional injections)

Proceed to full basal-bolus regimen

(i.e., basal insulin and prandial insulin with each)

Consider self-mixed/split insulin regimen

Can adjust NPH and short/rapid-acting insulins separately

INITIATION:

- Total NPH dose = 80% of current NPH dose
- 2/3 given before breakfast
- 1/3 given before dinner
- Add 4 IU of short/rapid-acting insulin to each injection or 10% of reduced NPH dose

TITRATION:

- Titrate each component of the regimen based on individualized needs

Consider twice daily premix insulin regimen

INITIATION:

- Usually unit per unit at the same total insulin dose, but may require adjustment to individual needs

TITRATION:

- Titrate based on individualized needs

Case Study: Jenny

Jenny is a 50-year-old woman that takes insulin glargine 100 units daily, glipizide 10mg BID, metformin 1000mg BID, and linagliptin 5mg daily. A1C is 9.3%. She weighs 110kg. She checks glucose in the AM only and reports it's 90-130mg/dL. Her eGFR is 70. She previously had UTI's with empagliflozin.

What is the best recommendation to adjust this regimen?

Thinking about the choices

- Continue glargine?
- Continue glipizide?
- Continue linagliptin?
- Add GLP-1 agonist?
- Switch to combination GLP1 receptor agonist /insulin injectable?
- Add prandial insulin?
- Add SGLT-2 inhibitor?

Piecing it Together

- New Regimen:
  - Insulin glargine 80 units once daily (20% reduction)
- Semaglutide 0.25mg weekly, titrated up to 2mg weekly
- Stop linagliptin
- Continue glipizide (for now)
- Next step could be to retry SGLT2i with counseling on how to avoid UTIs
- Or replacing glipizide with prandial insulin with largest meal
- CGM!

How to Switch Basal Insulin

- When going from twice daily basal insulin to once daily, reduce dose by 20%
  - Examples:
    - Insulin NPH BID to insulin glargine daily
    - Insulin detemir BID to insulin degludec daily
- When switching between once daily, a unit per unit conversion is okay
- Long-acting to glargine U300 often requires higher doses (10 to 18%) but start with a unit to unit conversion
- When switching from glargine U300 to another long-acting insulin, reduce dose by 20%
- Need to use clinical judgement
  - For example, if A1C, FBG, and pre-meal BG are all above target, then may not be necessary to reduce basal insulin dose

Clinical Resource. Pharmacist's Letter/Prescriber's Letter. August 2019.

Poll 7 - Making the switch: Meet Joan

Joan is taking insulin glargine 30 units twice daily. Her insurance formulary wants her to switch to insulin degludec. Her current A1C is 6.9%. What is the best dose recommendation?

A. Insulin degludec 30 units twice daily
B. Insulin degludec 60 units once daily
C. Do not switch since her A1C is well-controlled and get a prior authorization to continue with insulin glargine
D. Insulin degludec 48 units once daily

Switching Meal time Insulin

- This is a 1:1 conversion when switching between regular insulin, aspart, lispro, and glulisine including Fiasp® and Lyumjev™.
- The exception is when switching to Afrezza

Injected Meal Time Dose	Inhaled Insulin Dose
Up to 4 units	4 units
5-8 units	8 units
9-12 units	12 units
12-16 units	16 units
17-20 units	20 units
21-24 units	24 units

Clinical Resource. Pharmacist's Letter/Prescriber's Letter. August 2019.
Afrezza (package insert) 2019.

Poll 8. Patient Case: Lumy

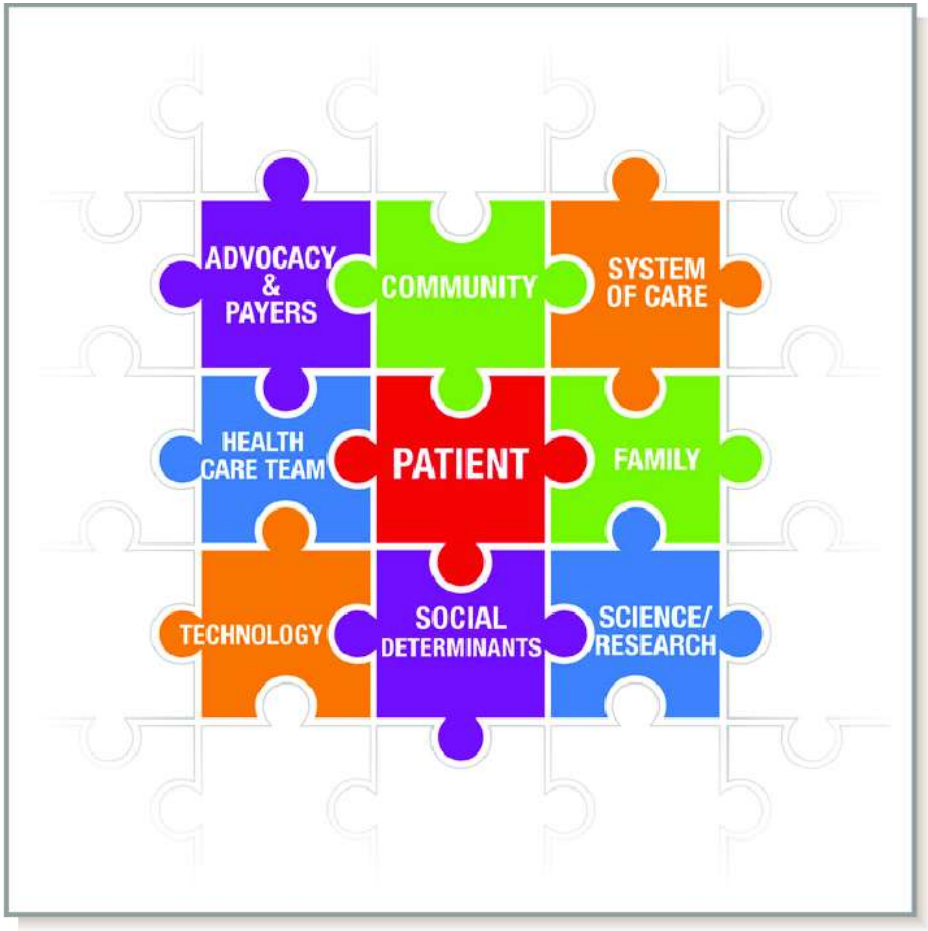
- Lumy's insurance formulary changed from insulin lispro to insulin aspart.
- She was following an insulin to carbohydrate ratio of 1:12 and a correction factor of 1:50.
- How should she dose insulin aspart when she switches?
  A. Reduce all doses by 10%
  B. Increase all doses by 10%
  C. Same dosing
  D. Submit prior authorization so she doesn't change insulin

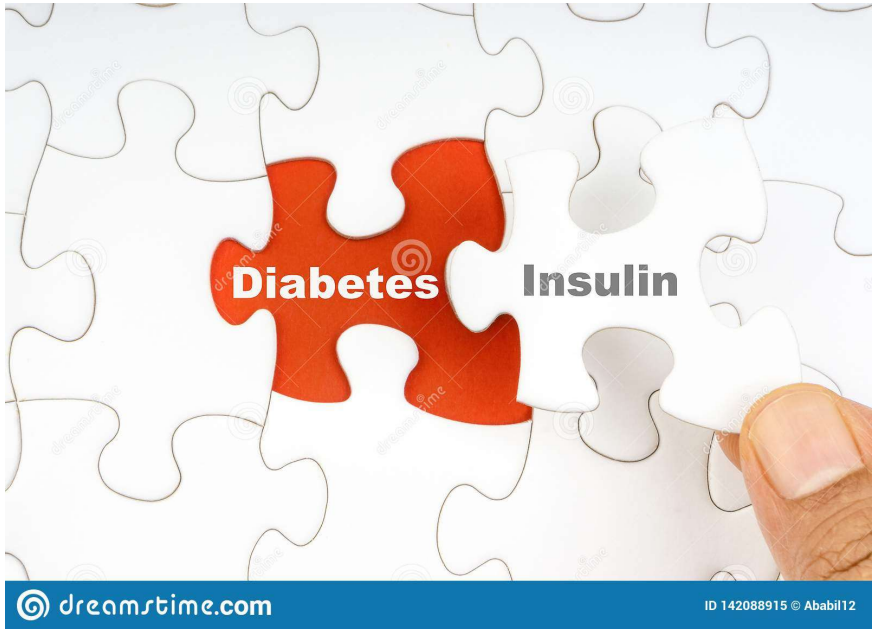
Pattern Management –AKA

How to think like a pancreas

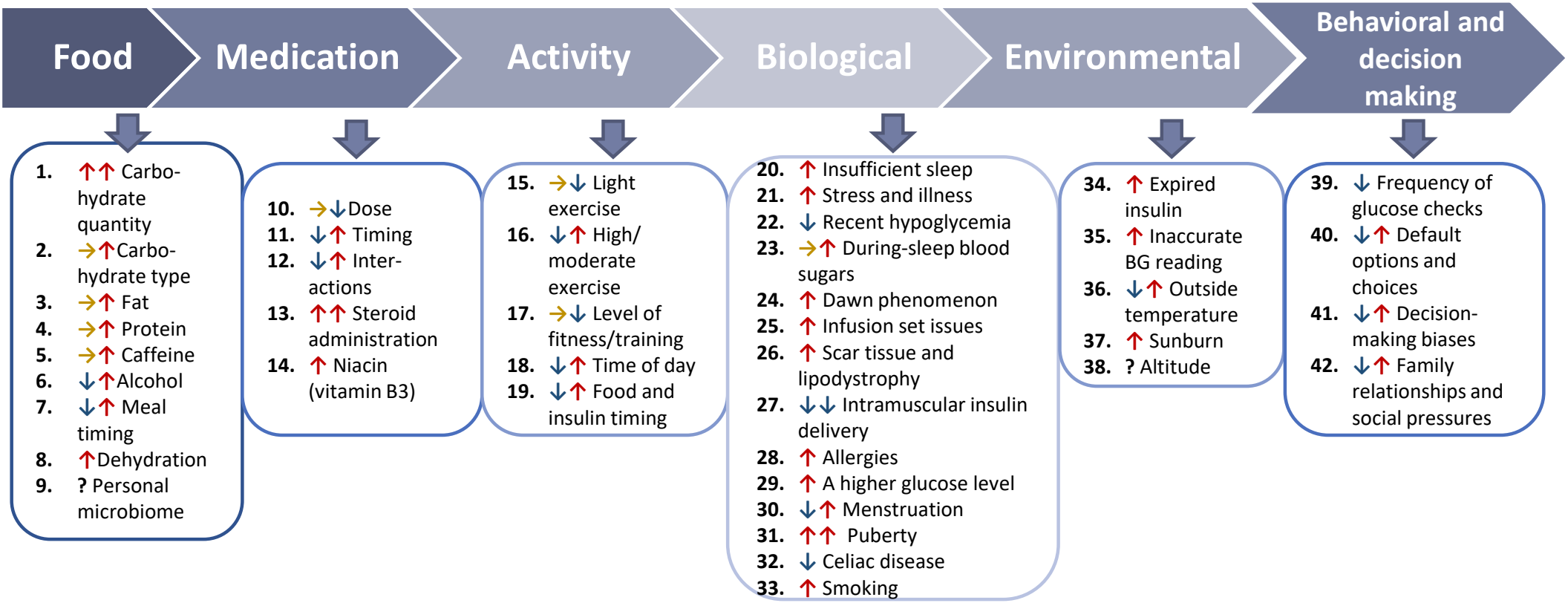
What do the numbers mean?

It’s like a BIG puzzle!





At Least 42 Factors Affect Glucose!



Adapted from Brown A. DiaTribe Learn: Making sense of diabetes... diatribe.org/42factors

Poll Question 9

- When looking at glucose patterns, which problem do you fix first?

  a. Hyperglycemia

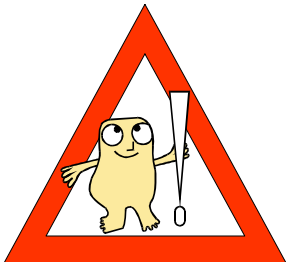
  b. Hypoglycemia

  c. Non-compliance

  d. Legible writing

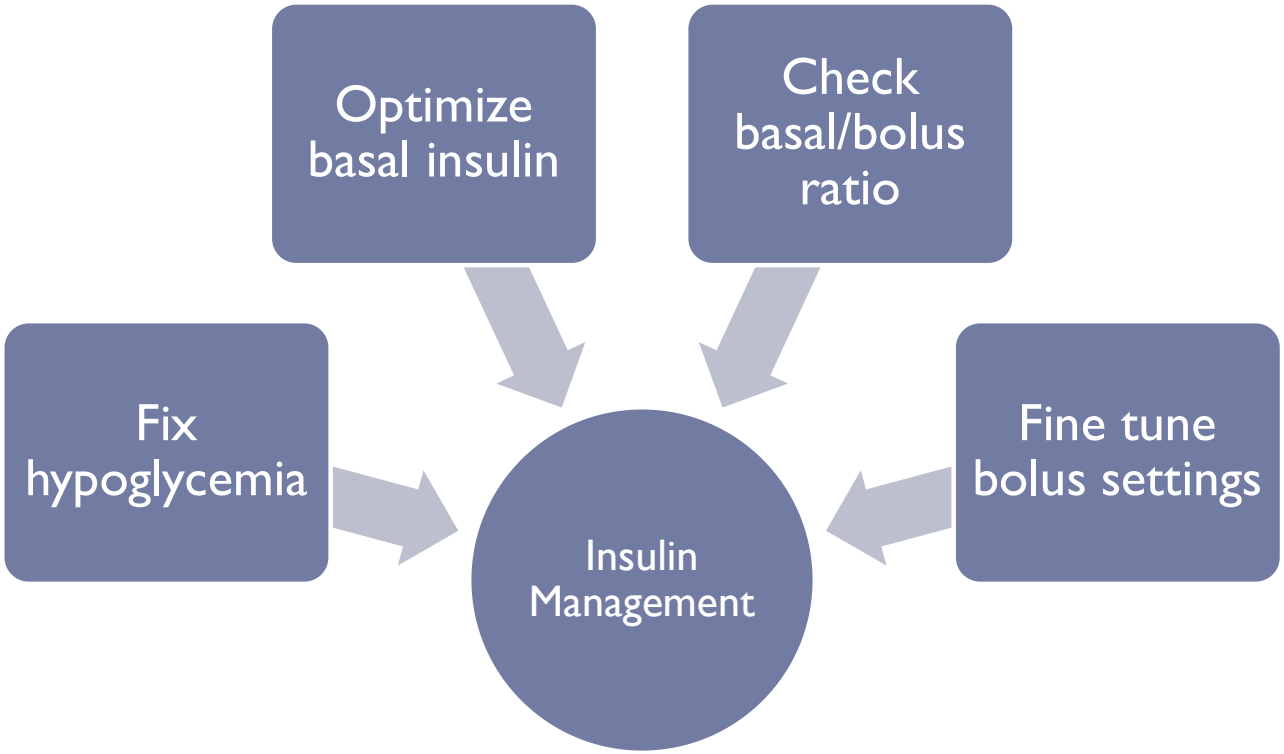
Pattern Management

- Safety 1st!! - Evaluate 3 day patterns
- **Hypo:** eval 1st and fix:
  - If possible, decrease medication dose
  - Timing of meals, exercise, medications
- **Hyperglycemia:** evaluate 2nd
  - Identify patterns
  - Before increase insulin, make sure not missing something (carbs, exercise, omission)



General Rules in T1DM

- Optimize basal dose (stay within 30mg/dL when not eating)

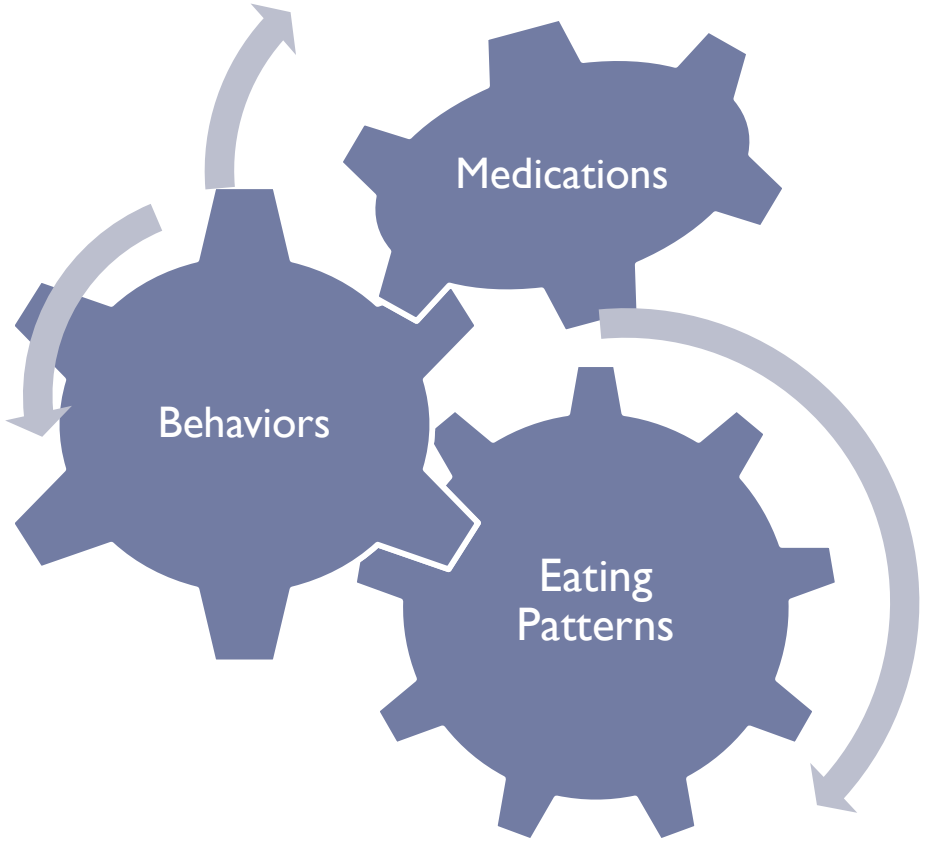


Adjusting Insulin doses in a Basal/Bolus regimen (T1DM & T2DM)

Out of Range Glucose	Insulin to Adjust
Fasting	Long acting insulin or evening NPH
Post-breakfast/pre-lunch	Pre-breakfast rapid/regular insulin
Post lunch/pre-dinner	Pre-lunch rapid/regular insulin or morning NPH
Post-dinner/before bedtime	Pre-dinner rapid/regular insulin

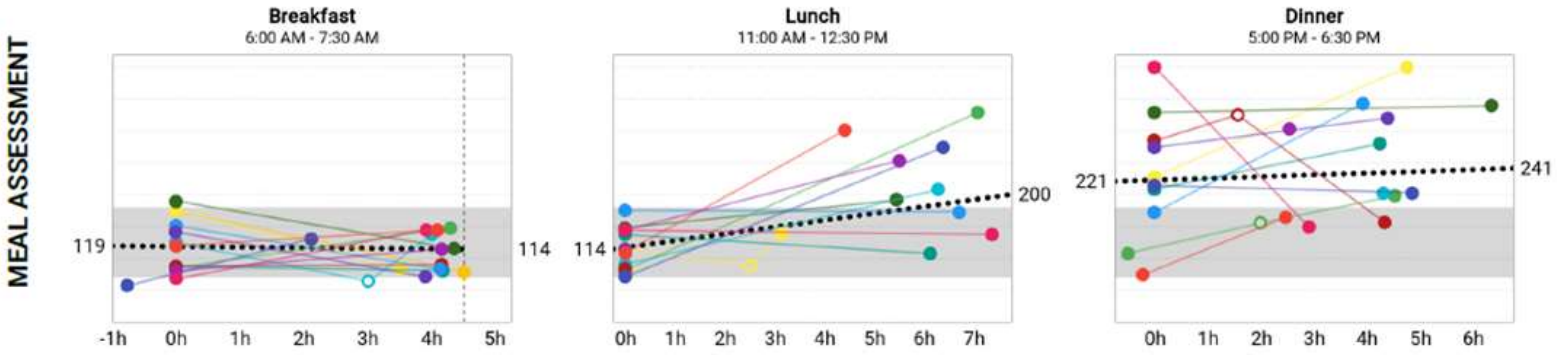
Tips for Data Interpretation

- Start by asking the person what they've experienced and noticed with their glucose patterns
- Avoid judgment
- Learn from 1 time episodes, but make changes based on patterns
- Fix lows first but some amount is expected (<1-4%) and if you remove all lows, you may end up with too many highs
- If it's not making sense, dig deeper (ex. missed doses, rationing, injection technique, food insecurity, etc)



Meal Time Data Review

- Glucose data before and after breakfast, lunch and dinner
- Ideally, 2 hour post-meal should not rise above 180mg/dL or 50mg/dL from the pre-meal start
- By 4-5 hours, glucose should return to pre-meal level



Bolus Pattern Management

- Does glucose go low after a correction dose?
  - May need a higher sensitivity
  - Ex. 1:60 instead of 1:50
- Does glucose remain high after a correction dose?
  - May need a lower sensitivity
  - Ex. 1:40 instead of 1:50
- Often people are more sensitive overnight (less insulin needed)
- Does the person spike high after eating?
  - Is the person bolusing BEFORE the meal
  - Counting carbs correctly?
  - May need a more intensive carb ratio
  - Ex. 1:6 instead of 1:8
- Does the person go low after eating?
  - Counting carbs correctly?
  - May need a less intensive carb ratio
  - Ex. 1:10 instead of 1:8

Adjustments typically made 10-20% at a time

Checking the Sensitivity

- TDD=49 units

Total daily dose (per day)	49 units
Bolus amount (per day)	21U (43%)
Auto Basal / Basal amount (per day)	28U (57%)

- Rule of 1700
  - 1700/49=35

Carbohydrate Ratio (g/U)			Insulin Sensitivity (mg/dL per U)		
Time	Ratio		Time	Sensitivity	
0:00	15.0		0:00	40	

- Current sensitivity is 40

The calculation is slightly different from the current sensitivity. Look at the glucose data to determine if the sensitivity should be decreased.

Checking the Carb Ratio

- TDD=49 units
- Rule of 450
  - 450/49=12.9
- Current carb ratio is 15

Total daily dose (per day)	49 units
Bolus amount (per day)	21U (43%)
Auto Basal / Basal amount (per day)	28U (57%)

Carbohydrate Ratio (g/U)

Time	Ratio
0:00	15.0

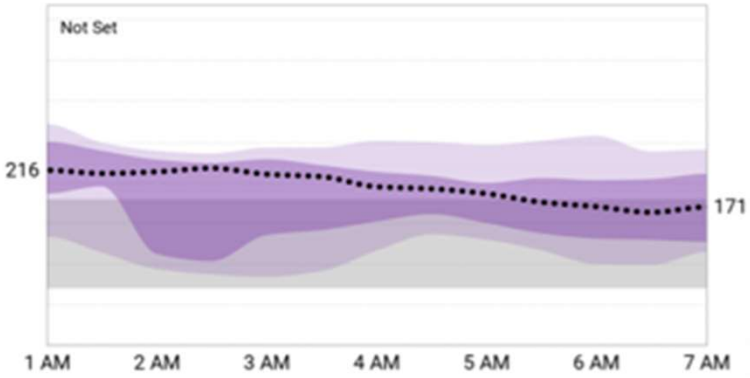
Insulin Sensitivity (mg/dL per U)

Time	Sensitivity
0:00	40

The calculation is different from the current carb ratio. Look at the glucose data to determine if the carb ratio should be decreased.

Basal Insulin Review

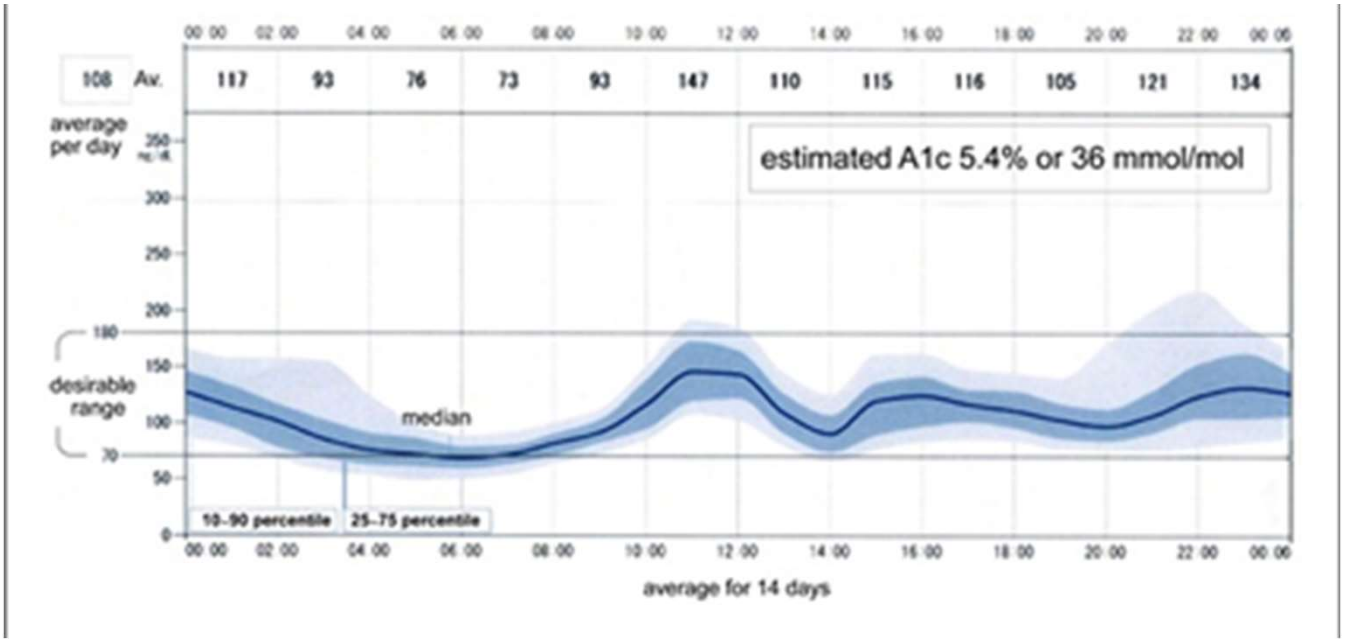
LONG-ACTING ASSESSMENT



Days Included in Assessment	11 of last 14 days
Average Daily Dose Taken	0 U
# Days with Glucose < 70 mg/dL	2 ▼
Median Bedtime to Fasting (Change)	216 to 171 (-45 mg/dL) ▼

Note: Days with overnight boluses are excluded.

▲ Rising fasting glucose of 30 mg/dL or more may indicate long-acting dose should be increased.
▼ Falling fasting glucose of 30 mg/dL or more or days with glucose < 70 mg/dL may indicate long-acting dose should be decreased.



Case Study: Larry Poll Question 10

Larry takes metformin 1000mg BID, insulin glargine 50 units once daily, empagliflozin 10mg daily. His A1C is 7.8%. He weighs 90kg. FBG averages 100mg/dL. 2 hr PP breakfast=190mg/dL, 2 hr PP lunch=210mg/dL, and 2 hr PP dinner is 240mg/dL. What is the best recommendation for an agent to add to the regimen to achieve A1C target?

