Current (and Future?) Treatment of Children With IDDM

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Pediatric Endocrinology

Ascension St. John Health System

Financial Disclosure

Some definitions

- Diabetes: to pass through
- Mellitus : sweet (from the Greek word for honey)
- Insipidus: having no taste
- Guess how ancient Greek doctors distinguished between diabetes mellitus and diabetes insipidus??

Insulin Physiology Effects

- Protein: Anabolic- enhances muscle amino acid uptake (especially branched chain AAs)
- Carbohydrate: Inhibits glycolysis, and stimulates glucose uptake in adipose, muscle, splanchnic tissues
- Fat: Inhibits hormone-sensitive lipase, stimulates free fatty acid uptake, and inhibits ketogenesis in liver

Effects and Symptoms of Insulin Deficiency

- Hyperglycemia: weight loss, polyphagia, polyuria/polydypsia. Irritability, headache are common
- Ketosis and/or ketoacidosis (DKA): abdominal pain, nausea, vomiting, sweet breath (acetone formed via Acetoacetate), dyspnea / Kussmaul respiration
- Muscle Breakdown for Glucose substrate: weakness, ill appearance

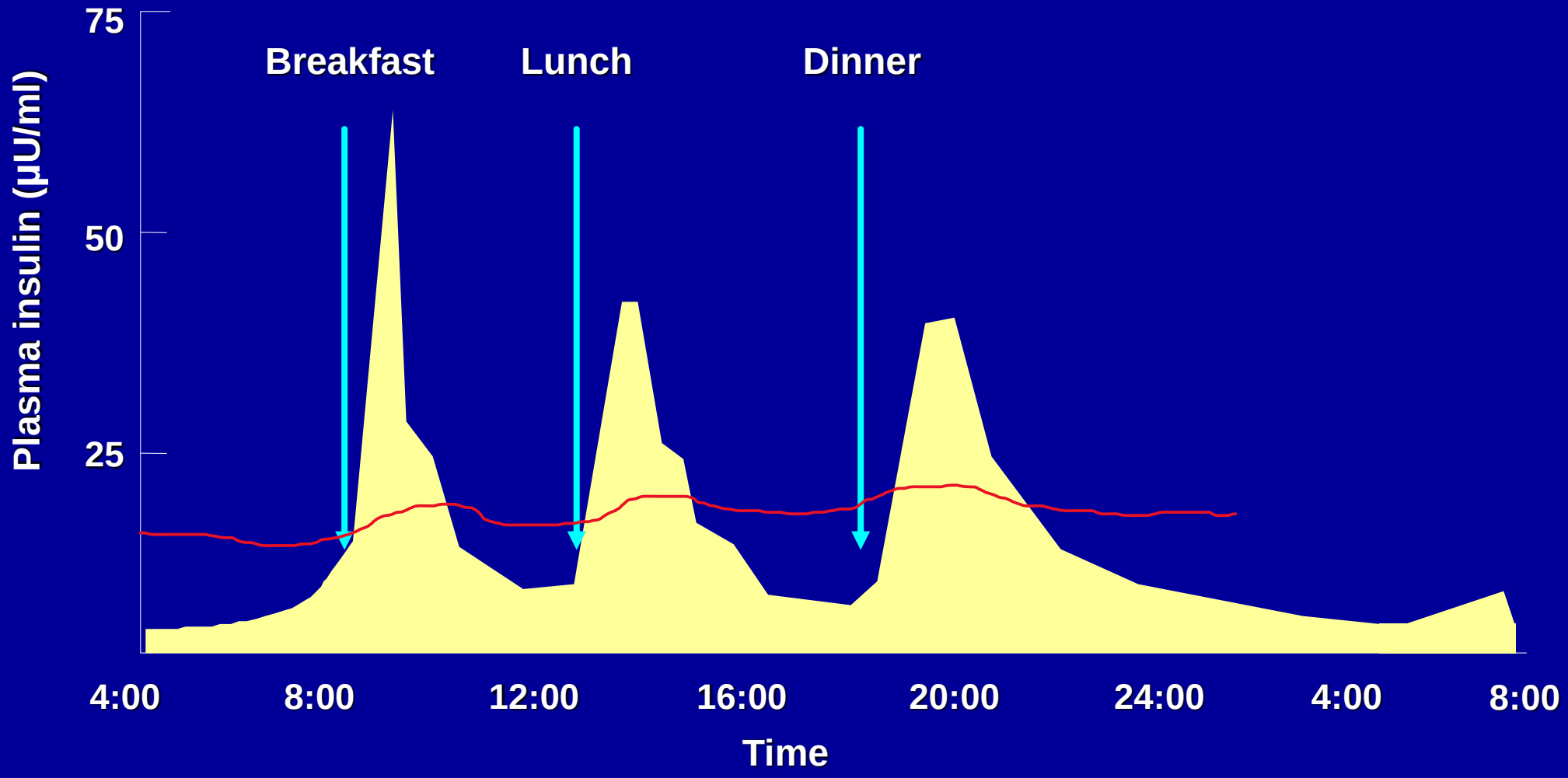
Diabetes in the US

- 8.5% of US population has type 2 diabetes
- 0.4% have type 1 diabetes (just under 1 million)
- Type 1 diabetes accounts for 2/3 of children <20 with diabetes (80% < 10 yo)

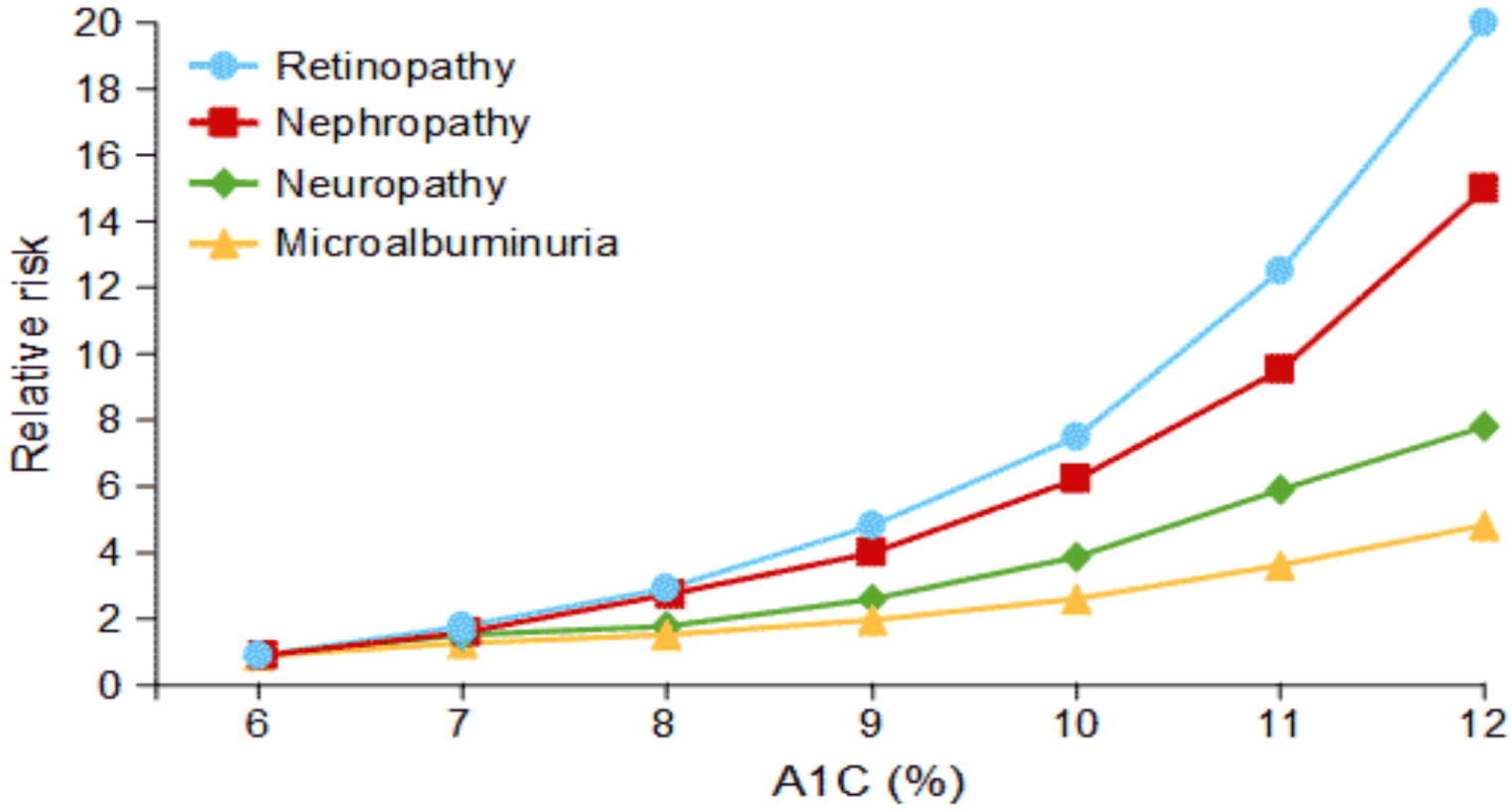
HOW DO WE TAKE CARE OF THIS?

- INTENSIVE INSULIN THERAPY
  - 1980's : two shots a day with NPH / Regular or maybe Lente or Ultralente
  - 1990's : HUMALOG led to more frequent shots (lunchtime) and insulin pump therapy
  - 2000's : Lantus use leads to initiation of intensive therapy at diagnosis

Physiological Serum Insulin Secretion Profile



Relative Risk of Progression of Diabetes Complications (DCCT)



DCCT Research Group, *N Engl J Med* 1993, 329:977-986.

Lifetime Benefits of Intensive Therapy (DCCT)

- Gain of **15.3 years** of complication free living compared to conventional therapy
- Gain of **5.1 years** of life compared to conventional therapy

DCCT Study Group, *JAMA* 1996, 276:1409-1415.

Lifetime Benefits of Intensive Therapy (DCCT)

- Reduce the risk of eye damage by more than 75 percent
- Reduce the risk of nerve damage by 60 percent
- Prevent or slow the progression of kidney disease by 50 percent
- Reduce the risk of diabetes-related heart attack and stroke by 50 percent

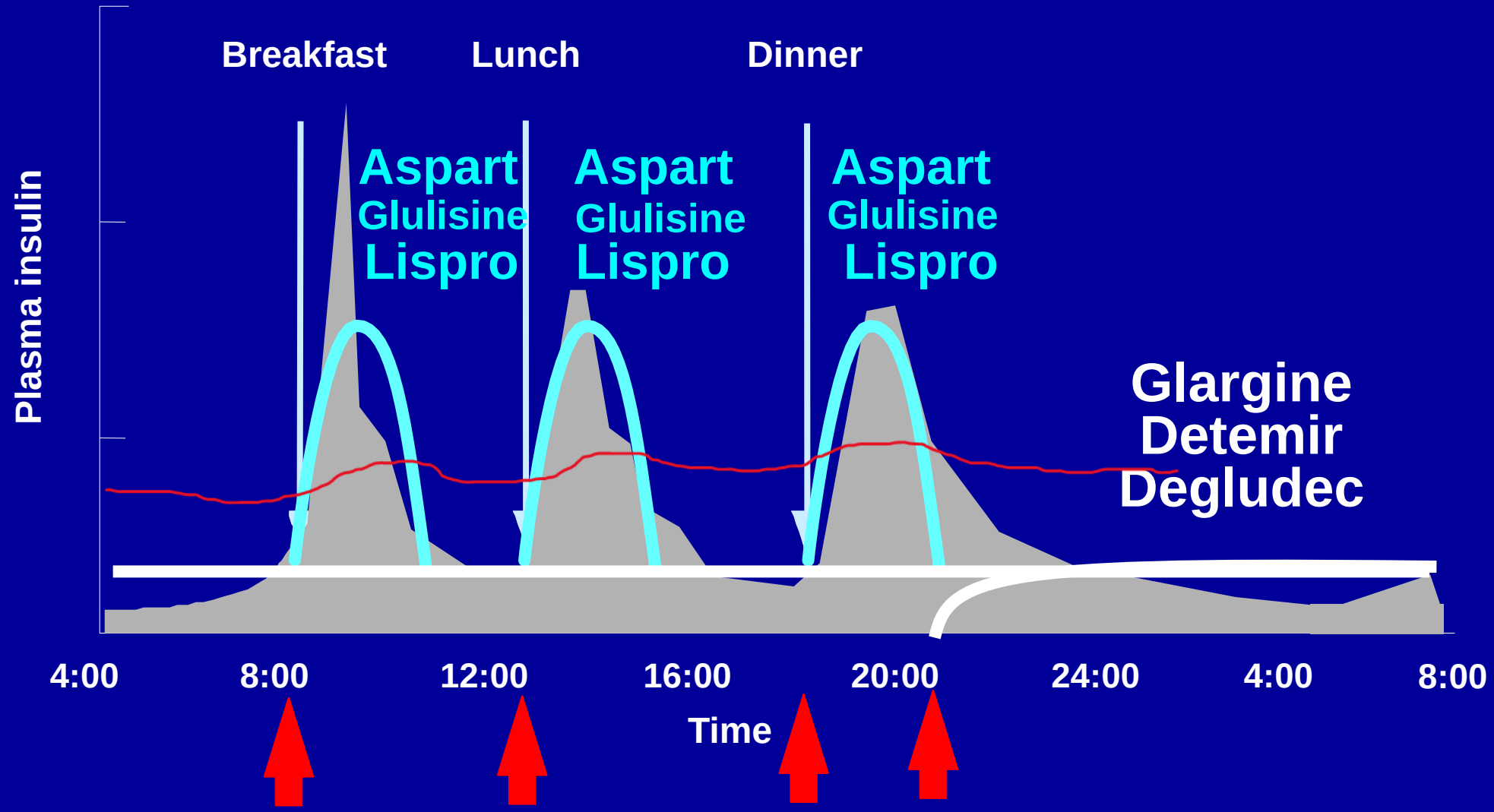
DCCT and EDIC

- Epidemiology of Diabetes Interventions and Complications (EDIC) study, has continued to follow DCCT participants for the last 20-plus years. EDIC has shown that there are long-term benefits of early and intensive blood glucose control on the future development of diabetes-related complications such as heart, eye, kidney, and nerve disease, and that early and intensive blood glucose control also lengthens life.

The Basal/Bolus Insulin Concept

- Basal insulin
  - Suppresses glucose production / release between meals and overnight
  - 40% to 50% of daily needs
- Bolus insulin (mealtime)
  - Limits hyperglycemia after meals
  - Immediate rise and sharp peak at 1 hour
  - 10% to 20% of total daily insulin requirement at each meal

Basal/Bolus Treatment Program with Rapid-acting and Long-acting Analogs



Comparison of Human Insulins and Analogs

Insulin Preparations	Onset of Action	Peak (hr)	Duration of Action (hr)
Lispro/Aspart/Glulisine*	5–15 min	1–2	4–6
Regular	30–60 min	2–4	6–10
NPH	1–2 hr	4–8	10–20
Glargine**	1–2 hr	“flat”	~24
Detemir***	1–2 hr	6-12	12-24
Degludec****	1-2 hr	“flat”	48Hr?

