

Foundations of Cardiometabolic Health Certification Course

Certified Cardiometabolic Health Professional (CCHP)



Continuous Glucose Monitoring: Rationale & Overview

Anne Peters, MD

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Disclosure of Potential Conflicts of Interest

Advisory Boards

- Abbott Diabetes Care
- Lilly
- Medscape
- Vertex

Research Funding

- Insulet
- Abbott

Stock Options

- Omada Health
- Livongo/Teladoc

Is A1c Enough To Help Us Manage Patients?

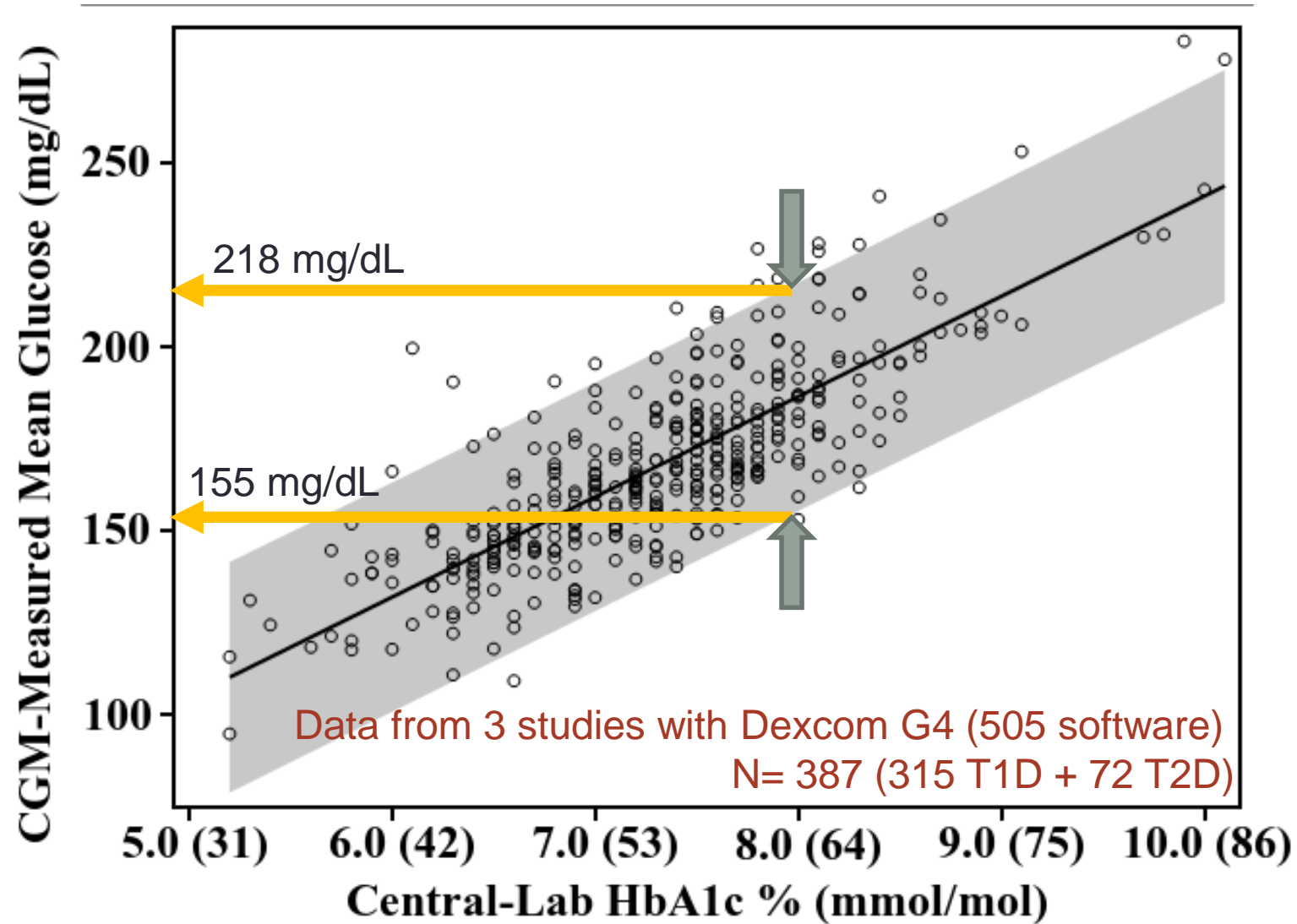
- **Strengths of A1c**

- Reflects blood glucose concentrations over ~3 months
- Only metric of glycemic control that has been prospectively associated with chronic complications
- Useful for assessing trends in a population over time