A. Initiate insulin aspart 5 units at dinner, decrease insulin glargine to 45 units daily
B. Initiate insulin aspart 5 units with all meals, decrease insulin glargine to 35 units daily
C. Initiate insulin aspart 5 units at dinner, continue insulin glargine 50 units daily
D. Initiate tirzepatide 2.5mg weekly, decrease insulin glargine to 45 units daily

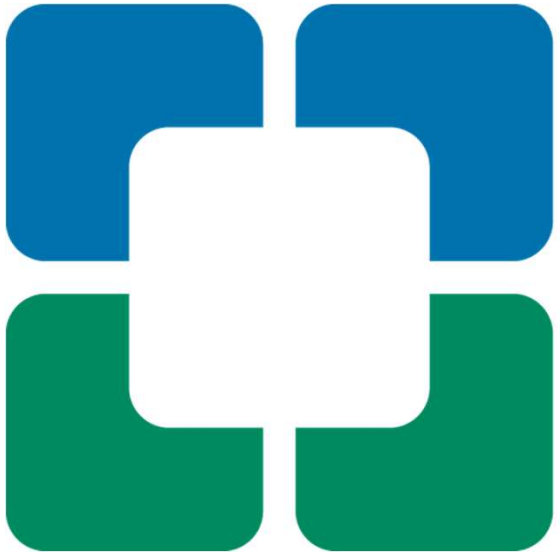
Summary

- Many different types of insulin
- Basal + bolus needed for T1DM
- Weight based dosing and rules of 1700/1800 and 500/450 can be used to calculate correction factor and carb ratio
- GLP1 agonist preferred 1st injectable in T2DM
- Avoid overbasalization, if taking more than 0.5unit/kg/day, think about GLP1 agonist +/- prandial insulin
- Counsel on injection site technique, administration and storage
- Fine tune insulin settings based on BGM and CGM data

Integrating Technology: CGM Connected Pens and Insulin Pumps DiabetesEd Training Conference – Day 2

Diana Isaacs, PharmD, BCPS, BC-ADM, BCACP CDCES, FADCES, FCCP

Director, Education & Training in Diabetes Technology

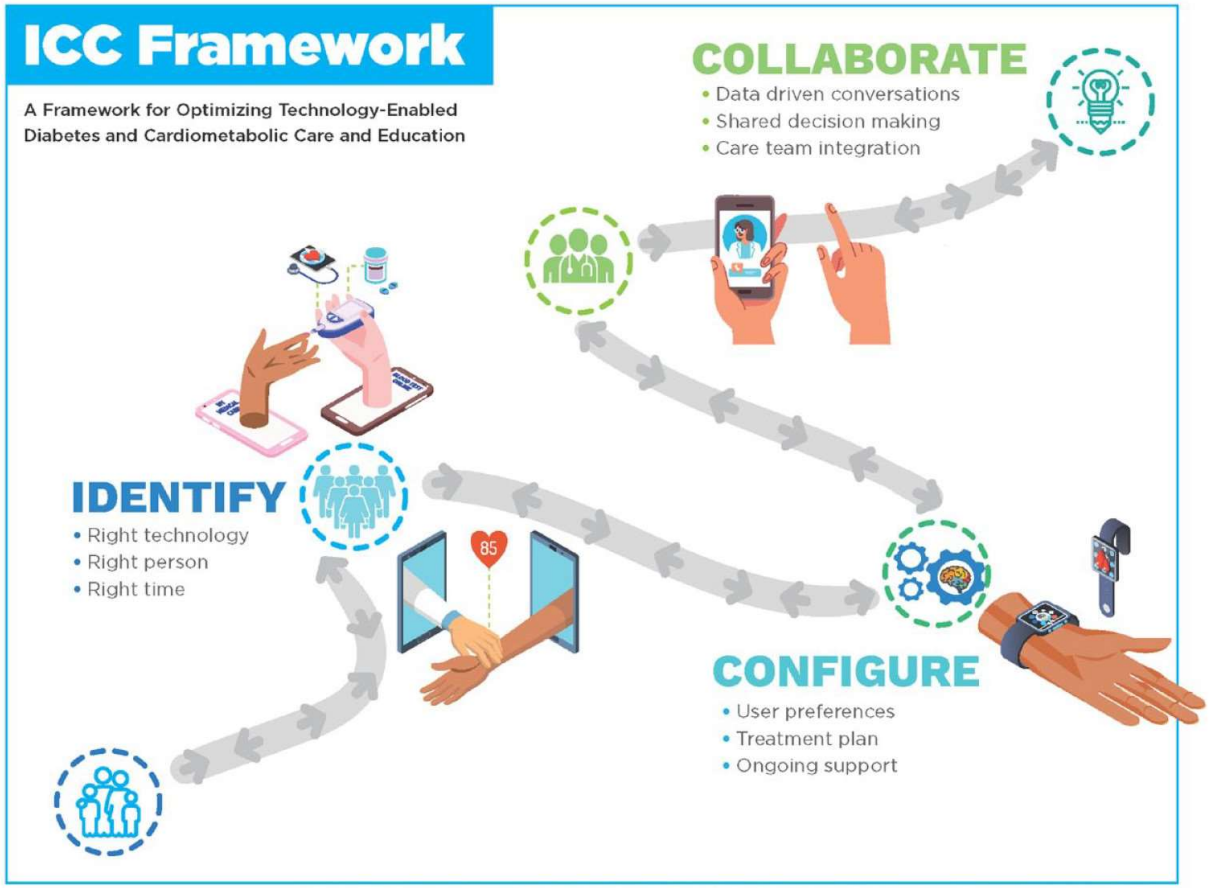


Learning Objectives

- Discuss continuous glucose monitoring (CGM) and the clinical benefits for managing diabetes
- Compare and contract different CGM, insulin pump, and connected pen devices
- Describe critical teaching content for insulin pump, connected pen and CGM use
- Describe appropriate candidates for insulin pump therapy
- List inpatient considerations for insulin pump therapy and CGMs

ICC Framework – Identify-Configure-Collaborate

A framework to overcome barriers to technology use and therapeutic inertia



Greenwood DA, Howell F, Scher L, et al. A Framework for Optimizing Technology-Enabled Diabetes and Cardiometabolic Care and Education: The Role of the Diabetes Care and Education Specialist. The Diabetes Educator. 2020;46(4):315-322. doi:10.1177/0145721720935125

Technology is Here

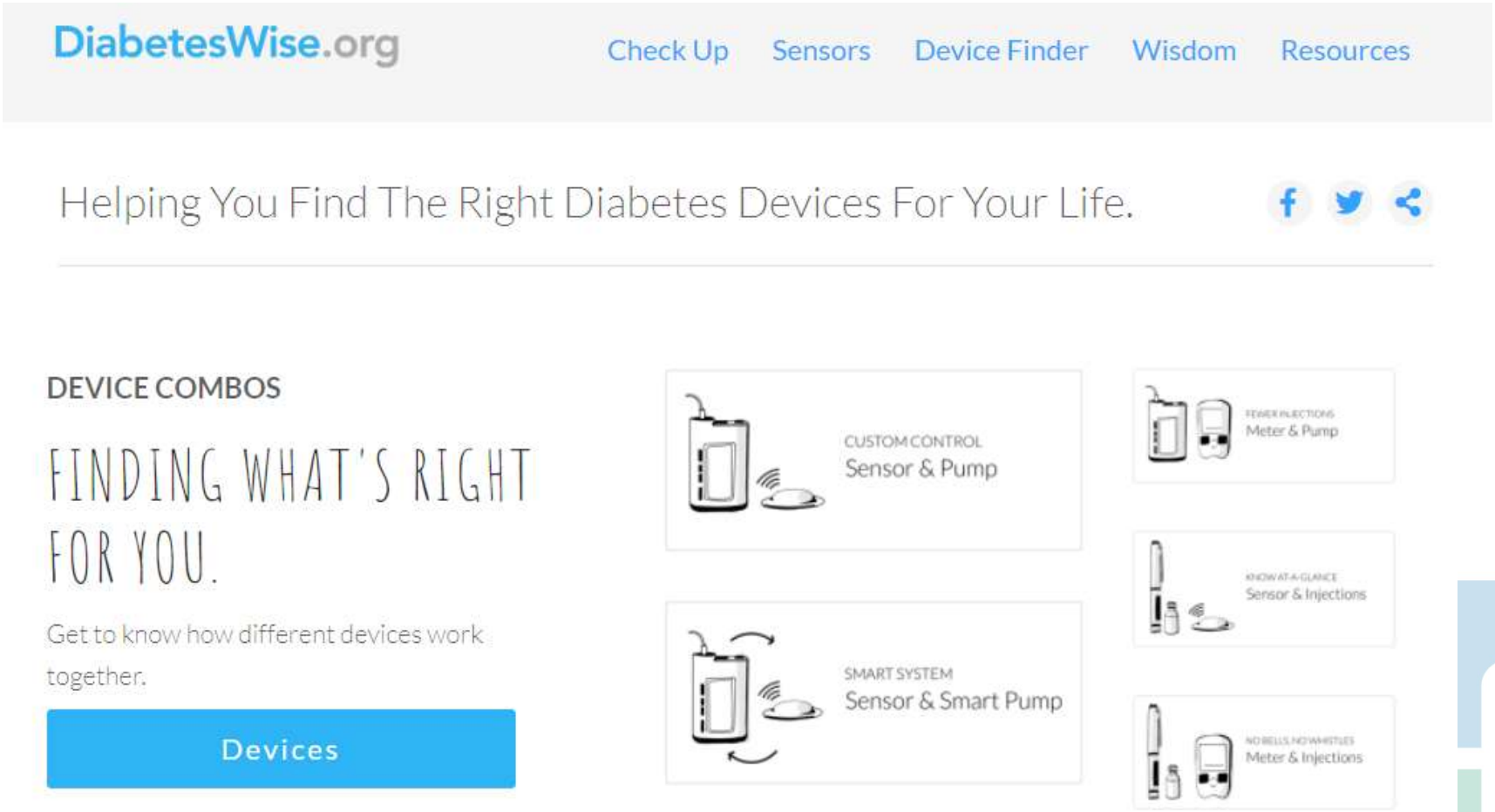
CONTINUOUS GLUCOSE MONITORS (CGM)

INSULIN PUMPS

CONNECTED PENS AND CAPS

MOBILE APPS

Identify: PWD Identify the “Right” Technology



Diabeteswise.org, providers.diabeteswise.org/#/

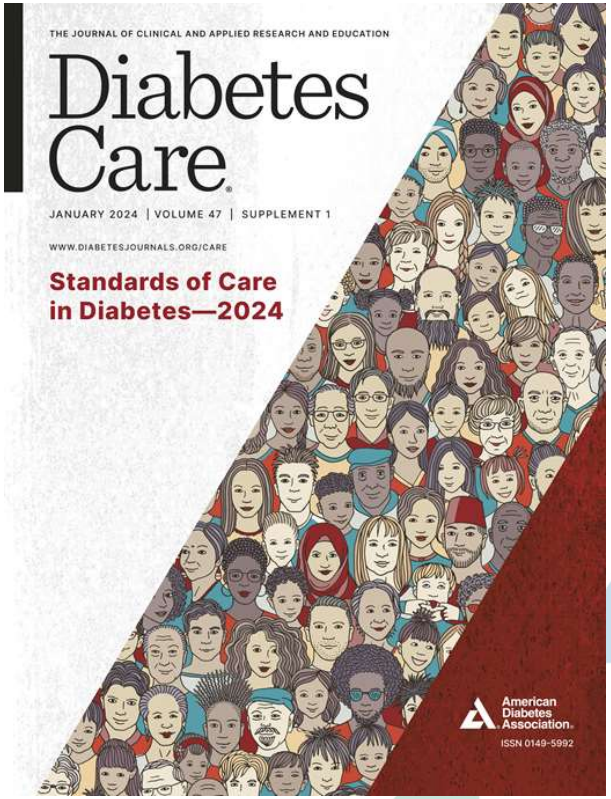
The Importance of Education & Training

"No device used in diabetes management works optimally without education, training, and follow-up."

ADA. Diabetes Care. 2024.

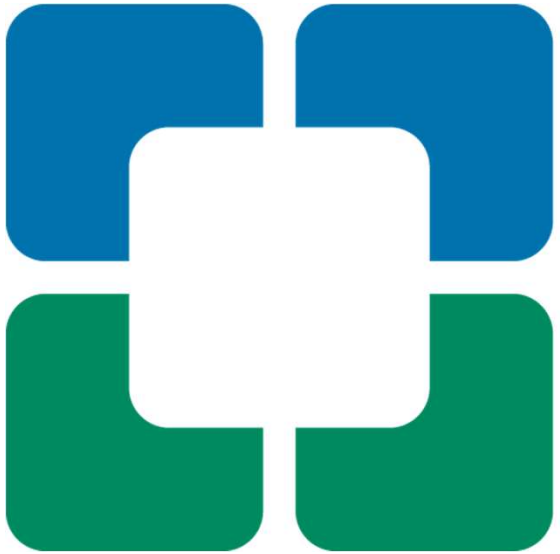
Guidelines: ADA

- Initiation of CSII and/or AID early, even at diagnosis, in the treatment of diabetes can be beneficial depending on a person's or caregiver's needs and preferences. (C)
- AID systems should be offered for diabetes management to youth and adults with T1D (A) and other forms of insulin deficient diabetes (E) who are capable of using the device safely.
- Connected insulin pens can be helpful for diabetes management and may be used in people with diabetes taking subcutaneous insulin. E
- Systems that combine technology and online coaching can be beneficial in managing prediabetes and diabetes for some individuals. B
- The choice of device should be made based on the individual's circumstances, preferences and needs.



Diabetes Care 2024;47(Suppl. 1):S126–S144

Continuous Glucose Monitors



Continuous Glucose Monitors (CGM)

- Measures glucose (sugar) every 1-5 mins and records it every 5-15 mins (up to 288 readings/day)
- Includes 3 components: transmitter, sensor, receiver/reader

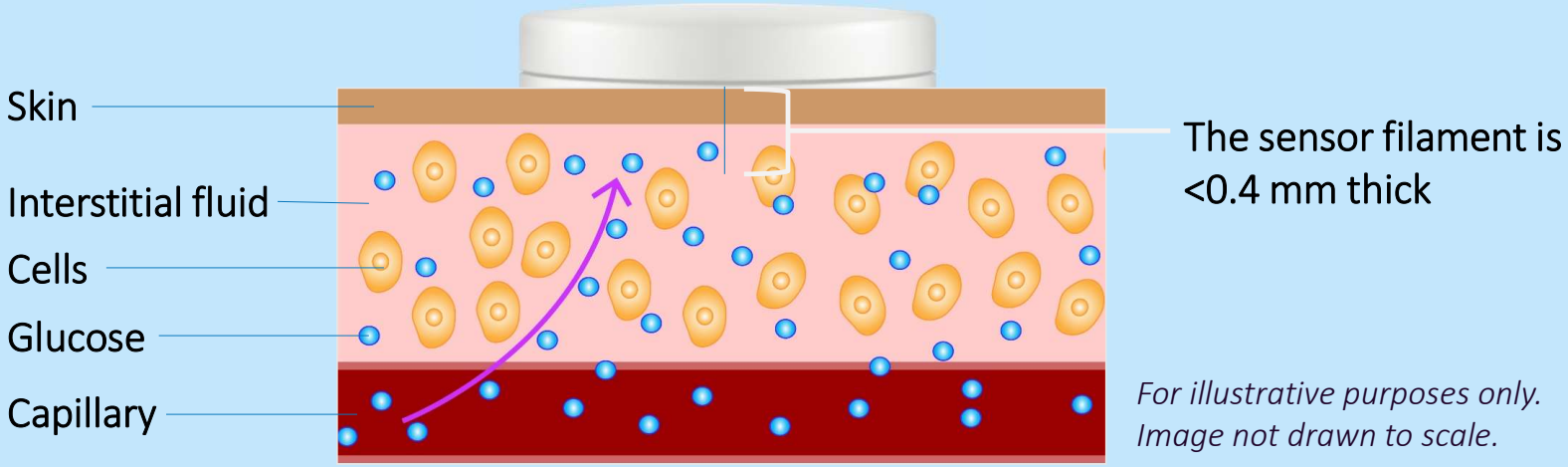


Illustration adapted from: Association of Diabetes Care & Education Specialists. ADCES Practice Paper. Accessed 11/9/21. https://www.diabeteseducator.org/docs/default-source/practice/practice-documents/practice-papers/the-diabetes-educator-role-in-continuous-glucose-monitoring.pdf?sfvrsn=4

CGM: Real-Time Data

Types of CGM

Professional	Personal
Owned by the clinic	Owned by the person with diabetes
Blinded and unblinded (real-time feedback) options	Real-time feedback or scan for feedback (flash device)
Short-term use (3-14 days)	Long-term use
Insurance coverage for most people with type 1 or type 2 diabetes	Insurance coverage more focused on type 1 diabetes or those on intensive insulin regimens
Not compatible with insulin pumps or connected pens	Compatible with smartphones, connected pens and insulin pumps with select devices

Wright LA, Hirsch IB. *Diabetes Technol Ther.* 2017;19(suppl 2):S16-S26; Kruger DF, et al. *Diab Educ*. 2019;45(suppl 1):S3-S20.

Professional CGM Comparison

	Dexcom G6 Pro	LibrePro
Blinded vs unblinded	Both	Blinded
Maximum wear time of sensor	10 days	14 days
Calibration	None	None
Downloading reports	Clarity	LibreView
Care between transmitter use	Disposable-1 time use, must attached transmitter	Disposable 1-time use, combined sensors/transmitter
Alarms for high/low glucose alerts	Yes	No
Interfering substances	Hydroxyurea	Salicylic acid and high-dose vitamin C

ADCES Practice Paper. The diabetes care and education specialist role in CGM.

Personal CGM Options

Owed by the person with diabetes → Typically used long term → Device options include real-time glucose monitoring (rtCGM) or intermittent scanning (isCGM) → Some options can be integrated with insulin pumps or connected insulin pens

Freestyle Libre 2

Freestyle Libre 3

Eversense

Guardian Connect or Guardian 3 or 4

Dexcom G6

Dexcom G7

Slide 13

AS1 Added Dexcome to G6

Added FreeStyle to Libre 2 and Libre 14 Day

Added Sensor to Guardian 3
Alissa Scott, 11/9/2021

CGM Comparison

	G6	G7	Libre 2	Libre 3	Guardian Connect Guardian 3/4	Eversense
Integration	T:Slim X2, Omnipod5, InPen, Tempo, iLet	T:Slim X2 Tempo, iLet	Bigfoot Unity, T:Slim X2 (Libre 2+)	No	770G, 780G, InPen	No
Type	rtCGM	rtCGM	isCGM	rtCGM	rtCGM	rtCGM
Maximum wear time	10 days	10.5 days	14 days (15 days with Libre2+)		7 days	180 days
Warm-up time	2 hours	30 min	1 hour		Up to 2 hours	24 hours
Calibrations required	0	0	0		At least 2/day	2/day for 21 days, then 1/day
Water depth	8 feet, 24h	8 feet, 24h	3 feet, 30 min		8 feet, 30 min	3.28 feet, 30 min
Sharing Data	Dexcom Clarity		LibreView		Carelink	Eversense Data Management System

Medtronic Guardian Connect, Guardian 3, Eversense

CGM Comparison (Continued)

	G6	G7	Libre 2	Libre 3	Guardian Connect, Guardian 3/4	Eversense
FDA approved sites	Abdomen (ages2+) Upper buttocks (ages 2-17)	Upper arm (ages 7+) Upper buttocks (ages 2-6)	Upper arm		Upper arm, abdomen Upper buttocks (ages 2-13)	Upper arm
Approved in pregnancy	No	Yes	Yes		No	No
Transmitter	3 months	Disposable	Disposable		Charge weekly	Charge daily
FDA approved ages (years)	≥2	≥2	≥4 (2 with Libre2+)		≥2 Guardian 3 ≥2 Guardian 4 ≥14 Guardian Connect	≥18
Drug interactions	Hydroxyurea	Hydroxyurea	Vitamin C (not with Libre 2+)		Acetaminophen, Hydroxyurea	Tetracycline antibiotics, mannitol

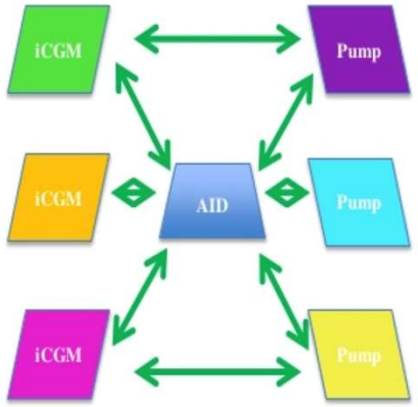
Product user guides: Dexcom G6, Dexcom G7, Libre 2, Libre 3, Medtronic Guardian Connect, Guardian 4, Eversense

Integrated CGM

- Dexcom G6, G7, Libre 2, Libre 2+ Libre 3 are integrated CGM (iCGM)

- Integration with digitally connected devices (eg, pumps, pens, automated insulin dosing [AID] systems)

Goal: Greater Interchangeability



- More efficient regulatory pathways
- Faster innovation
- A more vibrant device ecosystem

Poll Question 12

Which of the following drugs interact with the Libre 2 and Libre 3 systems?

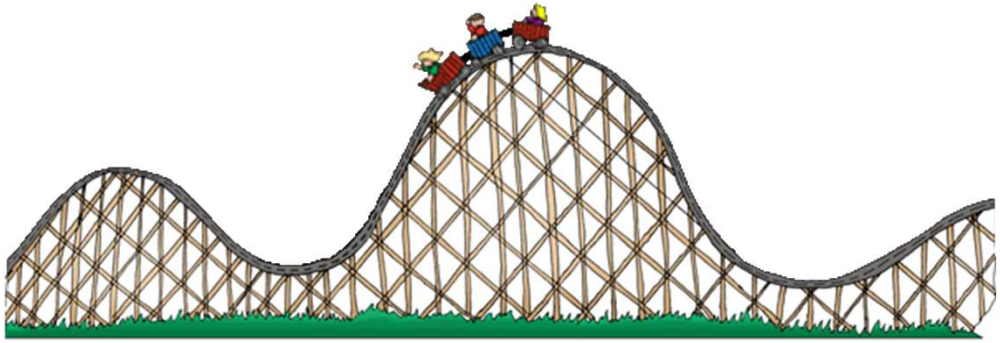
A. Aspirin
B. Vitamin C
C. Hydroxyurea
D. Acetaminophen

CGM Counseling Points

- Important to check glucose when indicated
  - Symptoms do not match sensor value
  - During warm-up period
  - When making dosing decisions for select devices
- Sensors are waterproof
  - Showering, bathing, swimming OK
  - Check water depth criteria for individual sensor
- Overlays and skin preps to help it stay on
- Avoid with MRI, CT, diathermy
  - Exception: Eversense implantable, transmitter should be removed
- Not FDA approved
  - Dialysis, critically ill
  - Pregnancy-Guardian, eversense, G6
  - If people choose to use, it is important they know it is off-label

Lag Time

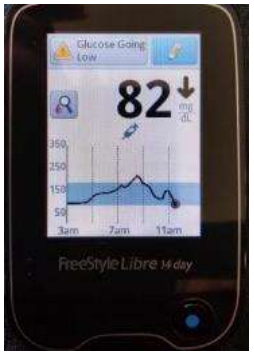
- Refers to a delay in CGM sensor readings compared to finger stick blood glucose readings
  - Estimated CGM sensor reading ~5 minutes behind
- Most apparent when glucose is changing rapidly
- Counsel patients on the train analogy



Causes of Falsely High or Low Readings

- Interfering substances
  - Falsely high
    - Vitamin C (Libre)
    - Acetaminophen (high dose Dexcom, Guardian)
    - Tetracycline antibiotics (Eversense)
  - Falsely low
    - Salicylic acid high dose
- Compression Lows
- Dehydration
- Faulty sensor

When to Check BGM?



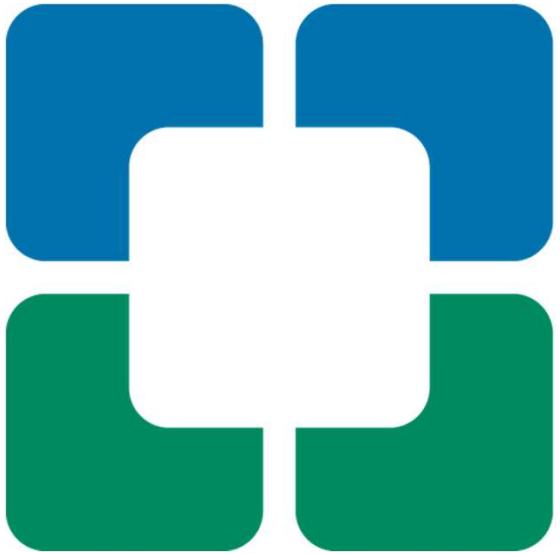
- A calibration or blood glucose symbol appears on the device
- Symptoms or expectations do not match CGM readings
- Off-label indications: dialysis
- After correcting a low
- If taking an interfering substance (ex. vitamin C, acetaminophen hydroxyurea)
- Counsel patients about “lag time”

Per ADA, every person using CGM should have access to a meter and test strips

ADCES Practice Paper. The Diabetes Care and Education Specialist’s Role in Continuous Glucose Monitoring. Updated March 2021

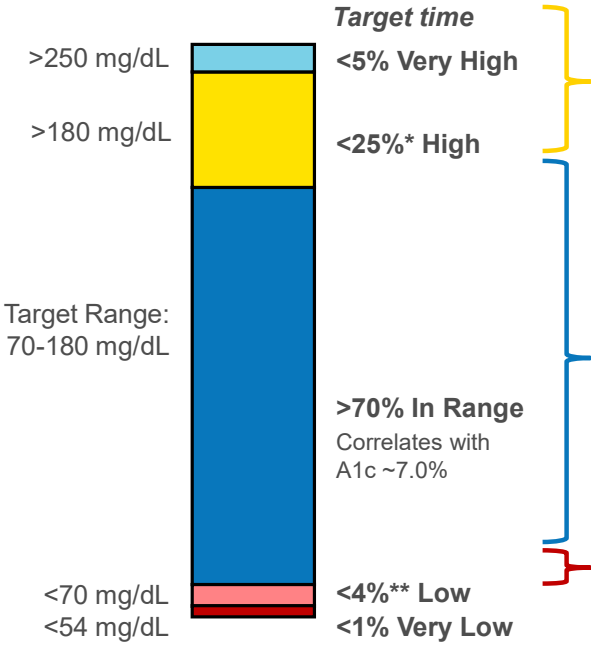
ADA Standards of Care 2024.

Downloading CGM Data



CGM Key Metrics

Recommended Time in Range for most people with T1D & T2D



Time above range (TAR)
< 1 hr, 12 min, > 250 mg/dL
< 6 hr, > 180 mg/dL

Time in range (TIR)
> 16 hr, 48 min

Time below range (TBR)
< 1hr < 70mg/dL
< 15 min < 54mg/dL

Number of days CGM is worn 14 days is recommended
Percentage of time CGM is active 70% of data from 14 days is recommended
Mean glucose
Glucose management indicator (GMI) Estimated A1C
Coefficient of variation (CV) This is a measure of glycemic variability. A CV >36% is considered unstable.