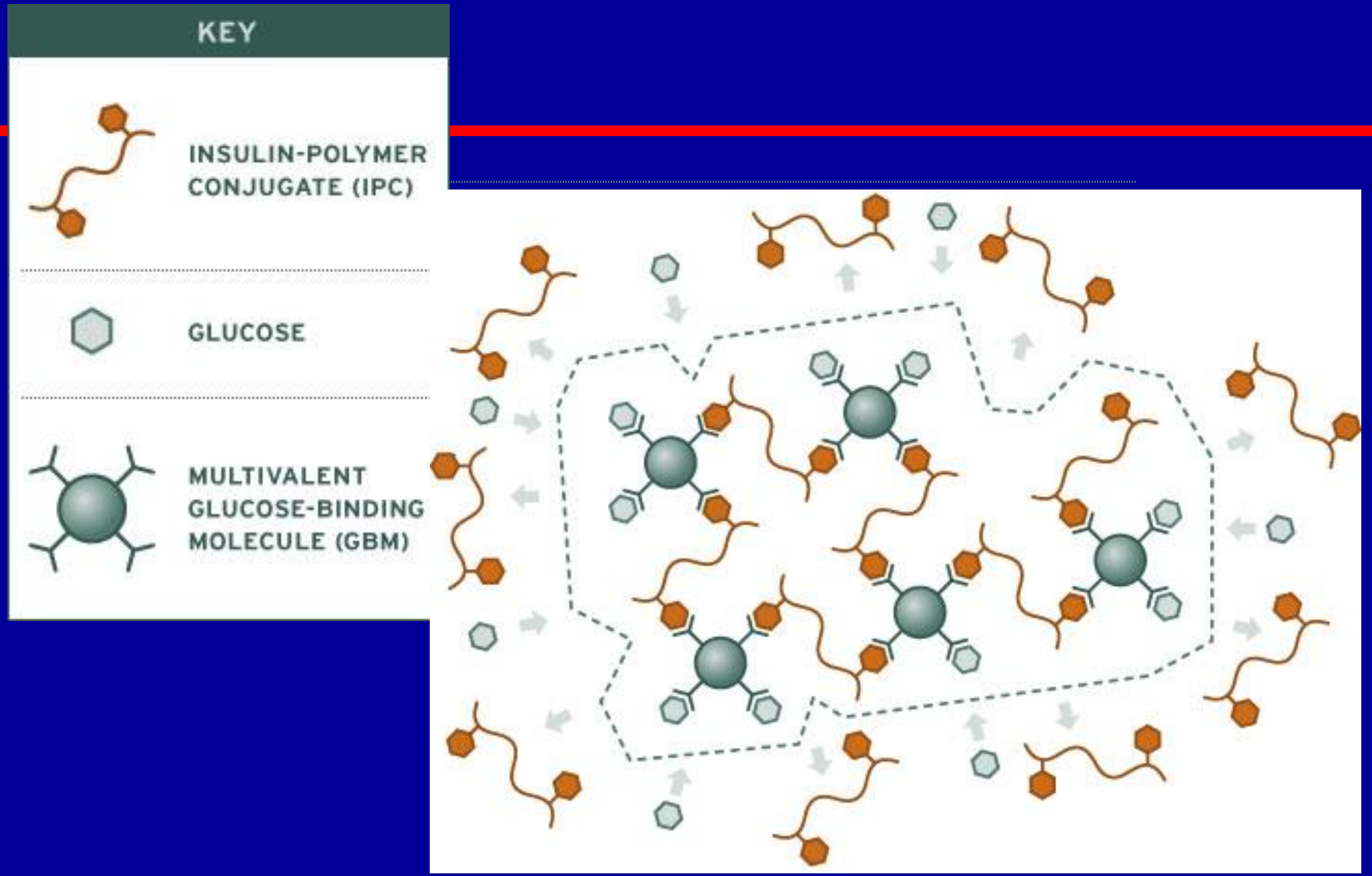
* “Rapid Insulin Analogs”-Lispro=Humalog/Admelog, Aspart=Novolog,Fiasp Glulisine=Apidra ** Glargine=Lantus, ***Detemir=Levemir, ****Degludec=Tresiba

Note: Action of any insulin varies between and within people

University of Michigan
C.S. Mott Children's Hospital

New forms of Insulin in development

- Ultra-long lasting
- Ultra-short acting
  - Intradermal
  - Intraperitoneal
- Oral insulin: more likely beneficial for Type 2
- Inhaled, intranasal
- Smart Insulin : “built-in” glucose sensors
  - Multi-valent glucose binding molecules


KEY
INSULIN-POLYMER CONJUGATE (IPC)
GLUCOSE
MULTIVALENT GLUCOSE-BINDING MOLECULE (GBM)

Inhaled Insulin

Starting MDI

- Starting total daily insulin dose is based on weight

  0.2 to 1.0 x wgt. in kg = Units / day

- Bolus dose (aspart/lispro/glulusine) = ~20% of starting dose at each meal
- Basal dose (glargine) = 40-50% of starting dose at bedtime or in AM (same time each day)

Estimating the Insulin to Carbohydrate Ratio

TDD = Total Daily Dose

Use the “500 Rule”

Insulin / Carb = 500 / TDD

- Anywhere from 5 to 40 g carb is covered by 1 unit of insulin
- In younger children, the ratio needed is usually higher than the formula predicts

Correction Bolus (for high glucose)

- Must determine how much glucose is lowered by 1 unit of short- or rapid-acting insulin
- This number is known as the correction factor (CF) or insulin sensitivity factor (ISF)
- Use the 1800 rule to estimate the CF
- CF = 1800 divided by the total daily dose (TDD)

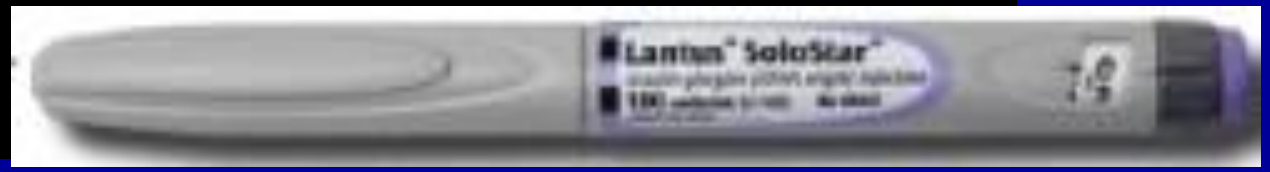
ex: if TDD = 36 units, then CF = 1800/36 = ~50

meaning 1 unit will lower the BG ~50 mg/dl

In younger children, the correction factor is often higher than the 1800 rule predicts due to increased sensitivity


1976
BANTING AND BEST

Insulin Pens




10:10 AM
August 1, 2011
BOLUS
OPTIONS
INSULIN ON BOARD (IOB)
Units
1.1 u
Time Remaining
1:09 hrs

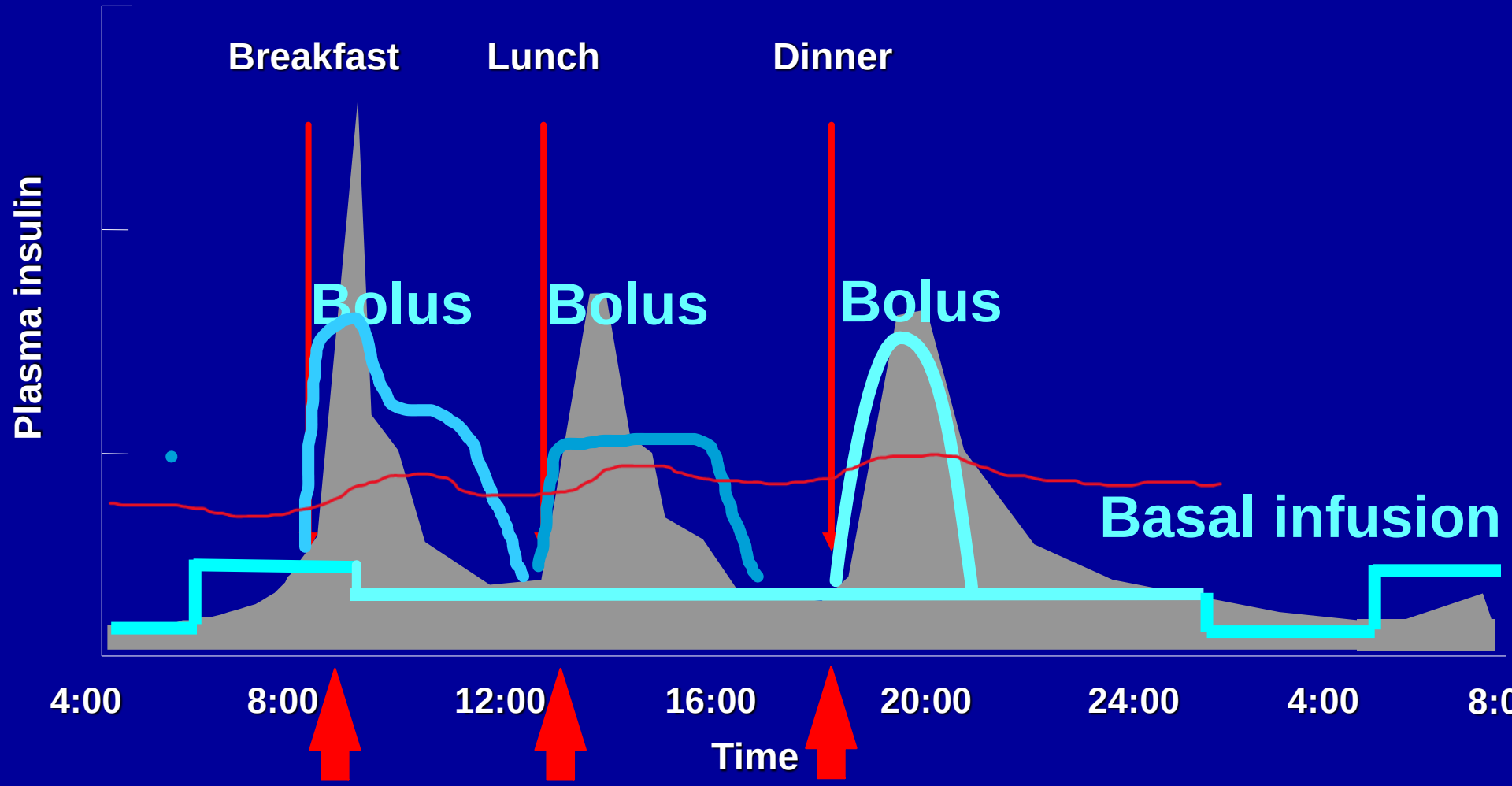

ACT


Bolus
Temp basal
My records
Settings
Suspend/cancel
Select
Status


Animas
10:20 AM
Basal Rate
0.025U/Hr
Insulin:171U
Status
Menu
OK

Pump Infusion Sets

Variable Basal Rate: CSII Program



Insulin Pump Profiles

- Basal rates
  - 12 AM = 0.8 Units/hr
  - 3 AM = 1.0 Units/hr
  - 9 AM = 0.7 Units/hr
  - 6 PM = 0.9 Units/hr
- Target
  - 12 AM = 100-150
  - 6 AM = 90-120
  - 9 PM = 100-150
- Carb Ratios
  - 12 AM = 20
  - 6 AM = 12
  - 10 AM = 15
  - 5 PM = 15
  - 9 PM = 20
- Sensitivity / Correction
  - 12 AM = 60
  - 6 AM = 50
  - 9 PM = 60

Insulin Pump instead of Syringe/Vial or Pen

Improved accuracy vs. syringes / Pens:

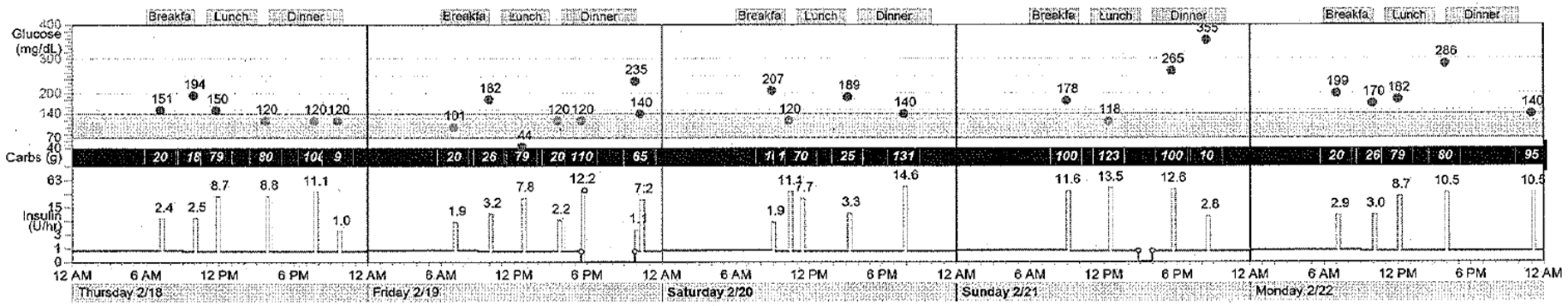
Insulin Pumps allow for much more flexible dosing, reduced risk of hypoglycemia; pens give 0.5 Unit increments at most

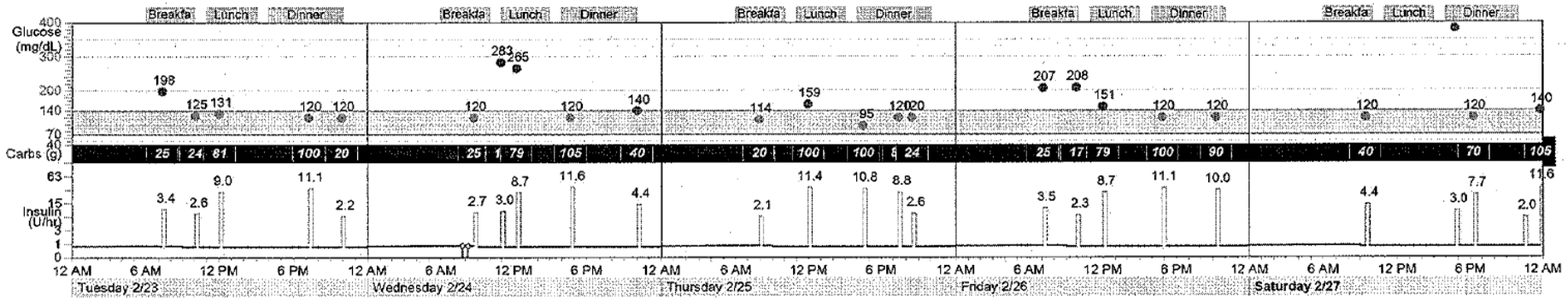
Precise insulin delivery (basal rates as low as 0.025 U/hr, boluses to nearest 0.1 unit)

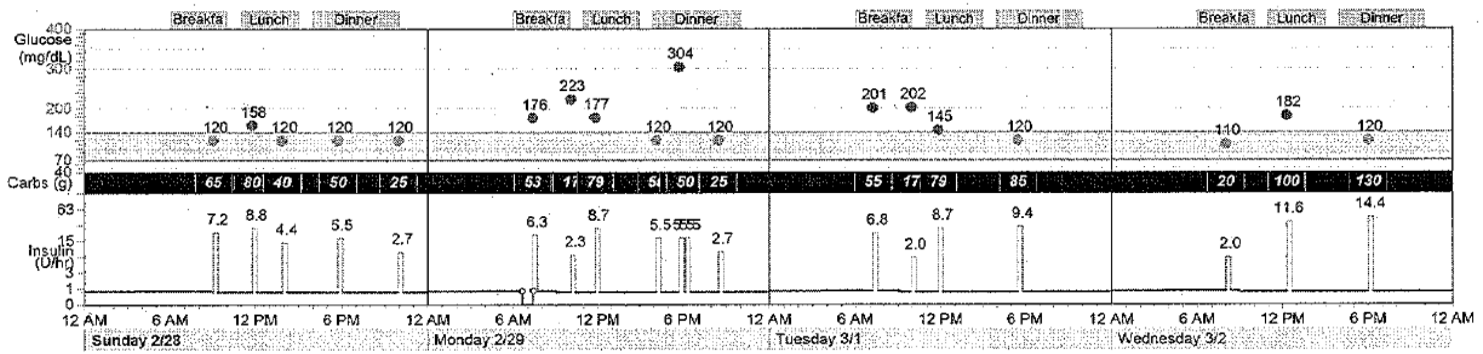
Multiple basal profiles possible: adjust for sick day, exercise, shift hours, etc.

