# INSULIN PUMP MADE EASY

◦ COURSE 101

# CONTENTS

- CASE; TYPE 2 DIABETES ON PUMP

- OLD WAY OF DOING PUMPS COMPLICATED RIGHT?

- NEW PUMPS AND TECHNOLOGY

- NEW NON PUMP TECHNOLOGY

**Relationships with commercial interests:**

Grants/Research support  NOVONORDISK; SANOFI

Speaker's bureau/honoraria:DEXCOM; ANIMAS; MEDTRONIC; ELI LILLY NOVORDISK; BI ; SANOFI;

Consulting/Advisory Board:SAME AS ABOVE

Other/Patents

# Presenter Disclosure

## Plan:
Type 1.5 diabetes
Declined to see genetics to rule out Mody or monogenic diabetes
Blood pressure near target
LDL A1c at target
Recent hair loss TSH on the low side
To repeat labs with graves antibody
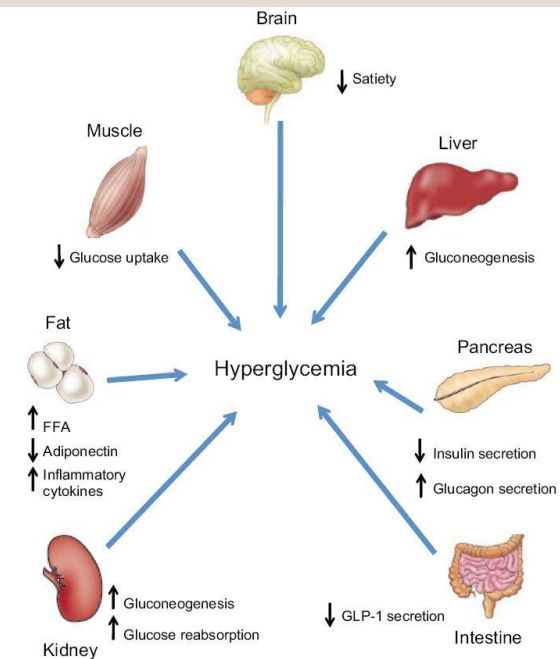She is having nuclear scan



**Figure 1** Multiorgan and tissue pathophysiology of type 2 diabetes.
**Notes:** Adapted with permission from DeFronzo RA. Banting Lecture. From the triumvirate to the ominous octet: a new paradigm for the treatment of type 2 diabetes mellitus. *Diabetes*. 2009;58:773–795.⁴
**Abbreviations:** FFA, free fatty acids; GLP-1, glucagon-like peptide-1.

## Physical Exam:

Physical Exam
Looks well
bp on high side
Thyroid normal
cvs normal
resp clear
abd some lipohypertrophy
Feet 2 plus monofilament normal

## Plan:

**Checks BG** **4** times per day for the past ninety days.
**Hypoglycemia:** 83 percent in range
Less than 1 percent lows
Finds she has to eat at bedtime to prevent lows at nigh
Prior cath ; one small artery; no tx ; just medical treatment
She is overall feeling very well
No major lows
On insulin pump therapy
And SGLT2 inhibitor and GLP-1 agonist
She is aware of sick day rules
She was found to have a lung nodule that is being followed
She goes for yearly eye exams
She is very happy with the current management
However feels she has to eat at night to prevent lows

# TIME IN RANGE

## Glucose (CGM)

| | | |
|---|---|---|
| 0% | Very High | > 250 mg/dL |
| 14% | High | 181-250 mg/dL |
| 85% | Target Range | 70-180 mg/dL |
| 1% | Low | 54-69 mg/dL |
| 0% | Very Low | < 54 mg/dL |

| | |
|---|---|
| GMI | N/A |
| Average | 134 mg/dL |
| SD | 39 mg/dL |
| CV | 29.4% |
| Median | 130 mg/dL |
| Highest | 263 mg/dL |
| Lowest | LO mg/dL |

| | |
|---|---|
| % Time CGM Active | 98.9% (13.5 days) |

## Insulin

| | |
|---|---|
| 88%  48.2 units  Basal/Day | 12%  6.3 units  Bolus/Day |

| | |
|---|---|
| Daily Dose | 54.5 units |
| Overrides (%) | 0% (0 boluses |
| # Bolus/Day | 0.9 |
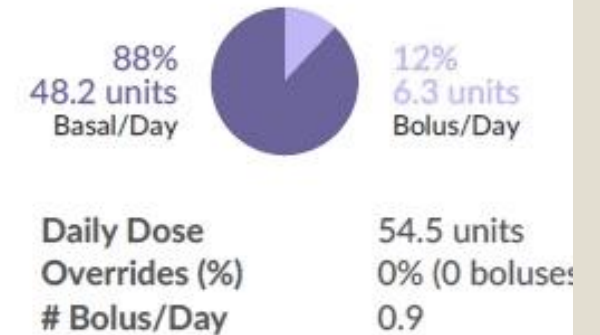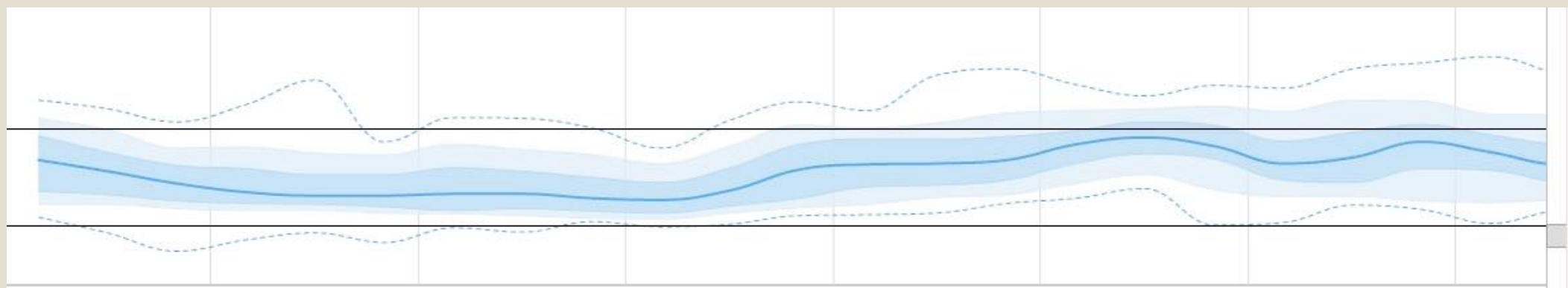
MOSTLY RUNS ON BOLUS
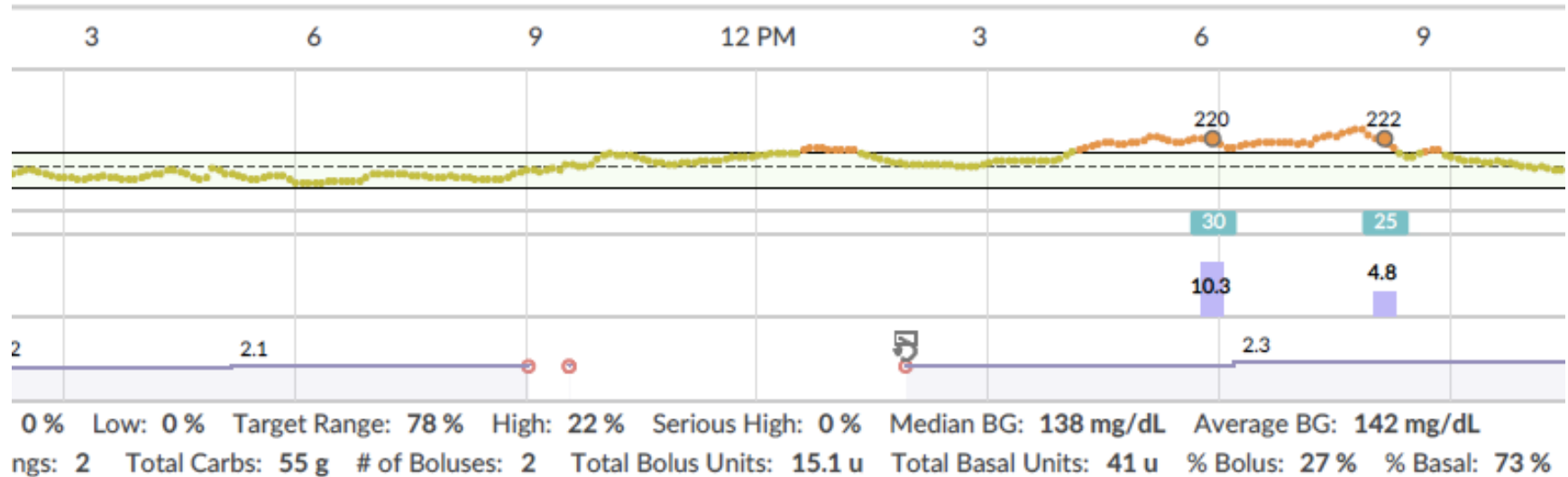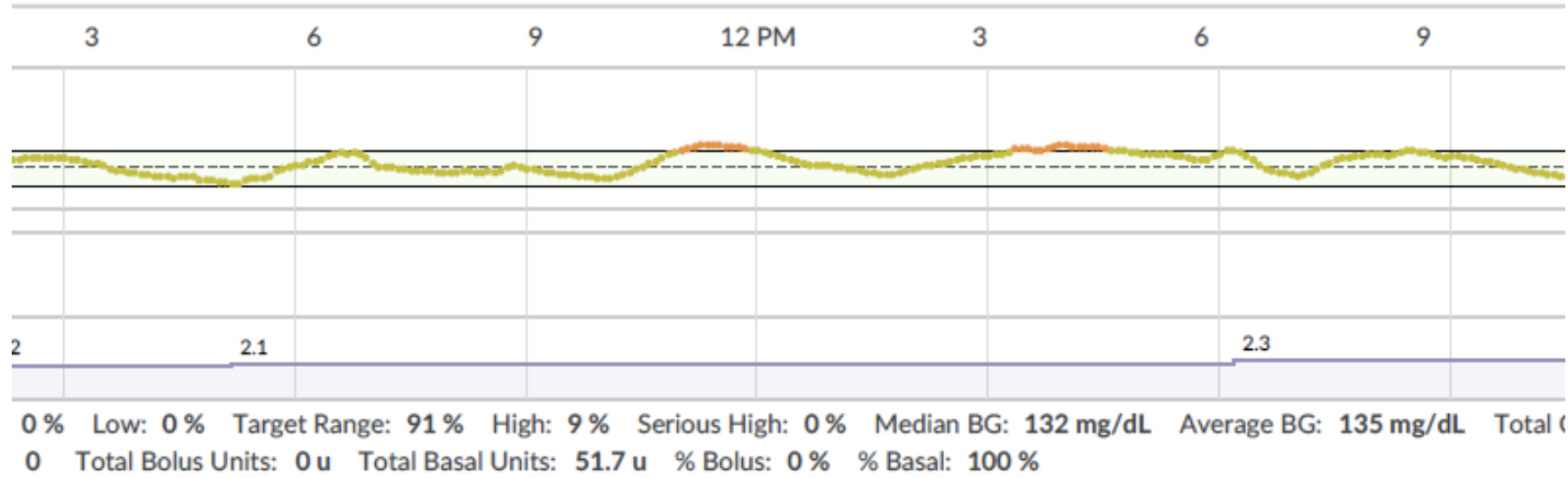
- TYPE 2 DIABETES ON ORALS AND GLP1 AGONIST
- INSULIN PUMP THERAPY IS A REASONABLE OPTION
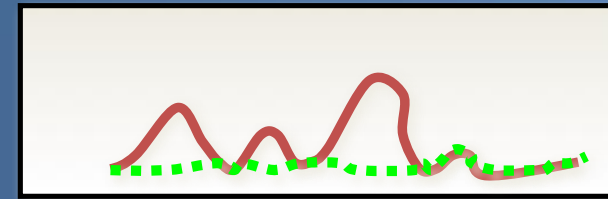
# CONTENTS

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- OLD WAY OF DOING PUMPS COMPLICATED RIGHT?