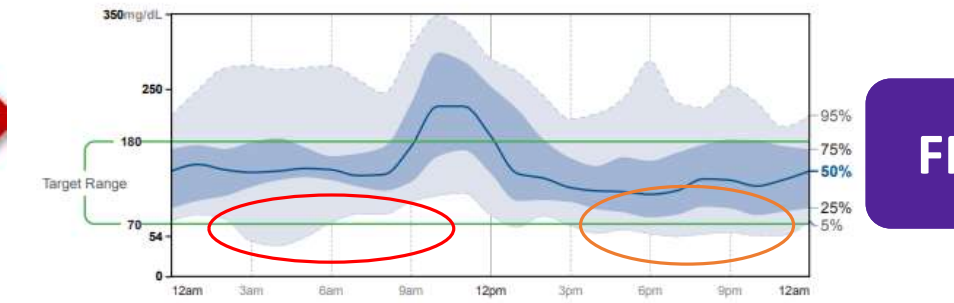
1. Battelino T et al. *Diabetes Care*. 2019;42(8):1593-1603. . 2. American Diabetes Association. *Diabetes Care 2021;44(Suppl. 1):S73–S84 | https://doi.org/10.2337/dc21-S006.*

AGP report

Metrics and targets

More Green, Less Red

AGP profile (14 days)

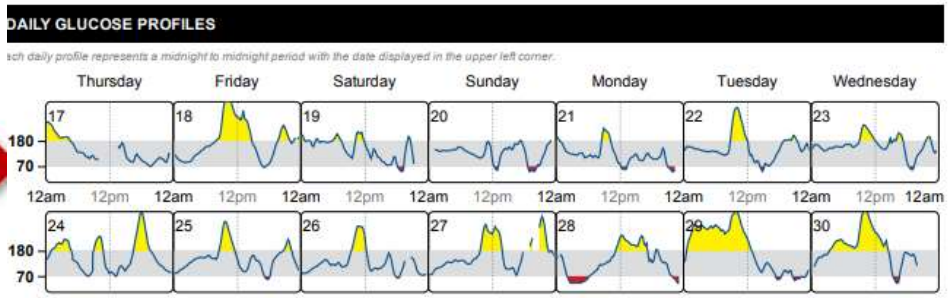


FNIR

Flat Narrow In Range

Treat Hypo 1st

Daily views



Patterns

15. What is the goal time in range for most adults with type 1 or 2 diabetes?

A.≥50%

B.≥70%

C.≥80%

D.≥90%

Target Glucose Ranges

Day

Start Time: 6:00 AM

End Time: 10:00 PM

Low Threshold: 70 mg/dL

High Threshold: 180 mg/dL

Night

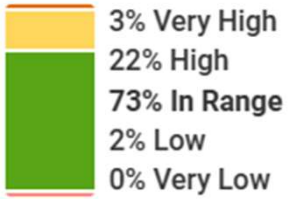
Start Time: 10:00 PM

End Time: 6:00 AM

Low Threshold: 70 mg/dL

High Threshold: 180 mg/dL

Time in Range



3% Very High
22% High
73% In Range
2% Low
0% Very Low

Target Range:
70-180 mg/dL

Day

Start Time: 6:00 AM

End Time: 10:00 PM

Low Threshold: 70 mg/dL

High Threshold: 130 mg/dL

Night

Start Time: 10:00 PM

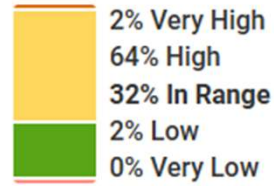
End Time: 6:00 AM

Low Threshold: 70 mg/dL

High Threshold: 130 mg/dL

Time in Range

Time in Range

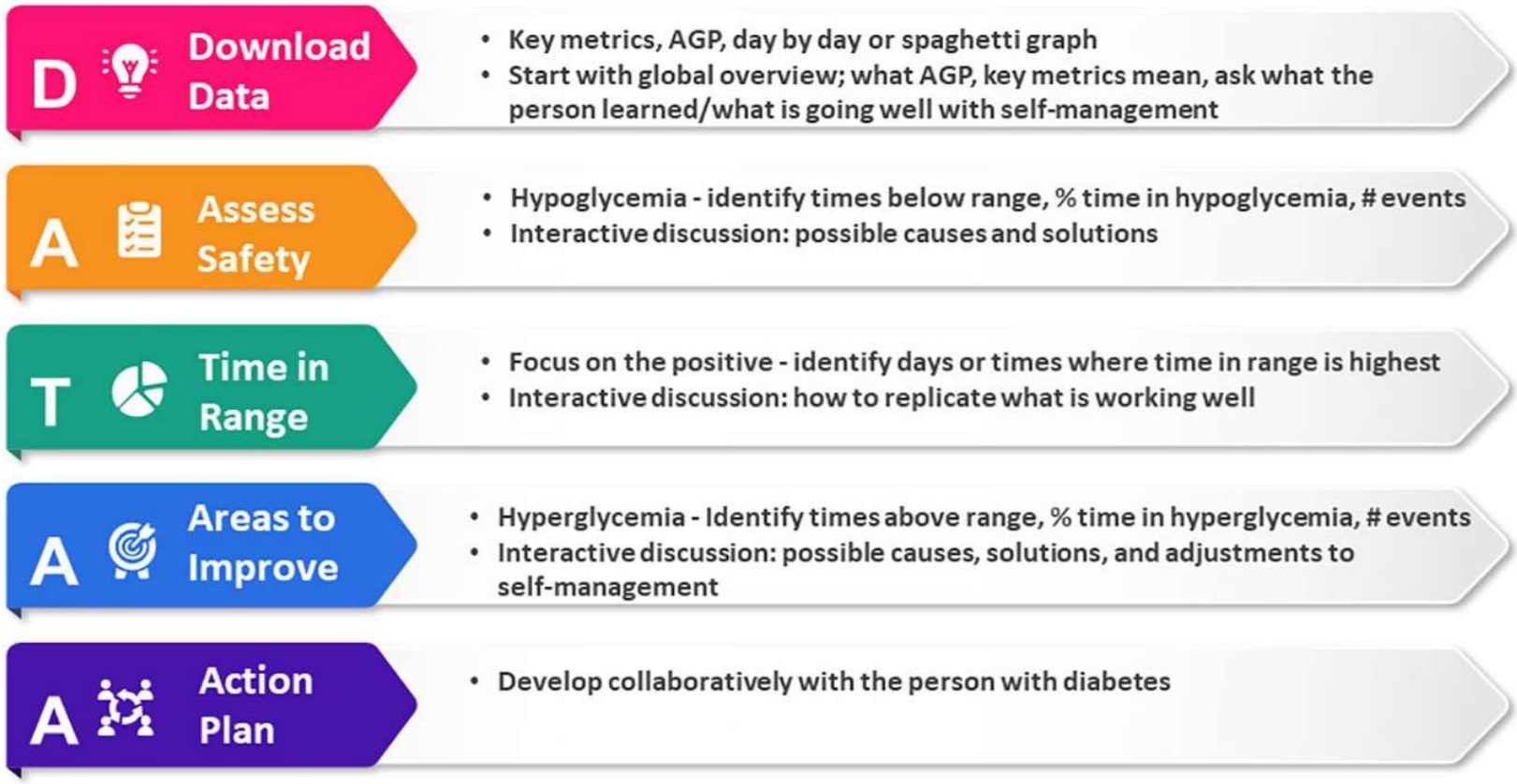


2% Very High
64% High
32% In Range
2% Low
0% Very Low

Target Range:
70-130 mg/dL

Same person, same data, look at the difference in time in ra

Review of CGM - DATAA

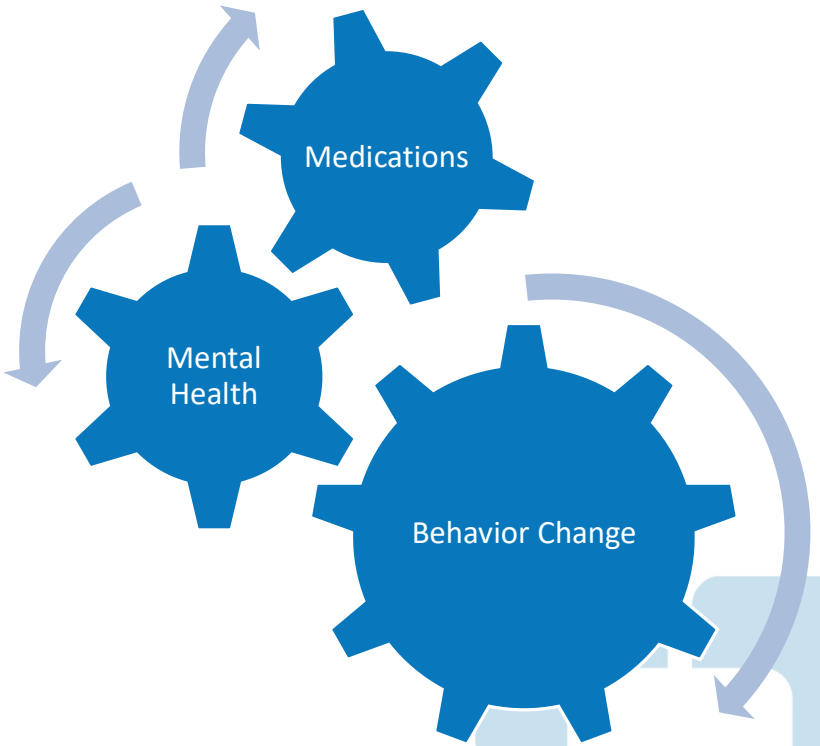


At each step, express that this is information, not good or bad

Isaacs D, Cox C, Schwab K, et al. Technology Integration: The Role of the Diabetes Care and Education Specialist in Practice. The Diabetes Educator. 2020;46(4):323-334. doi:10.1177/0145721720935123

Tips for DATA Interpretation

- Start by asking the person what they've experienced and noticed with their glucose patterns
- Avoid judgment
- Learn from 1 time episodes, but make changes based on patterns
- Fix lows first but some amount is expected (<1-4%) and if you remove all lows, you may end up with too many highs
- If it's not making sense, dig deeper (ex. missed doses, rationing, injection technique, food insecurity, etc)



Case Studies & 2 min Stretch

Case 1

Terrance is a 60-year-old man with T2D x 12 years

Current DM2 meds:

- Metformin 1000 mg twice daily
- Glimepiride 8mg daily

Other conditions

- CKD
- Hyperlipidemia
- Hypertension

Checks BGM once daily

Pertinent Labs

- SCr = 1.38 mg/dL, eGFR = 55
- A1C = 8.2%, BMI = 34 kg/m^2

- Works in project management
- Eats 3 meals/day, snacks at night, no regular exercise
- Glucose log

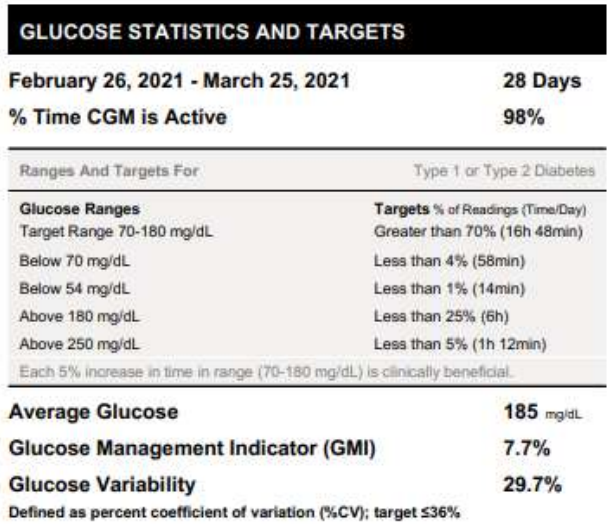
Day	FBG, mg/dL
1	125
2	123
3	110
4	108
5	99
6	81
7	134

Starts CGM

D Download Data

A Assess Safety

- Which CGM key metrics are at goal?
- Which are not?
- Overall patterns?



GLUCOSE STATISTICS AND TARGETS

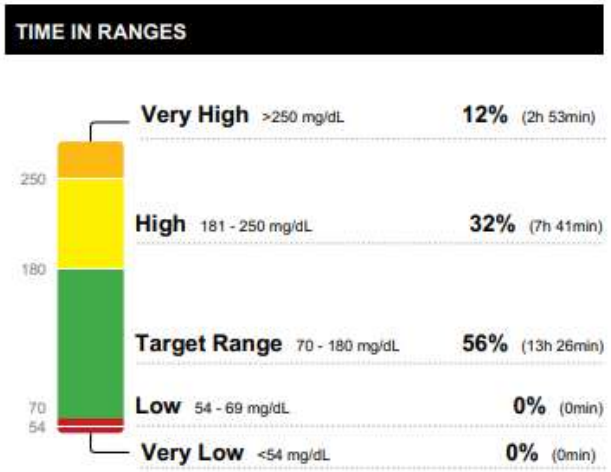
February 26, 2021 - March 25, 2021	**28 Days**
% Time CGM is Active	**98%**

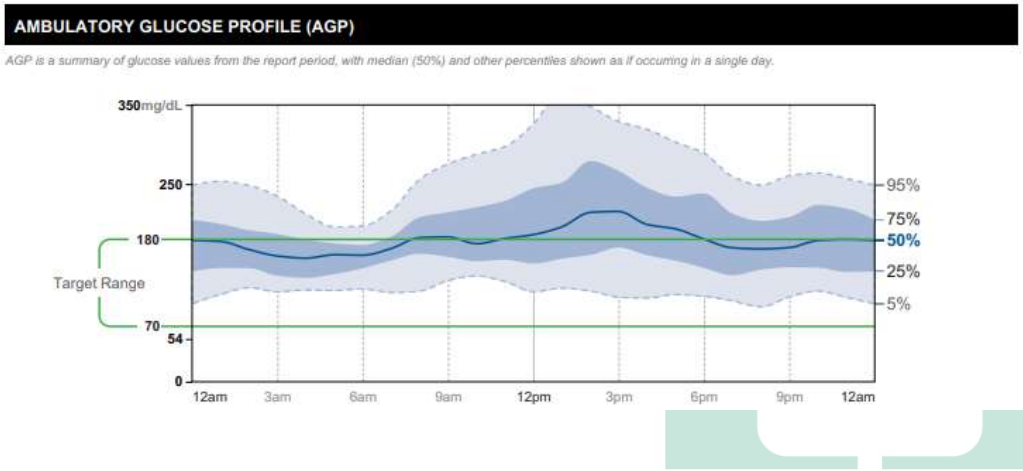
Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges	**Targets** % of Readings (Time/Day)
Target Range 70-180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)

Each 5% increase in time in range (70-180 mg/dL) is clinically beneficial.

Average Glucose	**185** mg/dL
Glucose Management Indicator (GMI)	**7.7%**
Glucose Variability	**29.7%**

Defined as percent coefficient of variation (%CV); target ≤36%





Assessment Question

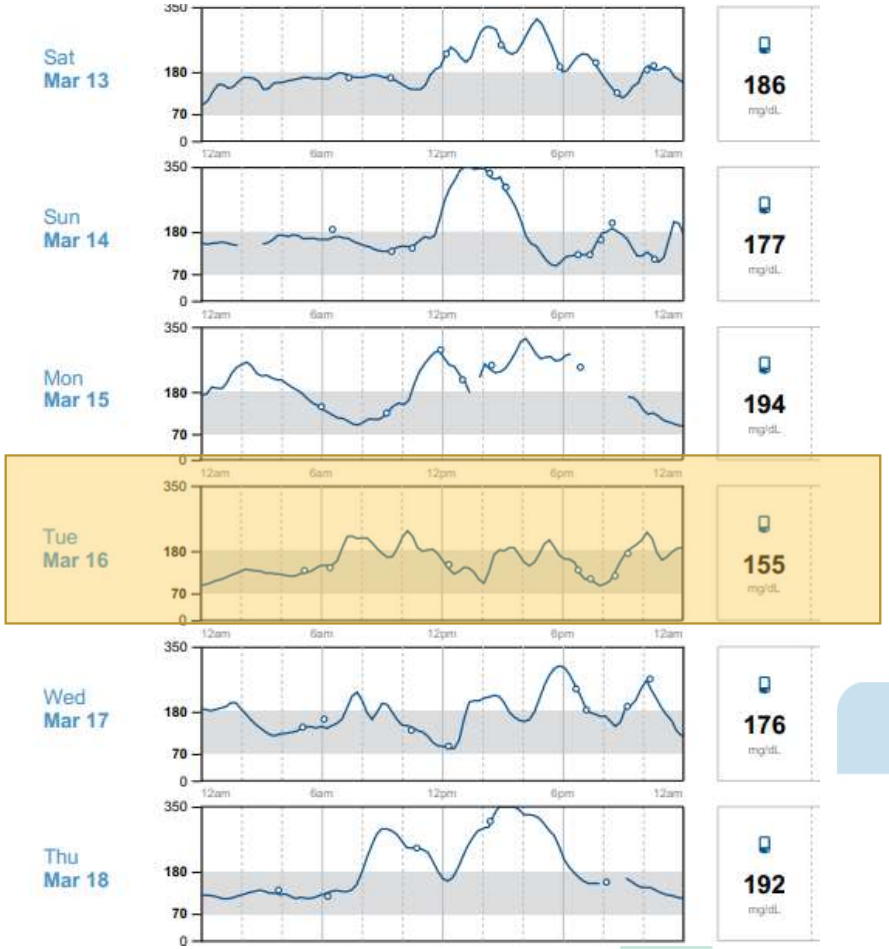
Which CGM key metrics are at goal?

A. Time in range
B. Time above range
C. Time below range
D. Glucose management indicator

Time in Range

Time in Range

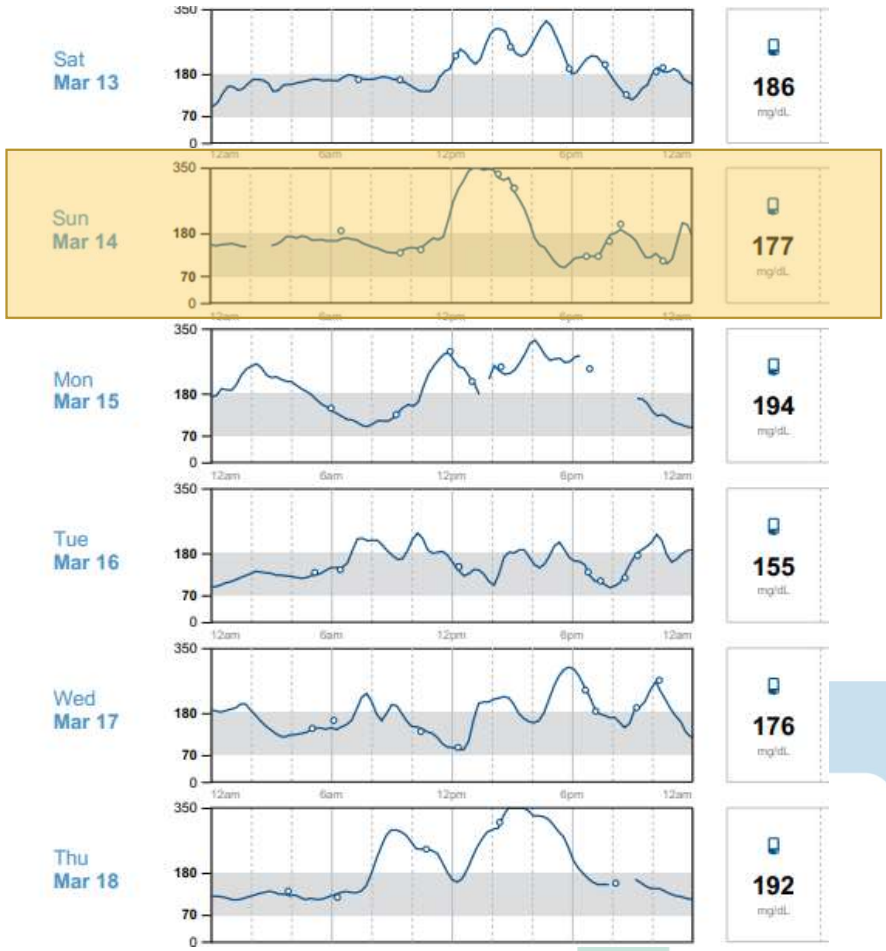
- Focus on the positive: what's worked well on Tue 3/16?
- Time in range is high this day
- Ate a granola bar for breakfast, grilled chicken salad at lunch, steak, greens, potato at dinner
- No missed medication doses
- Good night's sleep, low stress



Areas for Improvement

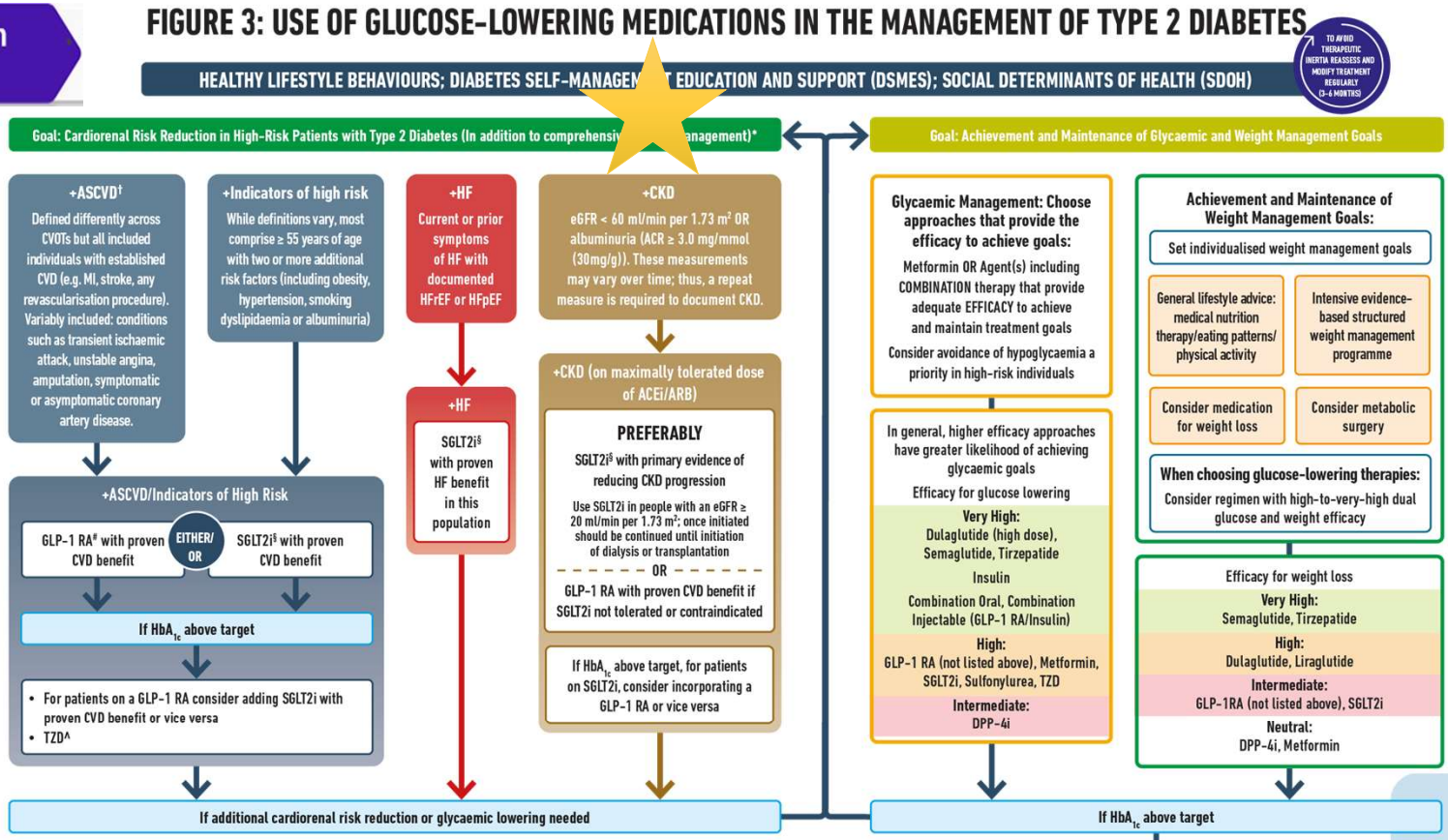
Areas to Improve

- Sun 3/14 glucose went high 12 pm
- Reports eating rice bowl and coke
- Silver lining
  - Walked around 3 pm (helped to lower glucose)
  - Avoided afternoon snacking
  - Ate low-carb dinner (salmon, salad, small potato)
  - Denies missed doses



Action Plan

FIGURE 3: USE OF GLUCOSE-LOWERING MEDICATIONS IN THE MANAGEMENT OF TYPE 2 DIABETES



ACEi, Angiotensin-Converting Enzyme Inhibitor; ACR, Albumin/Creatinine Ratio; ARB, Angiotensin Receptor Blocker; ASCVD, Atherosclerotic Cardiovascular Disease; CGM, Continuous Glucose Monitoring; CKD, Chronic Kidney Disease; CV, Cardiovascular; CVD, Cardiovascular Disease; CVOT, Cardiovascular Outcomes Trial; DPP-4i, Dipeptidyl Peptidase-4 Inhibitor; eGFR, Estimated Glomerular Filtration Rate; GLP-1 RA, Glucagon-Like Peptide-1 Receptor Agonist; HF, Heart Failure; HFpEF, Heart Failure with preserved Ejection Fraction; HFrEF, Heart Failure with reduced Ejection Fraction; HHF, Hospitalisation for Heart Failure; MACE, Major Adverse Cardiovascular Events; MI, Myocardial Infarction; SDOH, Social Determinants of Health; SGLT2i, Sodium-Glucose Cotransporter-2 Inhibitor; T2D, Type 2 Diabetes; TZD, Thiazolidinedione.

* In people with HF, CKD, established CVD or multiple risk factors for CVD, the decision to use a GLP-1 RA or SGLT2i with proven benefit should be independent of background use of metformin; † A strong recommendation is warranted for people with CVD and a weaker recommendation for those with indicators of high CV risk. Moreover, a higher absolute risk reduction and thus lower numbers needed to treat are seen at higher levels of baseline risk and should be factored into the shared decision-making process. See text for details; ^ Low-dose TZD may be better tolerated and similarly effective; § For SGLT2i, CV/renal outcomes trials demonstrate their efficacy in reducing the risk of composite MACE, CV death, all-cause mortality, MI, HHF and renal outcomes in individuals with T2D with established/high risk of CVD; # For GLP-1 RA, CVOTs demonstrate their efficacy in reducing composite MACE, CV death, all-cause mortality, MI, stroke and renal endpoints in individuals with T2D with established/high risk of CVD.

Davies MJ, Aroda VR, Collins BS, Gabbay RA, Green J, Maruthur NM, Rosas SE, Del Prato S, Mathieu C, Mingrone G, Rossing P, Tankova T, Tsapas A, Buse JB

Diabetes Care 2022; https://doi.org/10.2337/dci22-0034. *Diabetologia* 2022; https://doi.org/10.1007/s00125-022-05787-2 .

Assessment Question

3. **What is the most appropriate medication adjustment for Terrance?**

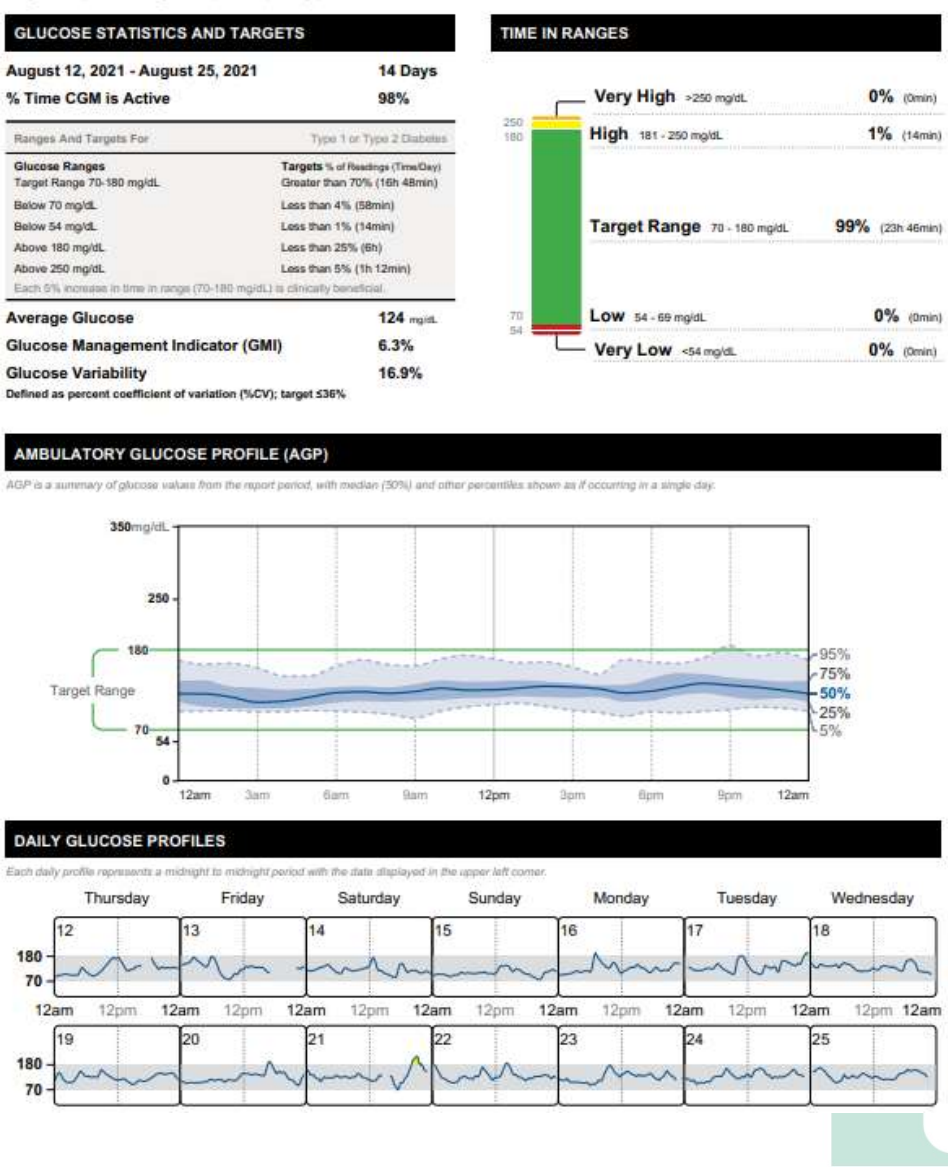
A. Add DPP4 inhibitor
B. Add GLP-1 receptor agonist
C. Add SGLT2 inhibitor
D. Lifestyle modifications only

Action Plan

- In collaboration with Terrance
  - Lifestyle changes
    - Incorporate a brisk walk 3 days per week
    - Reduce high-carbohydrate foods like fries
  - CGM optimization
    - Alerts, high for 280
  - Medication adjustments
    - Add a medication to help his CKD + optimize glucose → SGLT2 inhibitor
  - Follow-up in 3-4 weeks

3 Months Later

DM2 Meds:
Empagliflozin 10mg qday
Metformin 1000mg BID



GLUCOSE STATISTICS AND TARGETS

August 12, 2021 - August 25, 2021	14 Days
% Time CGM is Active	98%

Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges	**Targets** % of Readings (Time/Day)
Target Range 70-180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)

Each 5% increase in time in range (70-180 mg/dL) is clinically beneficial.

Average Glucose	124 mg/dL
Glucose Management Indicator (GMI)	6.3%
Glucose Variability	16.9%

Defined as percent coefficient of variation (%CV); target ≤36%

TIME IN RANGES

Very High	>250 mg/dL	0% (0min)
High	181 - 250 mg/dL	1% (14min)
Target Range	70 - 180 mg/dL	99% (23h 46min)
Low	54 - 69 mg/dL	0% (0min)
Very Low	<54 mg/dL	0% (0min)

AMBULATORY GLUCOSE PROFILE (AGP)

AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.