Extended boluses (“slow-release insulin dose”) for high fat and high protein meals, or more than one bolus per meal

- Bolus calculators
  - Once programmed with insulin to carbohydrate ratio (ICR) and Correction factor (CF), mistakes are minimized in dose calculation
  - Insulin on Board Feature: designed to eliminate insulin dose stacking

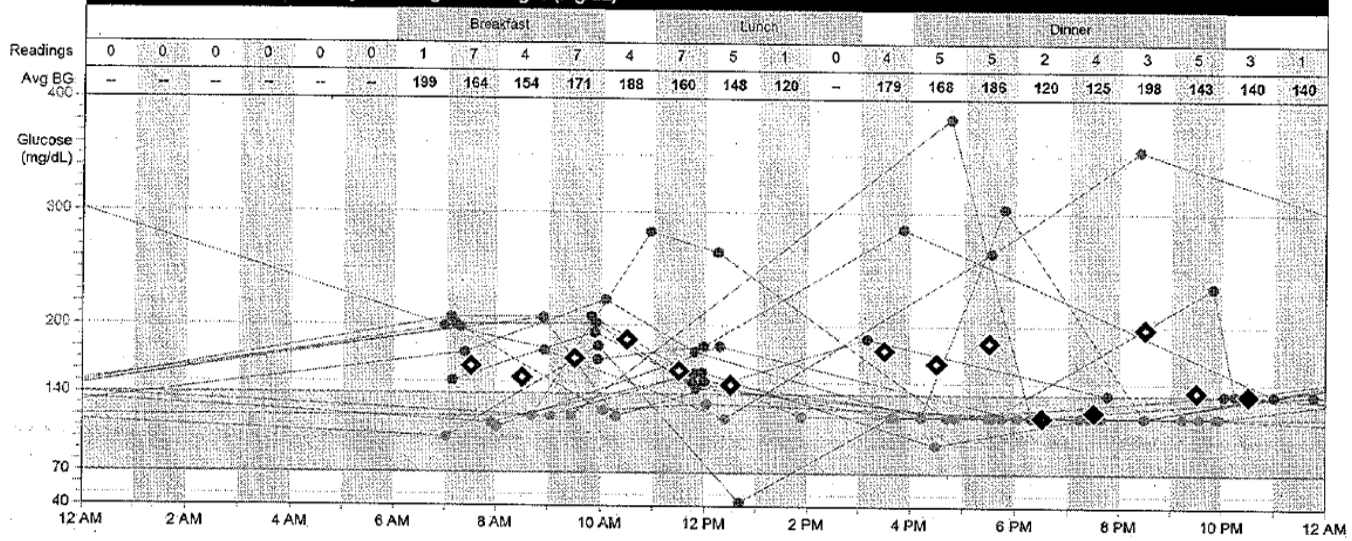






Sensor trace · Interrupted · BG reading · Off chart · Basal · Temp basal · Bolus · Suspend · Time change · Injected insulin (U) · Exercise · Other

24-Hour Meter Glucose Overlay - Readings & Averages (mg/dL)



Statistics	2/18 - 3/2	
Avg BG (mg/dL)	162 ± 62	
BG Readings	68	4.9/day
Readings Above Target	31	46%
Readings Below Target	1	1%
Sensor Avg (mg/dL)	--	
Avg AUC > 140 (mg/dL)	--	--
Avg AUC < 70 (mg/dL)	--	--

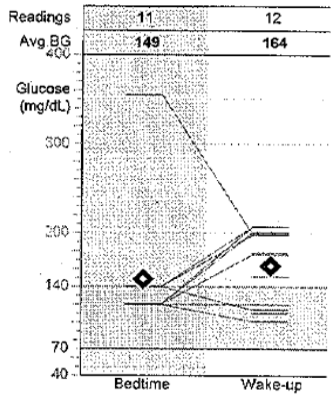
Avg Daily Carbs (g)	*288 ± 40*
Carbs/Bolus Insulin (g/U)	8.7

Avg Total Daily Insulin (U)	50.9 ± 4.3	
Avg Daily Basal (U)	17.8	35%
Avg Daily Bolus (U)	33.1	65%

Meter Glucose Overlay Bedtime to Wake-Up and Meal Periods – Readings & Averages (mg/dL)

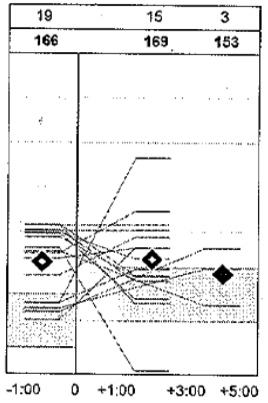
Bedtime to Wake-up

Bedtime: 8:00 PM - 12:00 AM
Wake-up: 5:00 AM - 9:00 AM



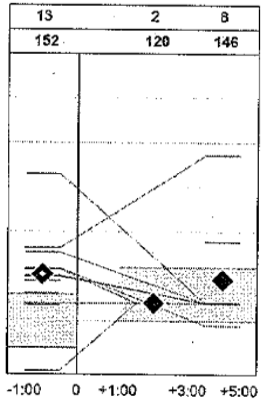
Breakfast: 6:00 AM - 10:00 AM
Meals Analyzed: 19

Avg Carbs: *32g*
Avg Insulin: 3.8U
Avg Carbs/Insulin: 8.3g/U



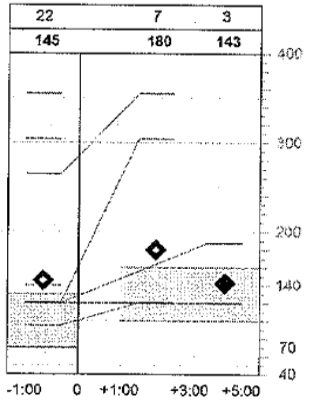
Lunch: 11:00 AM - 3:00 PM
Meals Analyzed: 14

Avg Carbs: *82g*
Avg Insulin: 9.0U
Avg Carbs/Insulin: 9.1g/U



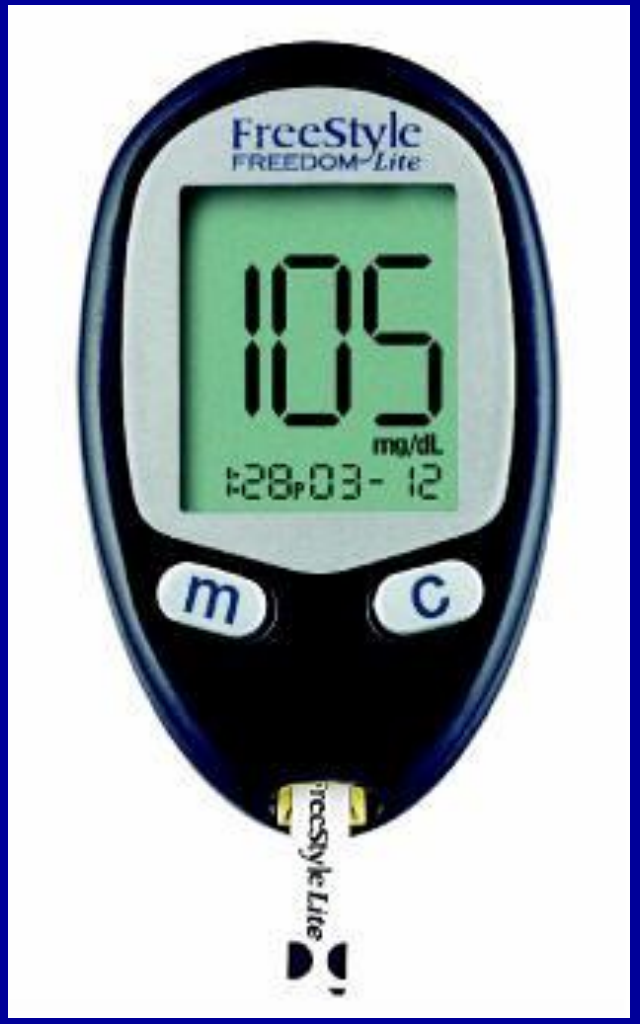
Dinner: 4:00 PM - 10:00 PM
Meals Analyzed: 23

Avg Carbs: *70g*
Avg Insulin: 7.9U
Avg Carbs/Insulin: 8.9g/U



BG reading BG reading Off chart Average within target range Average outside target range


Glucometer M
delete
mark 1
mark 2
set
advance
on/off
recall
program
start


FreeStyle
FREEDOM Lite
105
mg/dL
28 03 - 12
m
c
FreeStyle Lite

Continuous Glucose Monitor

- 3 basic components
  - Sensor creates the signal (electric current is created based on how much glucose is present)
  - Transmitter plugs into the sensor and sends the signal through the air
  - Receiver shows the signal in a number or graph format:
    - Insulin pump (Medtronic 530G, t:slim G4, Animas Vibe)
    - Separate receiver (Dexcom G4 or G5 Mobile) or iPhone / Android (soon) (Dexcom G5 Mobile)
    - Remote viewing after data is sent to the “cloud”

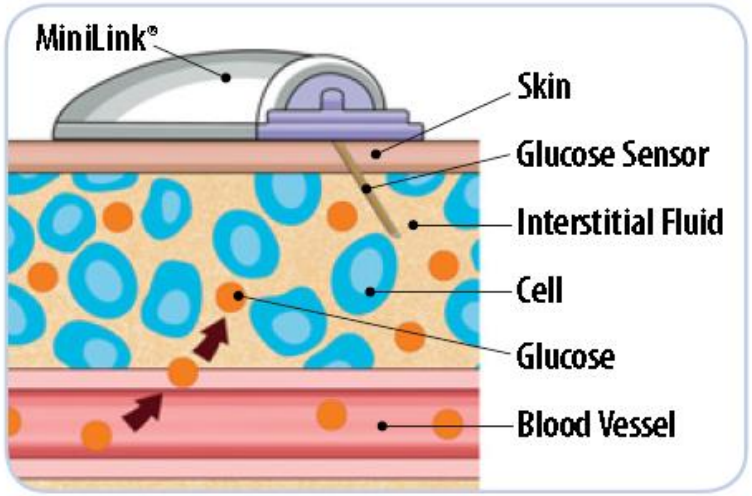
CGM is not the same as BG monitoring

Your BG meter measures glucose (sugar) levels in your **blood**, and your glucose sensor measures glucose levels in the fluid surrounding the cells in your tissue, which is called **interstitial fluid**.

Most of the time, glucose travels first to your blood and then to your interstitial fluid.

Because of how glucose travels, your BG meter readings and sensor readings will rarely match exactly. *This is normal and should be expected.*

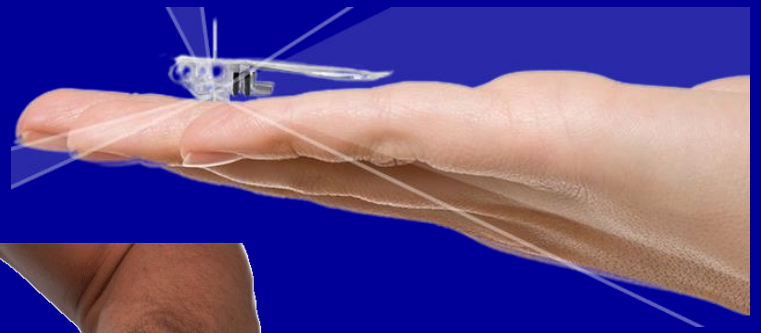
Usually your BG meter readings and your sensor readings will be close.



However, when glucose levels are rising or falling quickly, you should **expect** to see a larger difference between your BG meter value and the sensor glucose reading. Examples of times when this may occur include:

- After meals or after insulin
- When ↑ or ↓ arrows appear on your pump screen

Medtronic Enlite Sensor

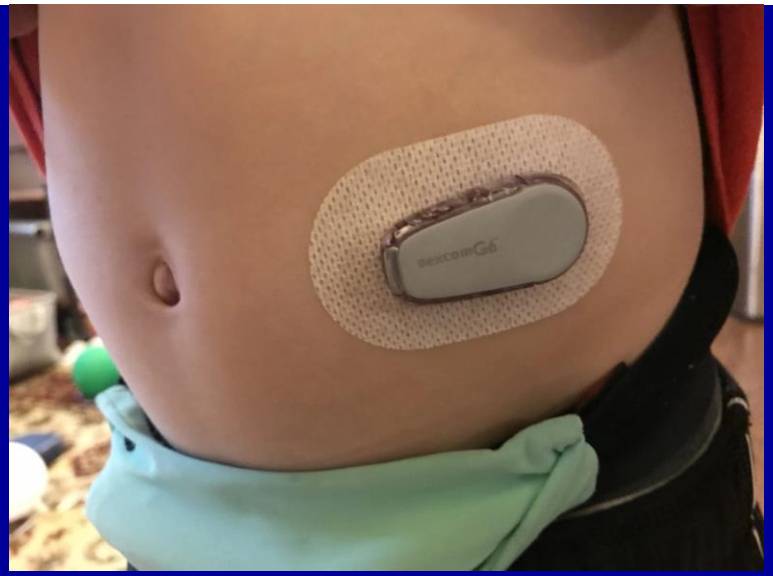


Guardian Connect CGM System from Medtronic

1. Guardian Connect App: glucose readings every 5 minutes, readout on a smartphone
2. Guardian™ Sensor 3 and Guardian™ Connect Transmitter. Sensor usable up to seven days with a Bluetooth® transmitter
3. Automatic uploads to CareLink™ account; easily accessed on the website.
4. **Smart technology to predict where glucose levels are headed**, the system alerts patients from 10 to 60 minutes before a glucose excursion, so they can take action in advance.
5. Sugar.IQ™ Intelligent diabetes assistant app. Uses **IBM Watson™** technology. Reveals hidden patterns to provide **personalized insights** to help patients make smarter decisions.
6. **Does not replace finger pokes for dosing**

Dexcom G6

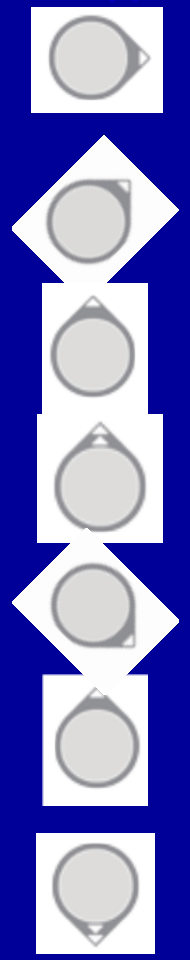
- Change site every 10 days
- 2-hour sensor warm-up period
- No calibration is required
- FDA approved to dose insulin
- Data viewable on the receiver or cell phone
- Acetaminophen **DOES NOT** interfere with glucose readings



CGM Glucose Trend Arrows

Dexcom

G4/G5 Phone Receiver App



Constant: glucose is steady (not increasing/decreasing more than 1 mg/dL/min).