- NEW PUMPS AND TECHNOLOGY

- NEW NON PUMP TECHNOLOGY

# Similarity Between Insulin Pumps and a Normal Pancreas

## Basal rates

- Continuous infusion of insulin 24/7 based on "individual" body needs

- Covers the body's <u>non-food</u> needs
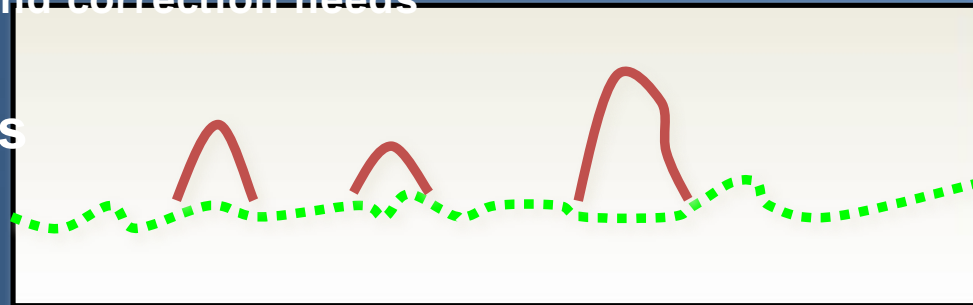
## Bolus delivery

- Burst of insulin used to meet the requirements of food intake (based on CHO ratio)

- Can be used to correct high blood glucose readings

- Covers the body's <u>food</u> and correction needs

### Normal pancreas

### Pump Basal/Bolus

CHO: carbohydrate

# THREE CONCEPTS TO KNOW

◦ BASAL RATE

◦ BOLUS AND CARB RATIO

◦ CORRECTION FACTORS

# Pump Concepts: TDD and Basal

- **Total daily dose (TDD)** is the absolute total of insulin over 24 hours
- **Basal insulin** represents the 24/7 continuous infusion of rapid- acting insulin broken into increments (usually by the hour, but can be by 30 minute increments for some pumps).

Adapted from Walsh J, Roberts R. Pumping Insulin: Everything You Need to Know for Success with an Insulin Pump. 2006.

# Establishing the Basal Rate...

75-80 % of TDD previously taken with 50% as basal, then divided up over 24 h (TDD X 0.8 X 0.5 = X/24 h)      OR

0.75 X weight in kg = TDD
40–50 % of TDD = initial basal amount divided by 24 for approximate per hour dose...

e.g.,     NPH 4 – 0 – 0 – 18
          RA   8 – 5 – 10 – 0

          Present TDD = 45 u
          80% of TDD = 36 u  (New Pump
TDD)      50 % of 36 u = 18 u
          18 u/24 = 0.75 u/hr

TDD: total daily dose; RA: rapid-acting insulin analogue

| Basal rates | Units/ hour |
|---|---|
| 24 – 04 | 0.6 |
| 04 – 08 | 1.0 |
| 08 – 12 | 0.75 |
| 12 – 18 | 0.75 |
| 18 – 24 | 0.75 |

To facilitate future adjustments:
- Usually split basal in night
- Establish blocks of time for morning, afternoon and evening to facilitate adjustments
- May set up adjustment for dawn phenomenon

# Establish CHO Ratio

## Settings

- Use of the pump computer to calculate the meal dose will help optimize care and often represents weakest link

- Education on CHO counting
  - Nutritional review with dietician comfortable with teaching CHO counting[1]
  - Use of additional information and on-line sources (e.g., CalorieKing)
  - Consideration of fat and protein contents of meal[2]

- Most people do best using CHO counting but for some, it is overwhelming – KISS (Keep it Simple Stupid) concept use may help…

- Examples of 15-g portion sizes:
  - 1 starch portion (e.g., 1 slice of bread)
  - 1 fruit/vegetable portion (e.g., an apple)
  - 1 cup of milk or yogurt



CHO: carbohydrate

1. CDA. Basic Carbohydrate Counting for Diabetes Management. Available at: http://www.diabetes.ca/for-professionals/resources/nutrition/basic-carb-counting

2. Bao J, et al. Diabetes Care 2011;34:2146-51.

# Pump Concepts: Bolus

- **Bolus insulin dose(s)**
1. Meal bolus(es) are based on an individual's insulin- to- carbohydrate ratio (ICR)
- 1 unit of insulin for __X__ grams of CHO intake
- e.g., ICR 8 and meal 40 g … means for 40 g/ 8 g = 5 u for meal
2. Correction dose(s) are based on the insulin sensitivity factor (ISF)
- 1 unit of insulin drops the BG by __X__ mmols.
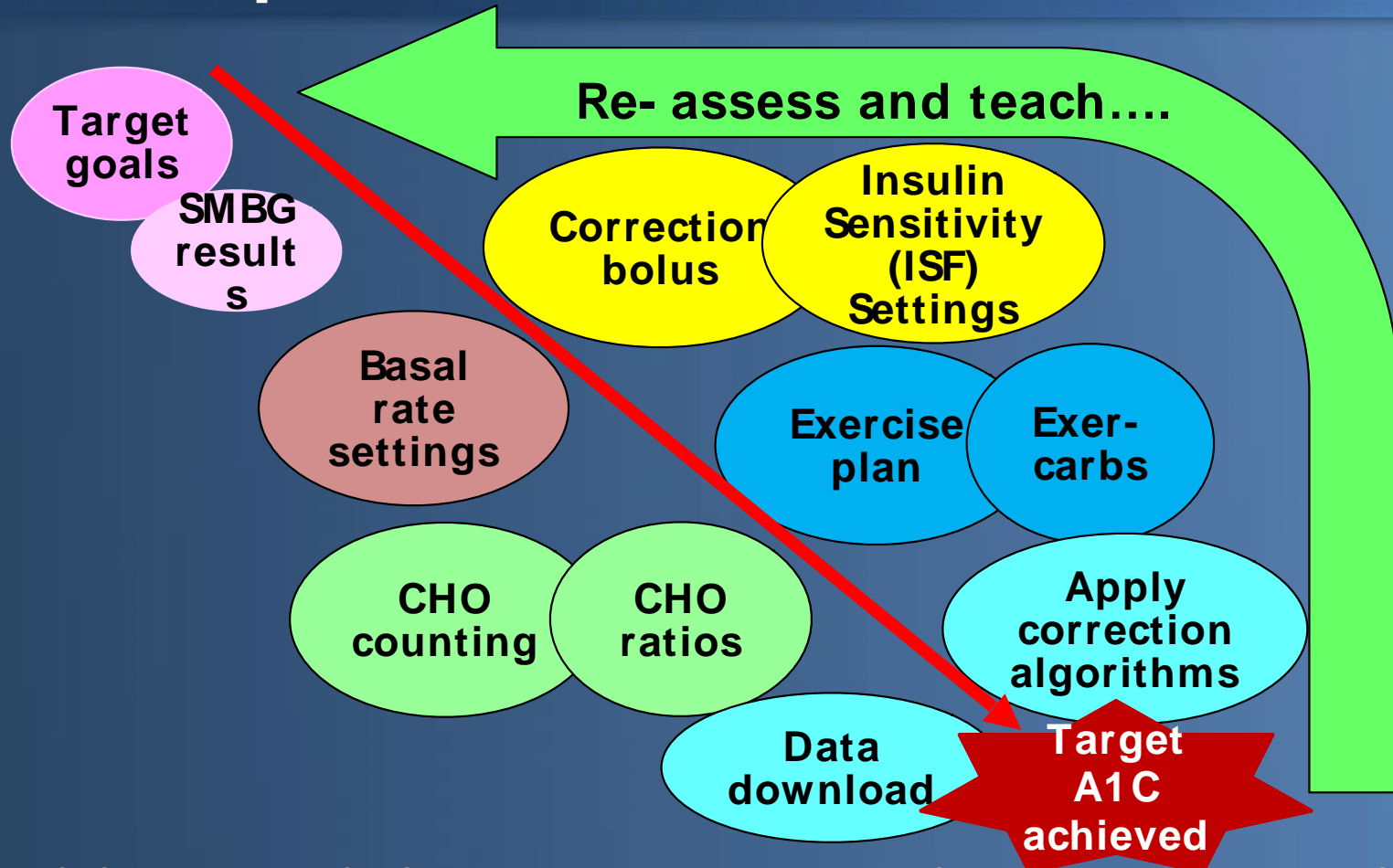- BG target range entered

e.g.,
▶ Current BG: 14.0 mmol/ L; Goal BG: 6.0  mmol/ L
▶ Current BG ─  Goal BG = 14 ─  6 = 8 mmol/ L (too high)
▶ ISF = 1 unit per 2 mmol/ L glucose- lowering expected
▶ 8 / 2 (ISF) = 4 u to correct

CHO: carbohydrate;
BG: blood glucose

Adapted from Walsh J, Roberts R. Pumping Insulin: Everything You Need to Know for Success with an Insulin Pump. 2006.

# Components of Pump Adjustment to Improve Glucose Control

**Re- assess and teach....**

- Target goals
- SMBG results
- Correction bolus
- Insulin Sensitivity (ISF) Settings
- Basal rate settings
- Exercise plan
- Exer-carbs
- CHO counting
- CHO ratios
- Apply correction algorithms
- Data download
- **Target A1C achieved**

CHO: carbohydrate; SMBG: self- monitoring of blood glucose; ISF: insulin sensitivity factor; A1C: glycated hemoglobin

# Setting Insulin Sensitivity Factor (ISF) or Correction Factor…

**Formula calculation:**

90 – 100* mmol/TDD

e.g., **90/36 = 2.5 mmol/L**

→1 u will likely lower glucose by 2.5 mmol/L

**OR**

**Pragmatic assessment:**

Ask patient how many units extra they would take to correct a glucose value, e.g., from 10 mmol/L to 6 mmol/L

If 1 u = ISF = 1 u/4 mmol/L; If 2 u = ISF = 1 u/2 mmol/L, etc..

Can adjust for time of day
(perhaps more at breakfast and slightly less in evenings)
e.g.,     1 u/1.5 mmol/L from 06–10 h;
           1 u/2 mmol/L from 10–21 h;
           1 u/3 mmol/L from 21–06 h.

* In Canada, the 100 rule is most commonly used to determine the ISF. However, some use 90 or 110 based on patient sensitivity/resistance.