- **Limitations of A1c**

- Affected by other conditions that affect red blood cell lifespan or interfere with glucose binding to hemoglobin
- A wide range of mean glucose concentrations exist for a given HbA1c level
- Provides no information about hypoglycemia frequency or severity
- May under-represent the burden of hyperglycemia in African-Americans

CGM-measured Mean Glucose Versus Lab-Measured HbA1c

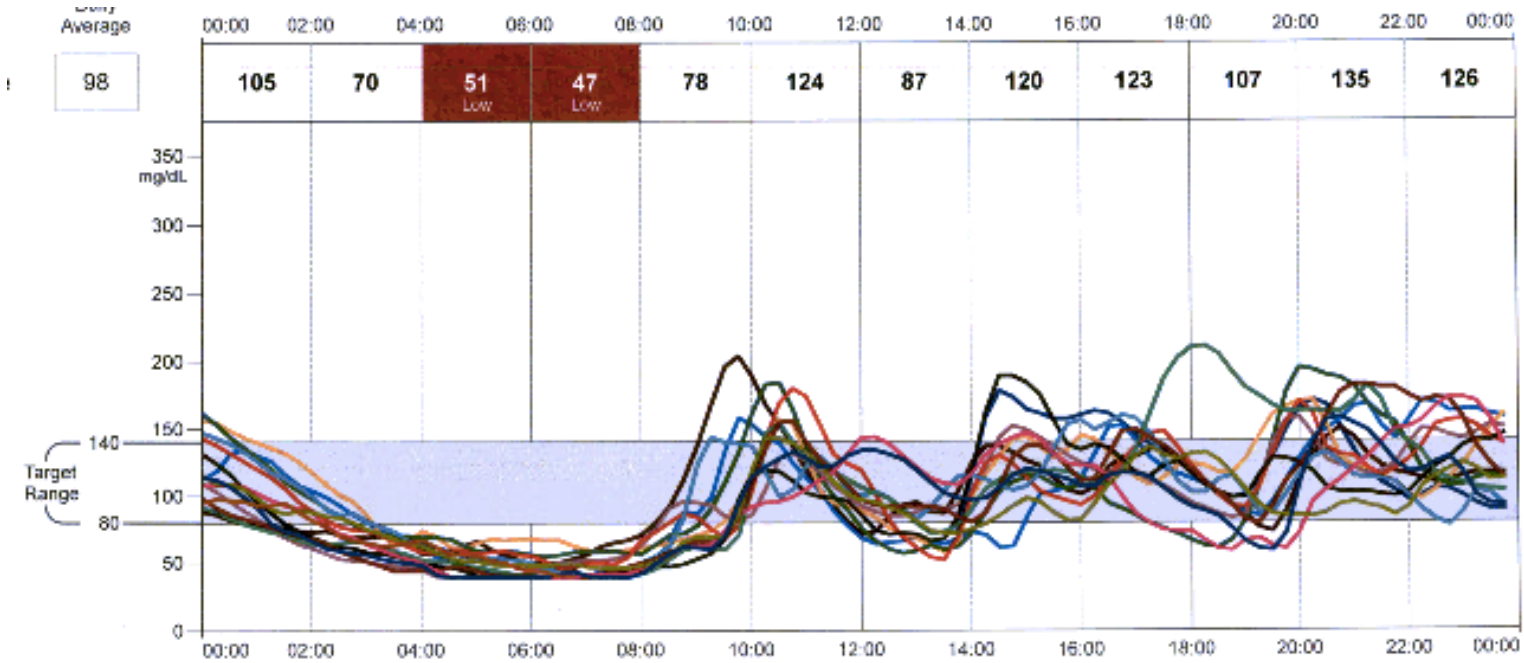


What Does Blood Glucose Monitoring (BGM) Show Us?