Slowly rising: glucose is rising 1-2 mg/dL/min

Rising: glucose is rising 2-3 mg/dL/min

Rapidly rising: glucose is rising more than 3 mg/dL/min

Slowly falling: glucose is falling 1-2 mg/dL/min

Falling: glucose is falling 2-3 mg/dL/min

Rapidly falling: Your glucose is falling more than 3 mg/dL/min

Medtronic

Constant: glucose is steady (not increasing/decreasing more than 1 mg/dL/min).

Rising: glucose is rising 1-2 mg/dL/min

Rapidly rising: glucose is rising more than 2 mg/dL/min

Falling: glucose is falling 1-2 mg/dL/min

Rapidly falling: glucose is falling more than 2 mg/dL/min

PEDIATRIC WORKSHEET

ADJUSTING INSULIN DOSES USING DEXCOM G5® MOBILE TREND ARROWS

ENDOCRINE SOCIETY

This is your worksheet based on the Endocrine Society approach[1] for making treatment decisions using the Dexcom G5® Mobile Continuous Glucose Monitoring (CGM) System.

FOOD + CORRECTION + ARROW = TOTAL INSULIN DOSE

STEP 1: Calculate your rapid-acting insulin dose for food and corrections as prescribed by your healthcare professional.

STEP 2: Add or subtract insulin based on your trend arrow.

Do not take any additional insulin until at least _____ hours from last dose.

ADJUSTING INSULIN DOSES USING TREND ARROWS: PRE-MEAL AND AT LEAST 3 HOURS POST-MEAL.

ARROW DIRECTION	CHANGE IN GLUCOSE	CORRECTION FACTOR	INSULIN DOSE ADJUSTMENT (U)	NOTES
 RAPIDLY RISING	Increasing >3 mg/dL/min	☐ less than 25 ☐ 25-49 ☐ 50-74 ☐ 75-124 ☐ over 125	☐ +4.0 ☐ +3.0 ☐ +2.0 ☐ +1.0 ☐ +0.5	Example: If your correction factor is 1:50 you will add 2.0 units of insulin for the double up arrows.
 RISING	Increasing 2–3 mg/dL/min	☐ less than 25 ☐ 25-49 ☐ 50-74 ☐ 75-124 ☐ over 125	☐ +3.0 ☐ +2.0 ☐ +1.0 ☐ +0.5 No adjustment	
 SLOWLY RISING	Increasing 1–2 mg/dL/min	☐ less than 25 ☐ 25-49 ☐ 50-74 ☐ 75-124 ☐ over 125	☐ +2.0 ☐ +1.0 ☐ +0.5 No adjustment No adjustment	
 STEADY	Not increasing/ decreasing >1 mg/dL/min	☐ less than 25 ☐ 25-49 ☐ 50-74 ☐ 75-124 ☐ over 125	No adjustment No adjustment No adjustment No adjustment No adjustment	
 SLOWLY FALLING	Decreasing 1–2 mg/dL/min	☐ less than 25 ☐ 25-49 ☐ 50-74 ☐ 75-124 ☐ over 125	☐ -2.0 ☐ -1.0 ☐ -0.5 No adjustment No adjustment	
 FALLING	Decreasing 2–3 mg/dL/min	☐ less than 25 ☐ 25-49 ☐ 50-74 ☐ 75-124 ☐ over 125	☐ -3.0 ☐ -2.0 ☐ -1.0 ☐ -0.5 No adjustment	
 RAPIDLY FALLING	Decreasing >3 mg/dL/min	☐ less than 25 ☐ 25-49 ☐ 50-74 ☐ 75-124 ☐ over 125	☐ -4.0 ☐ -3.0 ☐ -2.0 ☐ -1.0 ☐ -0.5	

See Back

14 days | Fri Feb 15, 2019 - Thu Feb 28, 2019

223
mg/dL
Average glucose (CGM)

63
mg/dL
Standard deviation (CGM)

HIGH
MODERATE
LOW
MINIMAL
Hypoglycemia risk

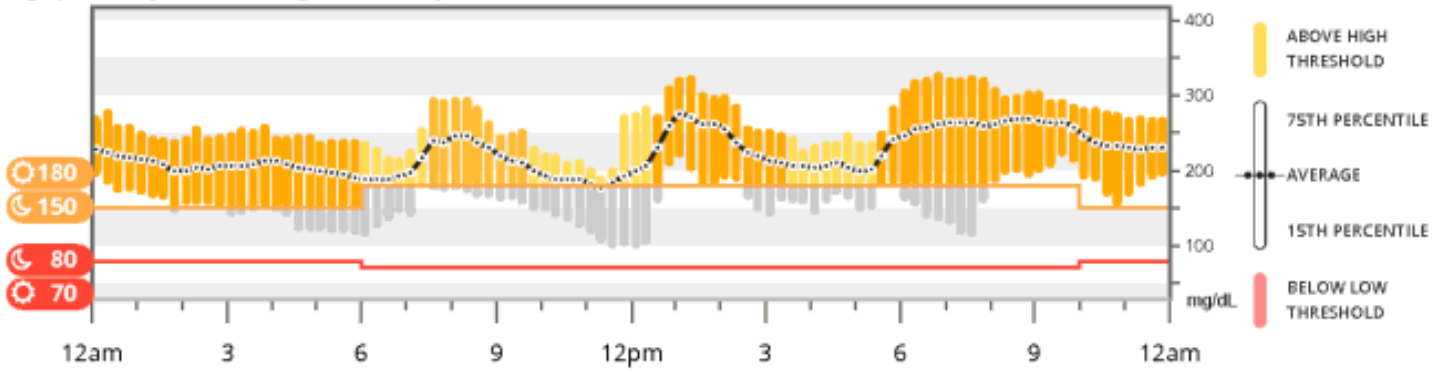
79%
20%
0%
0%
Time in range

Days with CGM data 93%
13 / 14
Avg. calibrations per day 0.0
Sensor usage

Top Patterns

1. [redacted] had a pattern of nighttime highs
   a pattern of significant highs between 5:35 PM and 5:45 AM.
2. [redacted] had a pattern of daytime highs
   a pattern of significant highs between 12:40 PM and 3:25 PM.
3. draven's best glucose day was February 24, 2019
   draven's glucose data was in the target range about 41% of the day.

This graph shows your data averaged over 14 days



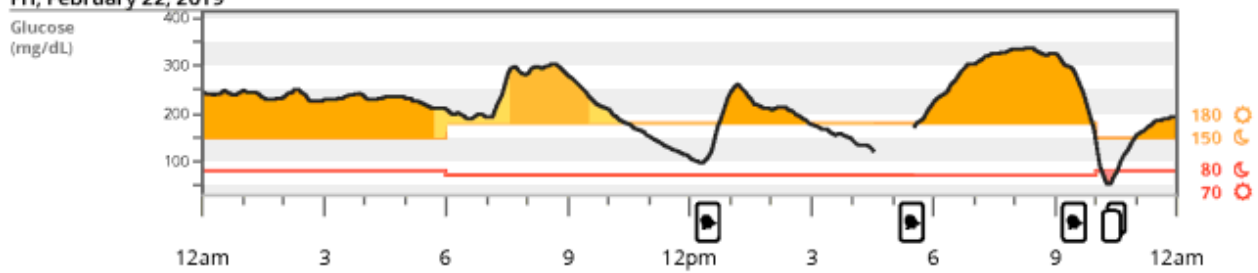
14 days | Fri Feb 15, 2019 - Thu Feb 28, 2019

Daily View

Legend

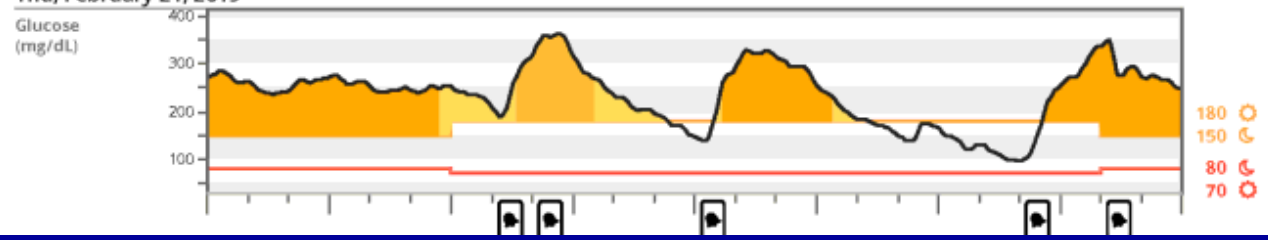
- CALIBRATIONS
- CARBS
- HEALTH
- FAST-ACTING INSULIN / INSULIN
- LONG-ACTING INSULIN
- ALERTS
- EXERCISE
- MULTIPLE EVENTS

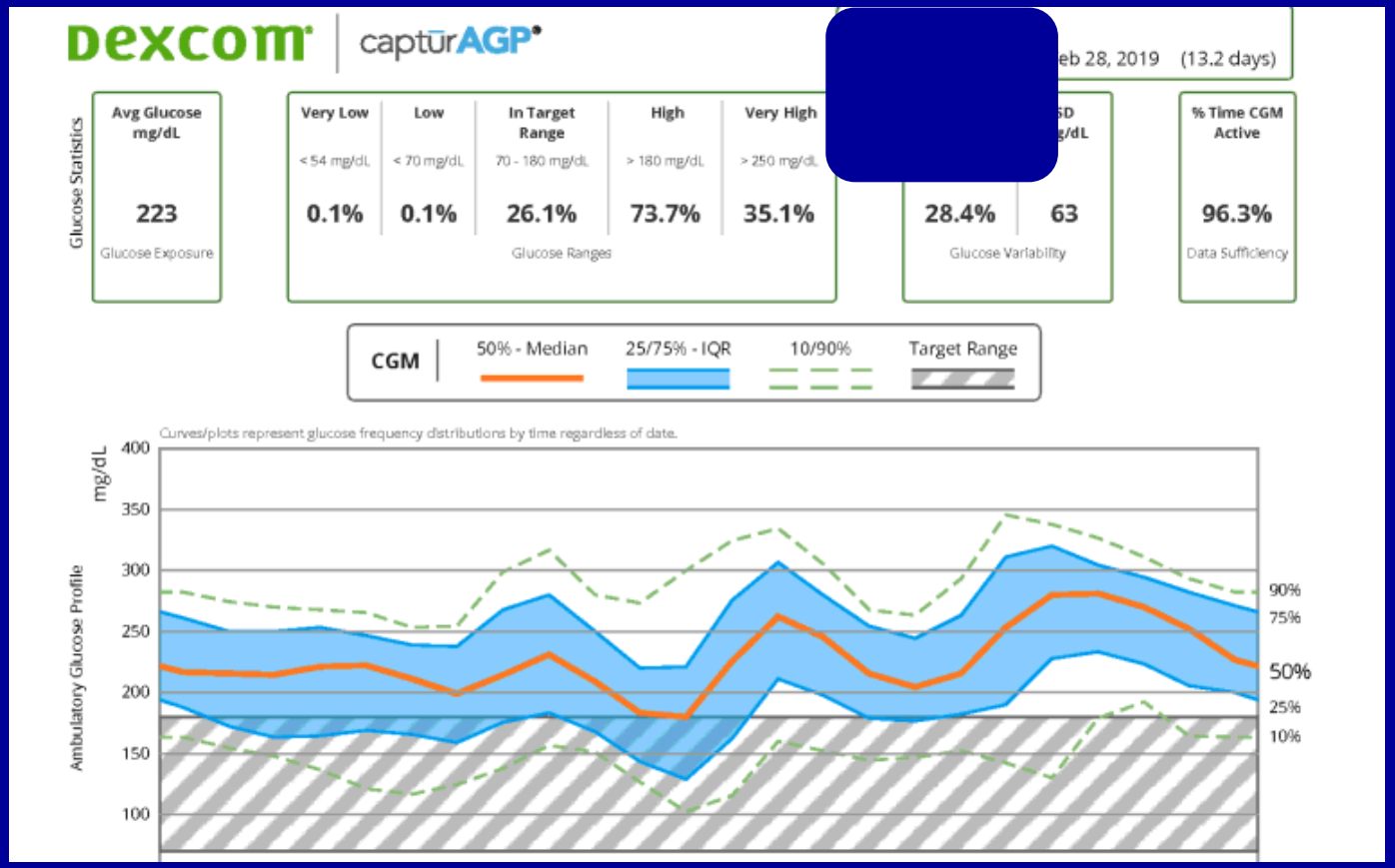
Fri, February 22, 2019



12:42 PM Rise Rate	5:32 PM Rise Rate	9:47 PM Fall Rate	10:12 PM Urgent Low Soon
10:17 PM Urgent Low	10:27 PM Urgent Low Soon		

Thu, February 21, 2019




Dexcom
captürAGP
eb 28, 2019 (13.2 days)
Glucose Statistics
Avg Glucose mg/dL
223
Glucose Exposure
Very Low
< 54 mg/dL
0.1%
Low
< 70 mg/dL
0.1%
In Target Range
70 - 180 mg/dL
26.1%
High
> 180 mg/dL
73.7%
Very High
> 250 mg/dL
35.1%
Glucose Ranges
28.4%
63
Glucose Variability
% Time CGM Active
96.3%
Data Sufficiency
CGM
50% - Median
25/75% - IQR
10/90%
Target Range
Curves/plots represent glucose frequency distributions by time regardless of date.
Ambulatory Glucose Profile
mg/dL
400
350
300
250
200
150
100
90%
75%
50%
25%
10%

Freestyle Libre

- Less expensive
- 1 hour “warm up”
- No calibrations needed
- 14 day wear
- You must request (swipe) the data
- NO ALARMS

Freestyle Libre Continuous Glucose Monitoring System

- ✓No finger stick BG calibration is required for the Freestyle Libre.
- ✓If the CGM reading is <80 or >300 mg/dl or if there is any question regarding accuracy, a finger stick BG check should be done immediately.

Medical Best Practices_12_1-2_17; Youth and Family Best Practices 12_4-7_17

Users can download an app to iPhone to use the phone as the scanner! FreeStyle LibreLink

[redacted]

lucose Pattern Summary

019 - February 12, 2019 (12 Days)

LibreView

CGM Device: FreeStyle Libre Pro [N/A]% Compliant w/Calibration* 100% Time Worn

*Not applicable to FreeStyle Libre or FreeStyle Libre Pro which do not require calibration.