Adapted from: Bode, BW. Pumping Protocol: A Guide to Insulin Pump Therapy Initiation. Atlanta, GA: Atlanta Diabetes Associates, 2008: p. 3.

# "Insulin on Board" (IOB) or "Active Insulin" Concept

- After the subcutaneous injection of insulin by the pump, the insulin is absorbed slowly and degraded. For rapid- acting insulin, this usually provides a duration of activity of about <u>4 hours</u>.

- The "duration of insulin action" is thus routinely set at 4 hours.

- The pump will automatically include any remaining insulin from a previous bolus within the last 4 hours in the <u>next bolus calculation</u>.

**Example Bolus Calculation**

Estimated lunch CHO = 50 g CHO
Ratio of 1 u/ 10 g
Bolus dose for CHO = 5 u

BG at 8.9 mmol/ L
ISF set at 1 u/ 2 mmol
Target at 5- 7 mmol/ L
Correction bolus (8.9 – 7/ 2) = 1 u

Active insulin from 2 units correction bolus given 2 h ago
Adjustment for IOB:
 2h/ 4h = ½ of 2 units = 1 u less

CHO: carbohydrate; BG: blood glucose; ISF: insulin sensitivity factor

# Bolus Calculator: Example 1

**Example:** BG = 12.5 mmol/L and CHO intake = 50 g; correction bolus of 2 units was made 2 hours before.

| Pump INFO | |
|---|---|
| ICR: | 14 |
| ISF: | 2.5 |
| BG target: | 6.0 |
| Active insulin: | 4 h |

**Total Bolus : 5.1 u (not 6.1 u)**

| Food Intake: | 50 g |
|---|---|
| Meter BG: | 12.5 |
| Insulin for food: | 3.5 |
| Correction insulin: | 2.6 |
| Adjustment for active Insulin: | 1.0 |

50 g
÷ 14 (CHO Ratio)
3.5 u (Food Bolus)

12.5 mmol/L – 6.0 mmol/L
÷ 2.5 mmol/L (ISF - Sensitivity)
2.6 u (Correction)

2.6 u (Correction)
- 1.0 u (IOB - Active Insulin)*
1.6 u **(Adjusted Correction)**

**\*NOTE: An assumption that half of the correction bolus of 2 units remains active since half of the 4 hours has passed (i.e., 1 unit of insulin remains active as IOB)**

ICR: insulin-to-carbohydrate ratio; ISF: insulin sensitivity factor; IOB: insulin on board; CHO: carbohydrate; BG: blood glucose

# Settings: Example

## Basal

| Maximum Basal Rate | 2.00 U/hr |
|---|---|
| Temp Basal Type | Insulin Rate (U/hr) |

| Standard (active) | | Pattern A | | Pattern B | |
|---|---|---|---|---|---|
| 24-Hour Total | 19.10 U | 24-Hour Total | 15.63 U | 24-Hour Total | 18.45 U |
| TIME | U/hr | TIME | U/hr | TIME | U/hr |
| 0:00 | 0.75 | 0:00 | 0.65 | 0:00 | 0.75 |
| 3:00 | 0.85 | 00 | 0.70 | 3:00 | 0.80 |
| 5:00 | 0.85 | 6:00 | 0.75 | 6:00 | 0.75 |
| 7:00 | | | | | 0.70 |
| 12:00 | | | | | 0.90 |
| 14:00 | | | | | 0.75 |
| 16:00 | | | | | 0.85 |
| 18:00 | | | | | 0.75 |
| 20:00 | | | | | |

**Standard day basal profile**
24h 0.45 u/h
03h 0.6
05h 1.0
09h 0.85
12h 0.675
18h 0.75

## Bolus

| Maximum Bolus | 10.0 U |
|---|---|
| Dual Square (Variable) | On |
| Blood Glucose Reminder | Off |
| Easy (Audio) Bolus | On |
| Entry (Step) | 0.50 U |
| Bolus Wizard | On |
| Units | g mmol/L |
| Active Insulin Time (h:mm) | 3:00 |
| Insulin Concentration | -- |

### Carbohydrate Ratio (g/U)

| TIME | Ratio |
|---|---|
| 0:00 | 8.0 |
| 8:00 | 8.0 |
| 12:00 | 9.0 |
| 16:30 | 7.0 |
| 20:00 | 12.0 |

### Insulin Sensitivity (mmol/L per U)

| TIME | Sensitivity |
|---|---|
| 0:00 | 3.0 |
| 8:00 | 3.0 |
| 12:00 | 3.0 |
| 17:30 | 3.0 |
| 20:3 | |

### Blood Glucose Target (mmol/L)

| TIME | Low | High |
|---|---|---|
| 0:00 | 6.0 | 7.0 |
| 8:00 | 6.0 | 7.0 |
| 12:00 | 6.1 | 7.0 |

**Notes**

## Sensor

**Insulin sensitivity settings**
00:00h  3.0
06:00h  2.0
11:00h  2.8
21:00h  3.0

**Blood glucose target**
00:00h ... 6 – 7
07:00h ... 5 – 6

**CHO ratio settings**
24:00h ...8 g
06:00h ... 8 g
11:00h ... 9 g
16:00h ... 7 g doses

**Newer pumps can adjust by decimals and go to higher**

# Activity and "Exer- Carbs"

- **An exer- carb** is the relative number of carbohydrates which would need to be eaten to offset the exercise undertaken…
- The relative amounts are available in tables
- Can use their value to reduce from meal bolus taken prior to the exercise or recently after an exercise

# Planning for Activities...

**Encourage patients to set up a plan for a recurrent activity and fine tune it with them until it works...**

| Type of activity | Reduction Bolus (%) Basal (%) | Temporary basal defined in advance (yes/ no) | Time set for temporary basal | Effective control or adjust next time? |
|---|---|---|---|---|
| Light (gardening, walk, shopping) | ~ | ~ | ~ | ~ |
| Moderate (biking, golfing [no cart]) | ~ | ~ | ~ | ~ |
| Energetic (basketball, jogging, swimming) | Reduced basal to 50% 30 min before run & during activity | Yes | Time of run & 30 min before | Went a bit low, try 50% decrease 1 hour prior to and during activity |
| Endurance (skating, cross- country skiing, hiking) | ~ | ~ | ~ | ~ |

**Rule of Thumb:** Since it takes rapid insulin up to 1 hour to begin peaking, temporary basal for exercise needs to be set 1 hour prior to the activity to reduce the risk of hypoglycemia

# Pump Setup

- Educate patient to competency, which will require more than one training session

- Determine TDD

- Set basal rates (generally ½ of TDD)

- Set bolus parameters

  - ICR: insulin/carbohydrate ratio (carbohydrate factor)

  - ISF: insulin sensitivity factor (correction factor)

  - Target glucose/active insulin time (varies between systems)

- Instruct the patient in pump features, troubleshooting

- Instruct the patient in use of apps, downloading devices, etc

    **REPEAT!**

# Troubleshooting

- Unexpected highs → infusion set or site problem until proven otherwise; low reservoir, low battery, overheated, or cooled insulin are also causes

- "Third day effect" may be due to insulin exposure and degradation

- Illness and steroids may require temporary basal rate, manual mode

- Exercise → individualize rate changes, nutrition

- Lows → replace CGM, check basal rate settings, downloads for errors, change carb ratio

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# Diabetes Technology Timeline
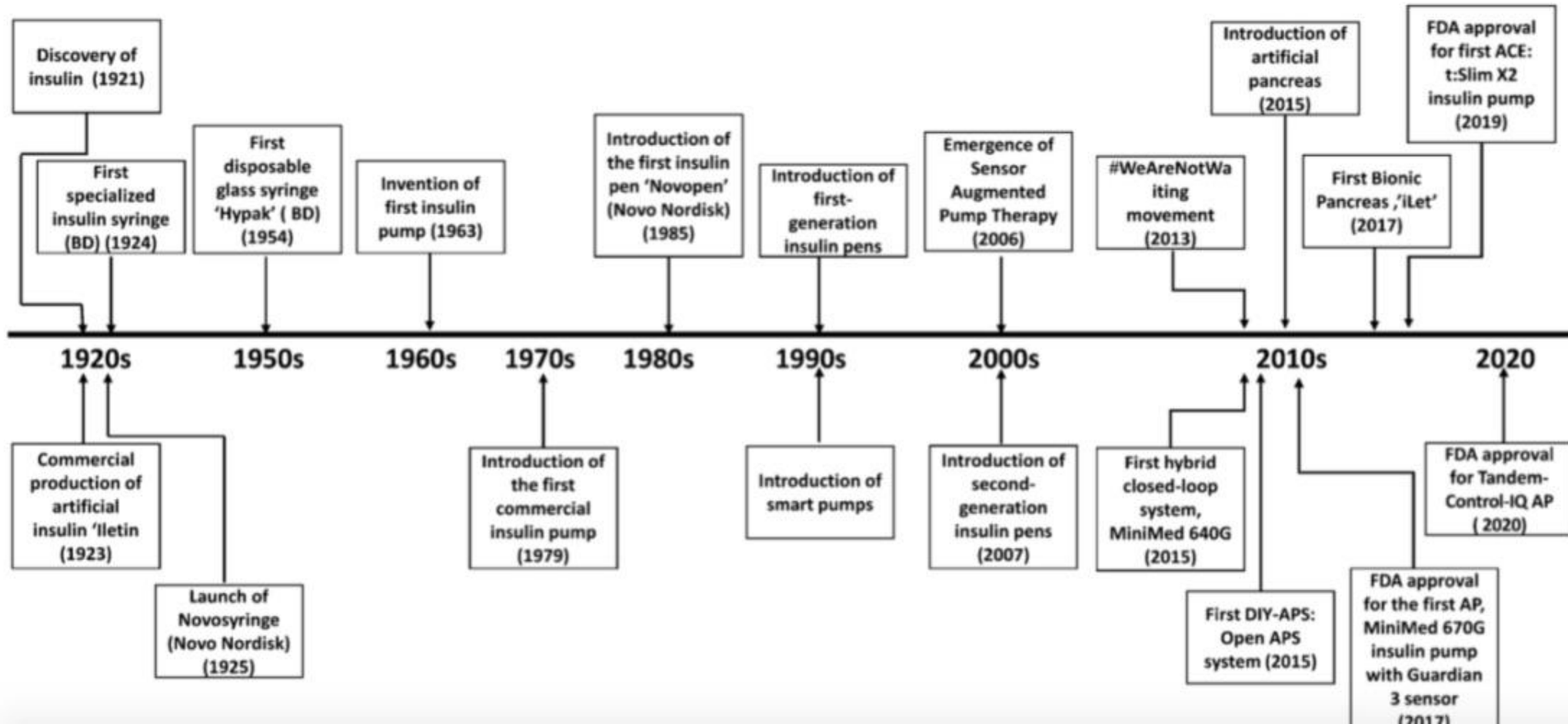
# MiniMed 780G HCL: Available in 2021?