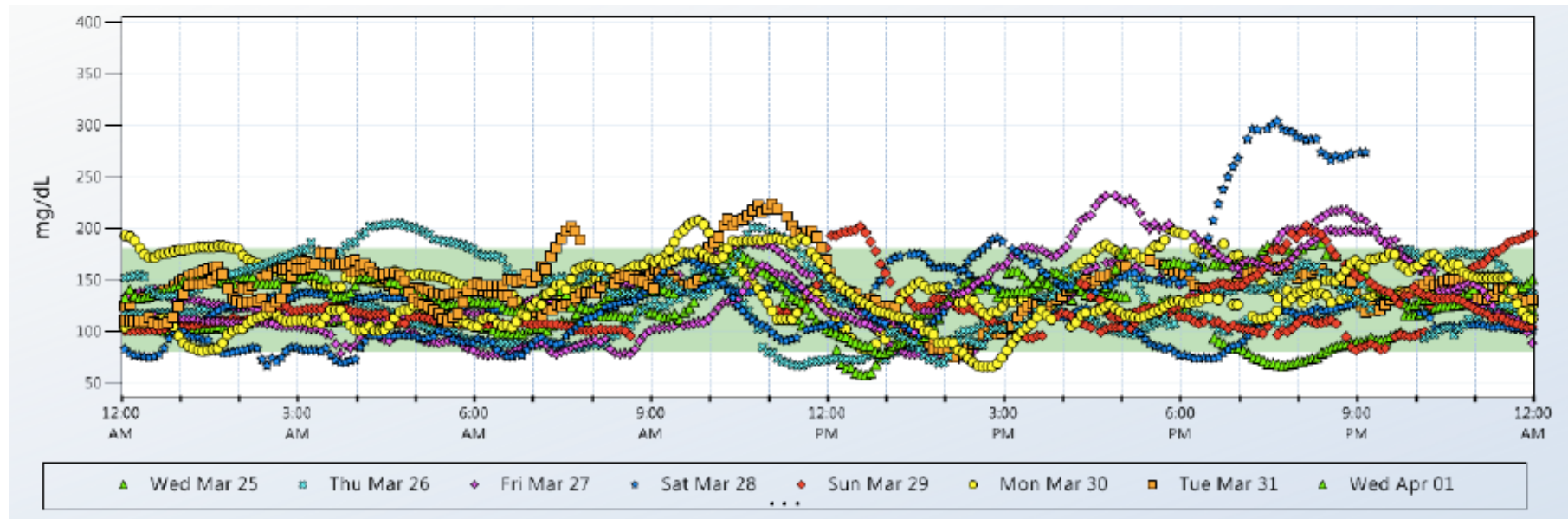
Date	Overnight			Early Morning			Late Morning			Early Afternoon			Late Afternoon			Early Evening			Late Evening			Bedtime		
	12 AM - 6 AM			7 AM - 9 AM			9 AM - 11 AM			11 AM - 2 PM			2 PM - 5 PM			5 PM - 7 PM			7 PM - 10 PM			10 PM - 12 AM		
	Gluc.	Med.	CHO	Gluc.	Med.	CHO	Gluc.	Med.	CHO	Gluc.	Med.	CHO	Gluc.	Med.	CHO	Gluc.	Med.	CHO	Gluc.	Med.	CHO	Gluc.	Med.	CHO
12/20/2016				○ 110						○ 95														
										● 156														
12/19/2016				○ 89						○ 113			● 210			○ 126			● 216					
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12/17/2016				○ 92						○ 99			● 167			○ 135			● 140					
12/16/2016				○ 97						○ 94			● 130			○ 131			● 139					
12/15/2016				○ 87						○ 107			● 123			○ 146			● 215					
12/14/2016				○ 106						○ 130			● 155			○ 105			● 150					
12/13/2016				○ 98						○ 94			● 125			○ 111			● 166					
12/12/2016				○ 101						○ 132			● 161			○ 143			● 165					
12/11/2016				○ 84						○ 77			● 99			○ 123			● 161					
12/10/2016				○ 98						○ 105			● 133			○ 170			● 143			● 129		