DAILY GLUCOSE PROFILES

Each daily profile represents a midnight to midnight period with the date displayed in the upper left corner.

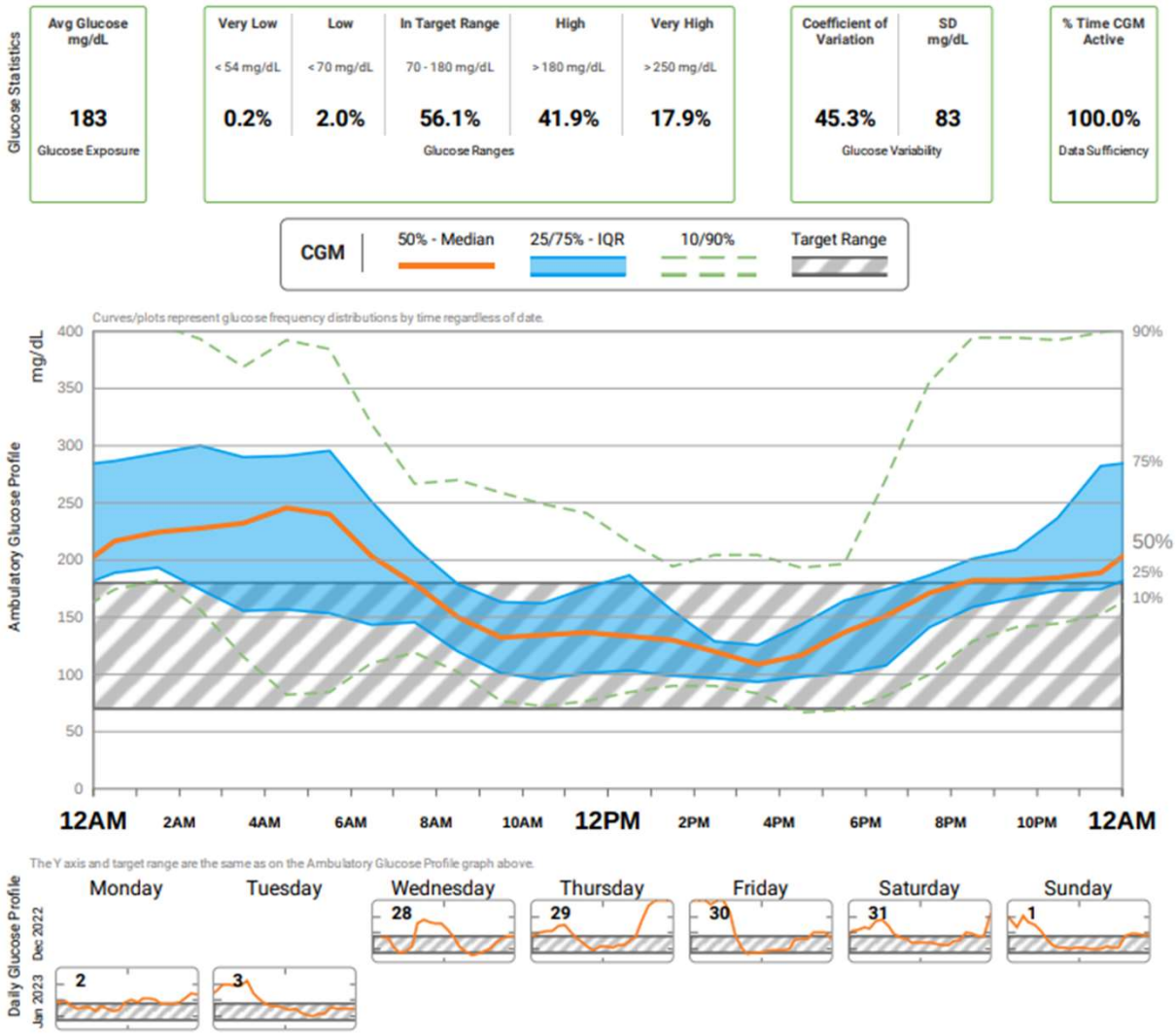
Case 2

75 yo F with 25 year h/o T2DM. PMH includes HTN, hyperlipidemia, hypothyroid, obesity, ASCVD.

Current DM Meds

-Insulin glargine inject 50 units QAM and 40 at night
-Insulin aspart 8-10-10 units plus correction scale
-Metformin 1000 mg daily
-Semaglutide, 0.25mg weekly (2 doses so far)

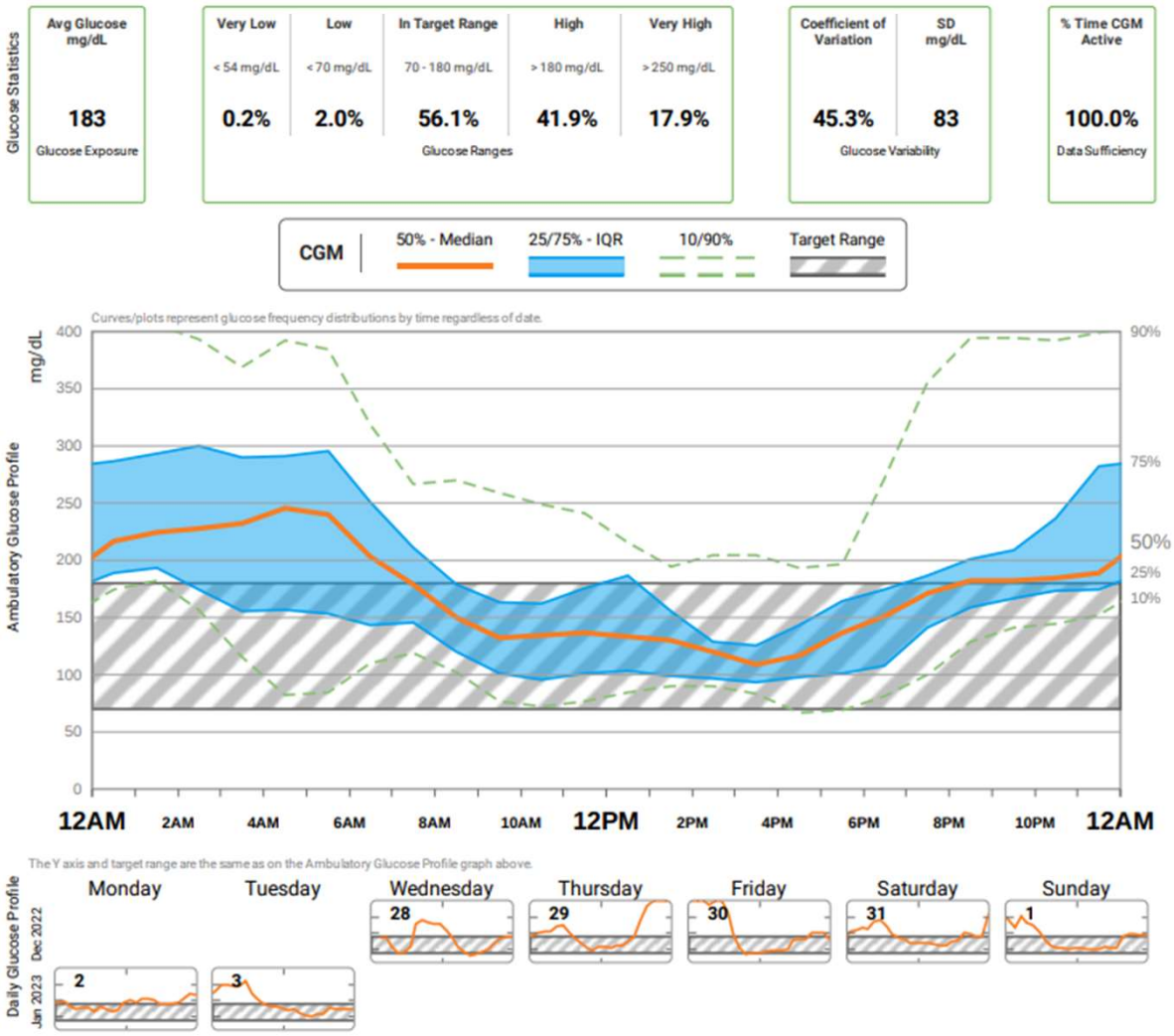
Wears rtCGM



Clarity report obtained from Diana Isaacs

Which of the following CGM key metrics is at target?

A. Time in range
B. Time above range
C. Coefficient of variation
D. Time below range



Clarity report obtained from Diana Isaacs

Using DATAA

A Assess Safety

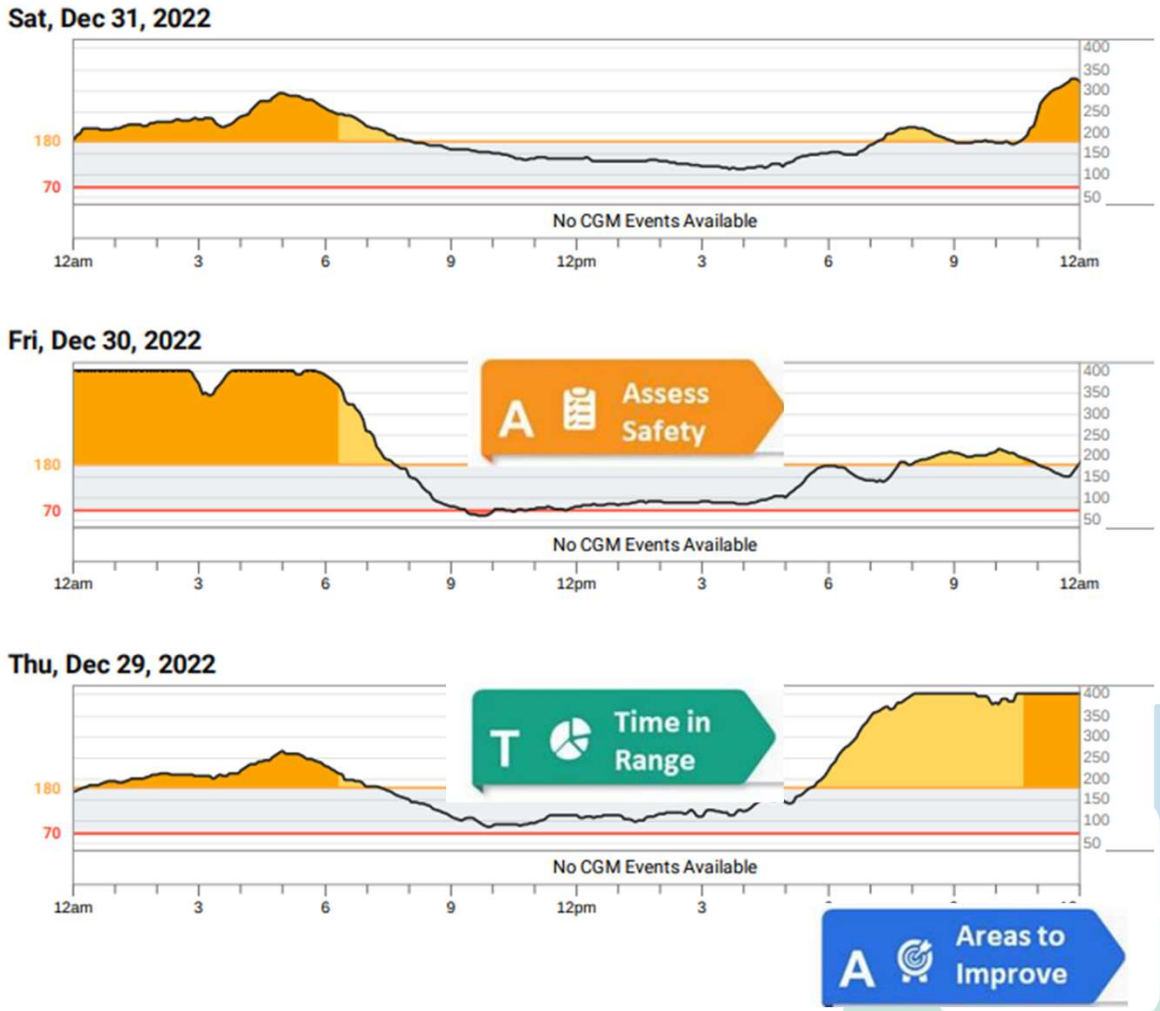
Less of an appetite since taking semaglutide, often going low during the day

T Time in Range

During the day, glucose often steady, but also having to drink juice to keep from going low

A Areas to Improve

Skipping aspart doses because running low, leading to rebound highs



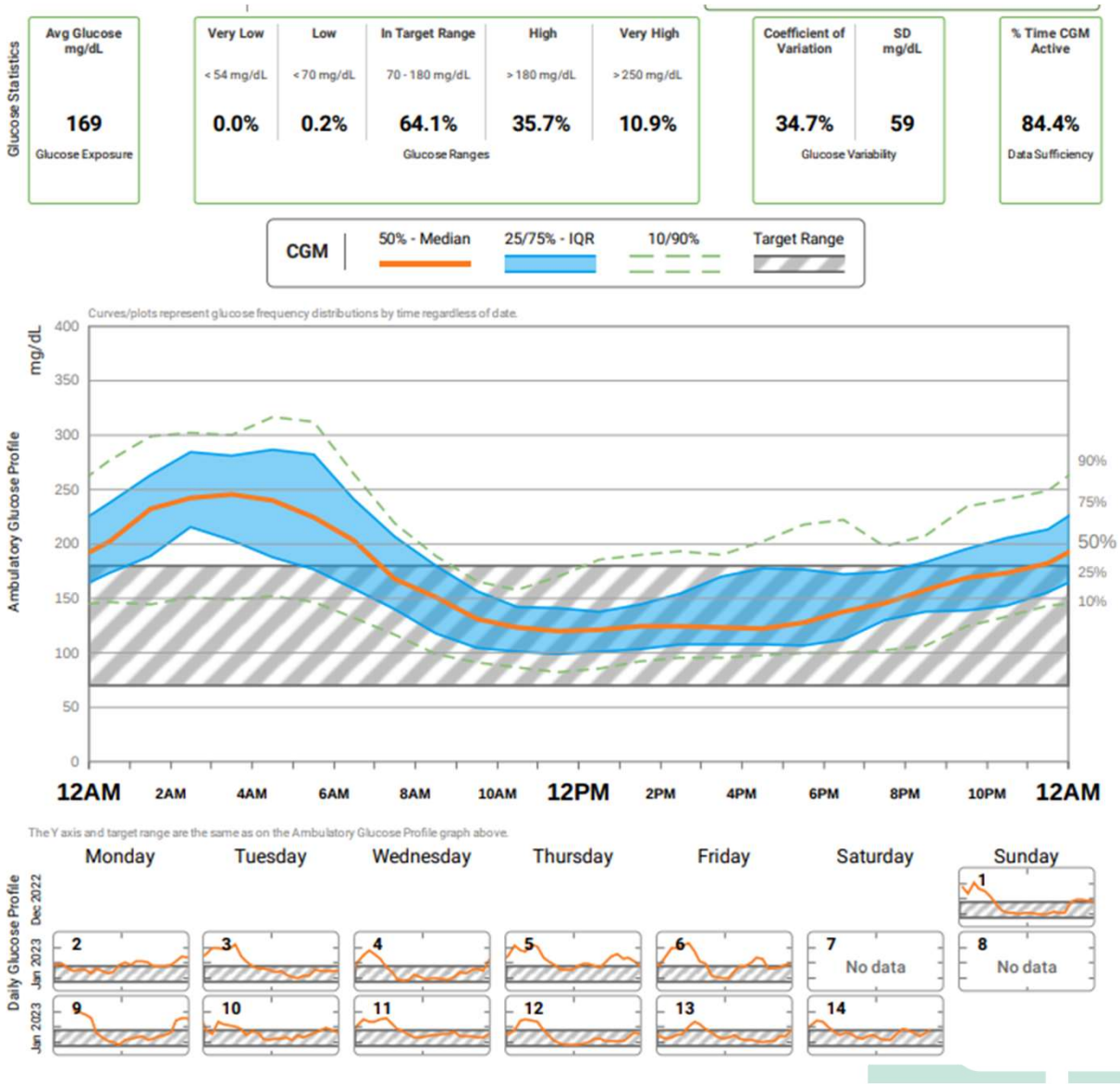
Clarity report obtained from Diana Isaacs

Action Plan

- Continue semaglutide 0.25mg weekly x 2 more weeks, then titrate up to 0.5mg weekly
- Decrease insulin glargine to 45 units qam and 35 units qpm
- Continue insulin aspart 8-10-10 + correction scale
- Continue metformin 1000mg daily

1 month later

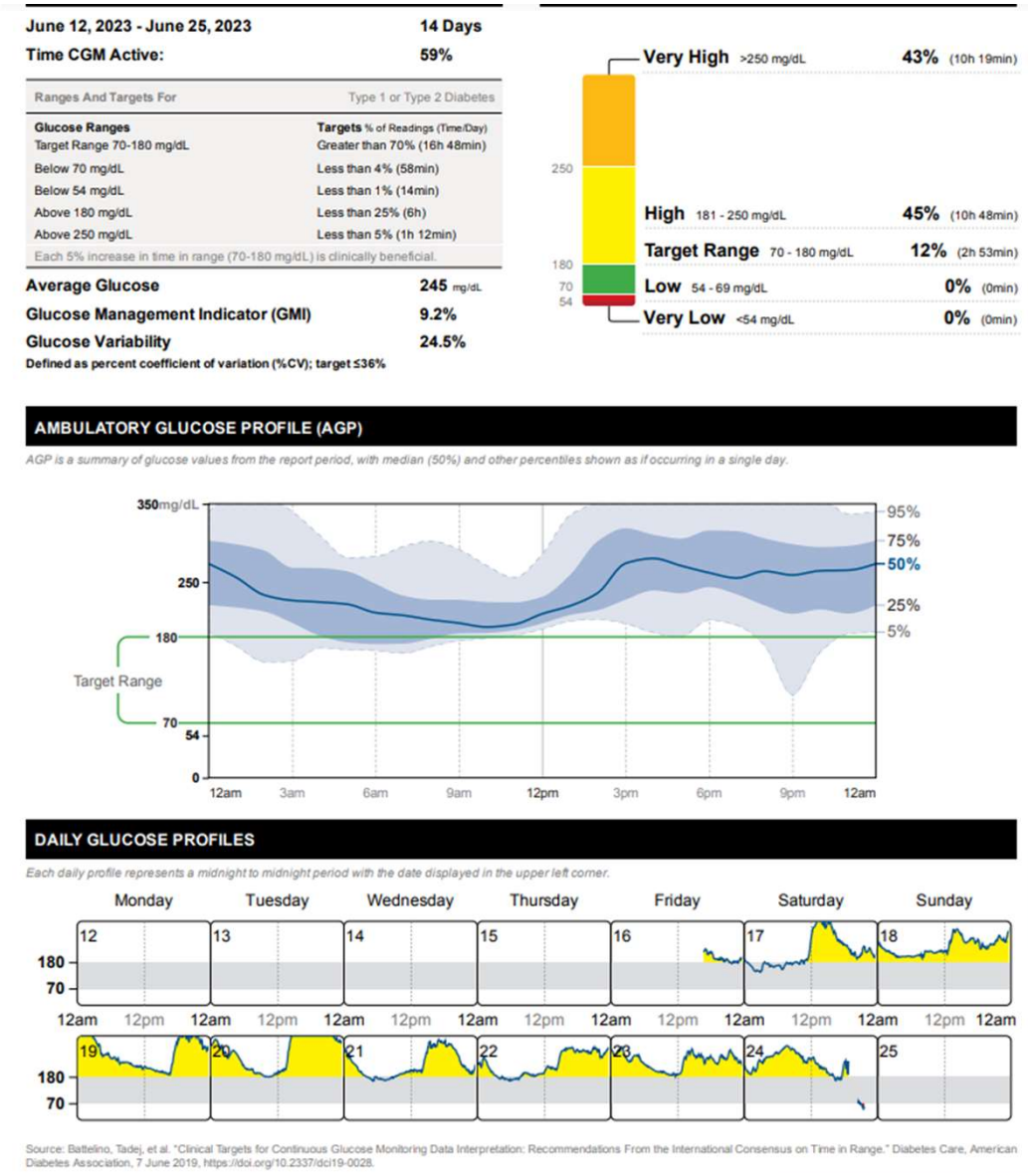
- Average glucose improved
- Time in range increased
- Glucose variability improved
- Less hypoglycemia



Clarity report obtained from Diana Isaacs

Case 3

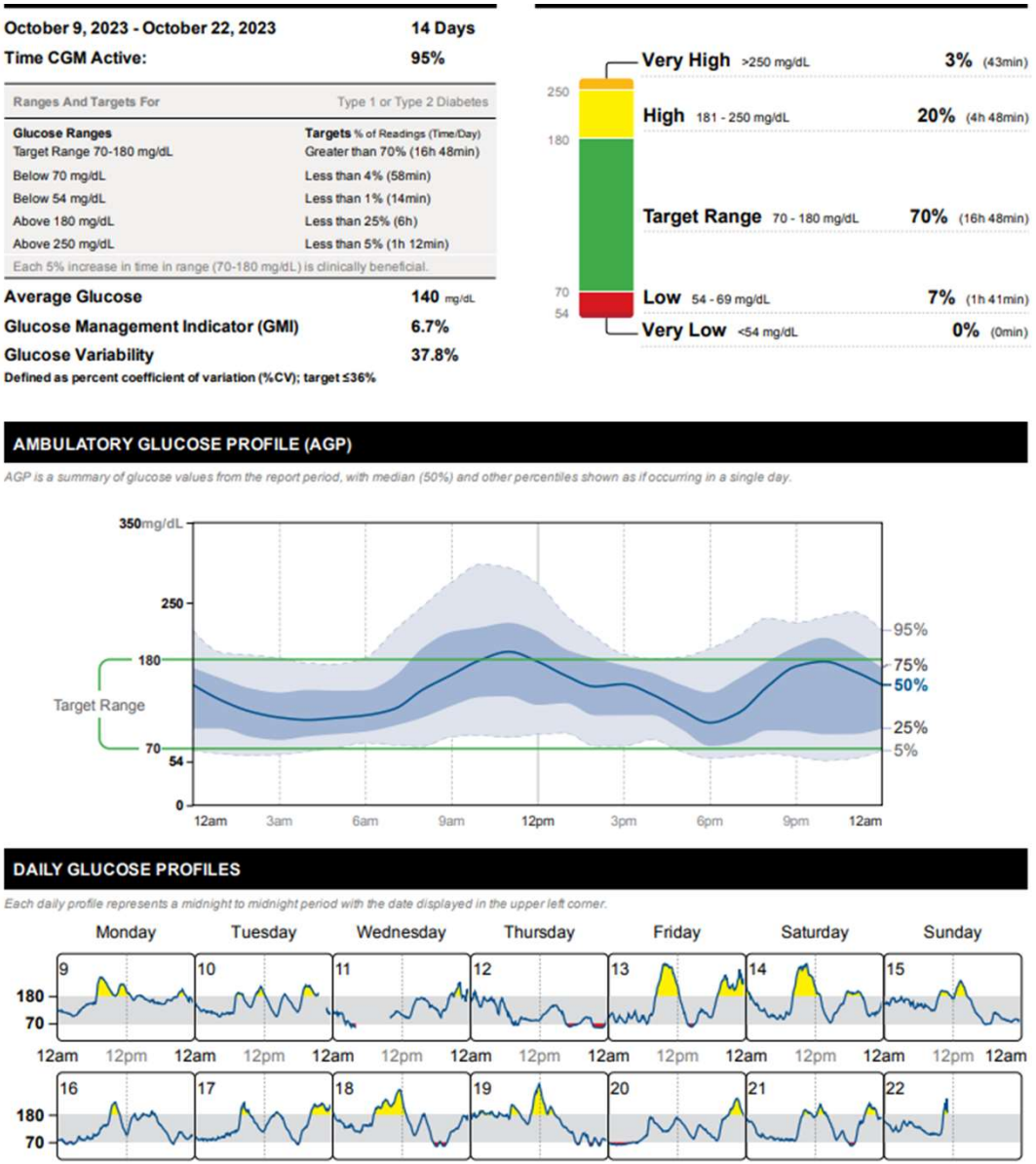
- Person with T2D taking metformin 1000mg twice daily and insulin glargine 20 units daily



Source: Battelino, Tadej, et al. "Clinical Targets for Continuous Glucose Monitoring Data Interpretation: Recommendations From the International Consensus on Time in Range." Diabetes Care, American Diabetes Association, 7 June 2019, https://doi.org/10.2337/dci19-0028.

Case 4

- Person with T2D
- 56yo, BMI=33, A1C=7%
- Meds:
  - Degludec 40 units daily
  - Dulaglutide 4.5mg weekly
  - Dapagliflozin 10mg daily
  - Metformin 1000mg twice daily



October 9, 2023 - October 22, 2023	14 Days
Time CGM Active:	95%

Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges	**Targets** % of Readings (Time/Day)
Target Range 70-180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)

Each 5% increase in time in range (70-180 mg/dL) is clinically beneficial.

Average Glucose	140 mg/dL
Glucose Management Indicator (GMI)	6.7%
Glucose Variability	37.8%

Defined as percent coefficient of variation (%CV); target ≤36%

Very High	>250 mg/dL	3% (43min)
High	181 - 250 mg/dL	20% (4h 48min)
Target Range	70 - 180 mg/dL	70% (16h 48min)
Low	54 - 69 mg/dL	7% (1h 41min)
Very Low	<54 mg/dL	0% (0min)

AMBULATORY GLUCOSE PROFILE (AGP)

AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.

DAILY GLUCOSE PROFILES

Each daily profile represents a midnight to midnight period with the date displayed in the upper left corner.

GLUCOSE STATISTICS AND TARGETS

March 3, 2022 - March 16, 2022	**14 Days**
% Time CGM is Active	**91%**

Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges	**Targets** % of Readings (Time/Day)
Target Range 70-180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)

Each 5% increase in time in range (70-180 mg/dL) is clinically beneficial.