- *Guardian* 3 CGM, algorithm changes

- 780G pump is Bluetooth connected

- Adjustable glucose target, down to ~100 mg/dL

- **Automatic correction bolus doses, will correct for missed carbs, ↑ TIR to 80%+**

- Bluetooth capability on the pump (will start with 770G model), communicates with smartphone

- CGM calibration required twice only on Day 1

- FDA approval for *Guardian* 3/Zeus nonadjunctive use is pending

# Insulin Only, Bihormonal, Closed Loop



## Components

- Dexcom G6
- iLet insulin pump
- Rapid acting insulin vs insulin plus glucagon
- HCL → CL, requires only body weight and meal announce
- Pivotal trial is underway

# Tidepool Loop: A DIY Algorithm Submitted to FDA



## Components

- Dexcom G6
- Omnipod or possibly Medtronic pump (future)
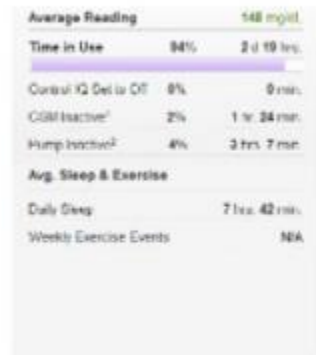- Algorithm resides on a smartphone; goal is availability at the App Store

# Tandem Insulin Pump: t:slim X2



Shows CGM trend line, glucose and direction arrow

- Bolus delivery: 1 unit in 20 seconds
- Extended bolus includes "Now" delivery for correction amount
- Insulin:carb ratios <1u:10g can be programmed in fractions, ie, 1u:5.5g
- Different insulin:carb ratios across the day
- **Basal IQ incorporates PLGS with auto-shut off**
- **Control IQ is HCL program, adjusts the basal rate and does correction boluses**
- *Note that a prescription is needed for the algorithm*

# T:Connect Download Report, Control IQ

# Medtronic 670G and 770G systems

- Automatic transmission of BG:
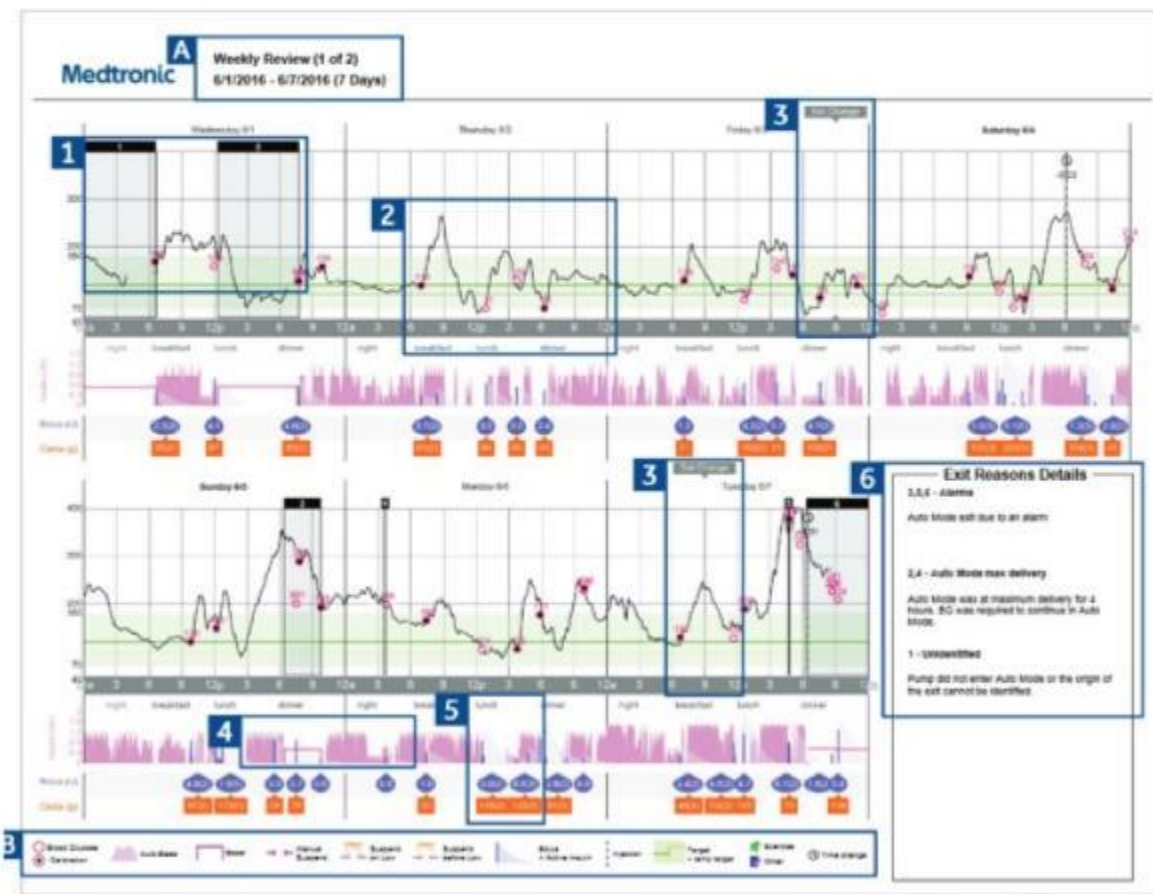
-  **670G**

If *Contour* Next Link 2.4 meter is linked, BG automatically transmits to pump

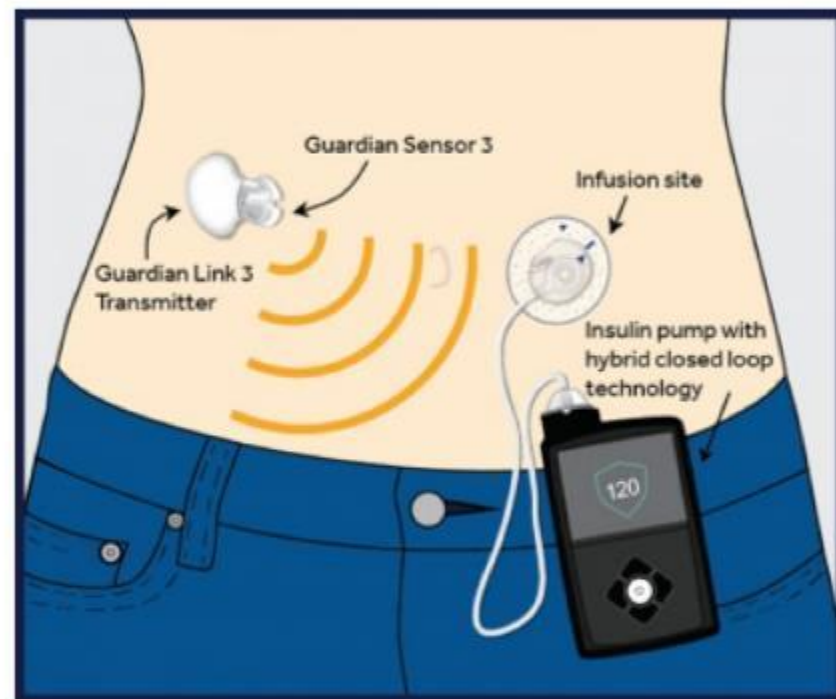If *Contour* Next Link 2.4 meter is not linked, BG can be entered manually

https://www.medtronicdiabetes.com/products/minimed-770g-insulin-pump-system

# Medtronic CareLink Report

https://www.medtronic.com/content/dam/medtronic-com/us-en/hcp/therapies-conditions/diabetes/documents/carelink-assessment-progress-report.pdf?bypassIM=true
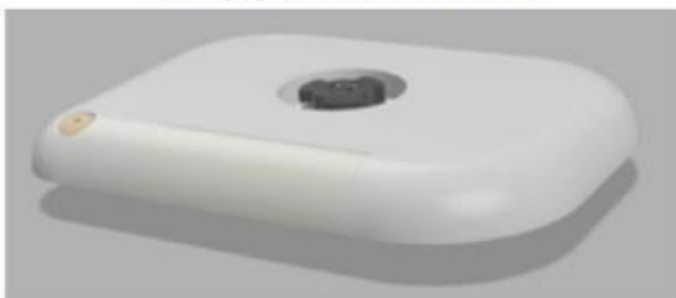
# Medtronic 670G/770G systems

- *Guardian* 3 CGM; *SmartGuard* program

- Hybrid closed loop adjusts basal rates only; PLGS in manual mode (alarm + shutoff)

- Nighttime glucoses are flat

- Patients enter glucose and carbs for bolus dose calculation

- Set for average BG of 120 mg/dL (6.7 mmol/L); corrects to BG of 150 mg/dL

- Approved for ages 7+, minimum TDD >8 units

- Need to wear for 3+ days in manual mode prior to turning on auto mode

- Handles insulin doses 8-250 units
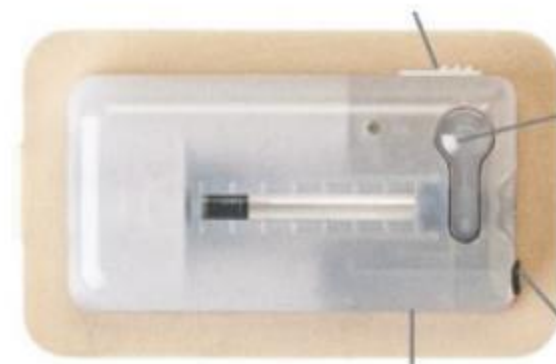
- PID algorithm is not equipped for illness/steroids



Guardian Sensor 3

Infusion site

Guardian Link 3 Transmitter

Insulin pump with hybrid closed loop technology

120

# Patch Pumps

**Qforma**

Flexible Patch Pump

**Solo Micropump**
FDA approved,
launched in Europe

**V-Go,** disposable patch pump
Basal rates of 20, 30, 40 units/day
Bolus doses in 2-unit increments
Mostly used in T2D

SA
PM
2U
3-Day Insulin Patch

**Simplicity**
Bolus doses only,
2-unit increments;
FDA approved, not
launched

106 mg/dL
10:00, 01 Jul 2018

150 U

Basal Rate Profile 1
0.90 U/h

25 min

Add
Data

cellnovo

# BF; hyperfear

- On Medtronic pump
- Does not like the sensor
- Hyperfear; had lows earlier in her diabetes career; prefers 15???

Print Reports    Download Reports    Export    Help ⌄

**dexcom®**
CONTINUOUS GLUCOSE MONITORING

Barbara Faric

Overview    Patterns    Data    Compare    Statistics    AGP    Settings

14 days | Sun Oct 13, 2019 - Sat Oct 26, 2019 ⌄

| 11.7 % | 16.0 | 2.9 | HIGH<br>MODERATE<br>LOW<br>**MINIMAL** | 97%<br>3%<br>0%<br>0% | Days with    93%<br>CGM data    13 / 14<br><br>Avg.<br>calibrations    0.0<br>per day |
|---|---|---|---|---|---|
| Estimated A1C | mmol/L<br>Average glucose<br>(CGM) | mmol/L<br>Standard<br>deviation<br>(CGM) | Hypoglycemia<br>risk | Time in range | Sensor usage |
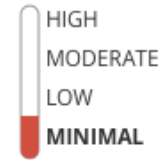
# We found no patterns during this date range. The best day was October 24, 2019.