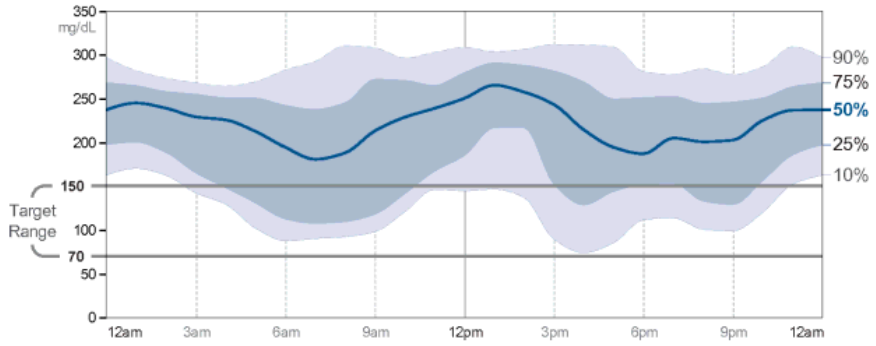
Summary

Average Glucose	Time In Range	Coefficient of Variation (CV)	Standard Deviation (SD)
211 mg/dL	Above 180 mg/dL (above 250 mg/dL: 34%) 66%	34.6%	73 mg/dL
88-116*	In Target Range 70-180 mg/dL 32%	19-25*	10-26*
	Below 70 mg/dL (below 54 mg/dL: 0%) 2%		

*Reference ranges calculated from population without diabetes.

Ambulatory Glucose Profile

Curves/plots represent glucose frequency distributions by time regardless of date



Medtronic 670G

MINIMED 670G SYSTEM HIGHLIGHTS.

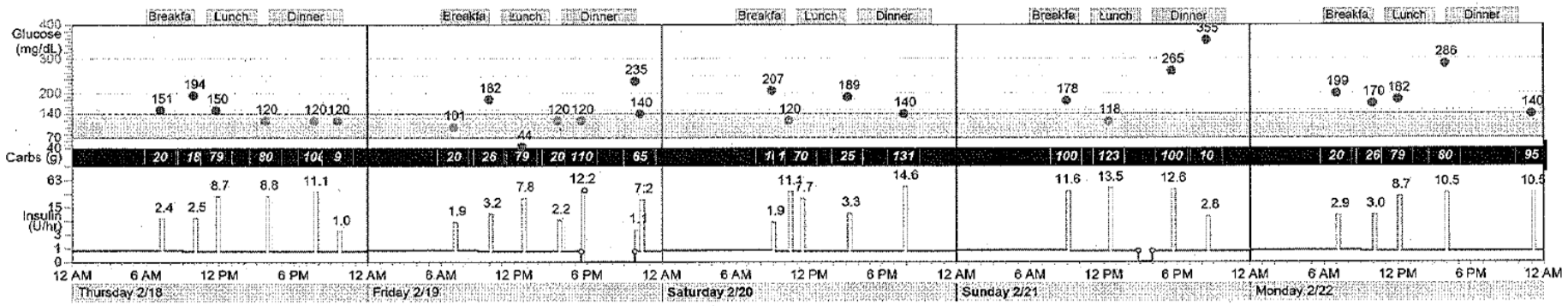
The MiniMed 670G system with **SmartGuard® HCL technology** offers **two new levels of personalization:**

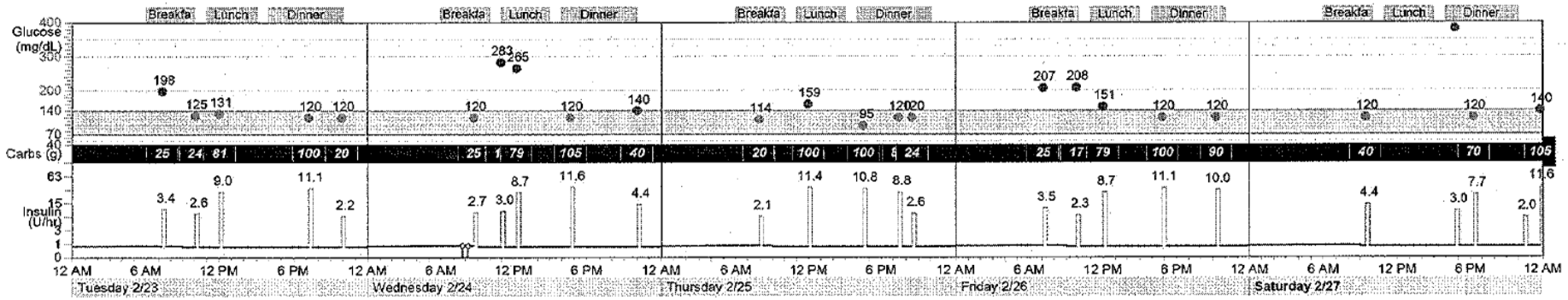
NEW! The **Suspend before low**§ option avoids lows and rebound highs proactively by automatically stopping insulin 30 minutes before you reach your pre-selected low limits, then automatically restarts insulin when your levels recover, all without bothersome alerts.

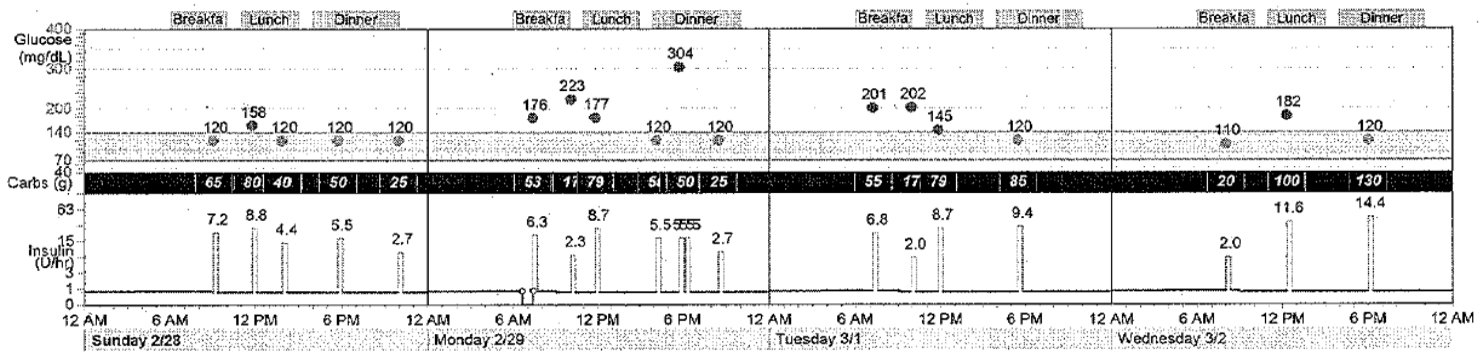
NEW! The **Auto Mode**‡ option automatically adjusts your basal insulin delivery every 5 minutes based on your sugar levels to keep you in target range, all day and night.

NEW! Guardian® sensor 3 continuous glucose monitoring sensor. Introducing the most accurate sensor from Medtronic, now with up to 7 day wear and easy insertion. It is the FIRST and ONLY continuous glucose monitoring sensor FDA approved and trusted to control insulin dosing.

Exclusive CONTOUR®NEXT LINK 2.4 meter[1] Get easy and accurate CGM calibration, insulin dosing and remote bolusing with our exclusive meter.

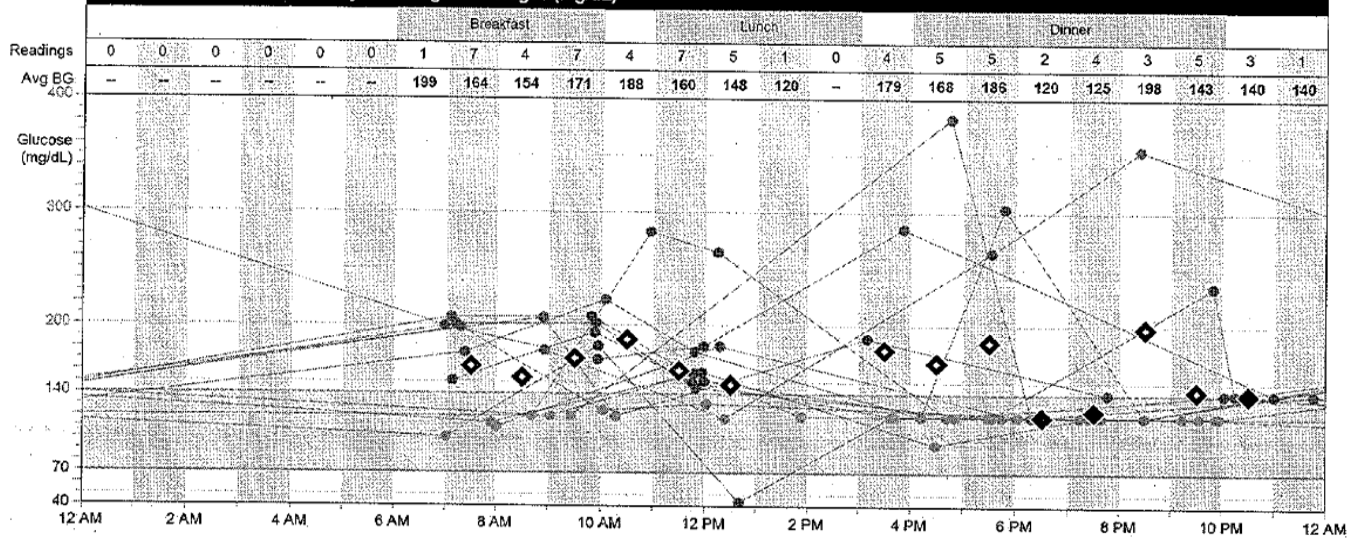






Sensor trace · Interrupted · BG reading · Off chart · Basal · Temp basal · Bolus · Suspend · Time change · Injected insulin (U) · Exercise · Other

24-Hour Meter Glucose Overlay - Readings & Averages (mg/dL)



Statistics	2/18 - 3/2	
Avg BG (mg/dL)	162 ± 62	
BG Readings	68	4.9/day
Readings Above Target	31	46%
Readings Below Target	1	1%
Sensor Avg (mg/dL)	--	
Avg AUC > 140 (mg/dL)	--	--
Avg AUC < 70 (mg/dL)	--	--

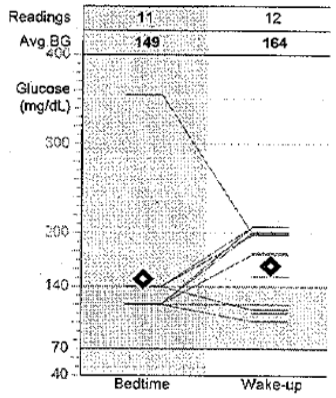
Avg Daily Carbs (g)	*288 ± 40*
Carbs/Bolus Insulin (g/U)	8.7

Avg Total Daily Insulin (U)	50.9 ± 4.3	
Avg Daily Basal (U)	17.8	35%
Avg Daily Bolus (U)	33.1	65%

Meter Glucose Overlay Bedtime to Wake-Up and Meal Periods – Readings & Averages (mg/dL)

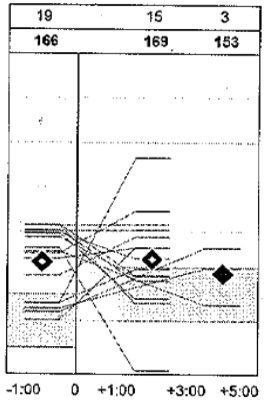
Bedtime to Wake-up

Bedtime: 8:00 PM - 12:00 AM
Wake-up: 5:00 AM - 9:00 AM



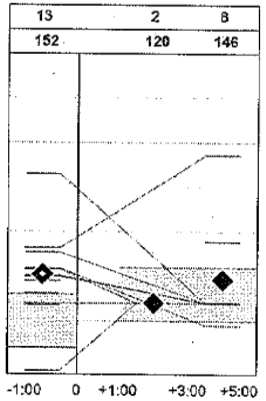
Breakfast: 6:00 AM - 10:00 AM
Meals Analyzed: 19

Avg Carbs: *32g*
Avg Insulin: 3.8U
Avg Carbs/Insulin: 8.3g/U



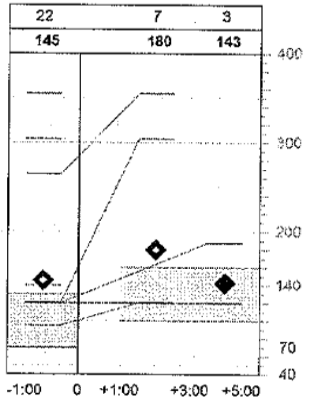
Lunch: 11:00 AM - 3:00 PM
Meals Analyzed: 14