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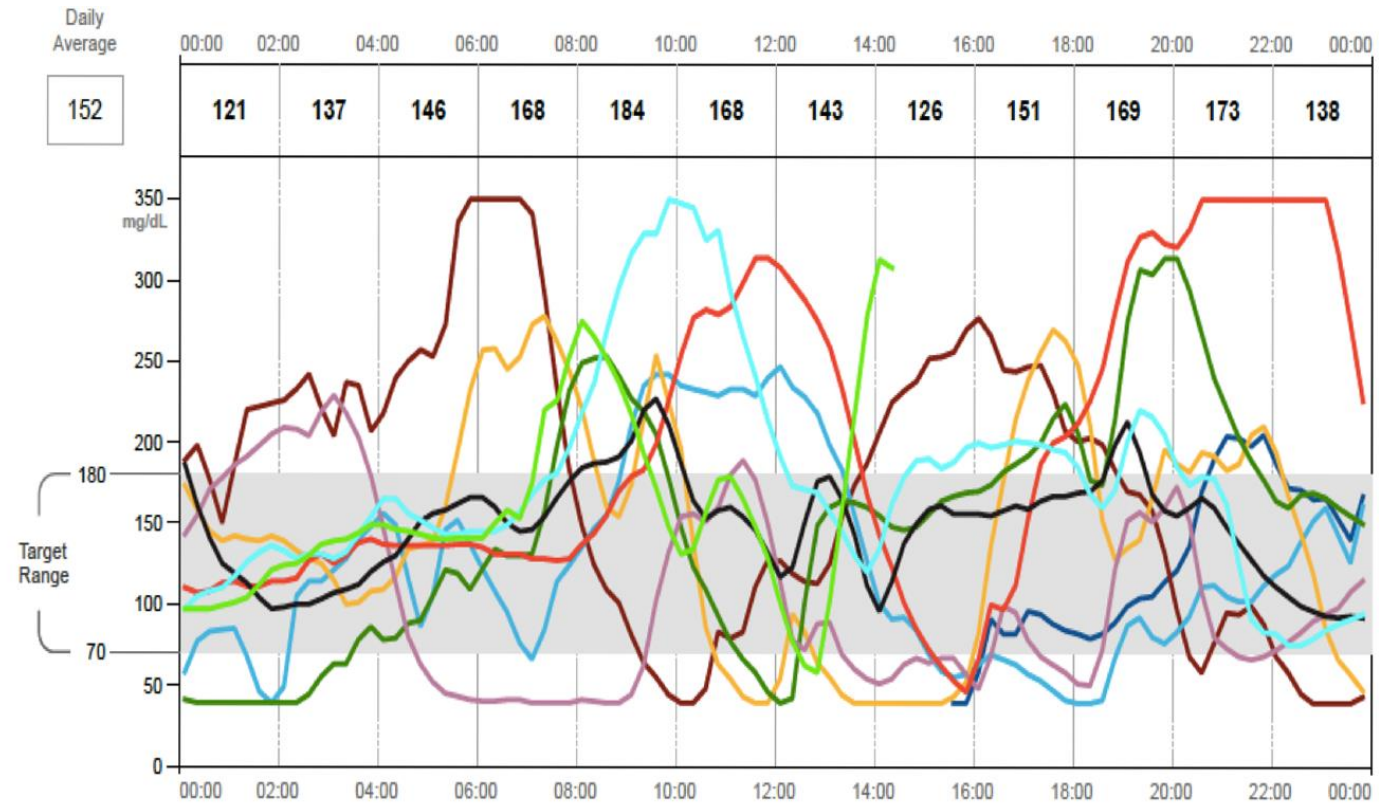
What Does Blinded (Professional) CGM Show Us?



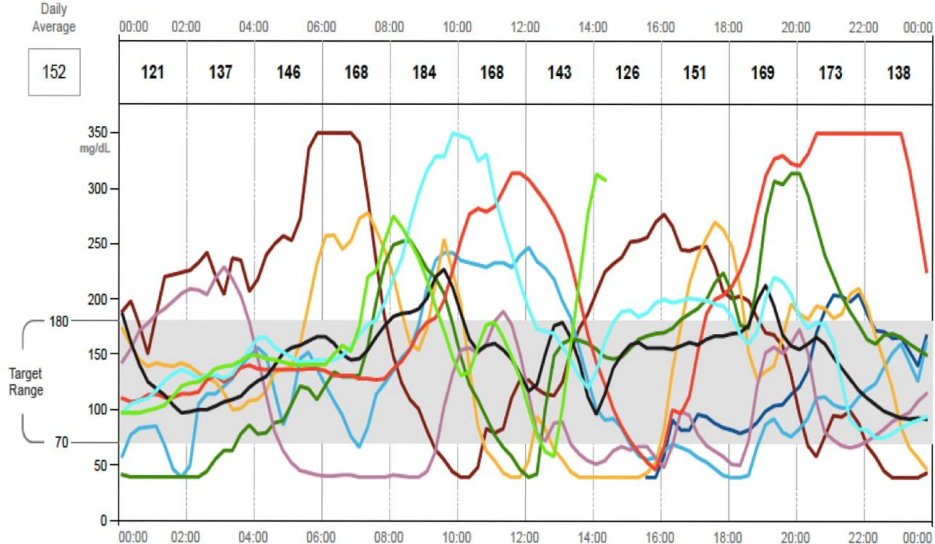
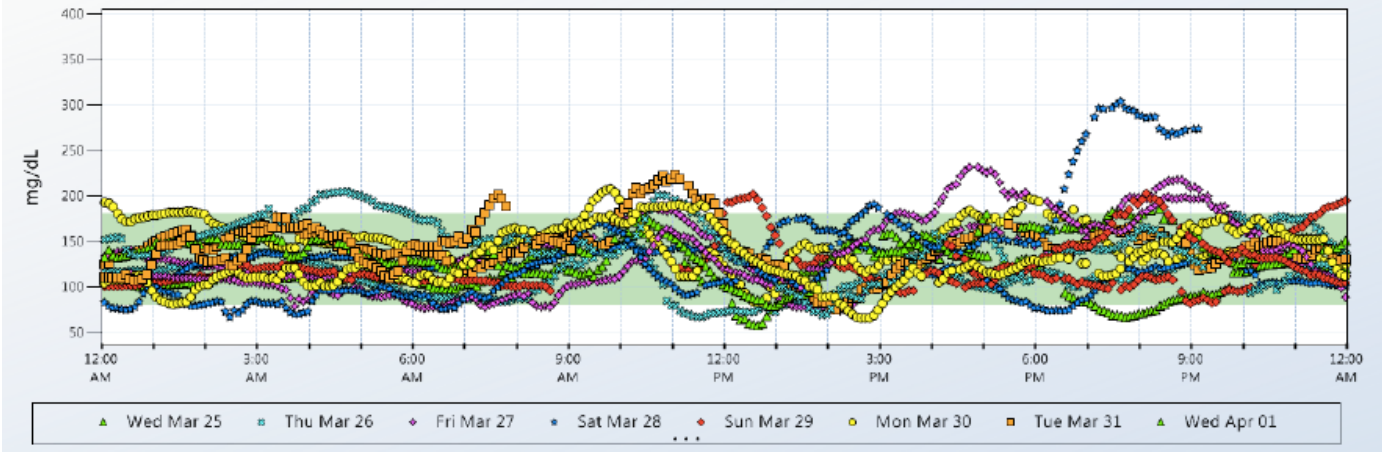
Real-Time CGM: A1C of 6.8% in a Person on Multiple Daily Insulin Injections (MDI)