① **Barbara's best glucose day**
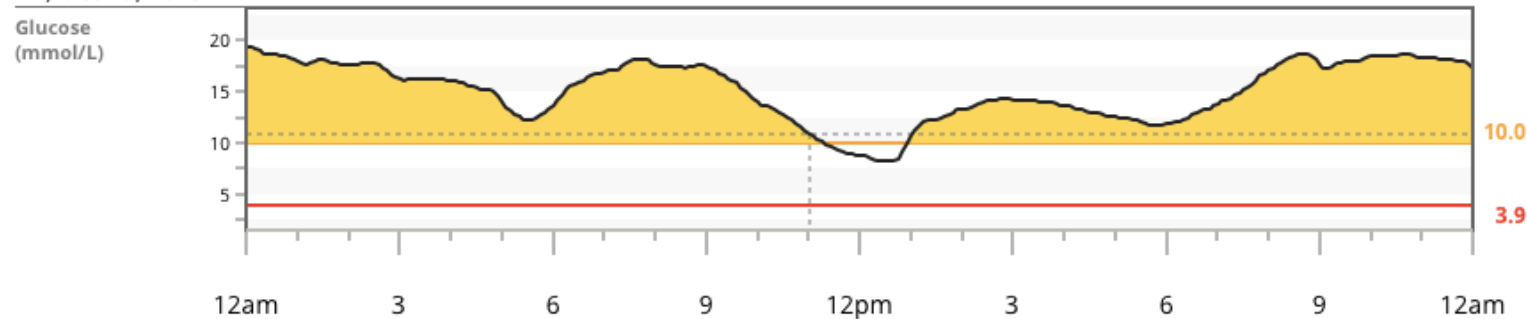Barbara's glucose data was in the target range about 9% of the day.    ›

🖨 Print Reports    📄 Download Reports    📊 Export    ⊕ Help ▾

**dexcom**®
CONTINUOUS GLUCOSE MONITORING

Overview    Patterns    **Data**    Compare    Statistics    AGP    Settings

14 days    Sun Oct 13, 2019 - Sat Oct 26, 2019    ⌄

**Sat, Oct 26, 2019**
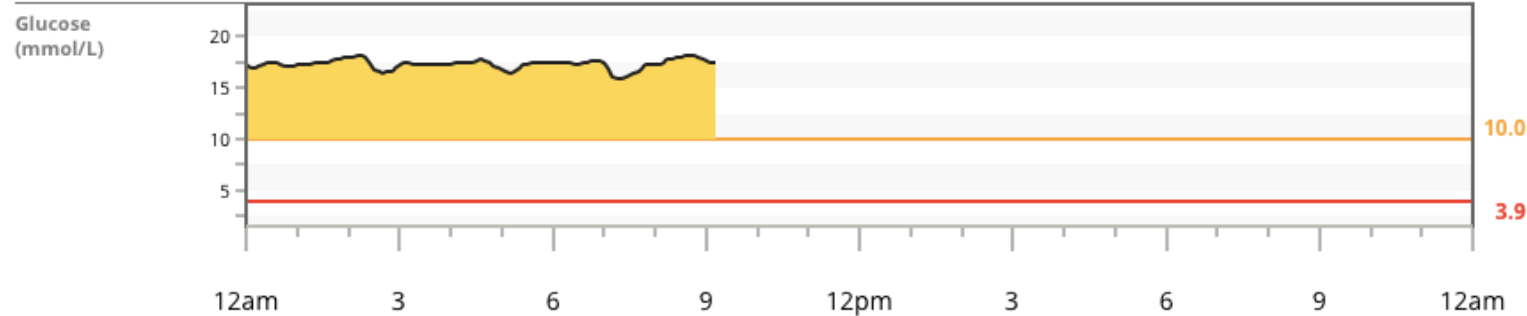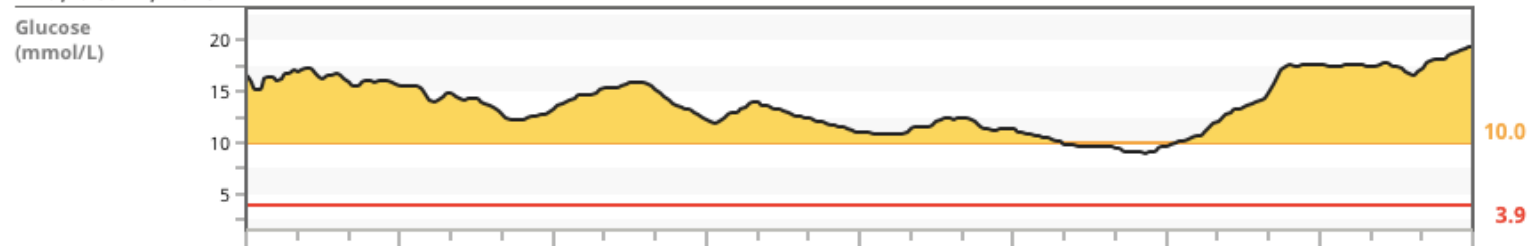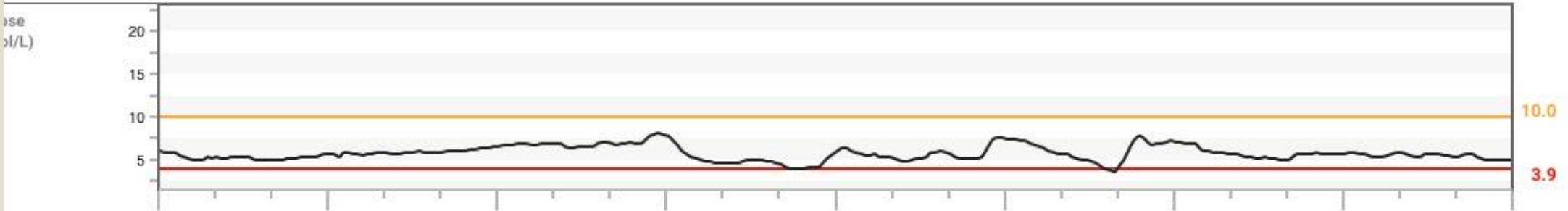
Glucose
(mmol/L)



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

**Fri, Oct 25, 2019**

Glucose
(mmol/L)



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

**Thu, Oct 24, 2019**

Glucose
(mmol/L)

Sep 25, 2020

Glucose (mmol/L)

| | 9:42 AM Urgent Low Soon | 9:55 AM Low | 10:47 AM Low | 12:12 PM Low |

, Sep 24, 2020
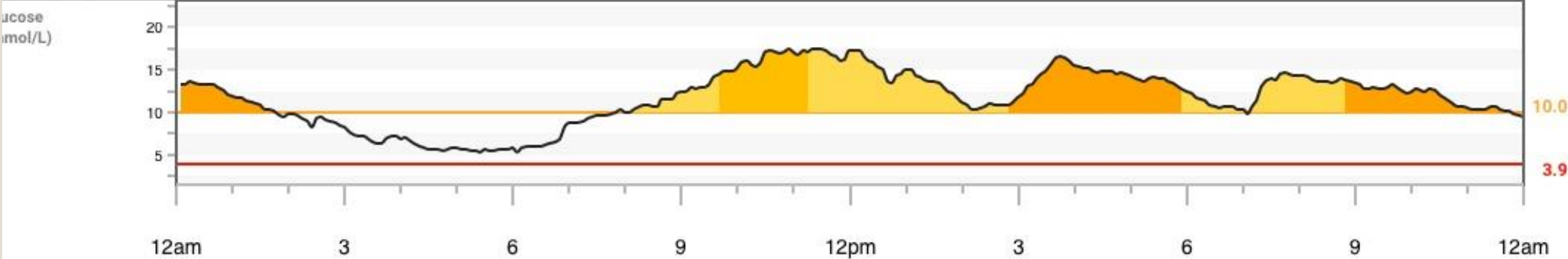
Glucose (mmol/L)

## 14 Days  Sun Sep 13, 2020 - Sat Sep 26, 2020 ✏️

### Average Glucose

# 12.7 mmol/L

| Standard Deviation | Estimated A1C |
|---|---|
| **4.2** mmol/L | **9.6**% |

### Time in Range

40% Very High
33% High
**26% In Range**
1% Low
0% Very Low

**Target Range:**
3.9-10.0 mmol/L

### Sensor Usage

Days with CGM data
**86**%

12/14

Avg. calibrations per day
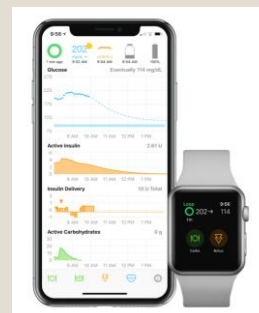**0.0**

# Automated Insulin Devices

## In development
**INVESTIGATIONAL/ NOT APPROVED IN CANADA**



- In development, Omnipod Horizon with algorithm in pod designed to receive Dexcom G6 and future G7 readings and automate insulin rates. [1]



- In development, Tidepool version of Loop intended to be an FDA regulated mobile App currently being studied with Medtronic and Dexcom CGM. [2,3]



- In development, Beta Bionics iLet. [4]



- In development, Ypsomed mylife YpsoPump [5]

[1] https://investors.dexcom.com/news-releases/news-release-details/dexcom-and-insulet-announce-commercial-agreement-integrate
[2] https://www.tidepool.org/loop/ [3] https://www.clinicaltrials.gov/ct2/show/NCT03838900 [4] https://www.betabionics.com/technology
[5] https://www.mylife-diabetescare.com/en/community/mylife-stories/mylife-stories-detail/cgm-integration-into-mylife-diabetescare-therapy-system.html https://www.ypsomed.com/en-CA/news-details/ypsomed-partners-with-jdrf-to-develop-new-open-technologies-for-next-generation-automated-insulin-delivery-aid-systems.html

# Automated Insulin Devices

## Available globally *NOT APPROVED IN CANADA

ACE*

- In **Canada**, Basal-IQ$^{TM}$ receives Dexcom G6 readings to automate basal rates[1], and in **US**, Control-IQ$^{TM}$ * adds automated correction boluses, using Tandem pump. *[2]

- In **Canada**, Medtronic 670G receives Guardian sensor readings (requires calibration) to attenuate basal rates [3], and in **EU,** Medtronic 780G* adds automated correction boluses. *[4]

ACE*

- In **UK**, CamAPS FX AID App * receives Dexcom G6 readings to automate basal rates and deliver manual boluses, using Diabecare RS pump.*[5]

- In **France**, Diabeloop* receives Dexcom G6 readings to attenuate basal rates, using Dana pump. *[6]

*Alternate controller enabled insulin pump.