Avg Carbs: *82g*
Avg Insulin: 9.0U
Avg Carbs/Insulin: 9.1g/U

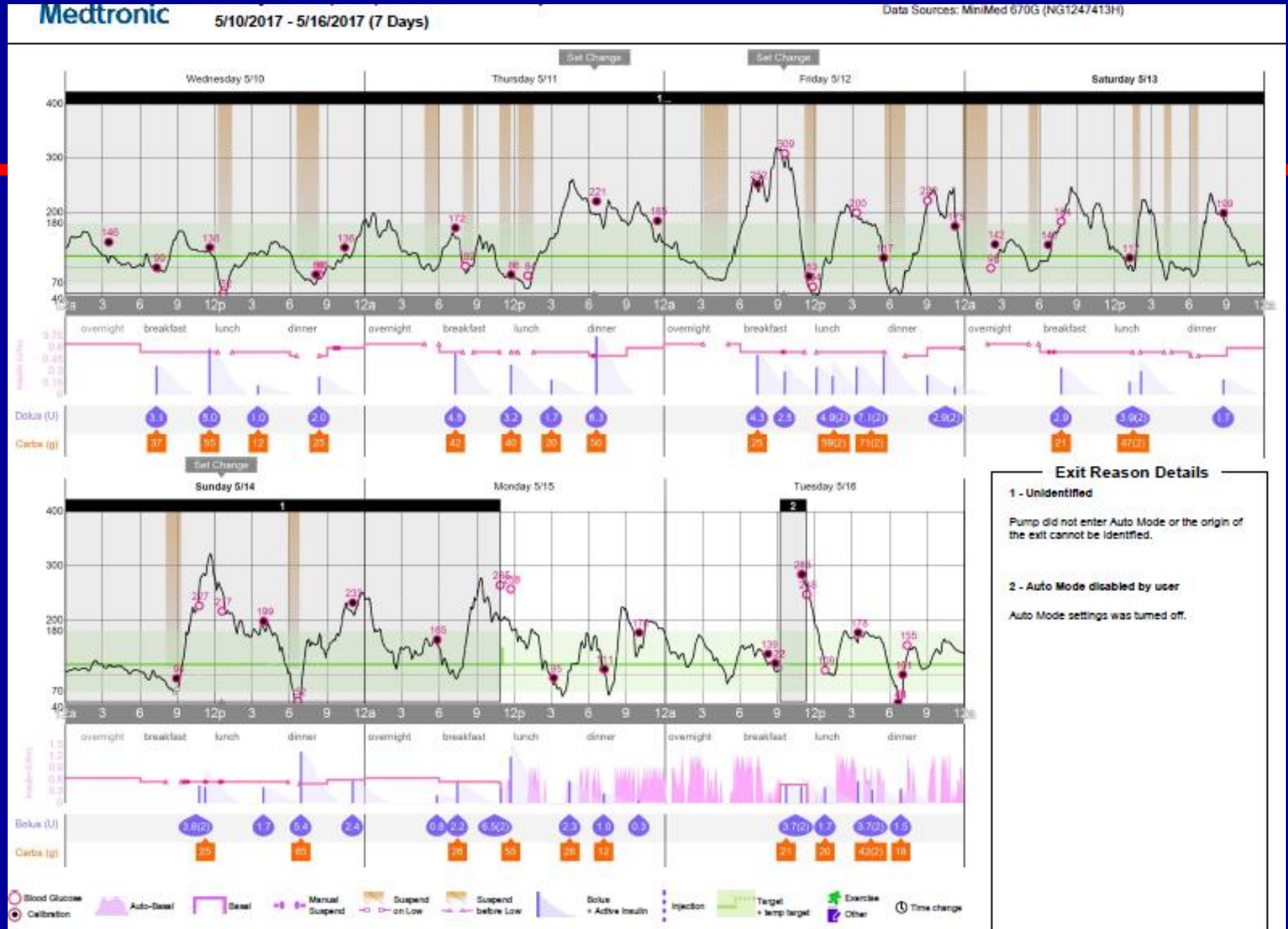


Dinner: 4:00 PM - 10:00 PM
Meals Analyzed: 23

Avg Carbs: *70g*
Avg Insulin: 7.9U
Avg Carbs/Insulin: 8.9g/U



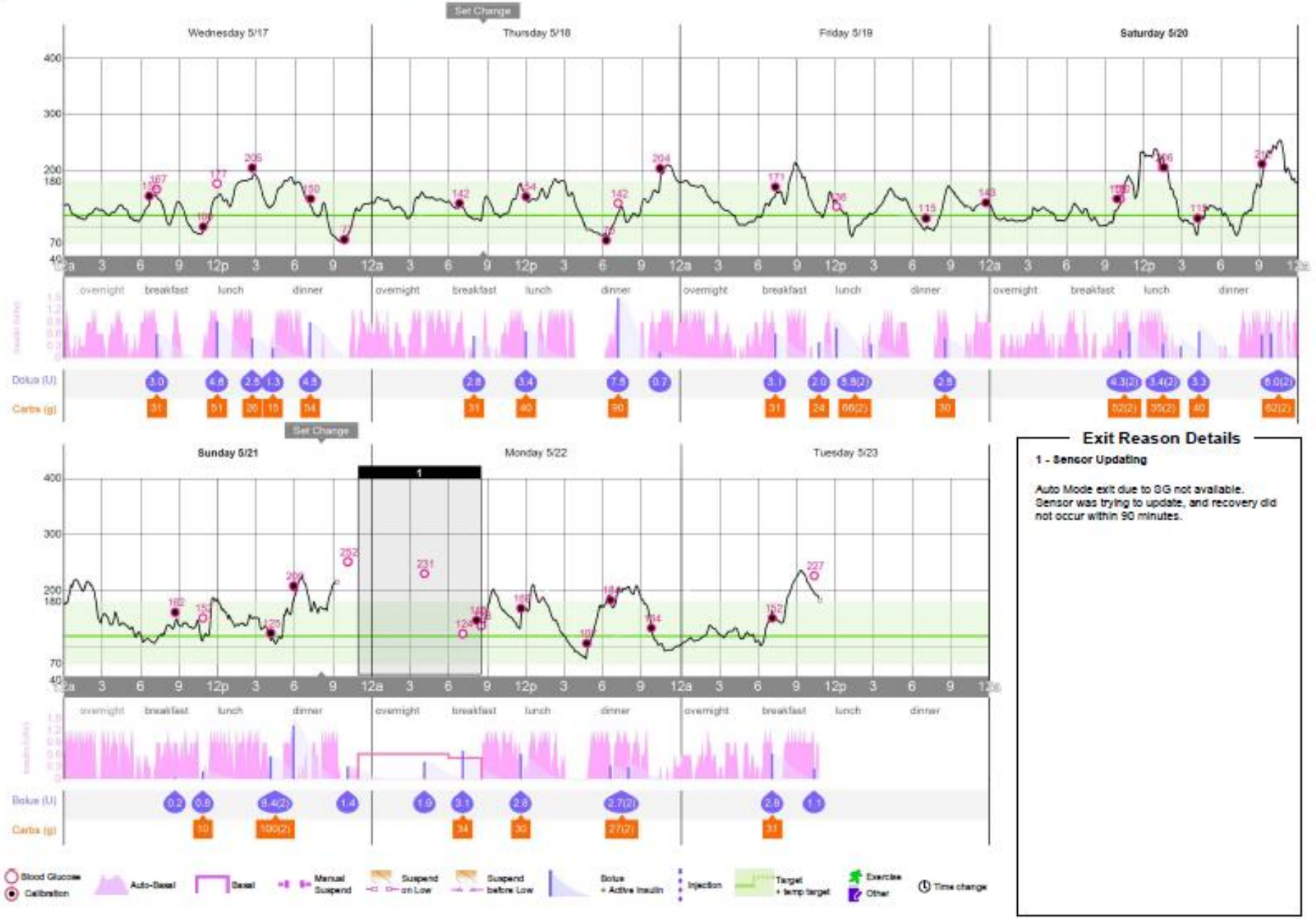
BG reading BG reading Off chart Average within target range Average outside target range


Medtronic
5/10/2017 - 5/16/2017 (7 Days)
Data Sources: MiniMed 670G (NG1247413H)
Wednesday 5/10
Thursday 5/11
Friday 5/12
Saturday 5/13
Sunday 5/14
Monday 5/15
Tuesday 5/16
Set Change
overnight
breakfast
lunch
dinner
Bolus (U)
Carbs (g)
Exit Reason Details
1 - Unidentified
Pump did not enter Auto Mode or the origin of the exit cannot be identified.
2 - Auto Mode disabled by user
Auto Mode settings was turned off.
Blood Glucose
Calibration
Auto-Basal
Basal
Manual Suspend
Suspend on Low
Suspend before Low
Bolus + Active Insulin
Injection
Target + temp target
Exercise
Other
Time change

Medtronic

5/17/2017 - 5/23/2017 (7 Days)

Data Sources: MiniMed 670G (NG1247413H)



Exit Reason Details

1 - Sensor Updating

Auto Mode exit due to SG not available. Sensor was trying to update, and recovery did not occur within 90 minutes.

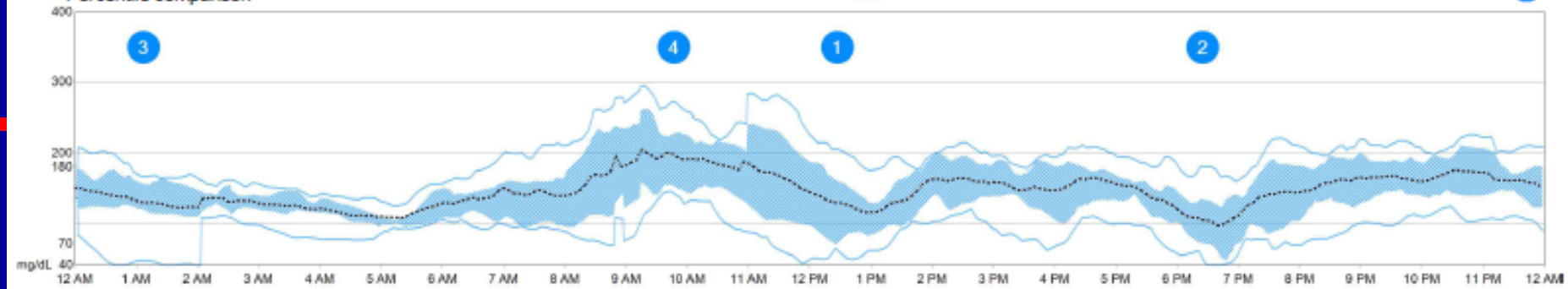
Medtronic

(A) 5/10/2017 - 5/16/2017 (7 Days) (B) Unavailable

Data Sources: MiniMed 670G (NG1247413H)

Percentile comparison

25-75% 0-90% Average (A)



Carb Ratio (g/U) * (A) 13 | 11 | 12 (B)

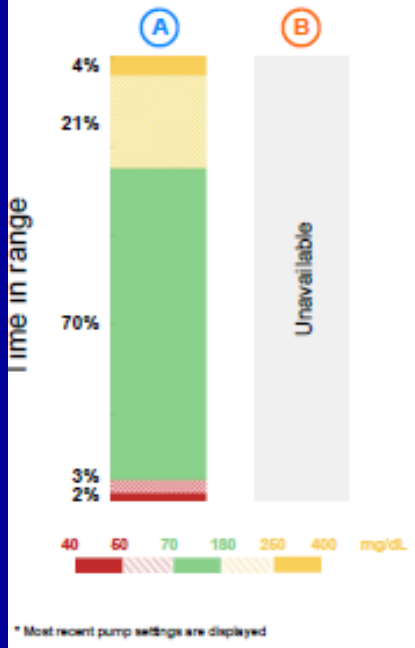
(A)

Hypoglycemic patterns(3)

1. 11:37 AM- 1:17 PM (3 occurrences)
2. 5:47 PM- 7:02 PM (2 occurrences)
3. 12:12 AM- 2:02 AM (1 occurrences)

Hyperglycemic patterns(1)

4. 8:50 AM- 10:45 AM



* Most recent pump settings are displayed

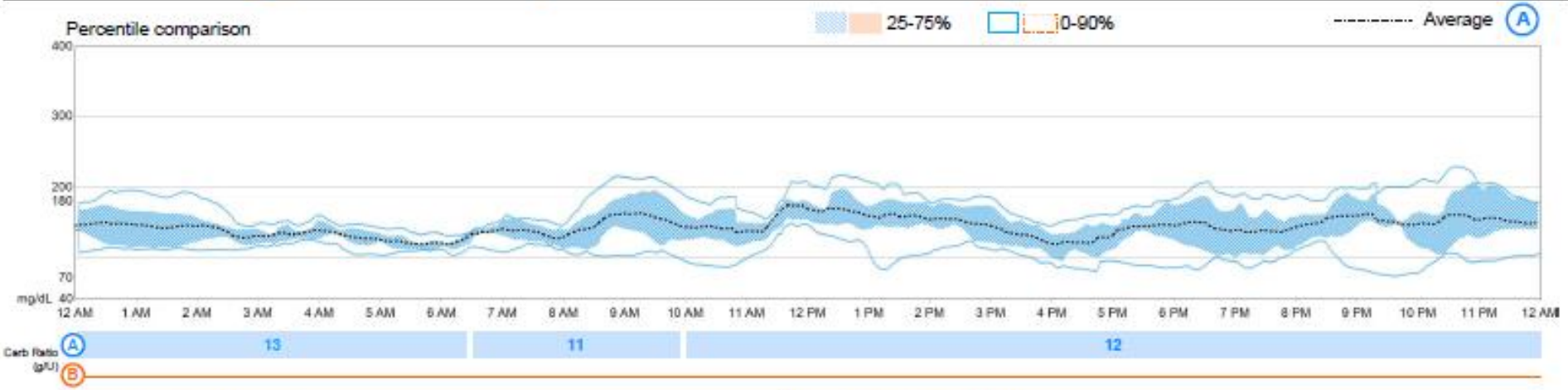
Auto Mode Exits	A	B
No Calibration	0	--
High SG Auto Mode Exit	0	--
Auto Mode max delivery	0	--
Auto Mode min delivery	0	--
BG required for Auto Mode	0	--
Sensor Algorithm Underread	0	--
Sensor Updating	0	--
No SG values	0	--
Sensor Expired	0	--
Auto Mode disabled by user	• 1	--
Alarms	0	--
Pump Suspend by user	0	--
Large time/date change	0	--
Unidentified	• 1	--

Statistics	A	B
Auto Mode (per week)	21% (1d 11hrs)	--
Manual Mode (per week)	79% (5d 13hrs)	--
Sensor Wear (per week)	99% (6d 22hrs)	--
Average SG ± SD	146 ± 52 mg/dL	--
Estimated A1C	6.7%	--
Average BG	147 ± 67 mg/dL	--
BG / Calibration (per day)	7.7 / 4.4	--
Total daily dose (per day)	25 units	--
Bolus amount (per day)	13U (52%)	--
Auto Basal / Basal amount (per day)	12U (48%)	--
Set Change	3	--
Reservoir Change	3	--
Meal (per day)	3.9	--
Carbs entered (per day)	117 ± 32g	--
Active Insulin time	3:00 hrs	--

Medtronic

(A) 5/17/2017 - 5/23/2017 (7 Days) (B) Unavailable

Data Sources: MiniMed 670G (NG1247413H)

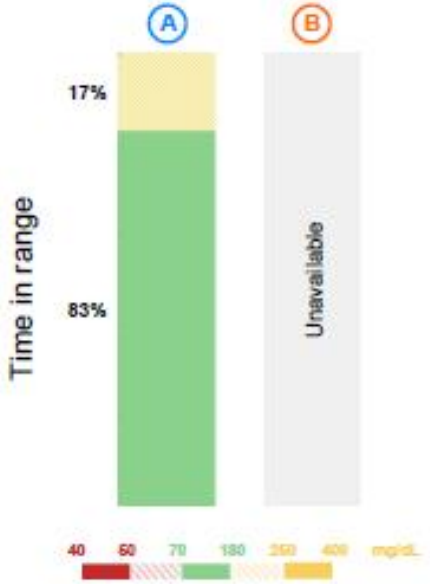


(A) Hypoglycemic patterns(0)

None

Hyperglycemic patterns(0)

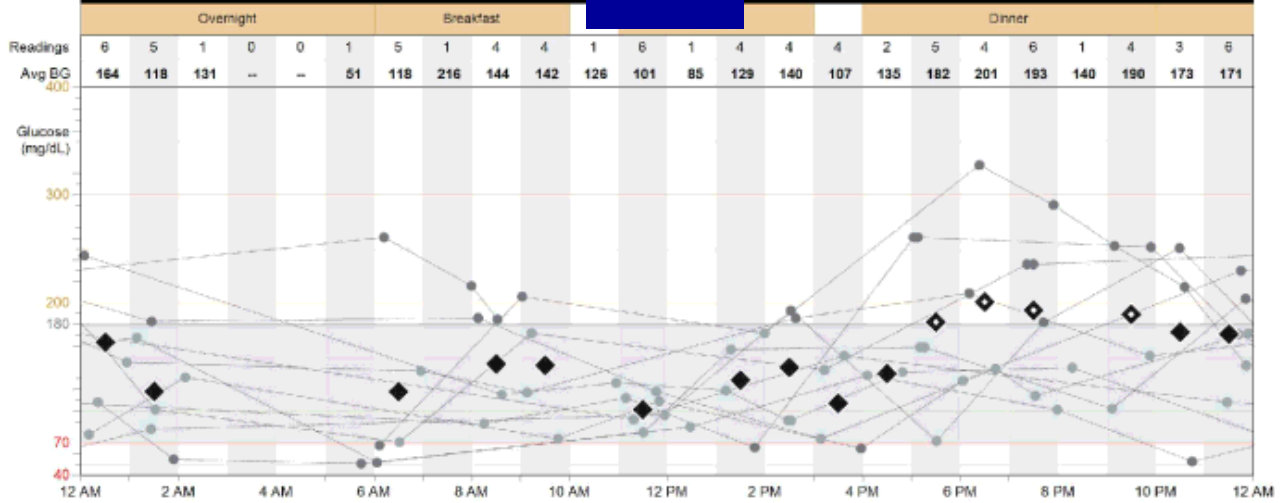
None



Auto Mode Exits	A	B
No Calibration	0	--
High SG Auto Mode Exit	0	--
Auto Mode max delivery	0	--
Auto Mode min delivery	0	--
BG required for Auto Mode	0	--
Sensor Algorithm Underread	0	--
Sensor Updating	• 1	--
No SG values	0	--
Sensor Expired	0	--
Auto Mode disabled by user	0	--
Alarms	0	--
Pump Suspend by user	0	--
Large time/date change	0	--
Unidentified	0	--