Average Glucose	**146** mg/dL
Glucose Management Indicator (GMI)	**6.8%**
Glucose Variability	**28.1%**

Defined as percent coefficient of variation (%CV); target ≤36%

TIME IN RANGES

AMBULATORY GLUCOSE PROFILE (AGP)

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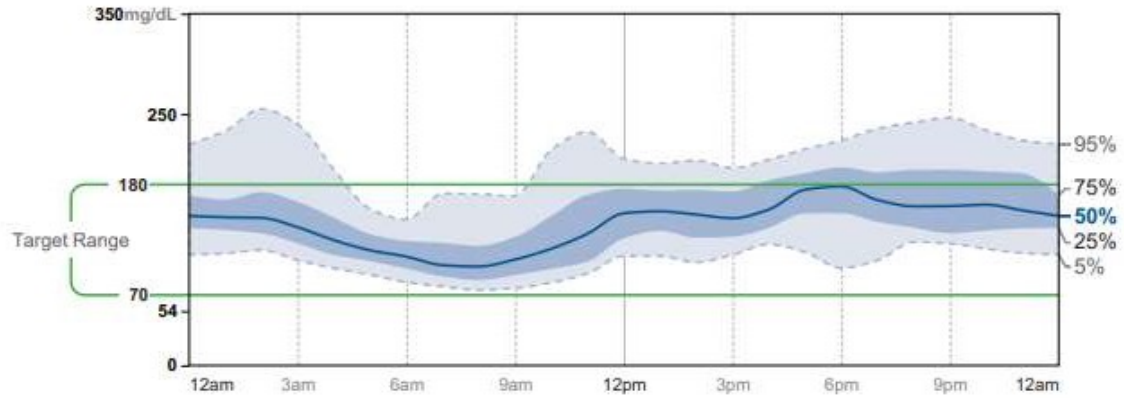
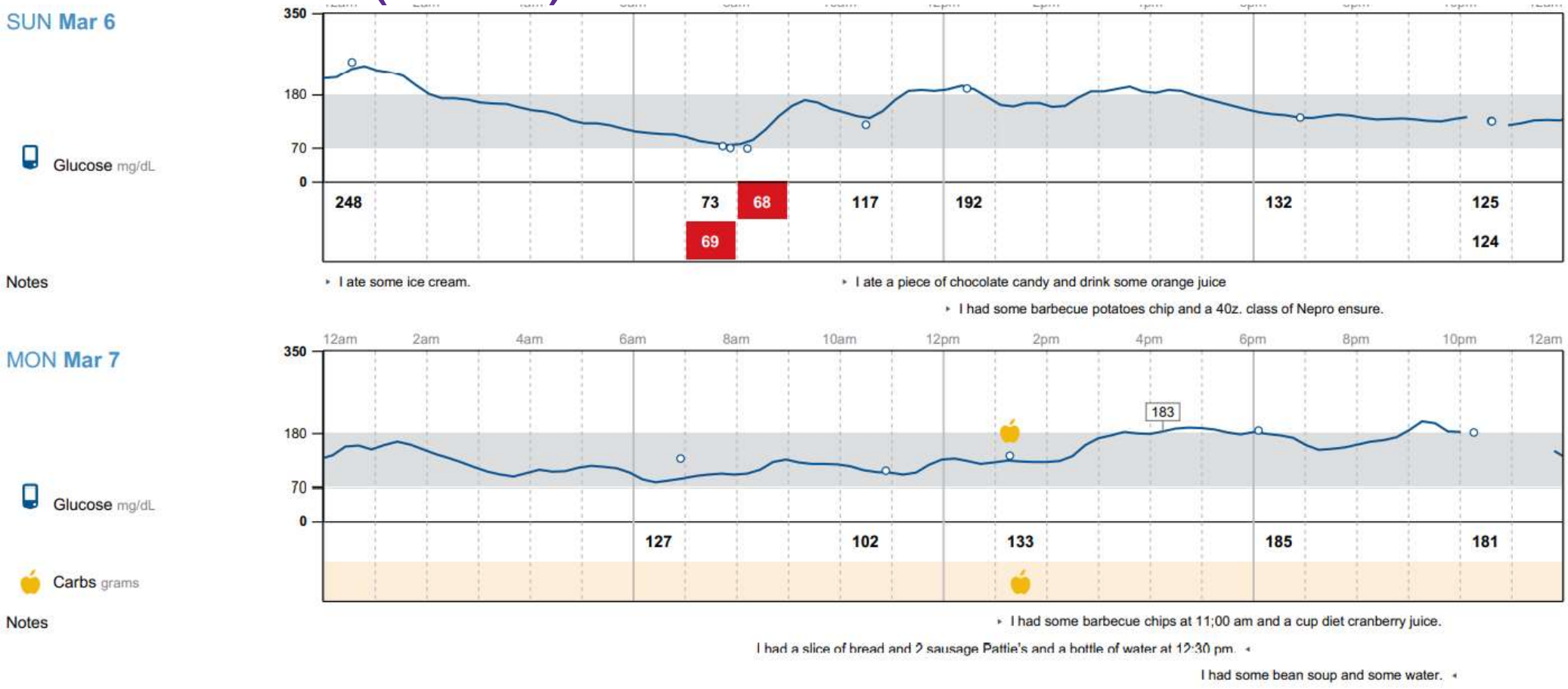


Case 5

- 57 year old woman with obesity, A1C=9.1%, needs a total knee replacement, but A1C was too high for surgery
- Current DM2 meds:
  - Insulin glargine 40 units daily
  - Dulaglutide 4.5 mg weekly

Case 3 (Cont)



Case 5 Cont

- The plan:
- Decrease insulin glargine to 36 units daily
- Continue dulaglutide

GLUCOSE STATISTICS AND TARGETS

March 3, 2022 - March 16, 2022	14 Days
% Time CGM is Active	91%

Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges	**Targets** % of Readings (Time/Day)
Target Range 70-180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
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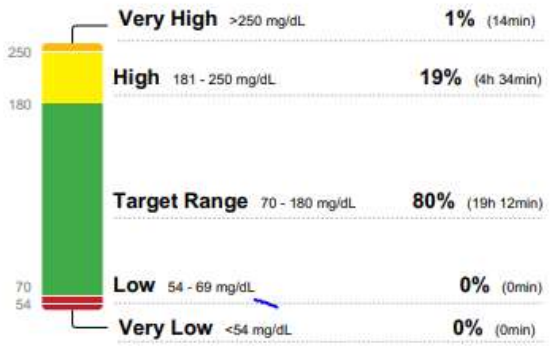
Average Glucose	**146** mg/dL
Glucose Management Indicator (GMI)	**6.8%**
Glucose Variability	**28.1%**

Defined as percent coefficient of variation (%CV); target ≤36%

TIME IN RANGES



AMBULATORY GLUCOSE PROFILE (AGP)

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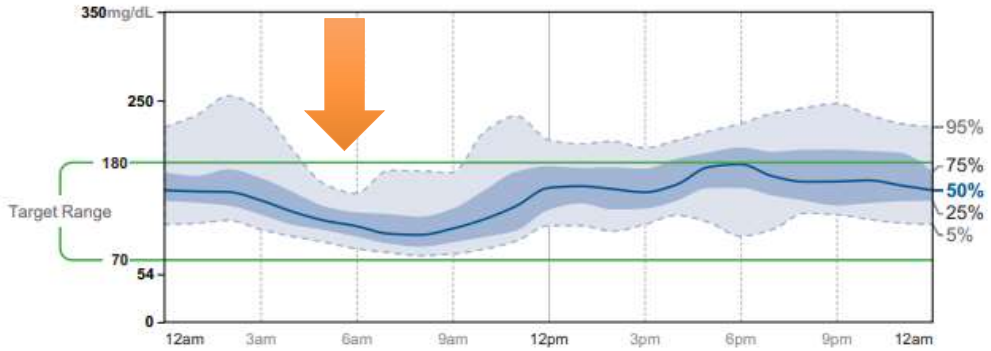
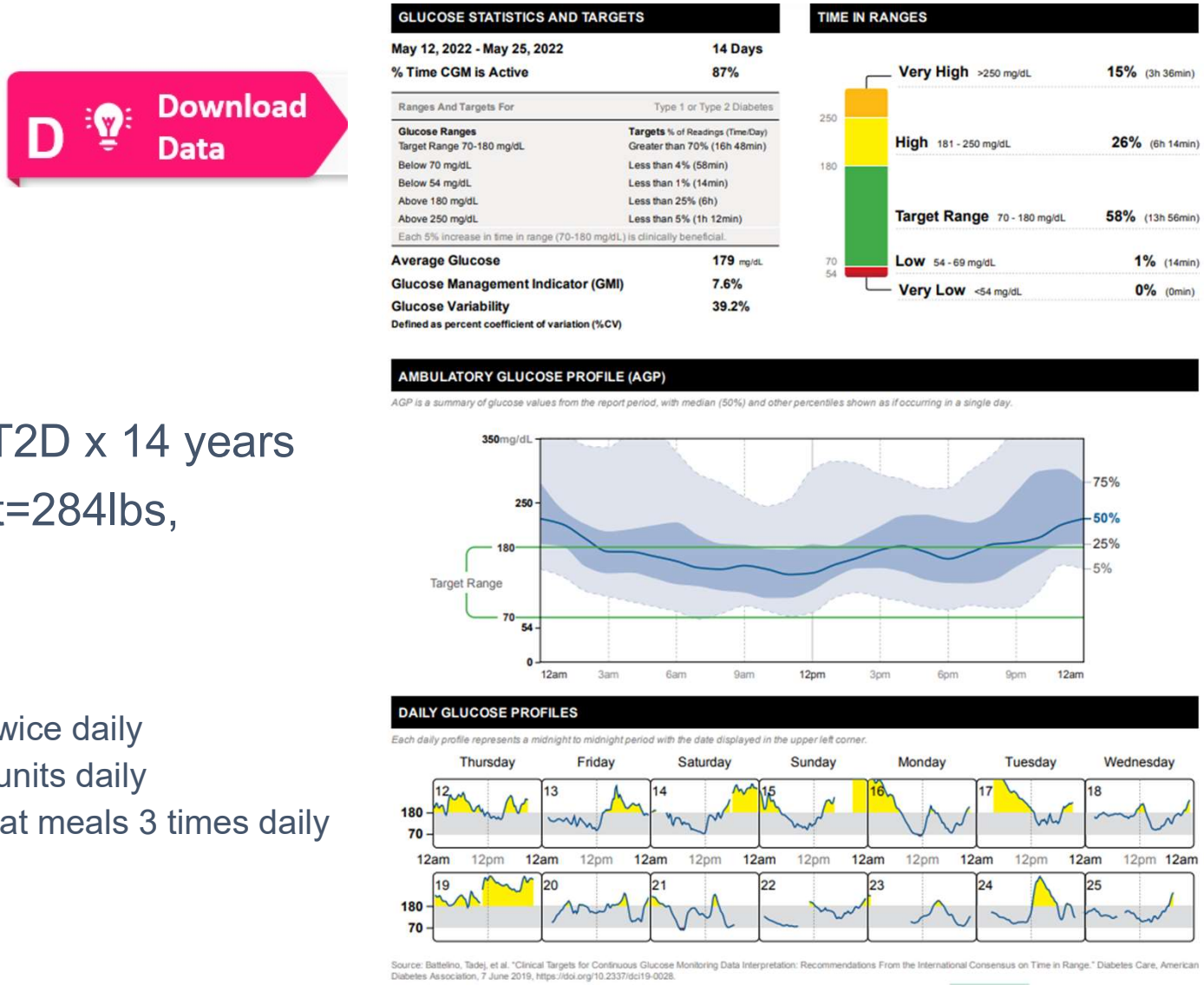


Case 6

- 73 yo female with T2D x 14 years
- A1C=7.5%, Weight=284lbs, BMI=55kg/m^2
- Scr/LFTs wnl
- T2D Meds:
  - Metformin 1000mg twice daily
  - Insulin degludec 18 units daily
  - Insulin lispro 5 units at meals 3 times daily + correction factor



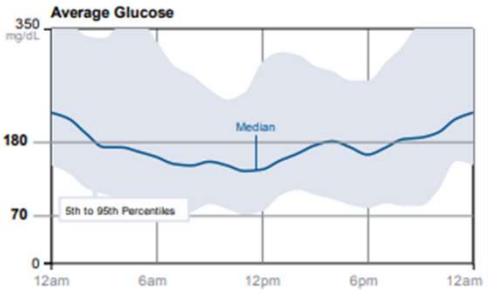
Snapshot

May 12, 2022 - May 25, 2022 (14 Days)

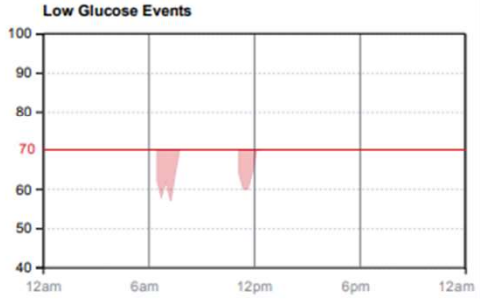
Glucose

GMI **7.6**% or **60** mmol/mol

AVERAGE GLUCOSE	**179** mg/dL
% above target	**42** %
% in target	**57** %
% below target	**1** %

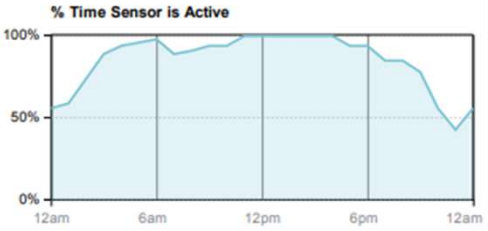


LOW GLUCOSE EVENTS	**2**
Average duration	**76** Min

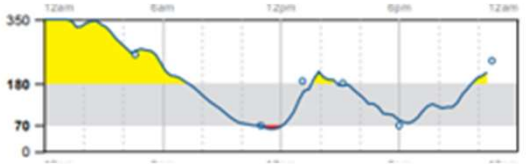


Sensor Usage

% TIME SENSOR IS ACTIVE	**87** %
Average scans/views	**5 / Day**

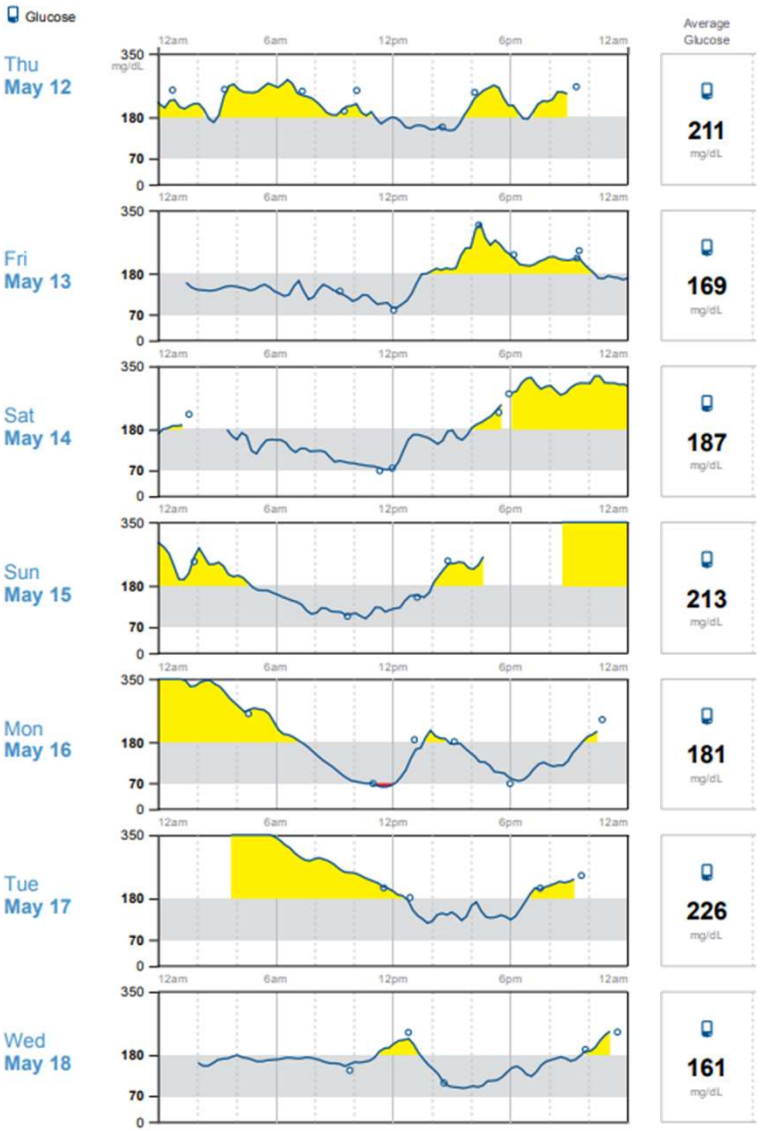


Mon
May 16



181
mg/dL

it Master Title Style



A Areas to Improve

T Time in Range

Balanced eating, walked after lunch

3 Weeks Later

vs. diet coke

When she takes her insulin late

Is she meetin, the me tics

- Time in range?
- Time below range?
- Glucose variability?

GLUCOSE STATISTICS AND TARGETS

June 4, 2022 - June 17, 2022	**14 Days**
% Time CGM is Active	**72%**

Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges	**Targets** % of Readings (Time/Day)
Target Range 70-180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)

Each 5% increase in time in range (70-180 mg/dL) is clinically beneficial.

Average Glucose	**144** mg/dL
Glucose Management Indicator (GMI)	**6.8%**
Glucose Variability	**35.5%**

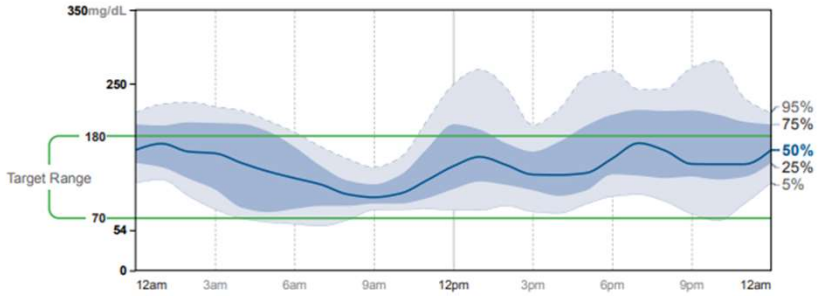
Defined as percent coefficient of variation (%CV)

TIME IN RANGES

Very High	>250 mg/dL	**3%** (43min)
High	181 - 250 mg/dL	**23%** (5h 31min)
Target Range	70 - 180 mg/dL	**72%** (17h 17min)
Low	54 - 69 mg/dL	**2%** (29min)
Very Low	<54 mg/dL	**0%** (0min)

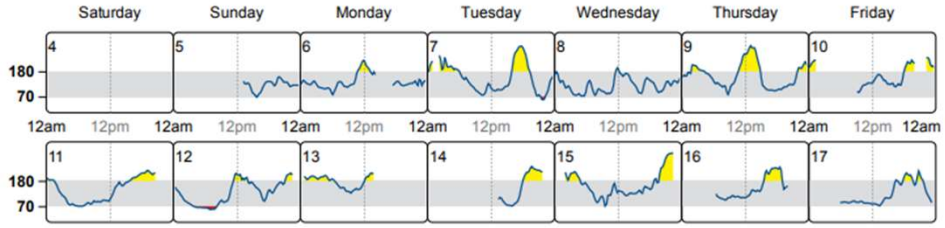
AMBULATORY GLUCOSE PROFILE (AGP)

AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.



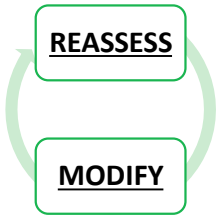
DAILY GLUCOSE PROFILES

Each daily profile represents a midnight to midnight period with the date displayed in the upper left corner.



Source: Battelino, Tadej, et al. "Clinical Targets for Continuous Glucose Monitoring Data Interpretation: Recommendations From the International Consensus on Time in Range." Diabetes Care, American Diabetes Association, 7 June 2019, https://doi.org/10.2337/dci19-0028.

What Do the Guidelines Say?



Healthy lifestyle behaviors + DSMES + SDOH

Cardiorenal risk reduction (+ comprehensive CV risk management)

Glycemic and weight management

ASCVD

High-risk of ASCVD

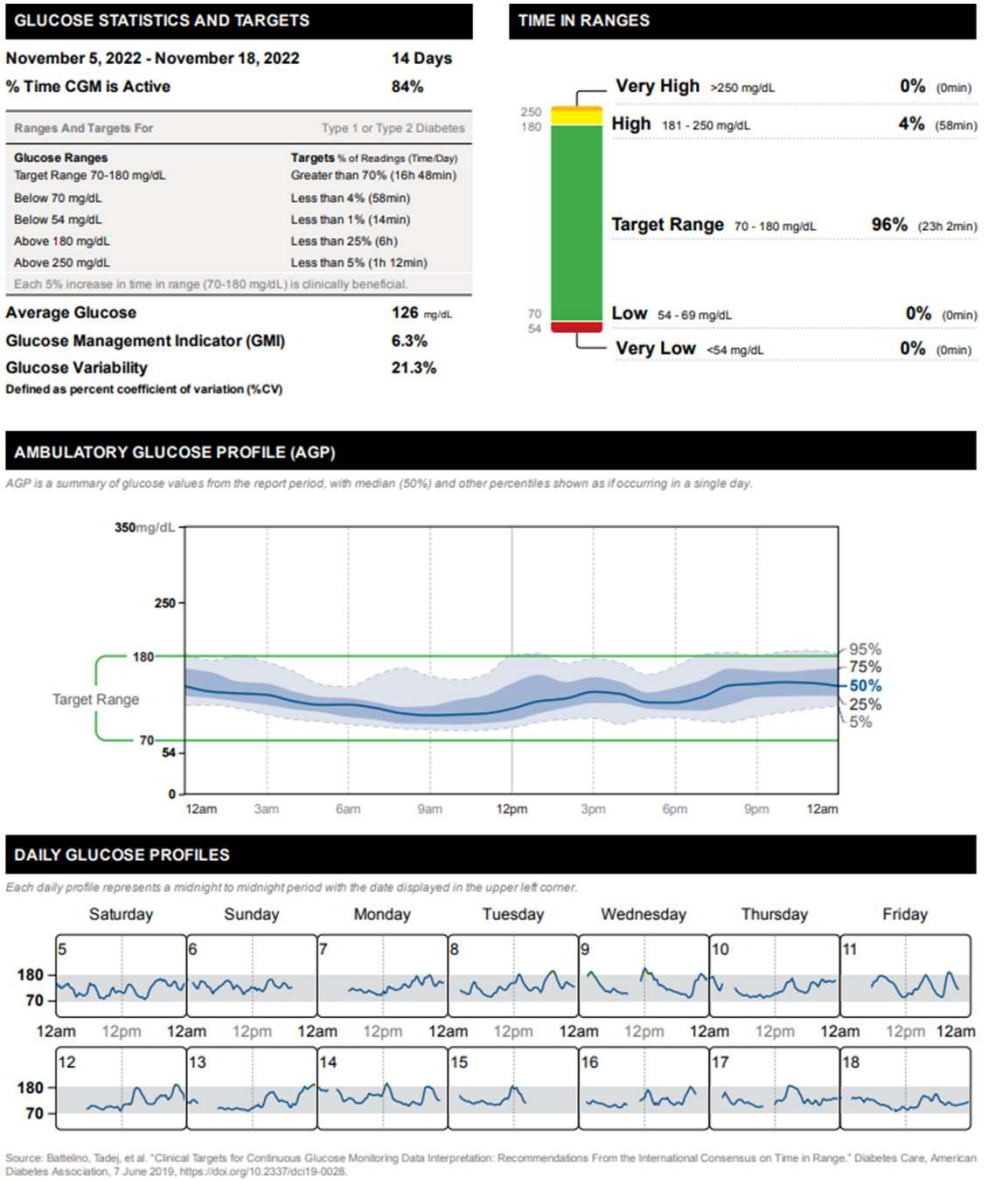
HF

CKD

- Start semaglutide 0.25mg x 4 weeks, then increase to 0.5mg weekly x 4 weeks, then increase to 1mg weekly x 4 weeks, then 2mg weekly
- Continue insulin degludec 18 units daily
- Stop insulin lispro, change to correction factor before meals only (ICF 50, BG target 150)

6 Months Later

- Insulin degludec 14 units daily
- Semaglutide 2mg weekly
- A1C=6.6%
- Wt: 262lbs, 22lbs weight lossloss



GLUCOSE STATISTICS AND TARGETS

November 5, 2022 - November 18, 2022	14 Days
% Time CGM is Active	84%

Ranges And Targets For	Type 1 or Type 2 Diabetes
Glucose Ranges	**Targets** % of Readings (Time/Day)
Target Range 70-180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)

Each 5% increase in time in range (70-180 mg/dL) is clinically beneficial.

Average Glucose	126 mg/dL
Glucose Management Indicator (GMI)	6.3%
Glucose Variability	21.3%

Defined as percent coefficient of variation (%CV)

TIME IN RANGES

Very High	>250 mg/dL	0% (0min)
High	181 - 250 mg/dL	4% (58min)
Target Range	70 - 180 mg/dL	96% (23h 2min)
Low	54 - 69 mg/dL	0% (0min)
Very Low	<54 mg/dL	0% (0min)

250
180
70
54

AMBULATORY GLUCOSE PROFILE (AGP)

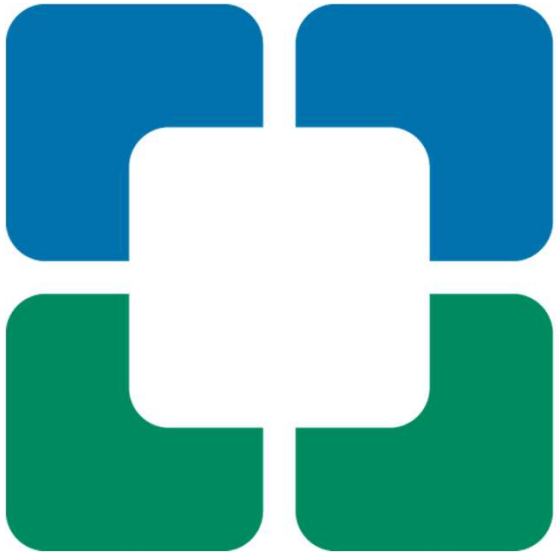
AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.

DAILY GLUCOSE PROFILES

Each daily profile represents a midnight to midnight period with the date displayed in the upper left corner.

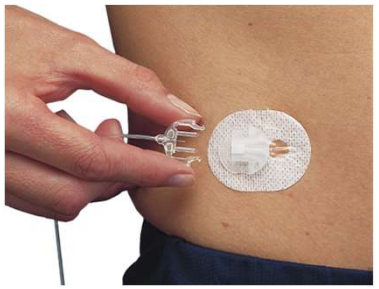
Source: Battelino, Tadej, et al. "Clinical Targets for Continuous Glucose Monitoring Data Interpretation: Recommendations From the International Consensus on Time in Range." Diabetes Care, American Diabetes Association, 7 June 2019, https://doi.org/10.2337/dci19-0028.

Insulin Pumps

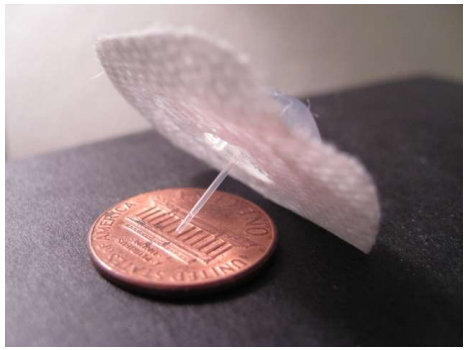


Common Insulin Pump Features

- Bolus calculator
- Temporary basal or temporary target
- Insulin-on-board/active insulin feature to prevent stacking
- Multiple basal patterns
- Small dose increments
- Integration with CGM
- Designed to work with U100 insulin
- Most have a 4-5 year warranty/contract



Infusion Sets



- Infusion sets are usually Teflon
  - Available in different sizes (ex. 9mm vs 6mm)
  - Silhouette (angled) may be better for kids/thinner/very active people
  - Steel infusion sets a good option for people with frequent site occlusions
- Insert at least 1 inch from CGM site
  - Auto-injectors vs. manually injecting
- Site selection/rotation
- Longer tubing options
  - Good if connected on leg, arm or wearing pump further from site
- Caution with kids/babies/pets-pouches available to hide pump
- When changing out infusion set, check glucose or CGM 1-2 hours after
  - Don't change right before bed

What Happens with a Bent Cannula?

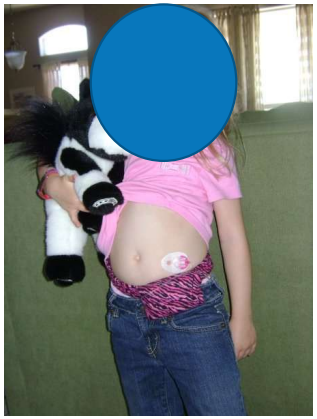
A. Hyperglycemia
B. Hypoglycemia
C. No effect

Filling the Pump

- Only fill with how much insulin you expect to use in 3 days + ~30 units
- Pumps hold 200-300 units
- Caution with air bubbles
- Fill cannula amount
  - Steel needle (0 units)
  - 6mm cannula (0.3 units)
  - 9mm cannula (0.5 units)

- If cannula overfilled, can lead to lows
- If cannula under-filled or air bubbles, can lead to highs

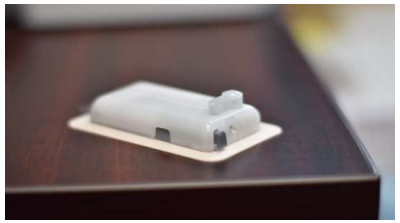
Where to Wear?