[1] https://www.tandemdiabetes.com/en-ca/home [2] https://www.fda.gov/news-events/press-announcements/fda-authorizes-first-interoperable-automated-insulin-dosing-controller-designed-allow-more-choices [3] https://www.medtronic.com/ca-en/diabetes/home/products/insulin-pumps/minimed-670g.html [4] https://newsroom.medtronic.com/news-releases/news-release-details/medtronic-secures-ce-mark-minimedtm-780g-advanced-hybrid-closed [5] https://camdiab.com/ [6] https://www.diabeloop.com/

# Do-It-Yourself Hybrid Closed-Loop Systems

- Available DIY HCL Systems:
  - Open APS
  - Android APS
  - Loop
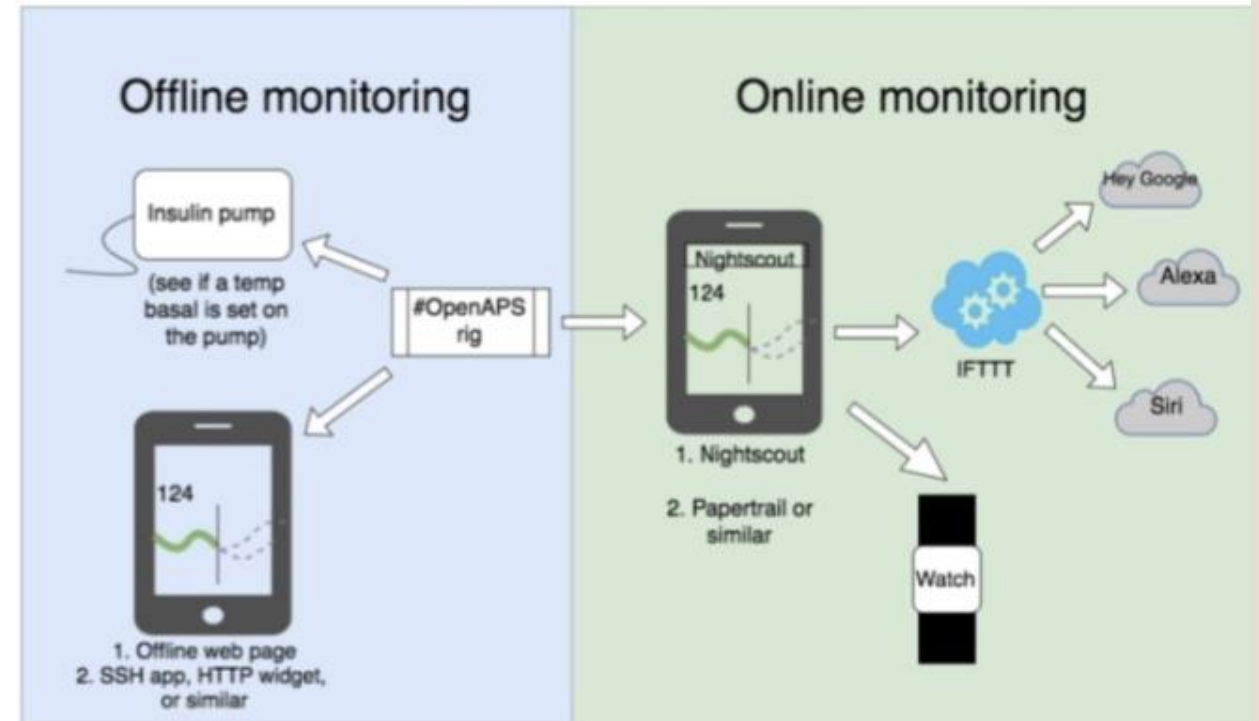


APS, artificial pancreas system; DIY, do-it-yourself; HCL, hybrid closed loop.

# AB

- DIAGNOSED AS GDM DURING PREGNANCY
- HER BROTHER IS MY PATIENT
- ANTI GAD VERY HIGH
- CPEPTIDE PRESENT
- POST PARTUM ON TRESIBA 10 UNITS
- 1/10 IC
- ICR ¼
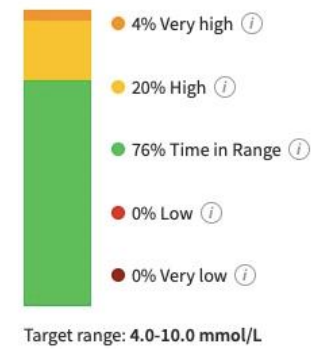- HATES BEING HIGH

# Omnipod DASH



- Integrated glucose testing: Ascensia *Contour* wireless connection with DASH

- Bolus dose calculator uses carbohydrates, blood glucose, and insulin on board

- Optional bolus presets for small, medium, large meals

- Bolus delivery rate: 40 seconds per unit

- Extended bolus can be delivered between 0.5-6 hr

- Omnipod DASH has *Calorie King* integration

Glucose data type   CGM   BG                              X Export to Excel   📄 Print to PDF   ⓘ

# CGM   🕐 Time CGM active: **38%**

- 🟠 4% Very high ⓘ
- 🟡 20% High ⓘ
- 🟢 76% Time in Range ⓘ
- 🔴 0% Low ⓘ
- 🔴 0% Very low ⓘ

Target range: **4.0-10.0 mmol/L**

| | |
|---|---|
| Time in Range | 🟢 **76%** |
| Average | 8.4 mmol/L |
| Standard deviation | 2.6 mmol/L |

➕ Show details

## Insulin

- 🔵 Bolus **36%**
  3.5 U
- 🔵 Basal **64%**
  6.3 U
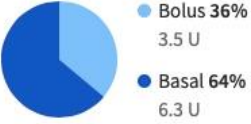
| | |
|---|---|
| Average daily dose | 9.8 Units |
| Standard deviation | 11.6 |

➕ Show details

CGM over time          Bi-hourly   By day

**mmol/L**



■ CGM   ▲ Carbs

**Basal (Units/hour)**　　　　　　　　　　　　　　**Bolus (Units)**



■ Basal　　　　　　　　■ Activity Sleep　　　■ Bolus
□ Automatic correction bolus

## mmol/L



Glucose chart (00:00–24:00) with readings: 10.3, 10.4, 8.2, 7.5, 7.7

■ Glucose

## mmol/L



CGM trace (00:00–24:00) with carbs markers

■ CGM ▲ Carbs

**Basal (Units/hour)** — **Bolus (Units)**



Values shown: 2.6, 2.5, 1.4, 0.3, 0.3, 0.0, 0.3, 0.4

■ LGS / PLGS   ■ Basal   ■ Activity Sleep
■ Bolus   □ Automatic correction bolus

---

**Bolus 33%**
7.8 U

● **Basal 67%**
15.6 U
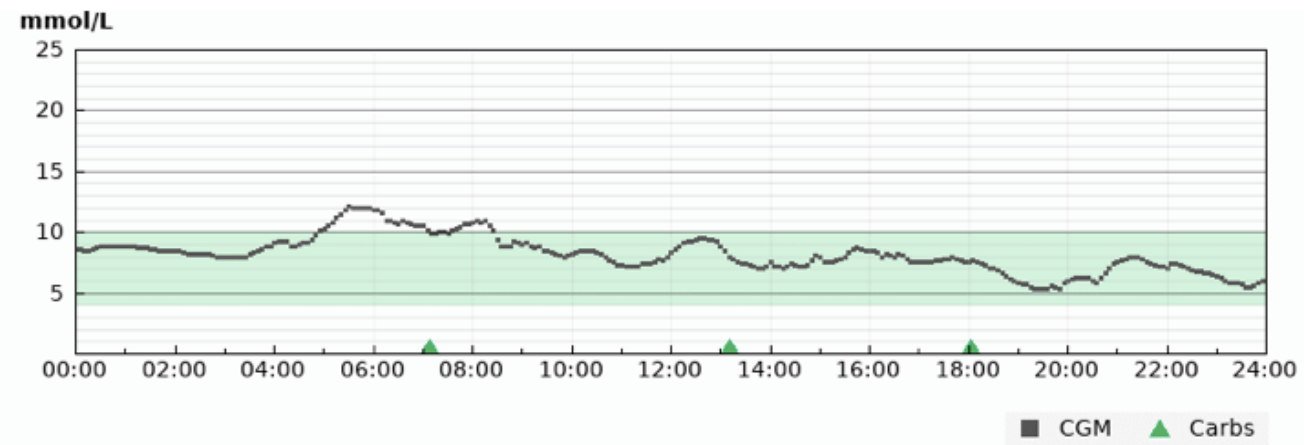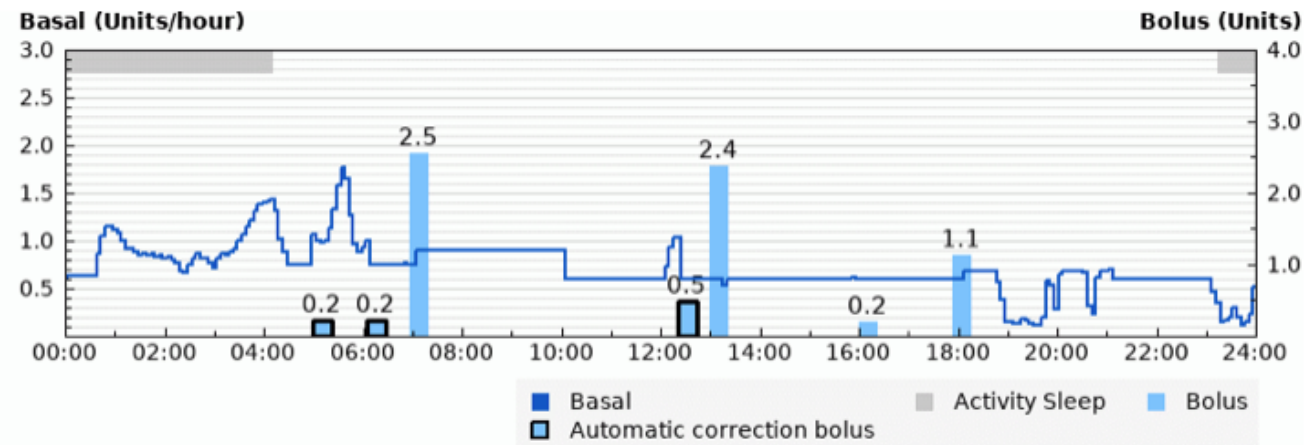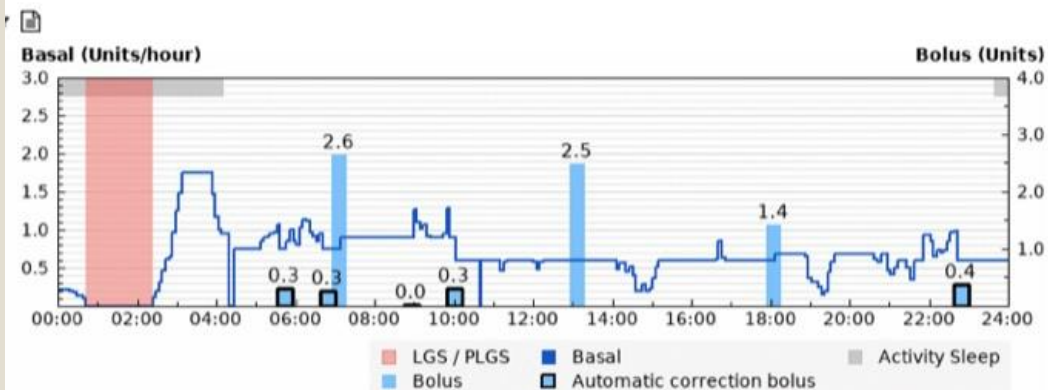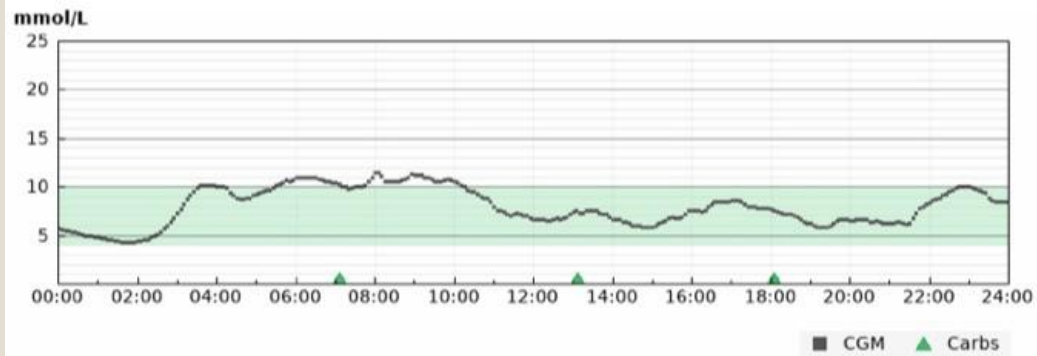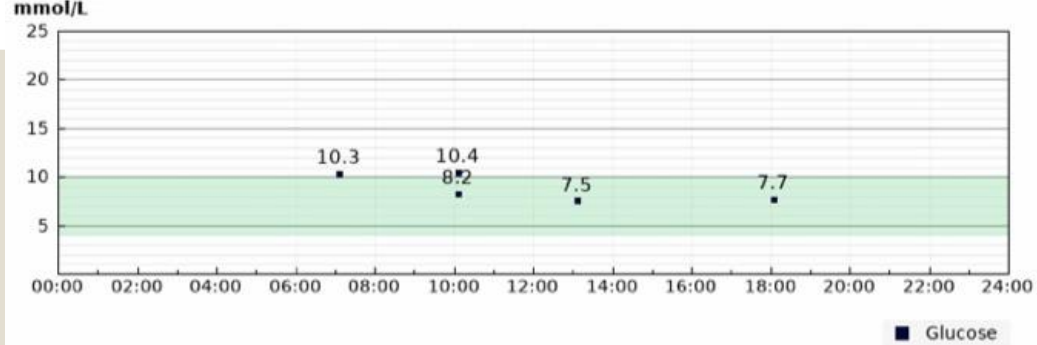
| Basal | | Bolus | Expand ▾ |
|-------|------|-------|------|
| Time | U/h | Time | U |
| 00:02 | 0.216 | 05:31 | 0.31 |
| 00:07 | 0.222 | (Corr: | 0.31) |
| 00:12 | 0.215 | (IOB: | 0.29) |
| 00:17 | 0.200 | 06:37 | 0.26 |
| 00:22 | 0.184 | (Corr: | 0.26) |
| 00:27 | 0.139 | (IOB: | 0.51) |
| 00:32 | 0.126 | 07:06 | 2.65 |
| 00:37 | 0.102 | (Corr: | 0.10) |
| 00:42 | 0.000 | (Meal: | 2.55) |
| 02:23 | 0.120 | (IOB: | 0.60) |