Statistics	A	B
Auto Mode (per week)	94% (6d 14hrs)	--
Manual Mode (per week)	6% (10hrs)	--
Sensor Wear (per week)	93% (6d 12hrs)	--
Average SG ± SD	144 ± 34 mg/dL	--
Estimated A1C	6.6%	--
Average BG	157 ± 41 mg/dL	--
BG / Calibration (per day)	5.7 / 4.0	--
Total daily dose (per day)	26 units	--
Bolus amount (per day)	14U (54%)	--
Auto Basal / Basal amount (per day)	12U (46%)	--
Set Change	2	--
Reservoir Change	2	--
Meal (per day)	4.5	--
Carbs entered (per day)	147 ± 38g	--
Active Insulin time	3:00 hrs	--

24-Hour Meter Glucose Overlay - Readings & Averages (mg/dL)



Statistics	01-16 - 01-29	
Avg BG (mg/dL)	149 ± 65	
BG Readings	78	6.8/day
Readings Above Target	24	31%
Readings Below Target	7	9%
Sensor Avg (mg/dL)	--	
Avg AUC > 180 (mg/dL)	--	--
Avg AUC < 70 (mg/dL)	--	--

Avg Daily Carbs (g)	*153 ± 40*	
Carbs/Bolus Insulin (g/U)	5.8	

Avg Total Daily Insulin (U)	58.6 ± 5.3	
Avg Daily Basal (U)	32.4	55%
Avg Daily Bolus (U)	26.1	45%

Meter Glucose Overlay Bedtime to Wake-Up and Meal Periods – Readings & Averages (mg/dL)

Bedtime to Wake-up

Bedtime: 8:00 PM - 12:00 AM
Wake-up: 5:00 AM - 9:00 AM

Readings 10 9
Avg BG 162 114

Breakfast: 6:00 AM - 10:00 AM
Meals Analyzed: 6

Avg Carbs: *32g*
Avg Insulin: 4.6U
Avg Carbs/Insulin: 7.1g/U

Readings 5 1 0
Avg BG 159 126 --

Lunch: 11:00 AM - 3:00 PM
Meals Analyzed: 13

Avg Carbs: *45g*
Avg Insulin: 6.4U
Avg Carbs/Insulin: 7.1g/U

Readings 11 1 4
Avg BG 126 193 87

Dinner: 4:00 PM - 10:00 PM
Meals Analyzed: 17

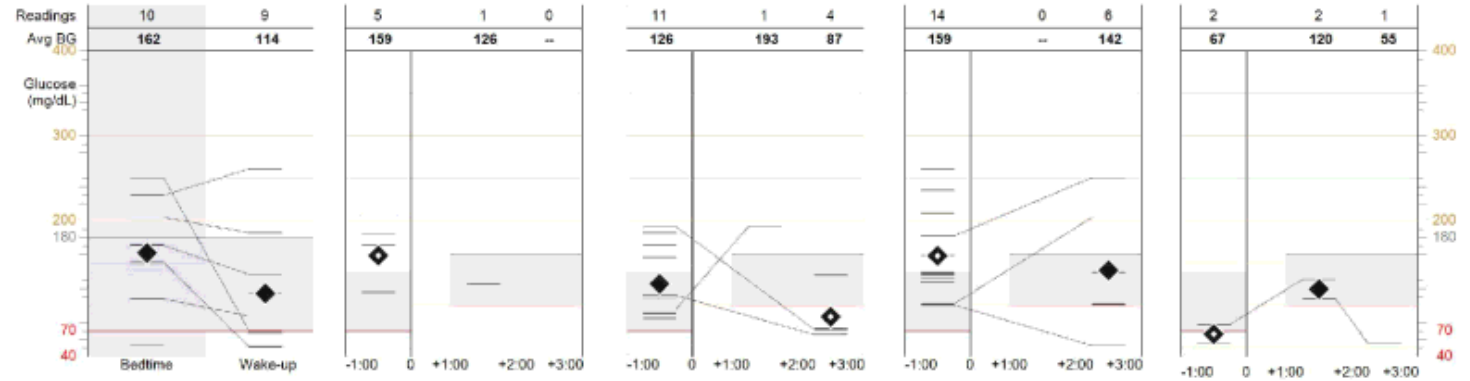
Avg Carbs: *37g*
Avg Insulin: 6.2U
Avg Carbs/Insulin: 6.0g/U

Readings 14 0 6
Avg BG 159 -- 142

Overnight: 10:00 PM - 6:00 AM
Meals Analyzed: 3

Avg Carbs: *11g*
Avg Insulin: 1.1U
Avg Carbs/Insulin: 9.4g/U

Readings 2 2 1
Avg BG 67 120 55



BG reading — BG reading ▼▲ Off chart ◆ Average within target range ◇ Average outside target range

Medtronic

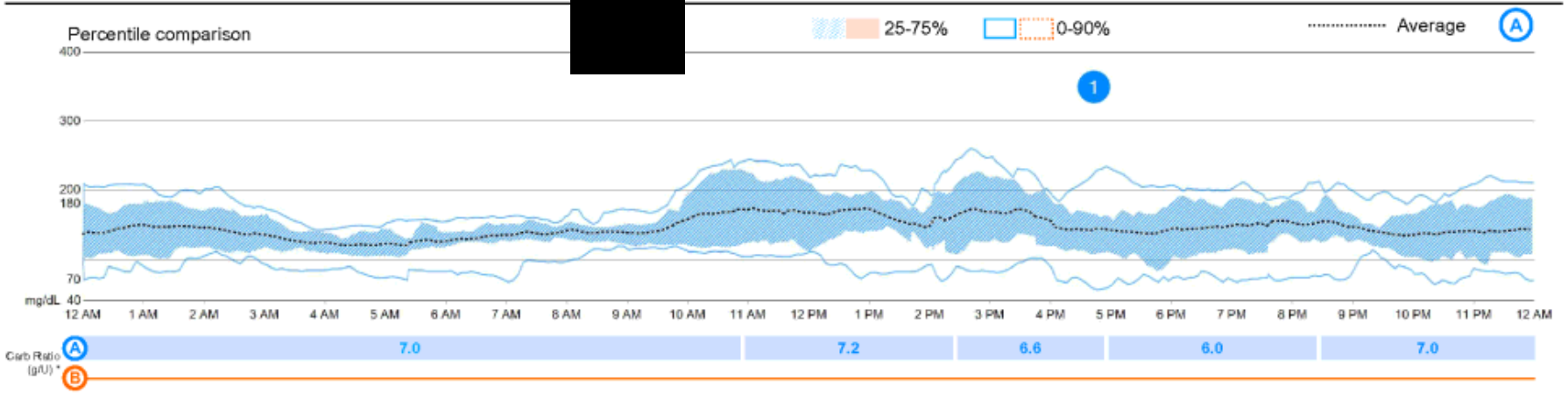
Assessment and Progress

A 02-01-2019 - 02-14-2019 (14 Days) B [redacted]

Generated: 02-14-2019 11:17 AM

Data Sources: MiniMed 670G, MMT-1780 (NG1770688H)

Percentile comparison



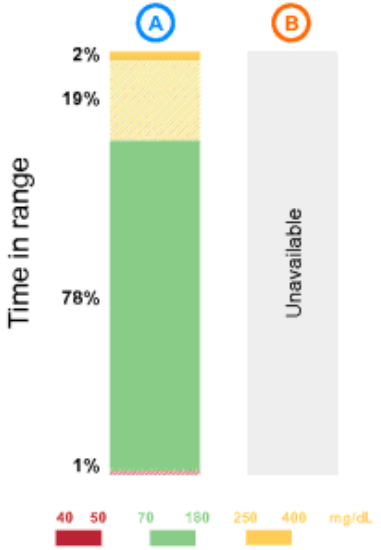
Carb Ratio (g/U) *					
A	7.0	7.2	6.6	6.0	7.0
B					

Hypoglycemic patterns (1)

1 4:06 PM- 5:21 PM (2 occurrences)

Hyperglycemic patterns (0)

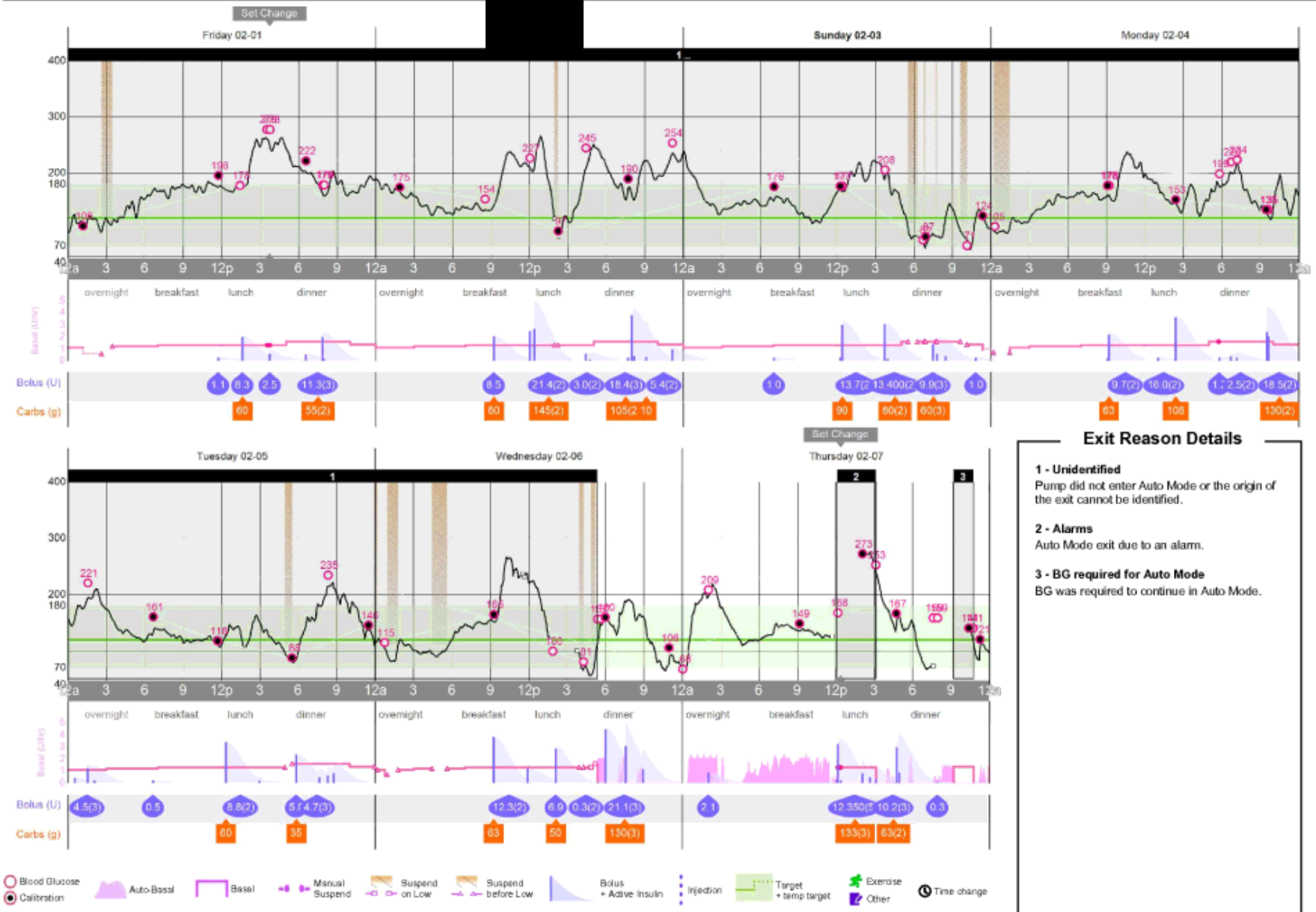
None



* Most recent pump settings are displayed

Auto Mode Exits	A	B
No Calibration	0	--
High SG Auto Mode Exit	0	--
Auto Mode max delivery	• 1	--
Auto Mode min delivery	• 1	--
BG required for Auto Mode	• 1	--
Sensor Algorithm Underread	0	--
Sensor Updating	0	--
No SG values	0	--
Sensor Expired	0	--
Auto Mode disabled by user	0	--
Alarms	•• 2	--
Pump Suspend by user	0	--
Auto Mode Warm Up	0	--
Unidentified	• 1	--

Statistics	A	B
Auto Mode (per week)	55% (3d 21h)	--
Manual Mode (per week)	45% (3d 03h)	--
Sensor Wear (per week)	97% (6d 19h)	--
Average SG ± SD	146 ± 43 mg/dL	--
Average BG	151 ± 55 mg/dL	--
BG / Calibration (per day)	8.8 / 3.7	--
Total daily dose (per day)	62 units	--
Bolus amount (per day)	36U (58%)	--
Auto Basal / Basal amount (per day)	26U (42%)	--
Set Change	Every 6.5 days	--
Reservoir Change	Every 1.9 days	--
Meal (per day)	4.5	--
Carbs entered (per day)	217 ± 76 g	--
Active Insulin time	3:00 hrs	--



Exit Reason Details

1 - Unidentified
Pump did not enter Auto Mode or the origin of the exit cannot be identified.

2 - Alarms
Auto Mode exit due to an alarm.