Real Time CGM: A1C of 6.9% in a Person on MDI



The Same A1C, Very Different Glucose Control



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Available CGM Devices and Associated Features

Anne Peters, MD

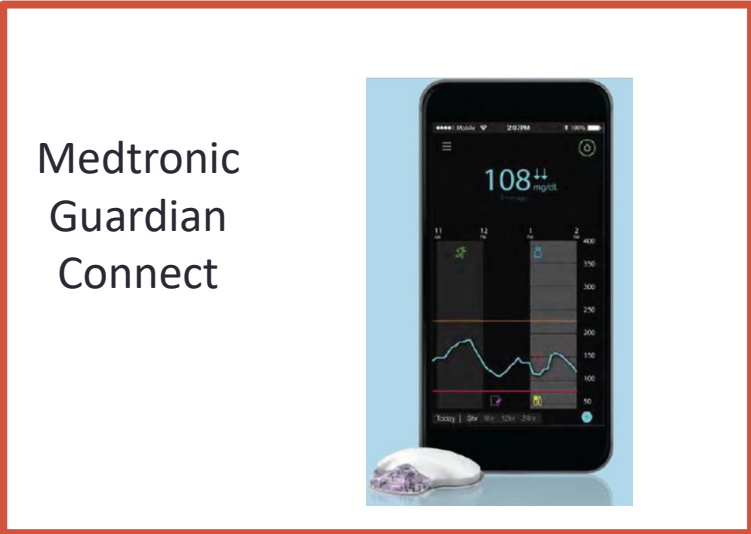
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Current Continuous Glucose Monitoring (CGM) Systems



What Types of CGM Are There?

- Professional: owned, provided by the clinician, placed on patient for 10 – 14 days to obtain brief “snapshots” of blinded or unblinded data

VS

- Personal: owned and used by the patient, replaced every 10 – 14 days (or implanted for 3 – 6 months), data viewed by the patient in real-time

RT-CGM: Dexcom G6 and G7



- Factory calibrated
- 10 days of sensor use
- Measures glucose concentration every 5 min
- Has alarms for hypoglycemia and hyperglycemia thresholds and alerts for trending high or low
- Can display glucose levels on a receiver, phone, or watch
- Can 'share' glucose readings with someone else
- G6 has two pieces, 2 hour warm up, larger
- G7 is smaller, one piece, 30 minute warm up
- G6 works with Tandem Control IQ + Omnipod 5

IS-CGM: Libre 14 day, Libre 2 and Libre 3

Abbott Libre and
Libre 2



- Factory-calibrated
- 14 days of sensor use
- Libre 14 day/2: Swiping for data
- Libre 3: direct to smart phone
- Libre 14 day: no alarms
- Libre 2 and 3: high and low alarms
- Not yet integrated with pumps

RT-CGM: Guardian Connect



- Sensor life 7 days
- Needs fingerstick calibration
- Transmits to smart phone
- Predictive alerts and alarms
- Sugar IQ decision support