**Carbohydrates**

| Time | |
|------|------|
| 07:05 | 51g |
| 13:07 | 46g |
| 18:05 | 34g |

**Glucose chart (top):**
Values: 12.1, 9.8, 10.1, 9.0, 7.9, 8.3, 7.6

Legend: ■ Glucose

**mmol/L (CGM chart):**

Legend: ■ CGM ▲ Carbs

**Basal (Units/hour) / Bolus (Units) chart:**
Values: 2.5, 2.4, 1.1, 0.2, 0.2, 0.5, 0.2

**Pie chart:**

● Bolus **30%**
7.2 U

● Basal **70%**
17 U
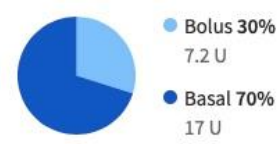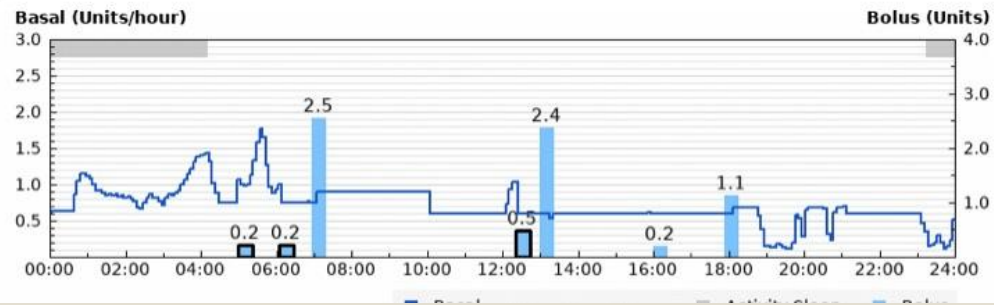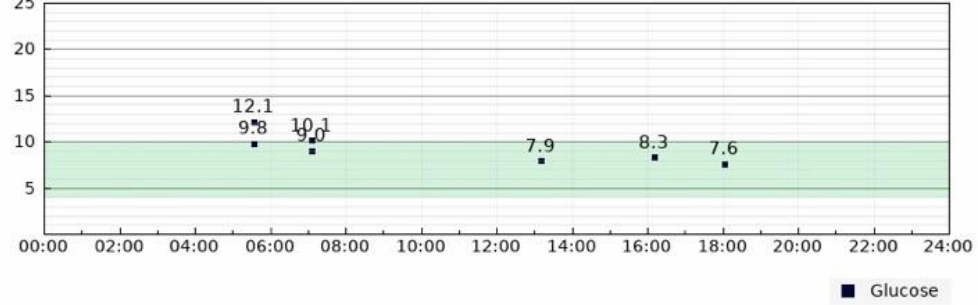
| Basal | | Bolus | Expand ▾ |
|---|---|---|---|
| Time | U/h | Time | U |
| 00:02 | 0.625 | 04:58 | 0.23 |
| 00:37 | 0.862 | (Corr: | 0.23) |
| 00:42 | 1.044 | (IOB: | 0.42) |
| 00:47 | 1.153 | 06:03 | 0.23 |
| 00:52 | 1.148 | (Corr: | 0.23) |
| 00:57 | 1.113 | (IOB: | 0.77) |
| 01:02 | 1.079 | 07:07 | 2.55 |
| 01:07 | 0.992 | (Meal: | 2.55) |
| 01:12 | 0.915 | (IOB: | 0.52) |
| 01:17 | 0.924 | 12:20 | 0.48 |

**Carbohydrates**

| Time | |
|---|---|
| 07:07 | 51g |
| 13:10 | 50g |
| 18:03 | 28g |

Export to Excel    Print to PDF

## CGM  ⏱ Time CGM active: **96%**

● 2% Very high ⓘ

● 14% High ⓘ

● 82% Time in Range ⓘ

● 2% Low ⓘ

● 0% Very low ⓘ
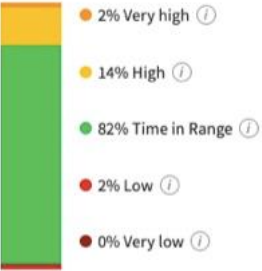
Target range: **3.9-10.0 mmol/L**

| Time in Range | ● **82%** |
|---|---|
| Average | 7.5 mmol/L |
| Standard deviation | 2.5 mmol/L |

⊕ Show details

## Insulin

● Bolus **59%**
27.6 U

● Basal **41%**
19.4 U

| Average daily dose | 47 Units |
|---|---|
| Standard deviation | 9.3 |

⊕ Show details

## Carbs

| Average carbs per day | 227 g |
|---|---|
| Standard deviation | 90 g |

## CGM over time

Bi-hourly  By day

100%

50%

0%

⏱  00-02  02-04  04-06  06-08  08-10  10-12  12-14  14-16  16-18  18-20  20-22  22-24

## Activity    No values

**mmol/L**



Glucose chart (00:00–24:00), value 6.7 shown

■ Glucose

**mmol/L**



CGM chart with Carbs marker

■ CGM  ▲ Carbs

**Basal (Units/hour)** — **Bolus (Units)**



9.0 · 0.1 · 1.0

■ LGS / PLGS  ■ Basal  ■ Activity Sleep
■ Bolus  ■ Automatic correction bolus

---

● Bolus **48%**
10.1 U

● Basal **52%**
10.9 U

| Basal | | Bolus | Expand ▾ |
|---|---|---|---|
| Time | U/h | Time | U |
| 00:01 | 0.875 | 09:12 | 8.96 |
| 00:06 | 0.850 | (Corr: | 0.21) |
| 01:01 | 0.811 | (Meal: | 8.75) |
| 01:06 | 0.762 | 11:06 | 0.14 |
| 01:11 | 0.832 | (Corr: | 0.14) |
| 01:16 | 0.848 | (IOB: | 3.49) |
| 01:21 | 0.845 | 12:57 | 0.97 |
| 01:26 | 0.716 | (Corr: | 0.97) |
| 01:31 | 0.471 | | |
| 01:36 | 0.850 | | |