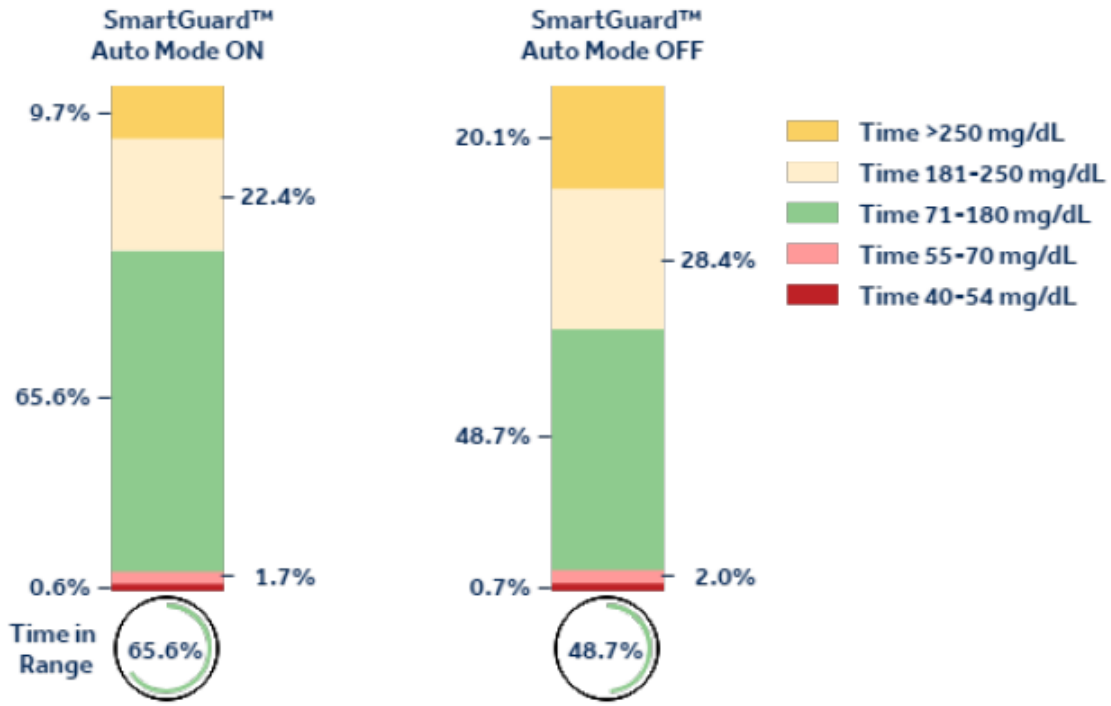
3 - BG required for Auto Mode
BG was required to continue in Auto Mode.

SENSOR GLUCOSE DISTRIBUTION: MINIMED™ 670G SYSTEM

Data Type: Healthcare Professional (BERNARD M DEGNAN)

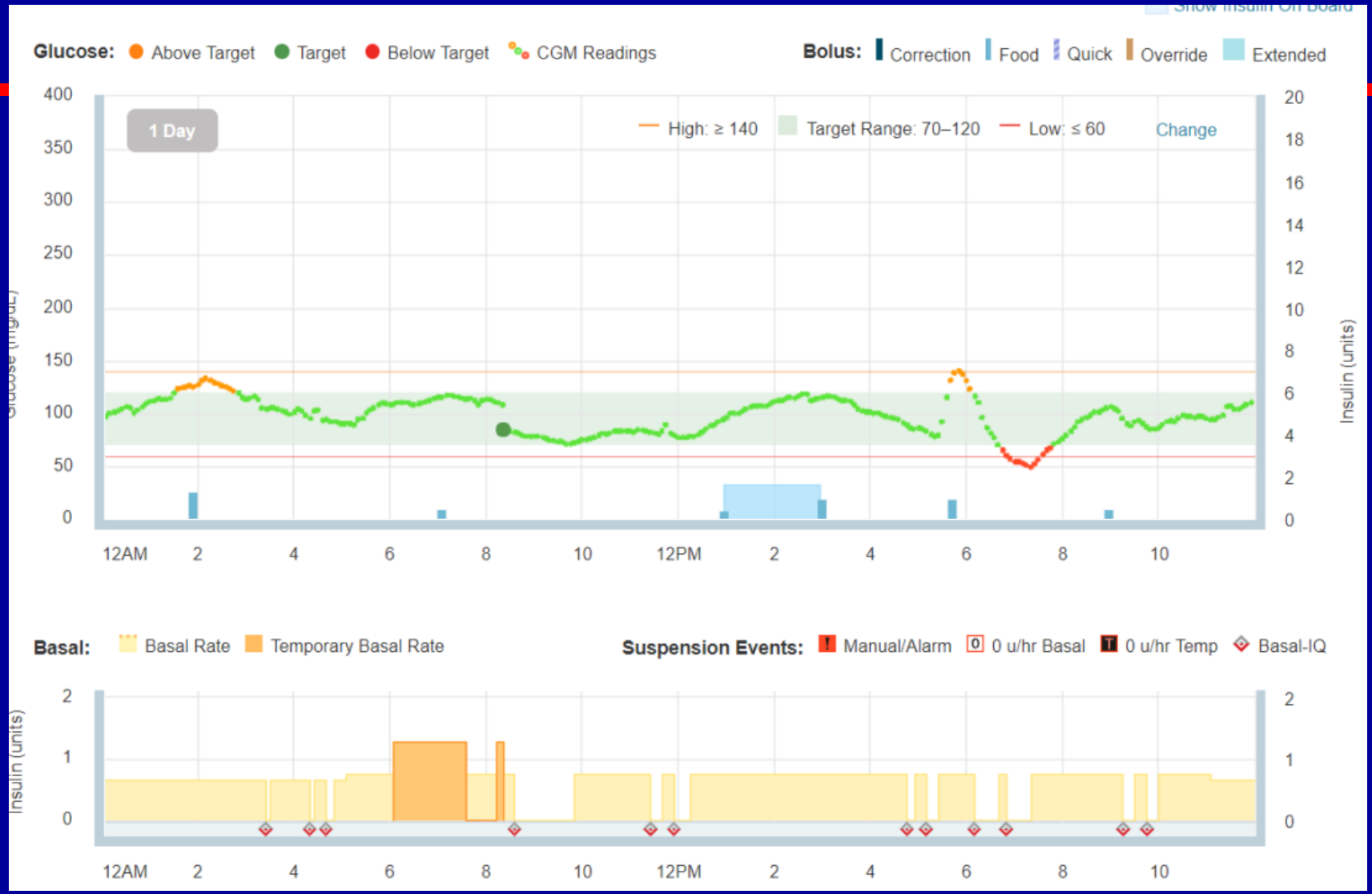
U.S. MINIMED™ SYSTEM DATASET*
CareLink™ Personal Data
41 Users
Average Sensor Glucose (SG): 170.7
Time in Auto Mode: 62.9%
Time in Range (Auto Mode): 65.6%

PARAMETER VALUES
Selected Age: All Ages
Selected Dates: All Dates



* Only data from voluntary CareLink™ Personal or System uploads in the U.S. have been evaluated. Based on 2,212 days of data. Data collection began on March 2017.
** Time in range is the percentage of time glucose levels are between 70 -180 mg/dL over a given period of time. Significant difference between SmartGuard™ feature on versus SmartGuard™ feature off ($P < 0.05$).

T-Slim X from Tandem


Glucose: Above Target Target Below Target CGM Readings
Bolus: Correction Food Quick Override Extended
1 Day
High: ≥ 140
Target Range: 70–120
Low: ≤ 60
Change
400
350
300
250
200
150
100
50
0
20
18
16
14
12
10
8
6
4
2
0
Insulin (units)
12AM 2 4 6 8 10 12PM 2 4 6 8 10
Basal: Basal Rate Temporary Basal Rate
Suspension Events: Manual/Alarm 0 u/hr Basal 0 u/hr Temp Basal-IQ
Insulin (units)
2
1
0
12AM 2 4 6 8 10 12PM 2 4 6 8 10

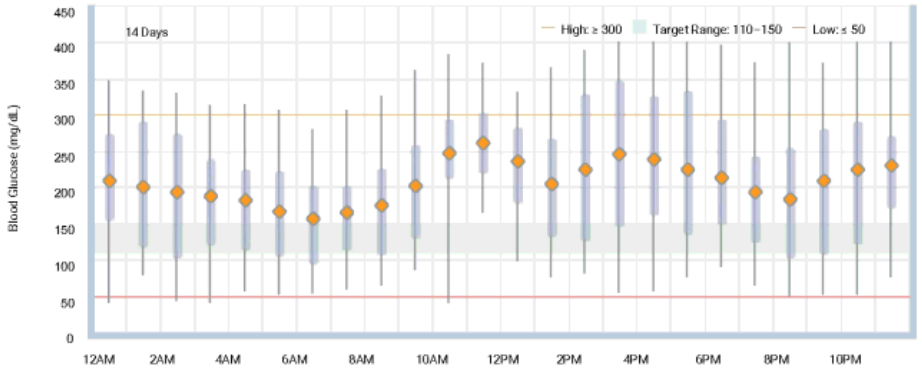
TANDEM DIABETES CARE

Born: Sun A[redacted]

Report Printed [redacted]

CGM Hourly | Aug 9 - 22, 2018

CGM Readings: Above Target Average | Target Average | Below Target Average | Mid Range (25/75% - IQR) | Highest-Lowest Reading



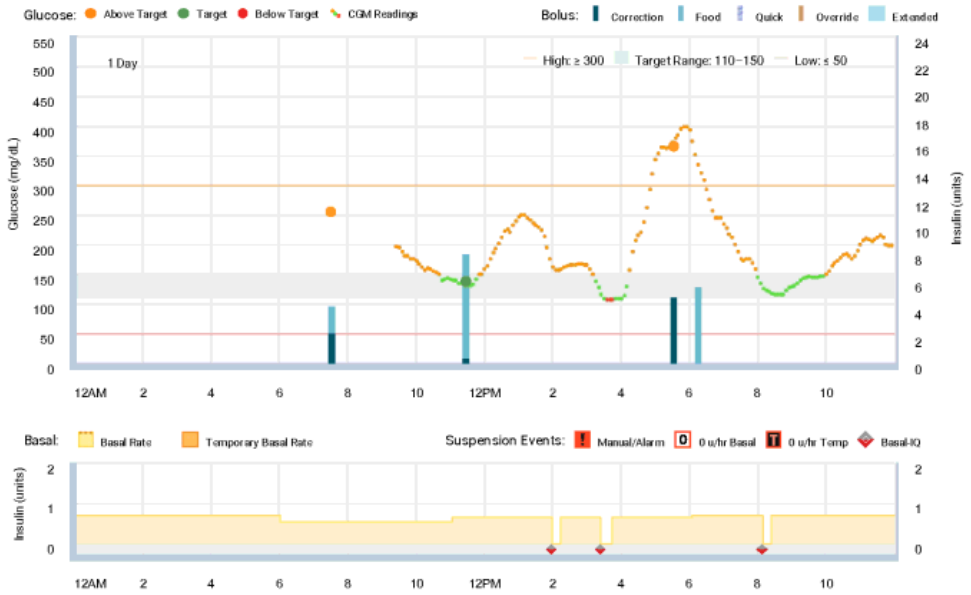
Night 12am - 6am	Low	Below	Target	Above	High
Total Readings:	2%	21%	10%	56%	12%
Time in range (Avg)	5 min.	1:07 hrs.	33 min.	2:58 hrs.	37 min.
Avg. Glucose (mg/dL):	190				
Standard Deviation (mg/dL):	79				
Avg. Readings Per Day	64				

Morning 6am - 12pm	Low	Below	Target	Above	High
Total Readings:	0%	17%	9%	61%	12%
Time in range (Avg)	1 min.	50 min.	27 min.	2:55 hrs.	35 min.
Avg. Glucose (mg/dL):	202				
Standard Deviation (mg/dL):	80				
Avg. Readings Per Day	58				

Afternoon 12pm - 6pm	Low	Below	Target	Above	High
Total Readings:	0%	10%	17%	47%	26%
Time in range (Avg)	-	29 min.	49 min.	2:14 hrs.	1:13 hrs.
Avg. Glucose (mg/dL):	229				
Standard Deviation (mg/dL):	92				
Avg. Readings Per Day	57				

Evening 6pm - 12am	Low	Below	Target	Above	High
Total Readings:	0%	20%	11%	52%	17%
Time in range (Avg)	-	1:01 hrs.	33 min.	2:44 hrs.	55 min.
Avg. Glucose (mg/dL):	210				
Standard Deviation (mg/dL):	94				
Avg. Readings Per Day	63				

Therapy Timeline | Dec 4, 2018



The Omnipod : Dash and Horizon

The next step: Closed Loop

All pumps are developing "personalized" dietary dosing software for their hybrid pumps

(4 years?)

Internalization??

This stuff works!

- Continuous Glucose Monitoring Associated With Less Diabetes-Specific Emotional Distress and Lower A1c Among Adolescents With Type 1 Diabetes, Anthony T. Vesco, Aneta M. Jedraszko, Kimberly P. Garza, Jill Weissberg-Benchel, J Diabetes Sci Technol. 2018 Jul; 12(4): 792–799
- Metrics Beyond Hemoglobin A1C in Diabetes Management: Time in Range, Hypoglycemia, and Other Parameters, Lorena Alarcon-Casas Wright, MD, FACE and Irl B. Hirsch, MD, Diabetes Technol Ther. 2017 May 1; 19(Suppl 2): S-16–S-26
- Deiss et al, Improved Glycemic Control in Poorly Controlled Patients with Type 1 Diabetes Using Real-Time continuous Glucose Monitoring, Diabetes Care 2006 29: 2730-2732

- Bergenstal Et al. Effectiveness of Sensor Augmented Insulin pump Therapy. NEJM 2010
- Del Favero S, Boscari F, Messori M, et al. Randomized Summer Camp Crossover Trial in 5- to 9-Year-Old Children: Outpatient Wearable Artificial Pancreas Is Feasible and Safe. Diabetes Care 2016; 39:1180.
- Zabeen B, Craig ME, Virk SA, et al. Insulin Pump Therapy Is Associated with Lower Rates of Retinopathy and Peripheral Nerve Abnormality. PLoS One 2016; 11:e0153033.

Psychosocial Aspects of Type 1 Diabetes

Diabetes Care. 2007 Oct;30(10):2716-24. Epub 2007 Jul 20.

Routine psychological screening in youth with type 1 diabetes and their parents: a notion whose time has come?

Cameron FJ1, Northam EA, Ambler GR, Daneman D.

Pediatr Diabetes. 2009 Sep;10 Suppl 12:175-84. doi: 10.1111/j.1399-5448.2009.00580.x.

Psychological care of children and adolescents with diabetes.

Delamater AM1

School Performance and Type 1 Diabetes

Effect of type 1 diabetes on school performance in a dynamic world: new analysis exploring Swedish register data

Emma Persson, Sofie Persson, Ulf-G. Gerdtham, Katarina Steen Carlsson & for the Swedish Childhood Diabetes Study Group

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ABSTRACT

This paper investigates if the effect of type 1 diabetes mellitus (T1DM) on school performance, documented in prior research, has changed in more recent birth cohorts of children using national Swedish population register data. The issue is of interest because management and treatment of the disease have improved over the last decades and, furthermore, because of changes in the educational grading system. Despite these changes, data indicate a persistent negative effect of T1DM on compulsory and upper secondary school grades with a standardized effect size of −0.109 and −0.070, respectively, and the results appear only marginally smaller compared to earlier findings in cohorts completing school under the previous grading system. Moreover, the results are consistent for alternative model specifications and econometric estimation strategies. Whereas access to new treatment technologies and improved diabetes management strategies has reduced the burden of diabetes in daily life, the results from this study indicate that continued efforts are needed to improve the situation in school for children with T1DM to prevent potential long-term socio-economic consequences.

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- Insulin Pump:
  - $5-7,000 for the pump
  - $100-200 pre month for infusion sets
- Continuous glucose sensor:
  - Transmitter: $240 (lasts 6-12 months)
  - Sensors: $120 each (1 per week)

Libre

- Scanner: $60-70
  - App available on I-Phones, can use as scanner
- Sensors: $50 each (last 2 weeks)

$$$$

- PICU hospitalization for DKA: $12,000
- One year of renal dialysis: $53,000

Access to care and technology

Future Topics (No time today…)

- Use of sensor / pump technology in hospital / procedures
- New onset: in or outpatient?
- Starting sensor and/or pump right away