Ideal Pump Candidates

- Require meal time insulin
- Wearing CGM or frequently checking BGM
- Carbohydrate counting or good with estimates
- Ability to learn pump programming or have caregivers that can
- Willing to follow up regularly with health care team
- Can afford the pump/supplies
- Following hyperglycemia treatment instructions
- Problem solving skills (ex. high or low glucose)

Patch Pumps



Cequr Simplicity

- Bolus pump patch only
- Approved for adults with T1DM or T2DM
- Holds up to 200 units of rapid acting insulin
- On-demand bolus doses in 2 unit increments
- Doses administered via clicks directly on the device
- Must be changed every 3 days

V-Go

- 24 hr. basal/bolus patch pump
- Approved for adults with T2DM
- Allows 20, 30, 40 unit basal rate options
- On-demand bolus doses in 2 unit increments
  - Up to 36 units/24 hrs
- Doses administered via clicks directly on the device
- Must be changed daily

https://myceqursimplicity.com/
https://www.go-vgo.com/

Automated Insulin Delivery Systems

Omnipod 5
(Insulet)

T:slim X2 (Tandem)
Control IQ

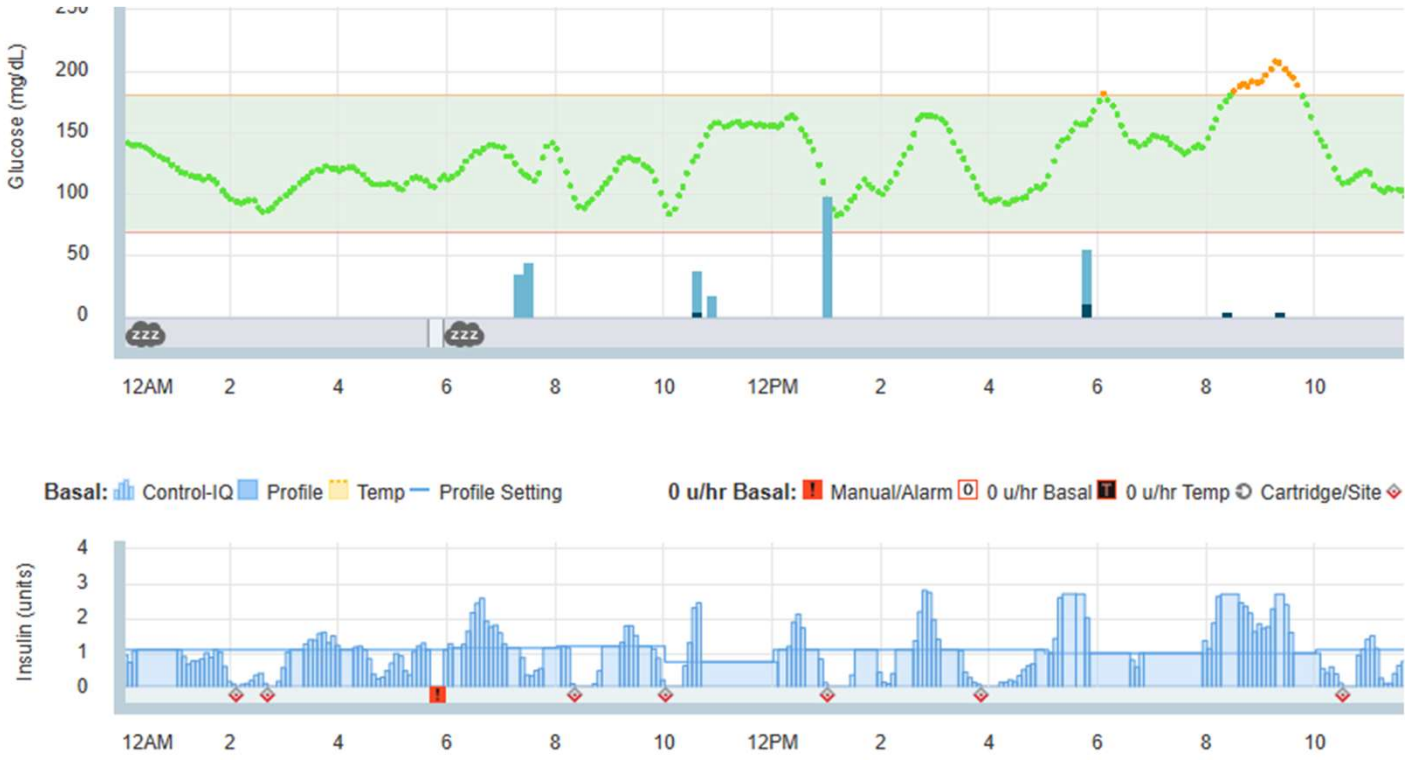
780G
(Medtronic)

iLet
(Beta Bionics)

Mobi (Tandem)
Control IQ

Tidepool Loop (Sequel)

Hybrid-Closed Loop



- Automated insulin delivery (AID)
- Auto adjust background insulin
- Some systems give auto corrections
- Maximize time 70-180mg/dL

Omnipod® 5

- No tubing
- Holds 200 units
- Uses last 4-5 pods for adjustments, based on TDD
- Control system from a compatible smartphone or controller
- Requires Dexcom G6® use from a compatible smart device
- SmartBolus calculator informed by CGM value and trend
- Glucose targets from 110-150 mg/dL adjustable in 10 mg/dL increments
- HypoProtect mode to reduce risk of lows
- Bluetooth connectivity with glooko, automatic data download
- Requires charging cable

Omnipod® 5 Automated Insulin Delivery System. User Guide.

Medtronic 780G

- Holds 300 units
- Compatible with Guardian Sensor 3 or 4
- Meal detection (auto correction + basal)
- Adjustable target (100, 110, 120)
- Bluetooth connectivity, remote software upgrades
- Suspend before/on low options (in manual mode)
- Bluetooth connectivity
- MiniMed and Carelink apps for data sharing/viewing
- 7 day infusion set
- Uses AA battery

Beta Bionics iLet

- Holds 180 units of insulin
- Works with Dexcom G6 and G7
- Future compatibility with pre-filled insulin cartridges
- Programmed by entering body weight
  - No other insulin pump settings
- Enter in meal estimates (usual, less, more)
- Provides calculated back up settings
- Requires charger

https://www.betabionics.com/

Tandem T:Slim X2 with Control-IQ

- Holds 300 units
- Compatible with Dexcom G6, Dexcom G7, Libre 2+
- Algorithm adjusts insulin delivery from programed “manual” settings
- Automatic correction doses
  - Up to 1 every hour based on projected glucose >180mg/dL
  - Calculated at 60% of programmed correction factor (target of 110)
- T:Connect app to bolus and for remote downloads (changing to Source soon)
- Requires charging cable
- Bolus from T:connect app from phone

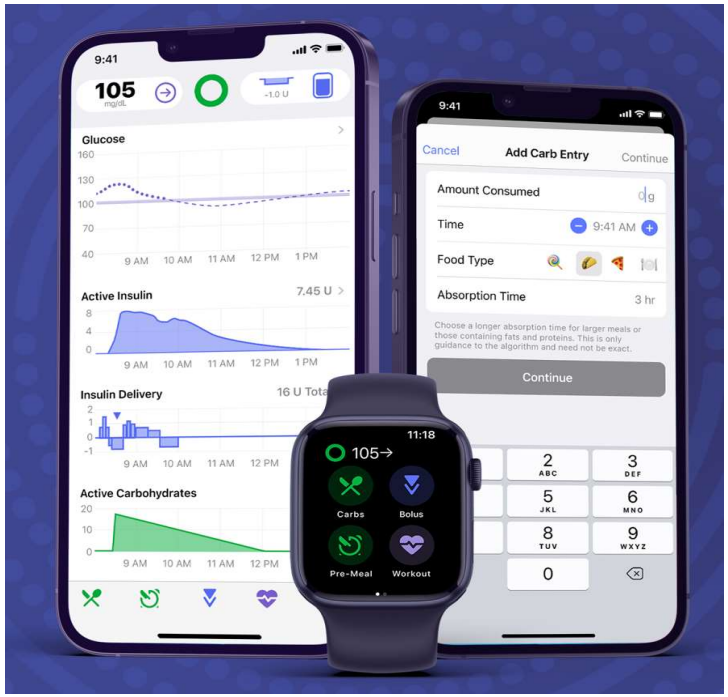
Control IQ Targets

		Control-IQ	Sleep Activity	Exercise Activity
Delivers	Delivers an automatic correction bolus if sensor glucose is predicted to be above ____ mg/dL	180	--	180
Increases	Increases basal insulin delivery if sensor glucose is predicted to be above ____ mg/dL	160	120	160
Maintains	Maintains active Personal Profile settings when sensor glucose is between ____ - ____ mg/dL	112.5 - 160	112.5 - 120	140 - 160
Decreases	Decreases basal insulin delivery if sensor glucose is predicted to be below ____ mg/dL	112.5	112.5	140
Stops	Stops basal insulin delivery if sensor glucose is predicted to be below ____ mg/dL	70	70	80

Tandem Mobi

- FDA approved 6 + years
- Compatible with Dexcom G6
- 200 unit cartridge
- Controlled with iphone
- Half the size of T:Slim X2
- 5 inches of tubing
- Everything controlled from mobile app (iPhone)
- New syringe-driven pump fill
- Wireless charging
- IP28 water resistant rating (8 feet for 2 hours)

Sequel MedTech Tidepool Loop



- At Launch iPhone
- FDA approved Ages 6 and Up.
  - Download the app from the App Store.
  - Prescription code needed
- Correction Range 87 mg/dL-180 mg/dL.
- Food type for extended boluses: Lollipop, Taco, Pizza Bolus
- Insulin action is fixed with Ultra Rapid, Rapid Acting
- Commercialization plans necessary with device partners are being finalized.
- Apple watch compatibility: bolus from watch

Pump Comparison

	Omnipod 5	Control IQ	780G	ILet
Min age	2 years	6 years	7 years	6 years
Min daily insulin	5 units	10 units, 55lbs	8 units	8 units
Max fill	200 units	300 units	300 units	160 units
Basal increment	0.05 units	0.001 units	0.025 units	NA
Bolus increment	0.05 units	0.01 units	0.025 units	NA
Site change frequency	3 days	3 days	7 days (extended infusion set)	3 days
CGM compatibility	G6	G6	Guardian 3, 4	G6
Calibration	No	No	3-4/day	No
CGM trend in calculator	Increase up to 30% Decrease down to 100%	No	No	NA

Cleveland Clinic

Pump Comparison

	Omnipod 5	Control IQ	iLet	780G
Algorithm target	110, 120, 130, 140, 150mg/dL	112.5 – 160 mg/dL	110, 120, 130mg/dL	100, 110, 120mg/dL
Basal automation	Calculated from total daily insulin, updated each pod change, 60 min prediction	Increases or decreases from programmed basal rates, 30 min prediction	Initiated based on user weight and adapts with glucose profile	Calculated based on total daily insulin from past 2-6 days
Automated Corrections	No	Max 1/hour if glucose predicted >180 mg/dL, 60% of calculated dose	No	If glucose > 120 mg/dL and at max "auto basal" delivery, up to every 5min
Extended bolus	No, manual mode only	Yes, up to 2 hours	No	No, manual mode only
Insulin action time (IAT)	2-6 hours	5 hours (automated mode)	NA	2-8 hours
Temporary targets	Activity 150 mg/dL	Exercise 140 -160 mg/dL Sleep 112.5 – 120 mg/dL	NA	150 mg/dL
Bolus adjustments	ISF, IAT, ICR, max bolus, reverse correction	ISF, ICR, max bolus, reverse correction	Usual, more, Less meal announcements	ICR, IAT, max bolus
Ability to override bolus	Yes	Yes	No	No

Sharing Pump Data

System:	Associated Mobile Apps	Website to Access Portal	Data Sources
Glooko	Glooko	Glooko.com	Insulin pumps (Omnipod, Tandem)
Carelink	MiniMed Mobile	https://carelink.medtronic.com/login	Medtronic pumps
Tidepool	Tidepool Mobile	Tidepool.org	Insulin pumps (Medtronic, Tandem),
T:Connect/Source	T:Connect Mobile	https://tconnecthcp.tandemdiabetes.com/hcp_account/#/hcplogin	Tandem pumps
Beta Bionics User Portal	Beta bionics smartphone app	https://report.betabionics.com/	iLet

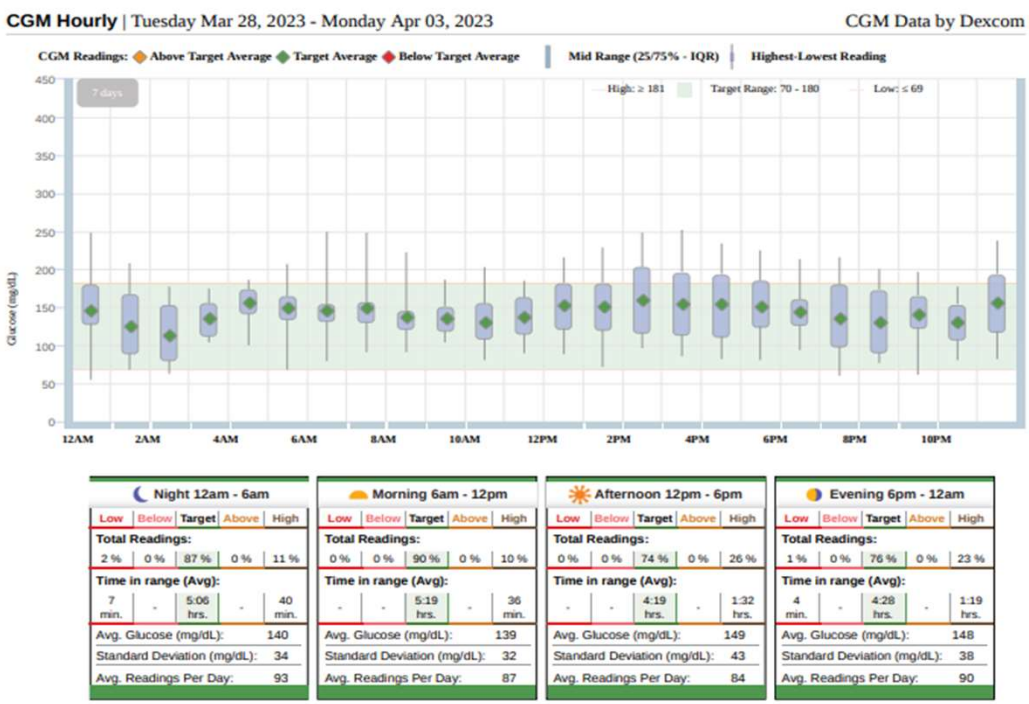
Patient Case

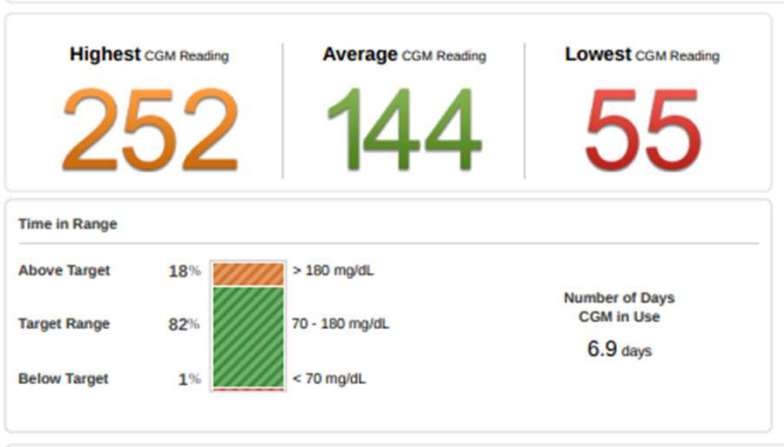
- 47 years old
- T2D x 20+ years
- A1C=8.1%
- BMI=39kg/m^2
- Works as a bank teller
- No diabetes complications
- Meds:
  - Insulin glargine 100 units qpm
  - Insulin aspart 45 units TID a.c.
  - Dapagliflozin 10mg daily
  - Dulaglutide 1.5 mg weekly

Is this a good candidate for an insulin pump?

Patient Case

47yo T2DM, A1C=8.1%, BMI=39kg/m²

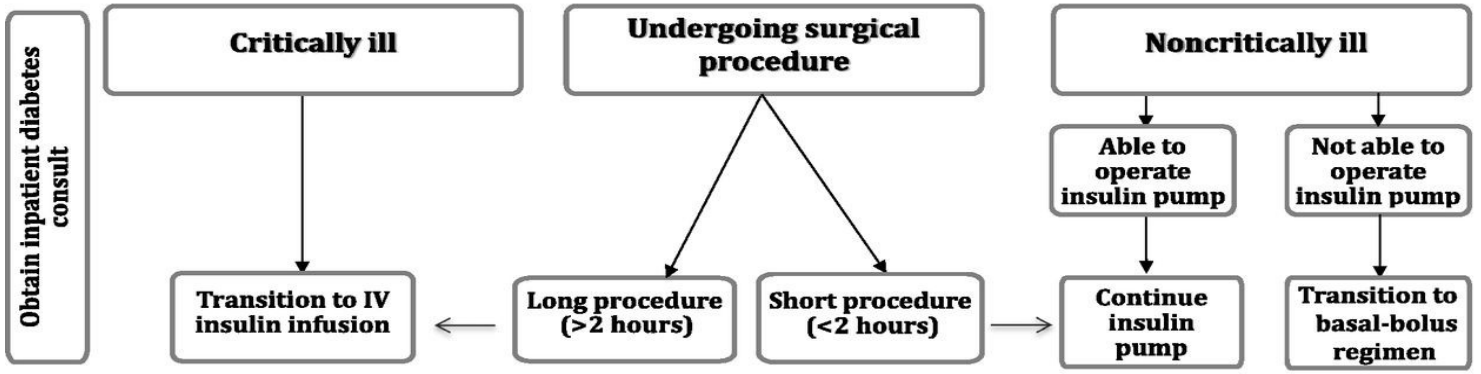




TDD decreased by 30%

Follow-Up A1C=6.7%

Patient With Insulin Pump Admitted to Hospital



Changes to Pump Therapy With Imaging Studies	
X-ray/CT	Pump should be covered by lead apron
MRI	Pump and metal infusion set should be removed
Ultrasound	No need to remove pump but transducer should not be pointed directly at the pump
Cardiac catheterization	Pump should be covered by lead apron
Pacemaker/automatic implantable cardioverter defibrillator (AICD)	Pump should be covered by lead apron
Colonoscopy/EGD	Pump can remain in place
Laser surgery	Pump can remain in place

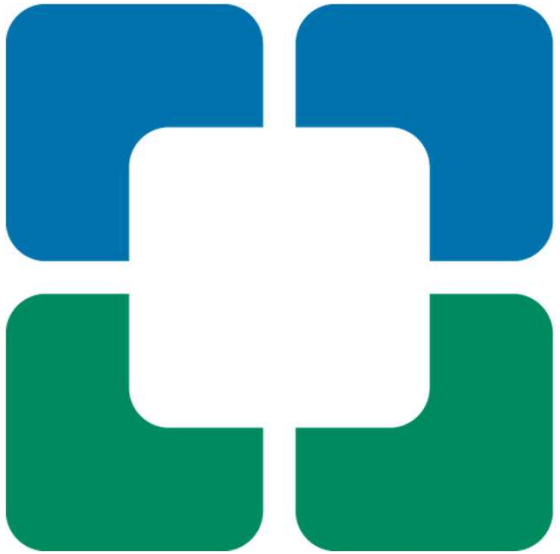
Umpierrez G et al. Diabetes Care 2018 Aug; 41(8): 1579-1589.

Contraindications to Insulin Pumps in the Hospital

Impaired level of consciousness (except during short-term anesthesia)
Patient's inability to correctly demonstrate appropriate pump settings
Critical illness requiring intensive care
Psychiatric illness that interferes with a patient's ability to self-manage diabetes
Diabetic ketoacidosis and hyperosmolar hyperglycemic state
Refusal or unwillingness to participate in self-care
Lack of pump supplies
Lack of trained health care providers, diabetes educators, or diabetes specialist
Patient at risk for suicide

Umpierrez G et al. Diabetes Care 2018 Aug; 41(8): 1579-1589.

Clinical Evidence

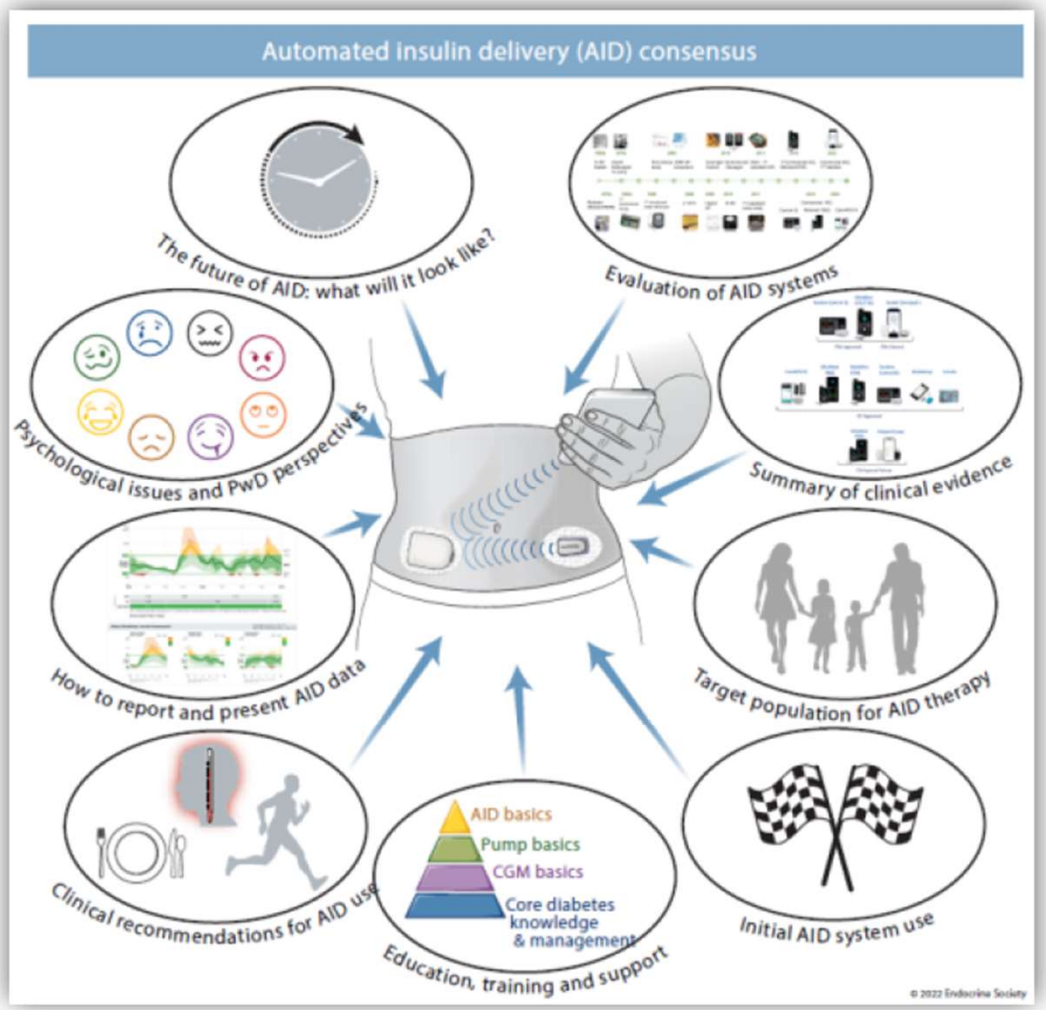


AID Use in Clinical Practice Recommendations

AID therapy should be considered for all populations with T1DM

AID systems still require basic diabetes management skills

All payers (government and private) should reimburse/cover AID systems



HCPs need to be aware of the different AID systems available, their benefits, and their limitations, to advise and support people with diabetes to reach AID benefits

Multifactorial racial and ethnic disparities in prescribing AID system technologies.
Preconceptions and unconscious biases about individual, family, and psychological attributes required to use AID technology effectively **should be recognized and mitigated to ensure fair and equitable access to AID systems**

Phillip M et al. Endocr Rev. 2023 44(2):254-280.

Summary of AID in T1D

System and Study	Study design	Sample	Change in Time in Range	Change in HbA1c	Change in Time Below Range	Adverse Events
MiniMed 670G Garg et al. [8••]	Three-month multicentre single-arm prospective clinical study (Auto vs Manual Mode)	Adults with T1DM (N = 94; ages 22–75 years) Adolescent with T1DM (N = 30, aged 14–21 years)	Adult + 6.8% p < 0.001 Adolescent + 5% p < 0.001	Adult -0.6% p < 0.001 Adolescent -0.5% p < 0.001	Adult -3% p < 0.001 Adolescent -1.2% P = 0.00928	No severe hypoglycemia or DKA
MiniMed 670G Forlenza et al. [10••]	Three-month multicentre single-arm prospective clinical study (Auto vs Manual Mode)	Children with T1DM (N = 46, aged 2–6 years)	+ 8.1% p < 0.001	-0.5% p < 0.001	-0.1% p = 0.996	No severe hypoglycemia or DKA
MiniMed 780G Carlson et al. [15••]	Three-month multicentre single-arm prospective clinical study (780G vs 680G)	People with T1DM (N = 60, aged 7–80 years)	+ 5.7% p < 0.001	-0.5% (p < 0.001) Using 100 mg/dL target: + 6.6%	-1% p < 0.001	No severe hypoglycemia or DKA
T:Slim X20 with Control IQ Brown et al. [17••]	Six-month multicentre randomized study (Control IQ vs SAP)	People with T1DM (N = 168, aged 14–71 years)	10% p < 0.001	-0.33% p = 0.001	-0.88% p < 0.001	No severe hypoglycemia 1 episode DKA in Control IQ group
Omnipod 5 Brown et al. [22••]	Three-month multicentre single-arm prospective clinical trial	Adults with T1DM (N = 128; ages 17–70) Children with T1DM (N = 112; ages 6–13.9)	Adult: + 9.3% p < 0.001 Children: + 15.6% p < 0.001	Adult: -0.38%; p < 0.001 Children: -0.71% p < 0.001	Adult: -1.57% p < 0.001 Pediatric: -0.43% p < 0.001	3 episodes severe hypoglycemia 1 episode DKA

K Zhou, Isaacs D. Curr Cardiol Rep. 2022;24(9):1159-1167.

UNIVERSITY
ER

Medtronic 780G Pivotal Trial

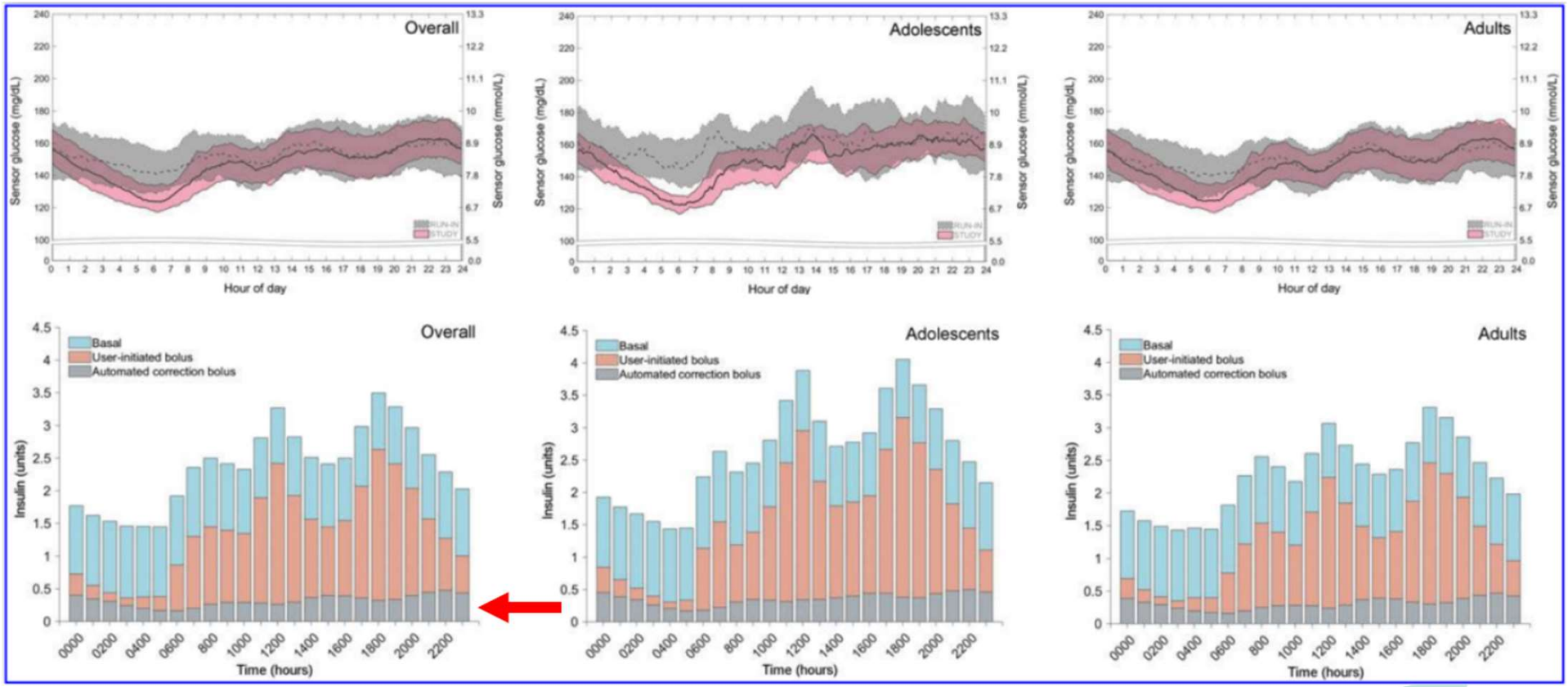
- FDA approved April, 2023

	Overall (n = *157*)	*Adolescents* (n = *39*)	*Adults* (n = *118*)
Age, years	38.3 ± 17.6	16.2 ± 2.1	45.6 ± 14.0
Female, *n* (%)	86 (54.8)	23 (59.0)	63 (53.4)
A1C, %	7.5 ± 0.8	7.6 ± 0.8	7.5 ± 0.9
Diabetes duration, years	22.6 ± 13.3	9.2 ± 3.7	27.0 ± 12.3
Weight, kg	80.1 ± 18.5	68.8 ± 11.9	83.9 ± 18.8
BMI, kg/m^2	27.5 ± 5.7	24.2 ± 4.0	28.6 ± 5.8
Therapy			
HCL	82	25	57
SAP	70	13	57
CSII	5	1	4

	Overall (n = *157*)		
	Run-in[a]	*Study*[b]	P
A1C, %[c]	7.5 ± 0.8	7.0 ± 0.5	<0.001[d]
24-h day			
Time in closed loop, %	—	94.9 ± 5.4	—
TBR <50 mg/dL	0.5 ± 0.7	0.3 ± 0.4	0.003[d]
TBR <54 mg/dL	0.8 ± 1.1	0.5 ± 0.6	0.001[d]
TBR <70 mg/dL	3.3 ± 2.9	2.3 ± 1.7	<0.001[d]
TIR 70–180 mg/dL	68.8 ± 10.5	74.5 ± 6.9	<0.001[d]
TAR >180 mg/dL	27.9 ± 11.0	23.1 ± 7.2	<0.001[d]
TAR >250 mg/dL	6.2 ± 4.7	4.6 ± 3.0	<0.001[d]
TAR >300 mg/dL	1.7 ± 1.9	1.2 ± 1.1	<0.001[d]

Carlson AL, et al. Diabetes Technol Ther. 2022 Mar;24(3):178-189

Medtronic 780G Pivotal Trial



Carlson AL, et al. Diabetes Technol Ther. 2022 Mar;24(3):178-189

Real World 780G Data

	Pediatric		Adult	
	Pivotal CAS (7-17 years) N=109	Real-world (≤15 years) N=10,204	Pivotal CAS (>17 years) N=67	Real-world (>15 years) N=26,099
AHCL use, %	94.4 ± 6.0	91.5 ± 14.0	95.1 ± 7.0	91.3 ± 14.4
CGM use, %	93.7 ± 4.9	92.6 ± 9.4	94.1 ± 6.5	92.0 ± 10.6
Mean SG, mg/dL	153.0 ± 13.0	154.0 ± 17.1	147.6 ± 13.6	152.2 ± 17.6
CV of SG, %	36.2 ± 4.3	37.4 ± 4.9	32.0 ± 4.2	33.1 ± 4.6
GMI, %	7.0 ± 0.3	7.0 ± 0.4	6.8 ± 0.3	7.0 ± 0.4
24-hour day Time at SG ranges, %	6.9 / 19.4 / 71.5 / 1.8 / 0.4	7.9 / 19.5 / 69.9 / 2.1 / 0.5	4.2 / 17.6 / 76.6 / 1.3 / 0.3	5.8 / 19.4 / 73.0 / 1.5 / 0.3
Nighttime Time at SG ranges, %	3.6 / 13.4 / 81.6 / 1.1 / 0.3	4.6 / 14.2 / 79.2 / 1.5 / 0.4	2.9 / 14.6 / 81.3 / 1.0 / 0.2	4.0 / 15.6 / 79.1 / 1.0 / 0.3

Data are shown as mean ± SD or mean.
Nighttime was defined as 12:00AM to 05:59 AM.
AHCL, advanced hybrid closed loop; CGM, continuous glucose monitoring; SG, sensor glucose; CV, coefficient of variation; GMI, glycemic management indicator.