RT-CGM: Eversense



- Implanted every 180 days
- Need fingerstick calibration
- Transmits to smart phone
- Predictive alerts and alarms

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CGM: Indications & Data Interpretation

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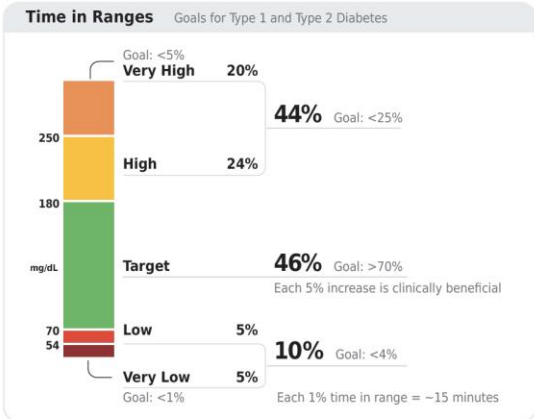
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Who Should Have a CGM?

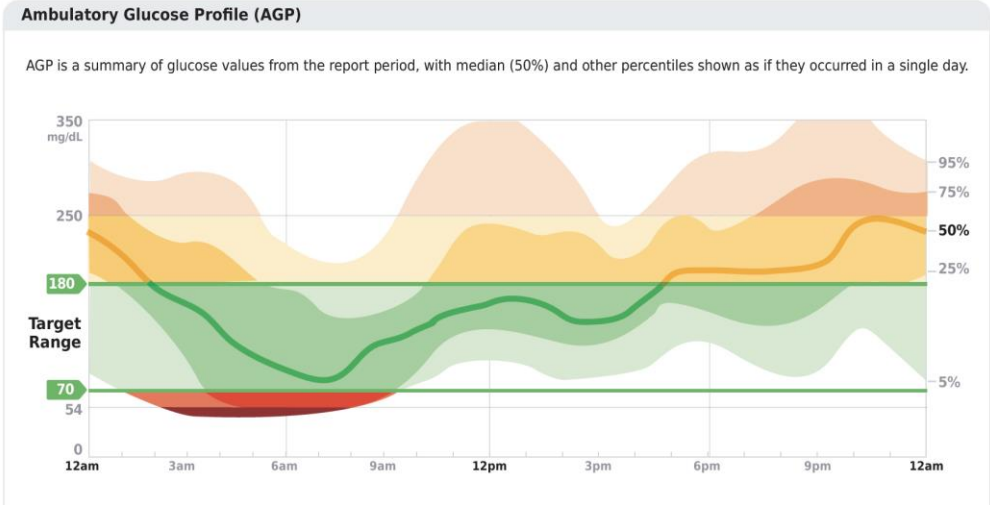
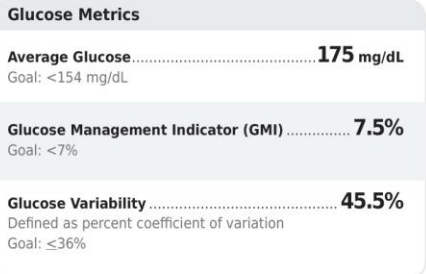
- Anyone on insulin—from one injection to many, any type of diabetes
- Anyone on noninsulin therapy having episodes of level 2 or 3 hypoglycemia
- Potentially everyone else when starting/adjusting therapy
 - Generally not covered, although some insurances will pay for it.

How Is Data From CGM Interpreted?