**Carbohydrates**

| Time | |
|---|---|
| 09:12 | 70g |

Bolus **41%**
12.9 U

Basal **59%**
18.6 U
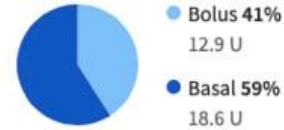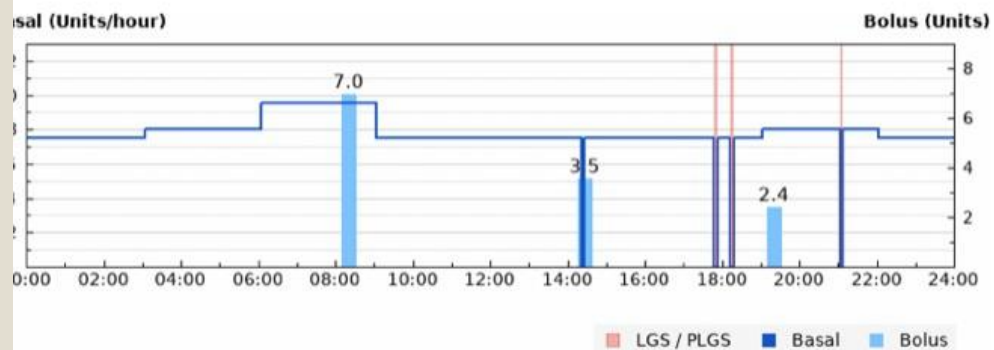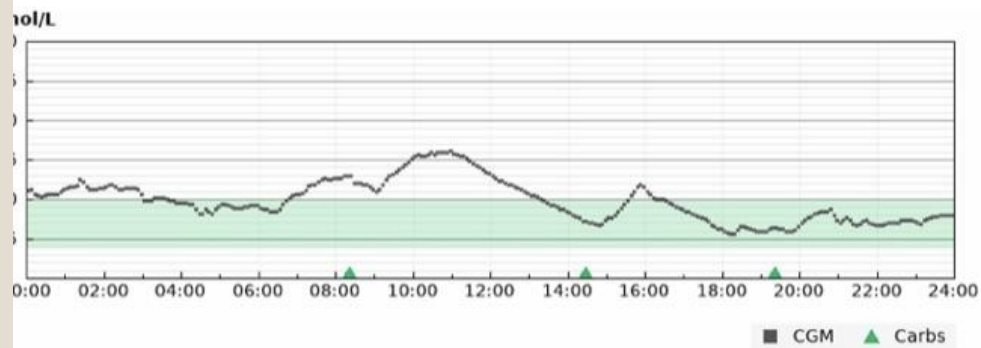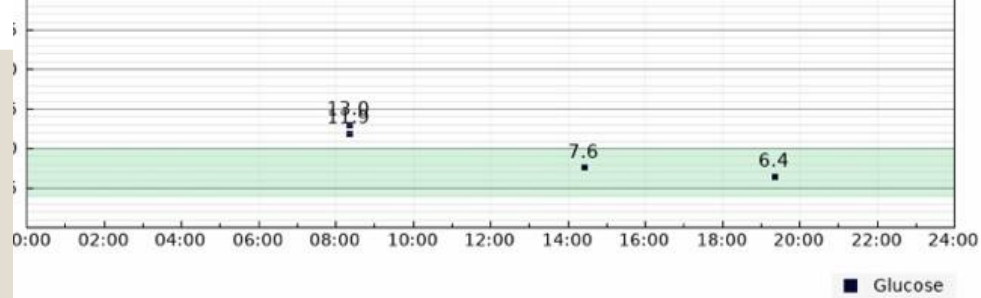
| Basal | | Bolus | Expand ▾ |
|---|---|---|---|
| Time | U/h | Time | U |
| 03:03 | 0.800 | 08:21 | 6.97 |
| 06:03 | 0.950 | (Corr: | 1.57) |
| 09:04 | 0.750 | (Meal: | 5.40) |
| 14:22 | 0.000 | 14:27 | 3.53 |
| 14:25 | 0.750 | (Meal: | 3.53) |
| 17:48 | 0.000 | 19:21 | 2.40 |
| 17:53 | 0.750 | (Meal: | 2.40) |
| 18:13 | 0.000 | (IOB: | 0.20) |
| 18:18 | 0.750 | | |
| 19:03 | 0.800 | | |

**LGS / PLGS** ℹ

| Time | Suspend duration |
|---|---|
| 17:48 | 00:05 |
| 18:13 | 00:05 |
| 21:03 | 00:05 |
| Total | 00:15 |

**Carbohydrates**

| Time | |
|---|---|
| 08:20 | 27g |
| 14:27 | 30g |
| 19:21 | 30g |

Glucose values: 12.0, 11.9, 7.6, 6.4

CGM ▲ Carbs

Basal (Units/hour)   Bolus (Units)

7.0   3.5   2.4

LGS / PLGS   Basal   Bolus

## CGM

**Target range**

## CGM overview
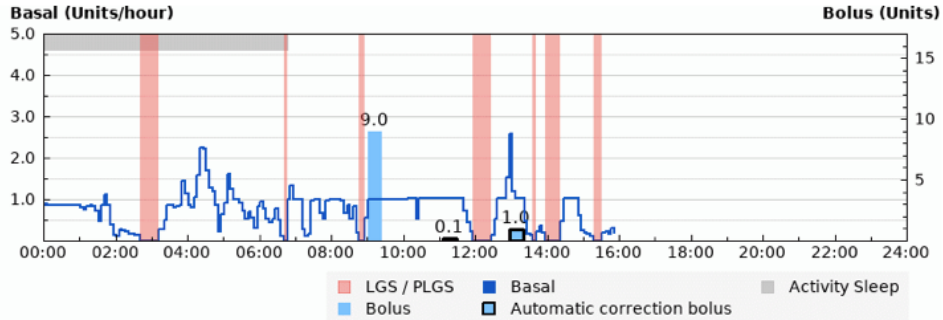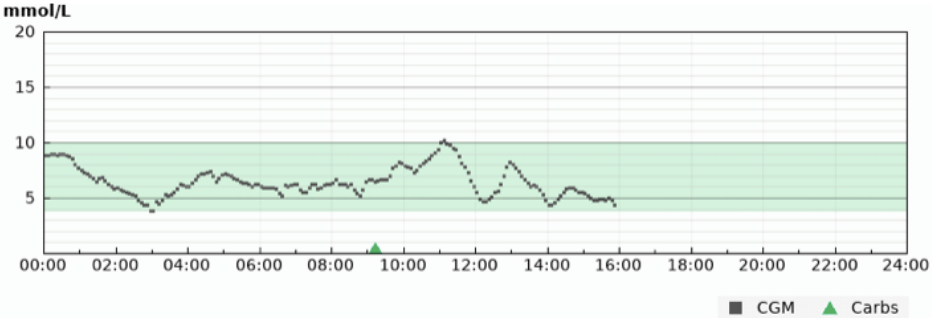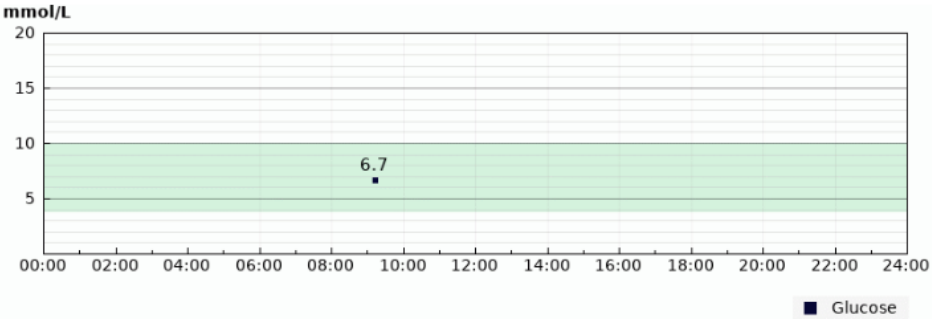
100%

50%

0%

---

**mmol/L**



6.7

■ Glucose

**mmol/L**



■ CGM   ▲ Carbs

---

Bolus **48%**
10.1 U

Basal **52%**
10.9 U

| Basal | | Bolus | Expand ▾ |
|---|---|---|---|
| Time | U/h | Time | U |
| 00:01 | 0.875 | 09:12 | 8.96 |
| 00:06 | 0.850 | (Corr: | 0.21) |
| 01:01 | 0.811 | (Meal: | 8.75) |
| 01:06 | 0.762 | 11:06 | 0.14 |
| 01:11 | 0.832 | (Corr: | 0.14) |
| 01:16 | 0.848 | (IOB: | 3.49) |
| 01:21 | 0.845 | 12:57 | 0.97 |
| 01:26 | 0.716 | (Corr: | 0.97) |
| 01:31 | 0.471 | | |
| 01:36 | 0.850 | | |

**Carbohydrates**

| Time | |
|---|---|
| 09:12 | 70g |

---

**Basal (Units/hour)**   **Bolus (Units)**



9.0

0.1   1.0

| ■ LGS / PLGS | ■ Basal | ■ Activity Sleep |
|---|---|---|
| ■ Bolus | ▣ Automatic correction bolus | |

# Which Pump for Which Patient?

**Tubing** — Yes / No
Also indication and reservoir

**Ex-US Approvals**
**Dana *DiabeCare*\***
- Tubing up to 31"
- 300 unit max
- Approved 7+

**Medtronic 630G, 670G, 770G**
- Tubing up to 43"
- 300 unit max for 72+ hr
- Approved 7+

**Tandem *t:slim X2***
- Tubing up to 43"
- 300 unit max for 72+ hr
- Approved 4+

**Omnipod/Omnipod DASH**
- No tubing; uses PDM
- 200 unit max for 72 hours
- Children and adults
- Glooko download

*Omnipod Horizon is emerging HCL system with Dexcom or Freestyle Libre integration and automated insulin delivery.*

**Roche *Accu-Chek* Spirit Combo**
- Tubing up to 31"
- 300 unit max
- ACE, Bluetooth enabled

**Solo Micropump**
- Patch pump
- No CGM integration

**CGM Integration**

**Medtronic 630G, 670G, 770G**
- *Guardian* 3 Sensor
- Works with *CareLink, Guardian Connect, Sugar.IQ*

**Tandem *t:slim X2***
- Dexcom G6 CGM integration
- Works with T:connect, Glooko, Tidepool, and Diasend

**LS, PLS, or HCL**

**Medtronic 670G, 770G**
- SmartGuard LS or PLS
- Auto-mode, HCL

**PLS or HCL**

**Tandem *t:slim X2***
- Basal IQ: PLGS
- Control IQ: HCL

Slide credit:
Janet B. McGill, MD; endocrine.org,
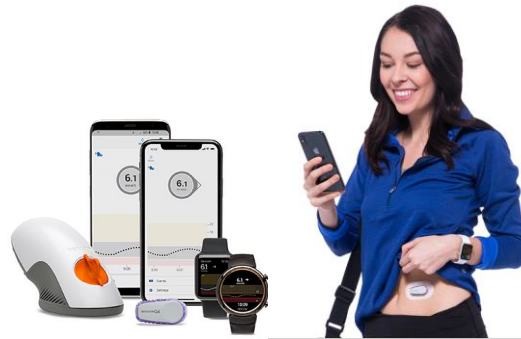diabeteseducator.org, clinicaloptions.com

# Available in Canada
## Glucose Sensor Systems

**Intermittent**
Abbott FreeStyle Libre

**Continuous**
Dexcom G5/G6

**Continuous**
Medtronic Enlite 2/
Guardian 3

# Smart pen*summary *NOT APPROVED IN CANADA

## Track when and how much insulin was injected

- In US, Companion Medical bluetooth enabled smart pen connects with US Dexcom Clarity. *[1,2]

- In development, Novo Nordisk smart pens. *[3]

- In development, Lilly smart pen designed to integrate with Dexcom. *[3,4]

NO IMAGE AVAILABLE

Accessed September 23 2020: [1] https://diatribe.org/keep-track-your-insulin-doses-bluetooth-enabled-smart-insulin-pen-now-available-pharmacies
[2]https://diatribe.org/latest-news-diabetes-10-highlights-easd-2019  [3] Dexcom Investor presentation July 2020. Slide 16 accessible at:
https://investors.dexcom.com/static-files/65d78bca-f16d-4fb6-99c5-c3753f4a2801  [4] https://provider.dexcom.com/industry-news/dexcom-announces-development-agreement-lilly-integrate-dexcom-cgm-connected-diabetes

# Medtronic *InPen*:
# Insulin Dose Calculator + Integrated System + App

**Combines reusable Bluetooth-enabled insulin pen with mobile app**

Compatible with *Nobolog*, *Humalog*, and *Fiasp* cartridges (not included)

Connects to the app via Bluetooth

Monitors insulin temperature

Battery lasts a full year with no need to charge

Delivers half-unit doses

## THE INPEN APP



Glucose values

Creates shareable reports of 7, 14, 30 or 90 days of data

Calculates personalized doses

Tracks active insulin

Glucose history

Syncs with CGMs and blood glucose meters

Reminds you to choose

Automatically logs doses given by *InPen*

https://www.medtronicdiabetes.com/products/inpen-smart-insulin-pen-system

TECHNOLOGY CASES UPDATE