- Continued Access Study participants Pivotal
  - 780G+G4S for 3 months
  - N = 109, aged 7-17 years
  - N = 67, aged >17 years
- Data of real-world 780G+G4S system users uploaded from 09-2021 to 12- 2022
  - N = 10,204 aged ≤15 years
  - N = 26,099 aged >15 years

Cordero TL, et al. Diabetes Technol Ther. 2023 Sep;25(9):652-658

Bionic Pancreas Pivotal Trial

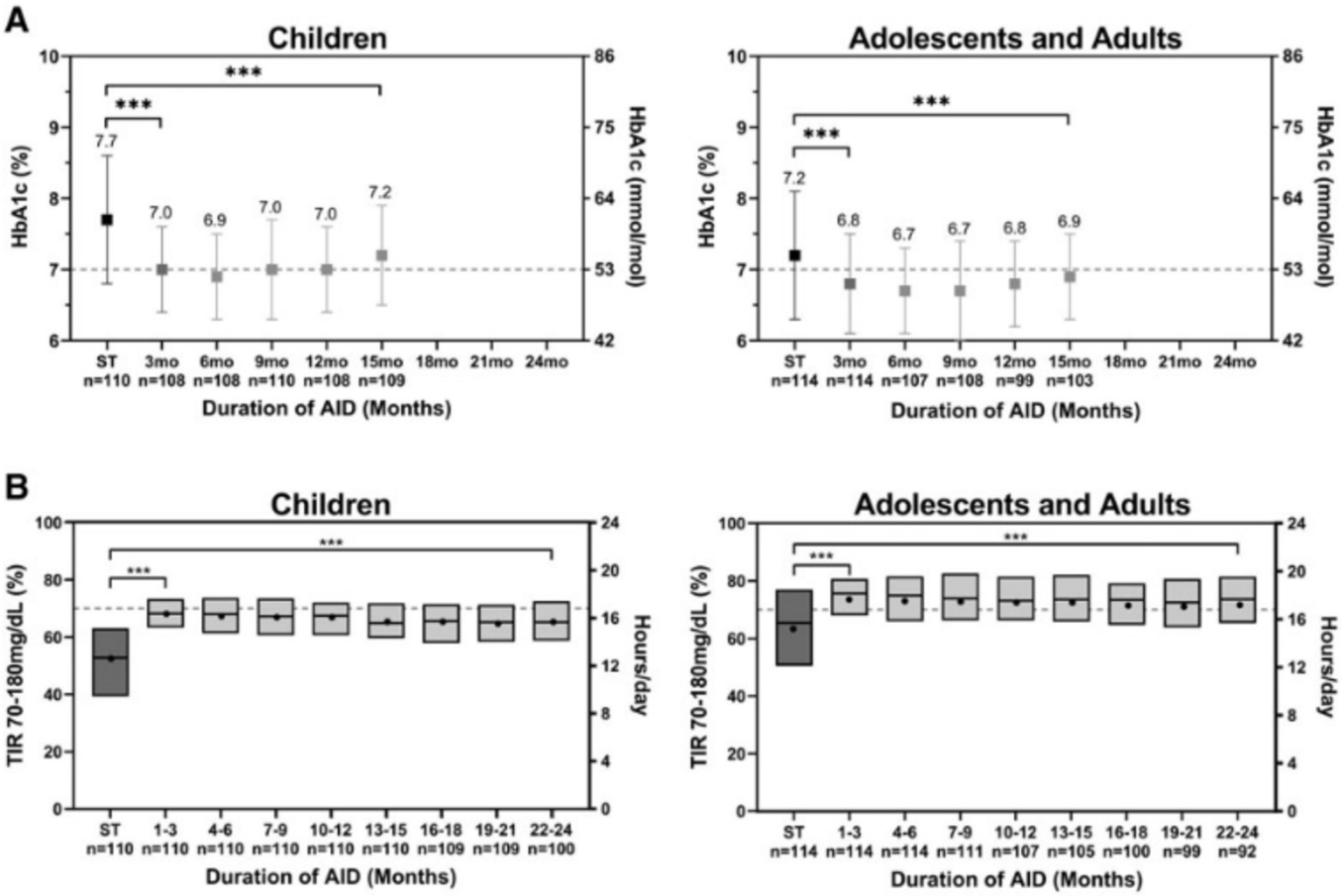
- FDA cleared May 22, 2023
- N=326 T1D ages 6 to 79 yrs randomized 2:1 to bionic pancreas vs. standard of care
- 13 weeks
- A1C decrease of -0.5% (p<0.001)

Table 2. Primary and Secondary Hierarchical Efficacy Outcomes.*

Outcome	Baseline		Follow-up over 13 Wk or at 13 Wk		Adjusted Difference (95% CI)†	P Value
	Bionic Pancreas (N=219)	Standard Care (N=107)	Bionic Pancreas (N=219)	Standard Care (N=107)		
Primary outcome						
Glycated hemoglobin — %	7.9±1.2	7.7±1.1	7.3±0.7	7.7±1.0	−0.5 (−0.6 to −0.3)	<0.001
Key secondary outcome						
Median percentage of time with glucose level <54 mg/dl (IQR) — %	0.2 (0.02 to 0.6)	0.2 (0.0 to 0.4)	0.3 (0.2 to 0.6)	0.2 (0.1 to 0.6)	0.0 (−0.1 to 0.04)	<0.001‡
Other secondary hierarchical outcomes in prespecified order						
Mean glucose level — mg/dl§	187±40	190±42	164±15	181±32	−16 (−19 to −12)	<0.001
Percentage of time with glucose level in range 70–180 mg/dl — %	51±19	51±20	65±9	54±17	11 (9 to 13)	<0.001
Percentage of time with glucose level >180 mg/dl — %	46±20	47±21	33±9	44±18	−10 (−12 to −8)	<0.001
Median percentage of time with glucose level >250 mg/dl (IQR) — %	16.0 (7.0 to 27.3)	17.8 (6.0 to 33.5)	8.5 (5.3 to 13.2)	14.9 (6.3 to 25.3)	−5.0 (−6.6 to −3.6)	<0.001
Glucose SD — mg/dl¶	67±16	68±18	60±11	67±16	−7 (−8 to −5)	<0.001
Median percentage of time with glucose level <70 mg/dl (IQR) — %	1.5 (0.5 to 2.8)	1.4 (0.4 to 2.9)	1.8 (1.1 to 2.9)	1.8 (0.8 to 3.1)	−0.1 (−0.3 to 0.2)	0.51
Median percentage of time with glucose level <54 mg/dl (IQR) — %‖	0.2 (0.02 to 0.6)	0.2 (0.0 to 0.4)	0.3 (0.2 to 0.6)	0.2 (0.1 to 0.6)	0.0 (−0.1 to 0.04)	—
Glucose coefficient of variation — %¶	36±6	36±6	36±5	37±5	−0.8 (−1.6 to 0.0)	—

Russell, S et al. N Engl J Med 2022; 387:1161-1172

Omnipod 5 – 2 Year Data



FDA cleared 1/27/22

N=224 T1D, age 6-70 years

2 wk standard, 12 wk AID,

2 year optional follow-up 224/235 elected to continue

Criego A, et al. Diabetes Technol Ther. 2023 Oct 18. doi: 10.1089/dia.2023.0364.

Real World Data: Control IQ

	Baseline (Basal-IQ)	*12-mth control-IQ use*	P
All users			
No. of participants	9010	9010	
Mean sensor glucose [mg/dL]	164 (146–185)	152 (140–166)	<0.001
Sensor time <54 mg/dL [%]	0.10 (0.00–0.30)	0.15 (0.06–0.30)	<0.001
Sensor time 54–70 mg/dL [%]	0.8 (0.3–1.8)	0.9 (0.4–1.6)	0.053
Sensor TIR [%]	63.6 (50.0–75.7)	73.6 (64.5–81.8)	<0.001
Sensor time 180–250 mg/dL [%]	25.1 (18.0–31.1)	19.7 (14.2–24.3)	<0.001
Sensor time >250 mg/dL [%]	8.1 (2.9–16.7)	4.6 (1.9–9.5)	<0.001
Coefficient of variation [%]	33.7 (30.0–37.6)	32.9 (29.5–36.3)	<0.001
GMI	7.2 (6.8–7.7)	6.9 (5.6–7.3)	<0.001
T1DM users			
No. of participants	7813	7813	
Mean sensor glucose [mg/dL]	163 (141–190)	151 (134–170)	<0.001
Sensor time <54 mg/dL [%]	0.01 (0.00–0.35)	0.02 (0.00–0.4)	<0.001
Sensor time 54–70 mg/dL [%]	0.9 (0.3–1.9)	0.9 (0.5–1.7)	0.123
Sensor TIR [%]	63.2 (49.8–75.1)	73.5 (64.4–81.6)	<0.001
Sensor time 180–250 mg/dL [%]	25.2 (18.2–31.0)	19.7 (14.3–24.2)	<0.001
Sensor time >250 mg/dL [%]	8.3 (3.1–16.9)	4.7 (2.0–9.6)	<0.001
T2DM users			
No. of participants	378	378	
Mean sensor glucose [mg/dL]	158 (138–184)	150 (136–169)	<0.001
Sensor time <54 mg/dL [%]	0.00 (0.0–0.07)	0.04 (0.01–0.10)	<0.001
Sensor time 54–70 mg/dL [%]	0.2 (0.0–0.6)	0.2 (0.0–0.6)	0.337
Sensor TIR [%]	69.9% (55.1–82.6)	78.0% (66.2–86.1)	<0.001
Sensor time 180–250 mg/dL [%]	23.9 (14.6–32.0)	19.0 (12.4–25.5)	<0.001
Sensor time >250 mg/dL [%]	3.6 (0.7–10.4)	2.3 (0.8–6.7)	<0.001

Data are expressed as median (IQR) unless otherwise specified.
GMI, glucose management indicator; IQR, interquartile range; T1DM, type 1 diabetes; T2DM, type 2 diabetes; TIR, time in range.

T1D: TIR increased from 63% to 73%

T2D: TIR increased from 69% to 78%

Breton MD, et al. Diabetes Technol Ther. 2021 Sep;23(9):601-608

AiDAPT Study (T1D, Pregnancy)

- N=124 T1DM pregnant participants < 14 weeks gestation RCT AID vs standard care
- Primary Outcome=% TIR 63 to 140 mg/dL from week 16 gestation until delivery
- Utilized Dexcom G6 with CamAPS app on smartphone with Dana insulin pump, Glucose targets 81-90 mgL

Table 2. Primary and Secondary Maternal Glucose Outcomes.*

Outcomes	Baseline†		Antenatal Intervention Phase‡		
	Closed Loop (N=59)	Standard Care (N=59)	Closed Loop (N=59)	Standard Care (N=61)	Adjusted Treatment Difference (95% CI)§
Primary outcome					
Percentage of time with glucose level in range 63–140 mg/dl	47.8±16.4	44.5±14.4	68.2±10.5	55.6±12.5	10.5 (7.0 to 14.0)¶
Key secondary outcomes					
Percentage of time with glucose level >140 mg/dl	48.7±18.0	51.8±16.2	29.2±10.6	41.4±13.2	−10.2 (−13.8 to −6.6)
Percentage of overnight time with glucose level in range 63–140 mg/dl (11 p.m. to 7 a.m.)†	47.4±20.8	44.5±16.6	70.8±11.2	56.7±13.6	12.3 (8.3 to 16.2)
Other secondary outcomes					
Percentage of time with glucose level in range 63–180 mg/dl	71±16	68±15	87±9	80±10	6 (3 to 9)
Percentage of time with glucose level >180 mg/dl	26±17	28±16	11±9	17±11	−5 (−8 to −3)
Glucose area under the curve >120 mg/dl	39.5±23.7	41.3±19.7	19.3±12.2	27.9±12.9	−7.4 (−11.1 to −3.7)
Mean glucose level — mg/dl‖	149±28	151±24	125±14	136±16	−9.2 (−13.7 to −4.7)
Glycated hemoglobin level — %	7.6±1.1	7.9±1.3	6.0±0.5	6.4±0.5	−0.3 (−0.5 to −0.1)
Glucose SD — mg/dl**	54±14	55±12	42±11	47±10	−4.5 (−7.3 to −1.6)
Glucose coefficient of variation — %	36±5	37±6	33±5	34±5	−1.1 (−2.5 to 0.3)

Lee TTM, et al. N Engl J Med. 2023 Oct 5. doi: 10.1056/NEJMoa2303911.

EDITORIAL FREE PREVIEW

Technology Use and Glycemic Outcomes during Pregnancy with Type 1 Diabetes

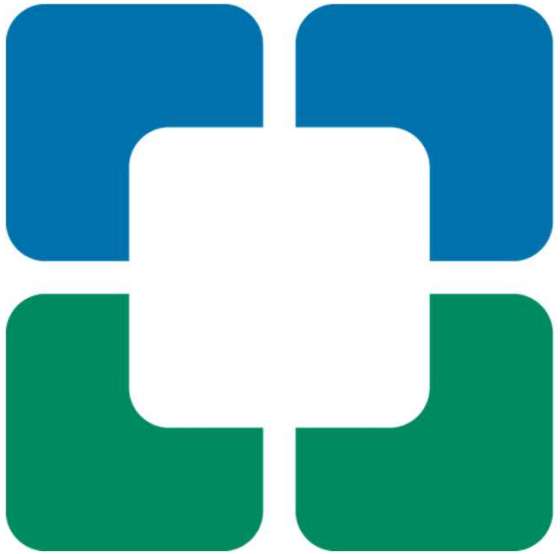
Satish K. Garg, M.D., and Sarit Polsky, M.D., M.P.H.

Table 1. Unknowns about Closed-Loop Use in Pregnancy.

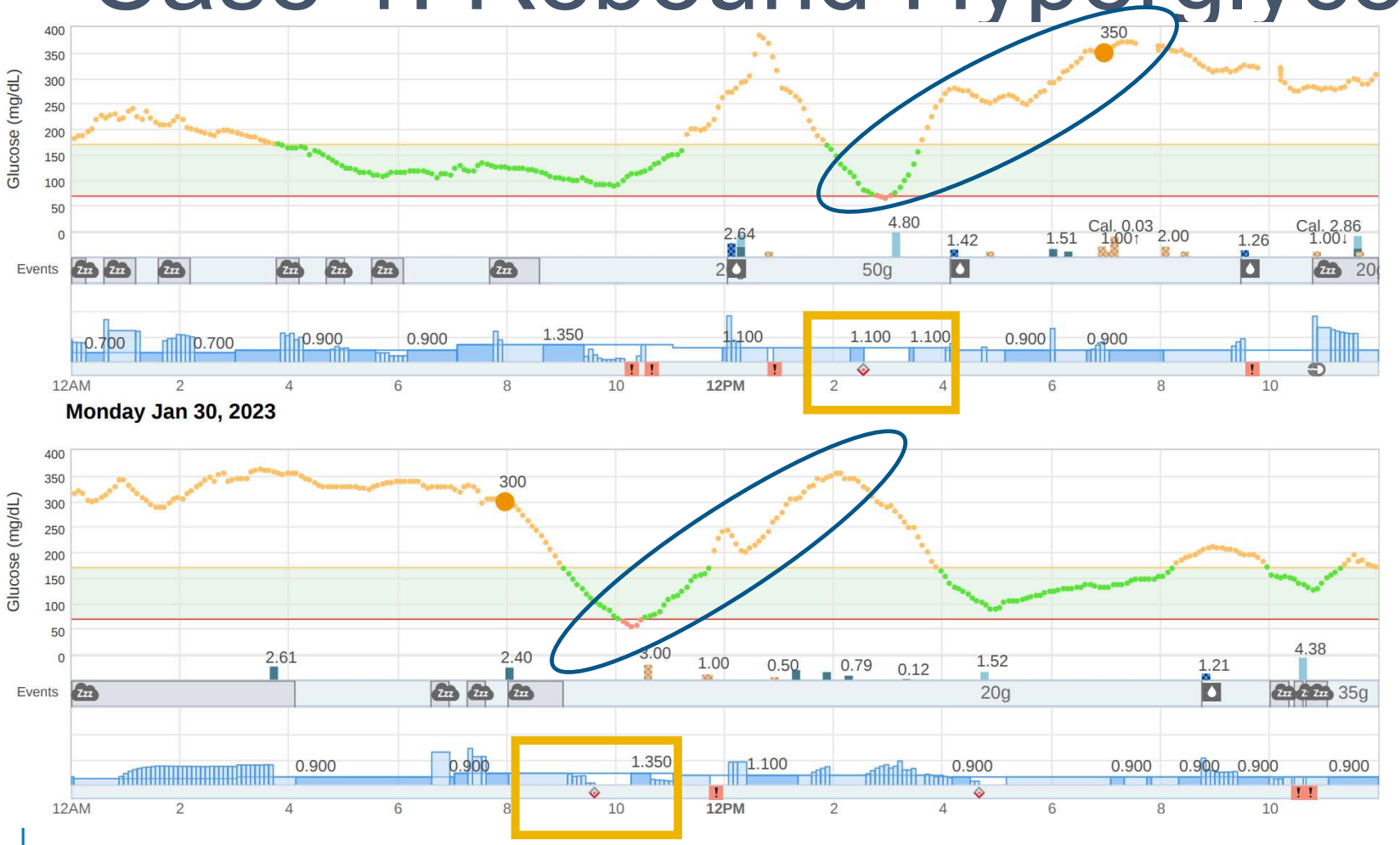
Unanswered Question	Hypotheses	Challenges
When should closed-loop therapy be initiated?	Preconception closed-loop initiation is likely to improve maternal and fetal outcomes.	Nearly 50% of pregnancies are unplanned. This approach may be cost-prohibitive.
Will closed-loop use be beneficial in persons with a glycated hemoglobin level <6.5% at the start of pregnancy?	Closed-loop use in pregnant patients with low glycated hemoglobin levels will still reduce hypoglycemia.	Some patients are unwilling to relinquish glucose control during pregnancy.
Should a closed-loop system have a pregnancy-specific glucose target range or an algorithm?	Both options are likely to be beneficial for maternal and gestational health outcomes.	This may require buy-in from manufactures and regulators.
Can closed-loop use early in pregnancy avoid all adverse maternal and neonatal health outcomes?	Adverse health outcomes would be significantly reduced but not completely eliminated.	Some outcomes are affected by nonglycemic factors (e.g., preeclampsia).
Can closed-loop use help pregnant patients with type 2 diabetes or gestational diabetes?	Anyone requiring intensive insulin treatment will benefit from closed-loop use in pregnancy.	Substantial education or resources are needed with closed-loop initiation, which may be cost-prohibitive.

Garg SK, Polsky S. N Engl J Med. 2023 Oct 5. doi: 10.1056/NEJMe2310798

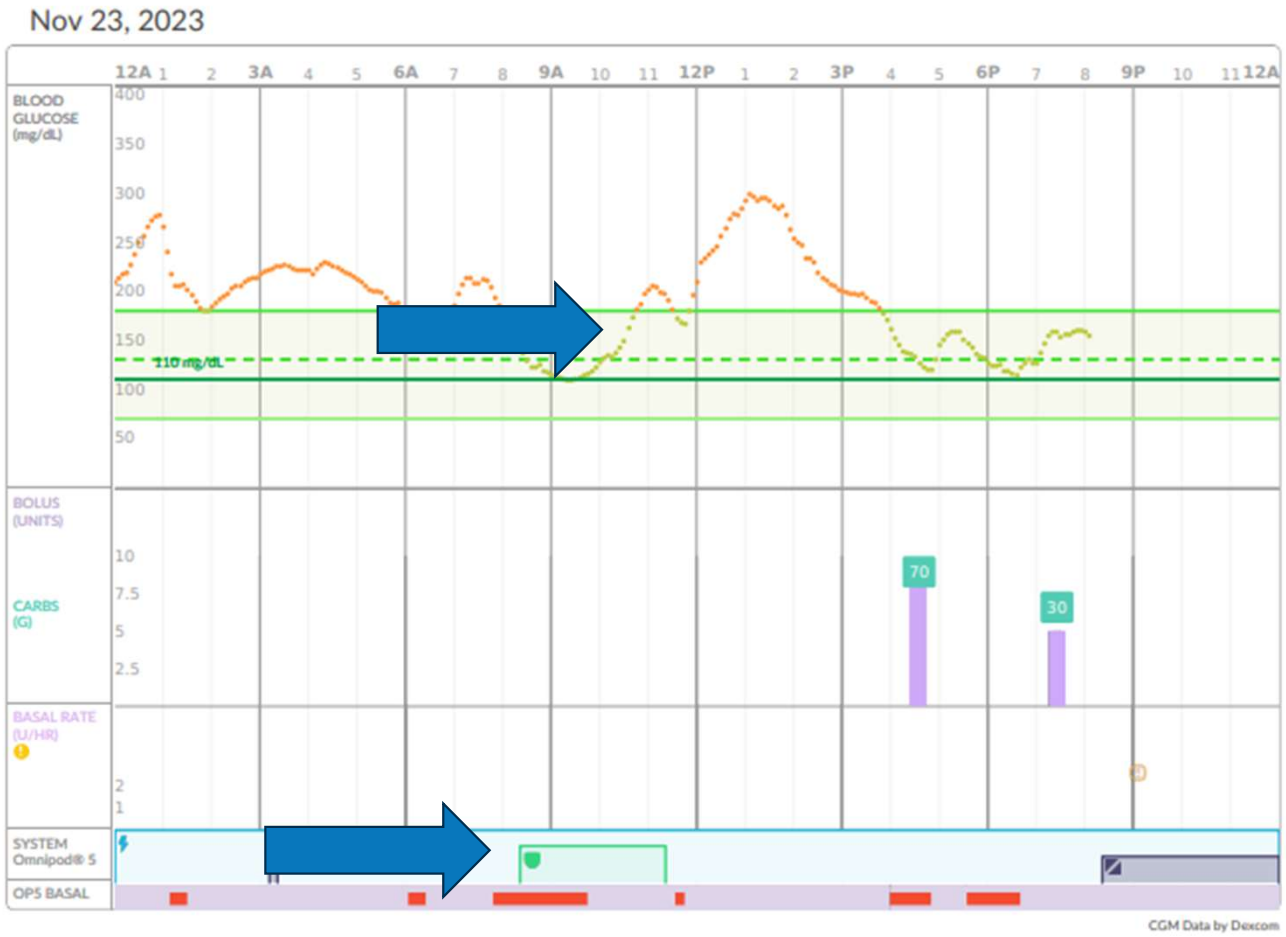
Clinical Scenarios



Case 1: Rebound Hyperglycemia

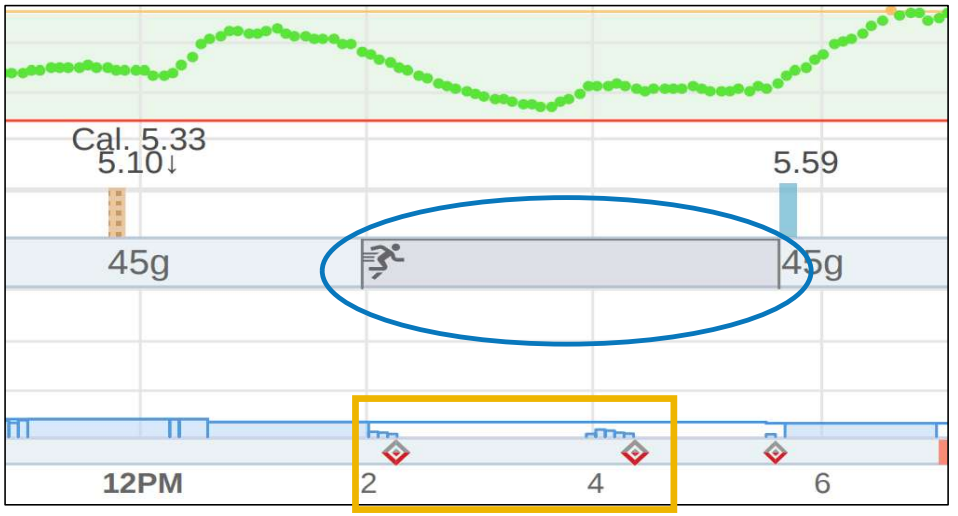


Case 2: Exercise



Case 3: More Optimal Exercise

Glucose steady



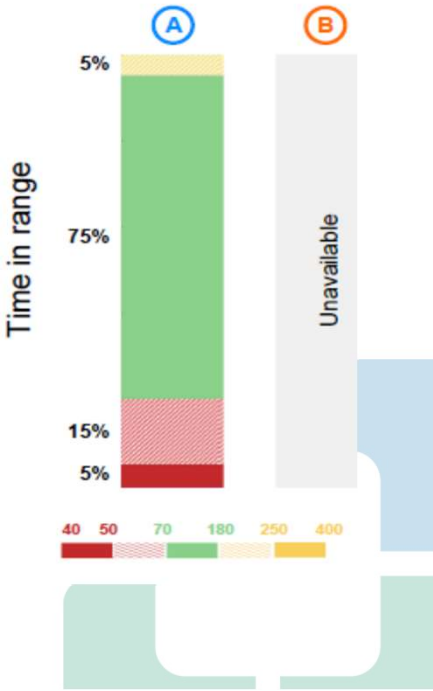
Glucose trending down
Insulin suspended

Exercise Activity increases target to
140-160 ★

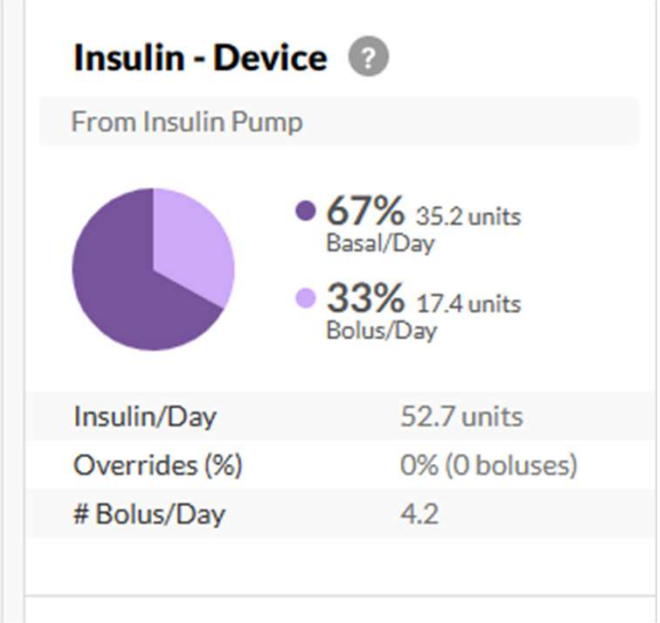
Case 4: Fake Carbs

Total daily dose (per day)	24 units
Bolus amount (per day)	18U (75%)
Auto Basal / Basal amount (per day)	6U (25%)
Set Change	Every 6.5 days
Reservoir Change	Every 4.3 days
Meal (per day)	8.9
Carbs entered (per day)	403 ± 159 g