AGP Report: Continuous Glucose Monitoring



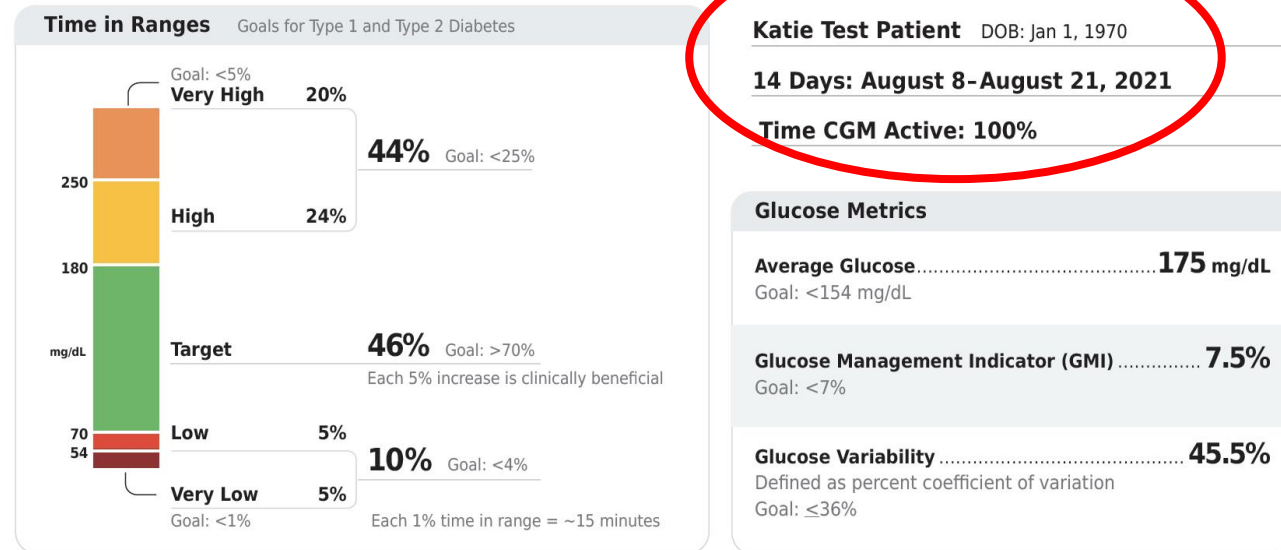
Katie Test Patient DOB: Jan 1, 1970
14 Days: August 8-August 21, 2021
Time CGM Active: 100%



How Is Data From CGM Interpreted? Step 1

Patient name, dates, use of CGM

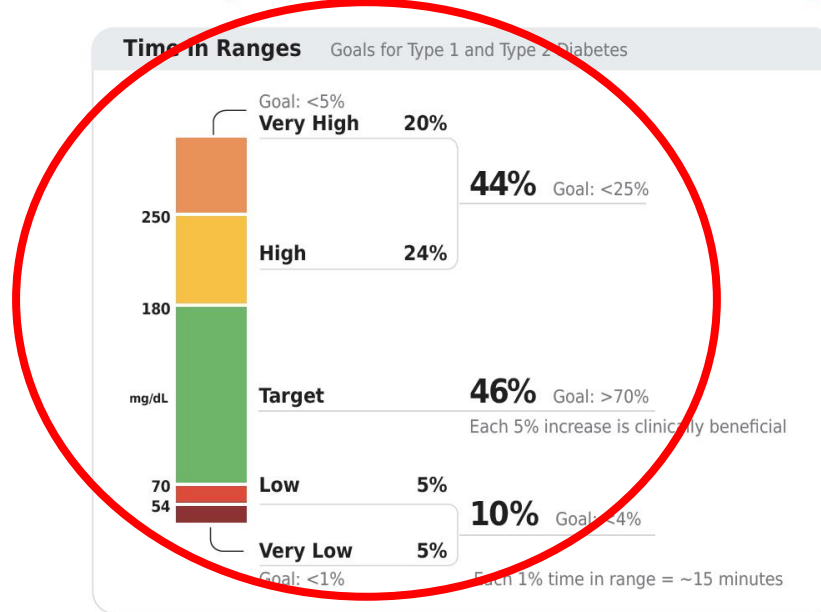
AGP Report: Continuous Glucose Monitoring



How Is Data From CGM Interpreted? Step 2

Percent time: low, in target, high

AGP Report: Continuous Glucose Monitoring



Katie Test Patient DOB: Jan 1, 1970

14 Days: August 8-August 21, 2021

Time CGM Active: 100%

Glucose Metrics

Average Glucose **175 mg/dL**
Goal: <154 mg/dL

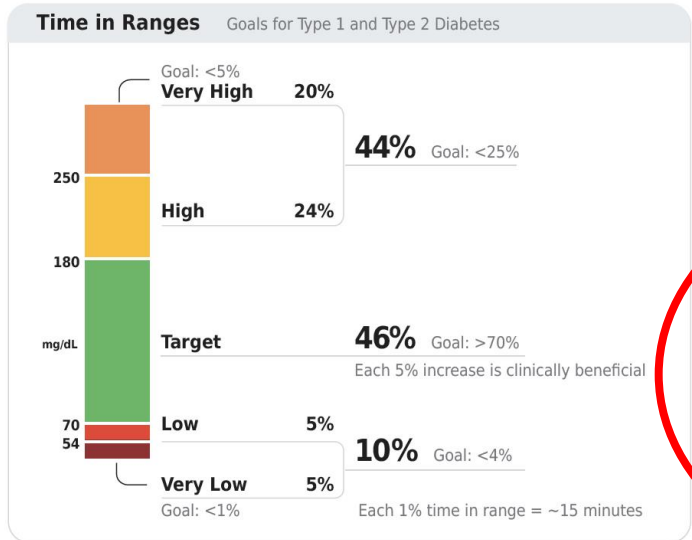
Glucose Management Indicator (GMI) **7.5%**
Goal: <7%