Statistics	A
Auto Mode (per week)	77% (5d 09h)
Manual Mode (per week)	23% (1d 15h)
Sensor Wear (per week)	94% (6d 14h)
Average SG ± SD	106 ± 42 mg/dL
Average BG	116 ± 56 mg/dL
BG / Calibration (per day)	7.8 / 5.9



Case 5: Overrides



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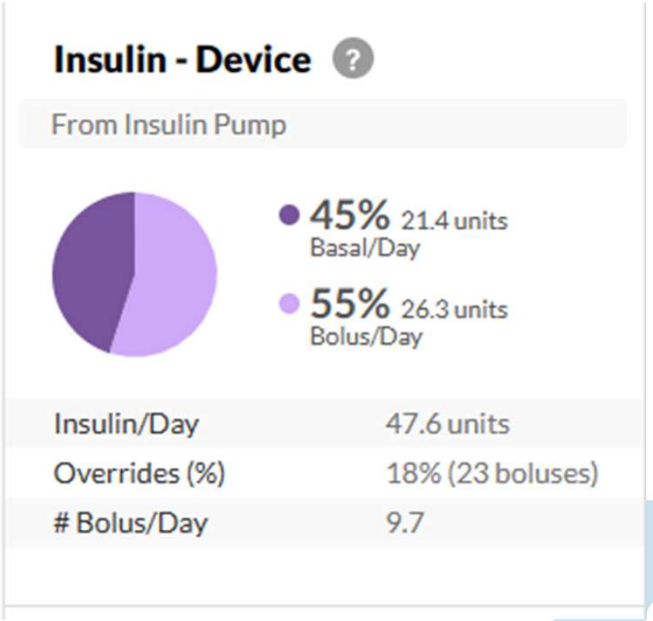
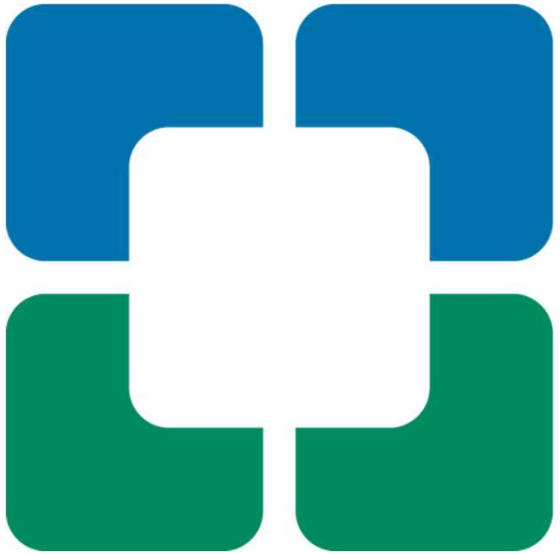


Connected Insulin Pens



InPen

- Delivers up to 30 units of insulin per dose
- Delivers in ½-unit increments
- Disposable needles (not included)
- 1 year life span
- Does not require charging
- Comes in blue, gray, and pink
- Integrates with Apple Health and Glooko
- Requires a prescription, uses cartridges
- Compatible with: Humalog, NovoLog, and Fiasp U100 3.0 mL prefilled cartridges
- Multiple pens can be paired to the InPen app.

https://www.companionmedical.com/InPen

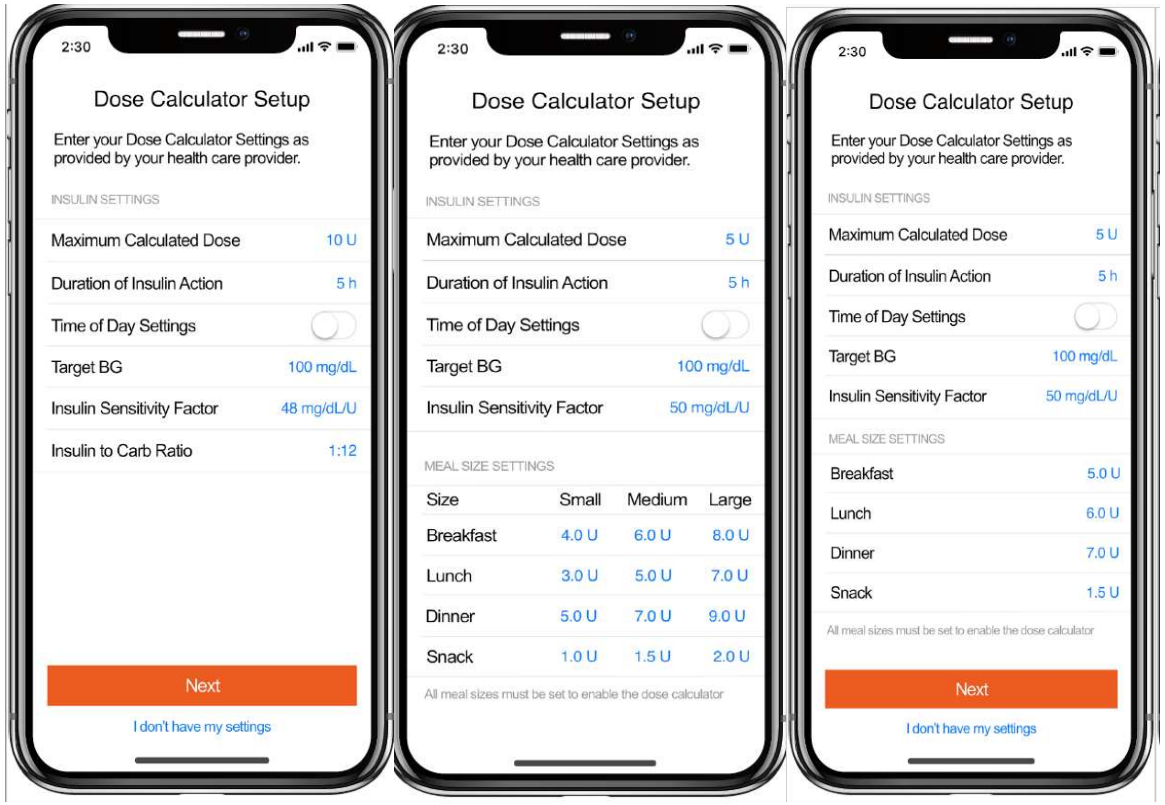
Bigfoot Unity Diabetes Management System

- Cleared by the FDA for ages over 12 years
- Smart insulin pen caps fits onto most commercially available insulin pens
- 2 versions of the pen cap:
  - Black for basal and white for bolus
- Uses glucose data from Freestyle Libre 2 CGM
  - Scan the sensor with the pen cap
- Recommended dose displayed by pen cap
  - 3 options based on small, medium large or carb counts
- Will not recommend insulin within 3 hours of last dose
- Records when a dose was taken (pen cap off for >4 seconds)
- Pen caps are rechargeable

Lilly Tempo Smart Button

- Tempo pen available with Lyumjev, Basaglar, Humalog
- Button uses Bluetooth to transfer insulin dose to mobile app
- TempoSmart App integrates insulin dosing data with glucose, food, exercise, and sleep data
- Set personalized reminders and alerts

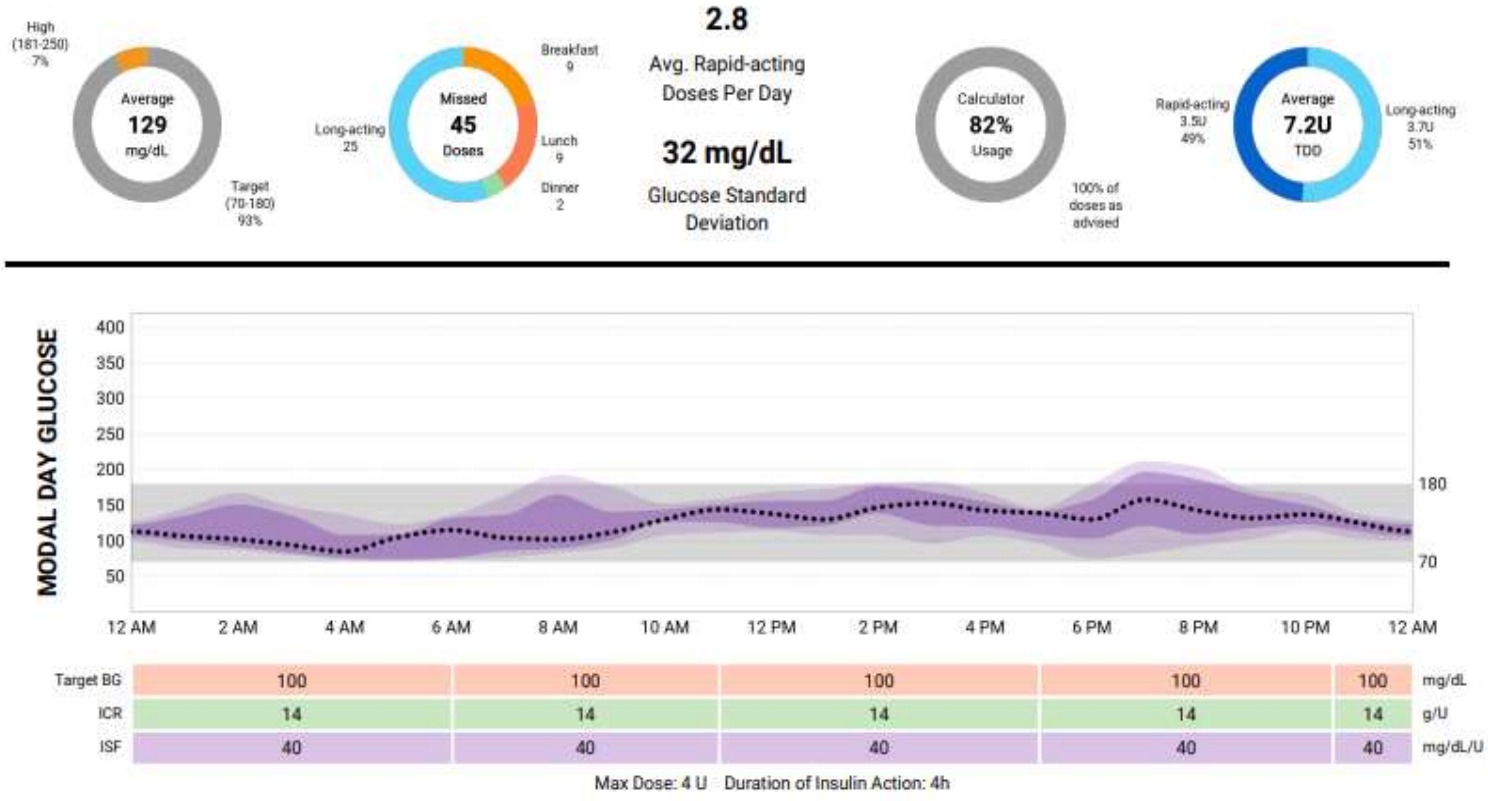
Therapy Settings



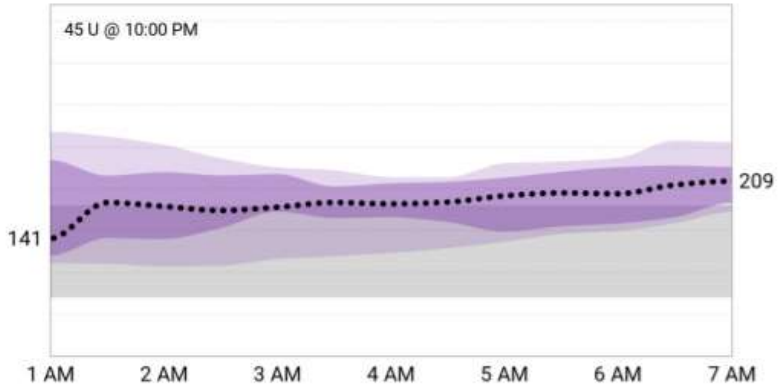
Time of Day Settings

Time of Day	6:00 AM	11:00 AM	5:00 PM	10:00 PM
Target Blood Glucose	100 mg/dL	90 mg/dL	90 mg/dL	110 mg/dL
Insulin Sensitivity Factor	35.0 mg/dL/U	38.0 mg/dL/U	38.0 mg/dL/U	38.0 mg/dL/U
Insulin to Carb Ratio	9.0 g/U	11.0 g/U	11.0 g/U	11.0 g/U

Connected Pen + CGM Data



LONG-ACTING ASSESSMENT

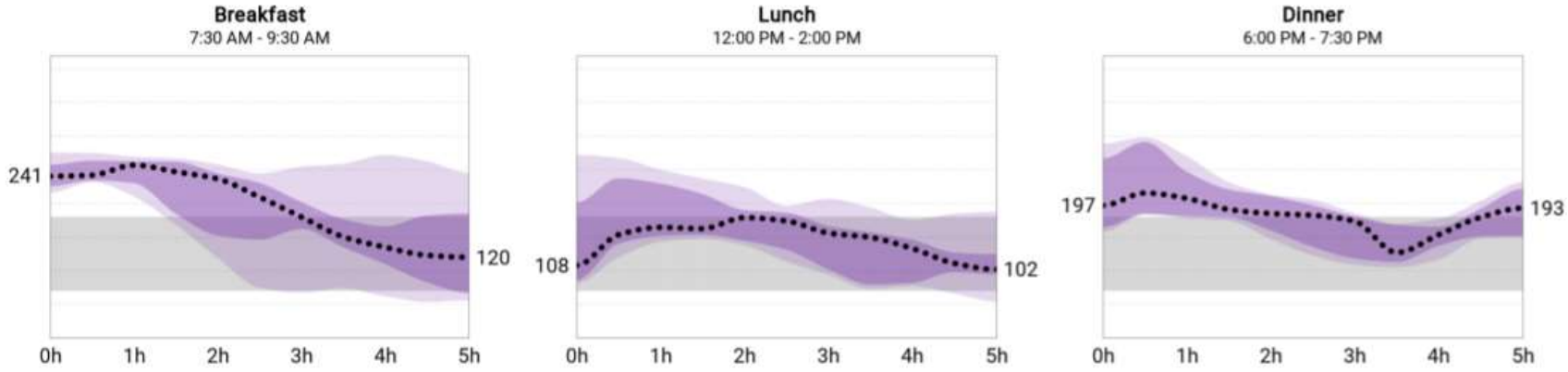


Days Included in Assessment	7 of last 14 days
Average Daily Dose Taken	45 U
# Days with Glucose < 70 mg/dL	0
Median Bedtime to Fasting (Change)	141 to 209 (+68 mg/dL) ▲

Note: Days with overnight boluses are excluded.

▲ Rising fasting glucose of 30 mg/dL or more may indicate long-acting dose should be increased.
▼ Falling fasting glucose of 30 mg/dL or more or days with glucose < 70 mg/dL may indicate long-acting dose should be decreased.

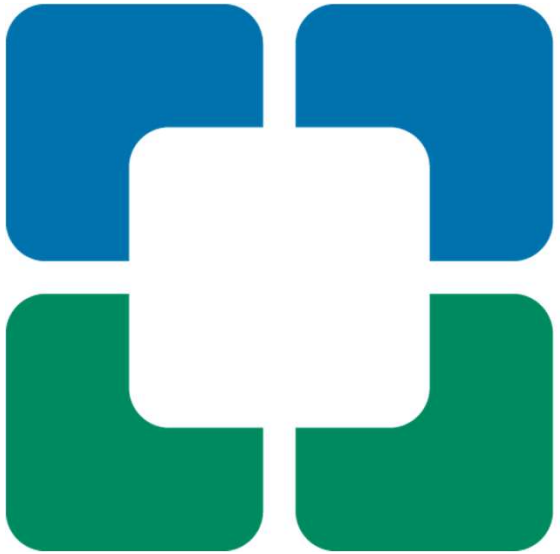
MEAL ASSESSMENT



In Summary

- There are several CGM, connected pen and insulin pump options, and the DCES can help PWD select the best device for their individual needs
- New era of hybrid closed loops
- No artificial pancreas yet, but we are getting closer to closing the loop
- Connected data can be used to discussion diabetes self-management with the person with diabetes and help to make meaningful changes-think DATAA

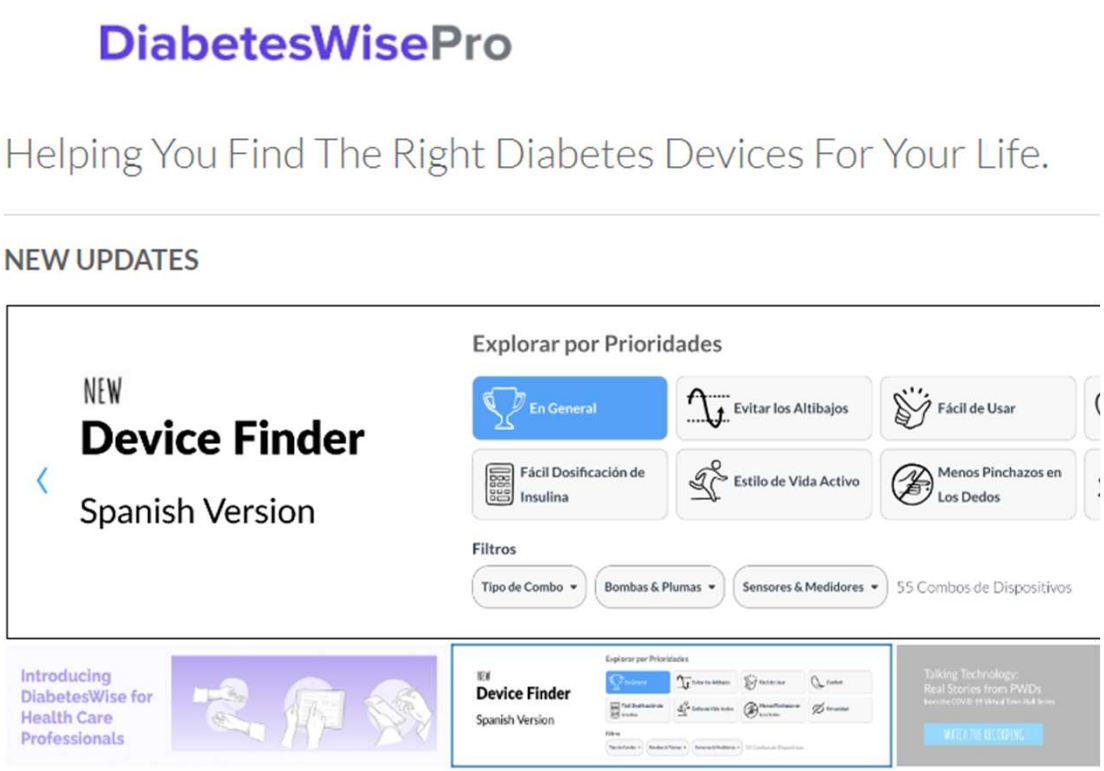
Resources



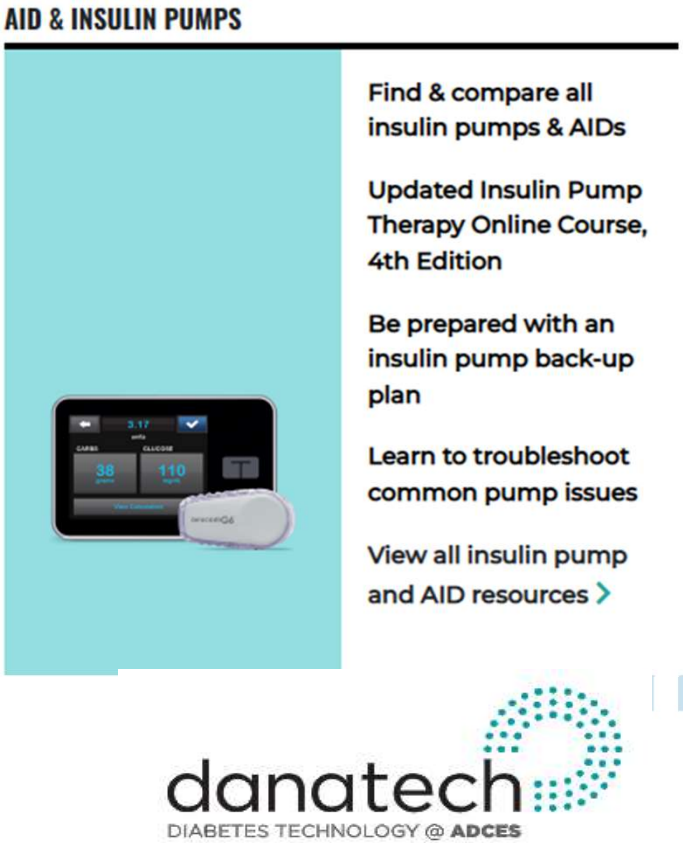
Collaborate: How to Share Data

System:	Associated Mobile Apps	Data Sources
Glooko	Glooko	Insulin pumps (Omnipod, T:slim X2), Dexcom, Eversense, many glucose meters, InPen
Clarity	Dexcom G6, G7, Clarity, Dexcom Follow, Undermyfork, Sugarmate	Dexcom, InPen
LibreView	LibreLink, LibreLinkUp, Libre 14 day, Libre 2, Libre 3	Libre 14 day, Libre 2, Libre 3
Carelink	Guardian Connect, Carelink	770G, Guardian CGM, InPen
Tidepool	Tidepool Mobile	Insulin pumps (770G, T:Slim X2, Tandem, Omnipod), Dexcom, Guardian, Libre, many glucose meters, InPen
T:Connect	T:Connect Mobile	T:Slim X2, G6
Eversense Data Management System	Eversense	Eversense
InPen Insights Report	InPen	InPen, Dexcom, Guardian Connect
Bigfoot Unity	Bigfoot Unity	Bigfoot Unity pen cap, Libre 2
Tempo Platform	TempoSmart	TempoSmart Button, Dexcom

Learn All About the Tech



https://pro.diabeteswise.org/



https://www.diabeteseducator.org/danatech/home)/

Panther Tools

PANTHERTOOL™ for

CONTROL-IQ

t:slim X2 insulin pump with Control-IQ technology

OVERVIEW using C|A|R|E|S Framework

C | How it CALCULATES

- A hybrid closed-loop system that uses CGM glucose data to adjust the basal insulin delivery by increasing, decreasing or suspending programmed basal rates
- Algorithm targets glucose levels 112.5-160 mg/dL
- Automatic correction boluses up to once per hour, 60% of a calculated correction dose

A | What you can ADJUST

- Can change basal rates, I:C ratios, correction factors
- CANNOT change active insulin time (5 hours) or correction bolus target (110 mg/dL)
- "Exercise Activity" targets glucose 140-160 mg/dL (to reduce insulin delivery)
- "Sleep Activity" narrows glucose target to 112.5-120 mg/dL and prevents automated correction doses overnight.

R | When to REVERT to open-loop

The system stays in hybrid closed-loop all the time except when CGM data is not available. Users must turn off Control-IQ if they want to use temporary basal rates.

E | How to EDUCATE

See PANTHERPOINTERS below as well as EDUCATE-bullets found under STEP 3.

S | SENSOR/SHARE characteristics

- Dexcom G6 sensor and transmitter: 10 day sensor life, factory calibrated, can be used for diabetes management decisions without BG check.
- User can connect Dexcom transmitter to the Dexcom G6 app on a phone and share data with others using Dexcom Follow app.
- Sensor glucose levels auto-populate into bolus calculator

PANTHERTOOL™ for

OMNIPOD® 5

Automated Insulin Delivery System

INSTRUCTIONS FOR USE

1 Download user's device to My.Glooko.com → Set report settings to Target Range 70-180 mg/dL

2 Create reports → 2 weeks → Select: a. CGM Summary; b. Week View; and c. Devices

3 Follow this worksheet for step-by-step guidance on clinical assessment, user education and insulin dose adjustments.

STEP 1 **BIG PICTURE** (PATTERNS)
→ STEP 2 **SMALL PICTURE** (REASONS)
→ STEP 3 **PLAN** (SOLUTIONS)

OVERVIEW using C|A|R|E|S Framework

C | How it CALCULATES

- Automated basal insulin delivery calculated from total daily insulin, which is updated with each Pod change (adaptive basal rate).
- Calculates dose of insulin every 5 min based on glucose levels predicted 60 minutes into future.

A | What you can ADJUST

- Can adjust the algorithm's Target Glucose (110, 120, 130, 140, 150 mg/dL) for adaptive basal rate.
- Can adjust I:C ratios, correction factors, active insulin time for bolus settings.
- Cannot change basal rates (programmed basal rates are not used in Automated Mode).

R | When to REVERT to open-loop

- System may revert to Automated Mode: Limited (static basal rate determined by system; not based on CGM value/trend) for 2 reasons:
  1. If CGM stops communicating with Pod for 20 min. Will resume full automation when CGM returns.
  2. If an Automated Delivery Restriction alarm occurs (insulin delivery suspended or at max delivery too long). Alarm must be cleared by user and enter Manual Mode for 5 min. Can turn Automated Mode back on after 5 minutes.

E | How to EDUCATE

- Bolus before eating, ideally 10-15 minutes prior.
- Tap Use CGM in bolus calculator to add glucose value and trend into bolus calculator.
- Treat mild hypoglycemia with 5-10g carb to avoid rebound hyperglycemia and WAIT 15 min before re-treating to give glucose time to rise.
- Infusion site failure: Check ketones and replace Pod if

S | SENSOR/SHARE characteristics

- Dexcom G6 which requires no calibrations.
- Must use G6 mobile app on smartphone to start CGM sensor (cannot use Dexcom receiver or Omnipod 5 Controller).
- Can use Dexcom Share for remote monitoring of CGM data.

PANTHERPOINTERS™ FOR CLINICIANS

1. Focus on behavior: Wearing the CGM consistently, giving all boluses, etc.
2. When adjusting insulin pump settings, focus primarily on Target Glucose and I:C ratios.
3. To make system more aggressive: Lower the Target Glucose, encourage user to give more boluses and intensify bolus settings (e.g. I:C ratio) to increase total daily insulin (which drives the automation calculation).
4. Avoid overthinking the automated basal delivery. Focus on the overall Time in Range (TIR), and optimizing system use, bolus behaviors and bolus doses.

PANTHER Diabetes Technology | danatech

Panther Tools

Download / Print PDF

	iLet Bionic Pancreas	MiniMed™ 780G	t:slim X2™ Control-IQ™	Omnipod® 5
				
CALCULATE	**iLet**	**780G**	**Control-IQ**	**Omnipod 5**
What is automation called?	iLet Bionic Pancreas	SmartGuard™	Control-IQ™	Automated Mode
Basal automation?	Insulin Automation is initialized by entering user's weight. Basal insulin delivery adjusts every 5 minutes based on CGM glucose trends and adapts over time based on the iLet's analysis of the user's daily glucose patterns.	"Auto Basal" calculated from total daily insulin, which is updated each day at midnight. Auto Basal is adjusted every 5 min based on recent CGM glucose trends, aiming for the target glucose value.	Increases or decreases the programmed basal rates based on a 30 min prediction of CGM glucose, aiming for the target glucose range.	"Adaptive Basal" calculated from total daily insulin, which is updated at each Pod change. Adaptive Basal is adjusted every 5 min based on a 60 min prediction of CGM glucose, aiming for the target glucose value.
Bolus automation?	All meal bolus doses and correction bolus doses are automated.	Auto correction boluses (max. every 5 min) if glucose is >120 mg/dL. Auto corrections can be turned on or off.	Auto correction boluses (max once/hr) if glucose is predicted to be >180 mg/dL in 30 min.	No automated boluses
Algorithm target glucose / target range?	3 target options: "Usual", "Lower", "Higher"	3 target options: 100, 110, 120 mg/dL	Target range: 112.5-160 mg/dL	5 target options: 110, 120, 130, 140, 150 mg/dL
Which insulin does the user give?	User completes a meal "announcement" to prompt the iLet to deliver a meal bolus, which involves indicating the carbohydrate amount for each meal ("Usual for Me"/"More" than usual/"Less" than usual).	User gives boluses for meals by entering total grams of carbs in the bolus menu / bolus calculator. User can deliver correction boluses as needed in the bolus menu / bolus calculator.		

Cleveland Clinic

Every life deserves world class care.

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Podcast: Diabetes Dialogue available at
https://www.hcplive.com/podcasts/diabetes-dialogue