Glucose Variability **45.5%**
Defined as percent coefficient of variation
Goal: ≤36%

How Is Data From CGM Interpreted? Step 3

Average glucose, GMI, variability

AGP Report: Continuous Glucose Monitoring



Katie Test Patient DOB: Jan 1, 1970

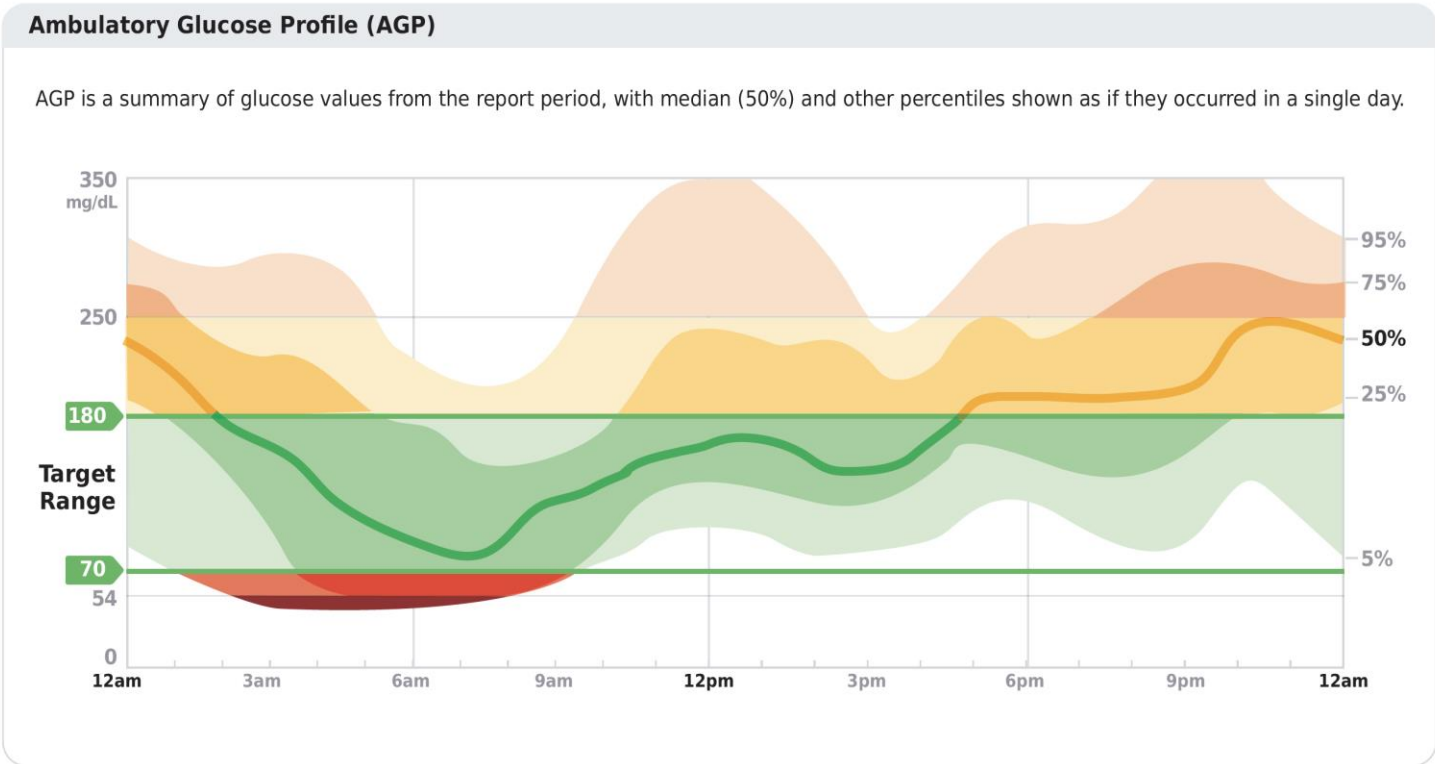
14 Days: August 8-August 21, 2021

Time CGM Active: 100%

Glucose Metrics	
Average Glucose	175 mg/dL
Goal:	<154 mg/dL
Glucose Management Indicator (GMI)	7.5%
Goal:	<7%
Glucose Variability	45.5%
Defined as percent coefficient of variation	
Goal:	≤36%

How Is Data From CGM Interpreted? Step 4

Modal Day

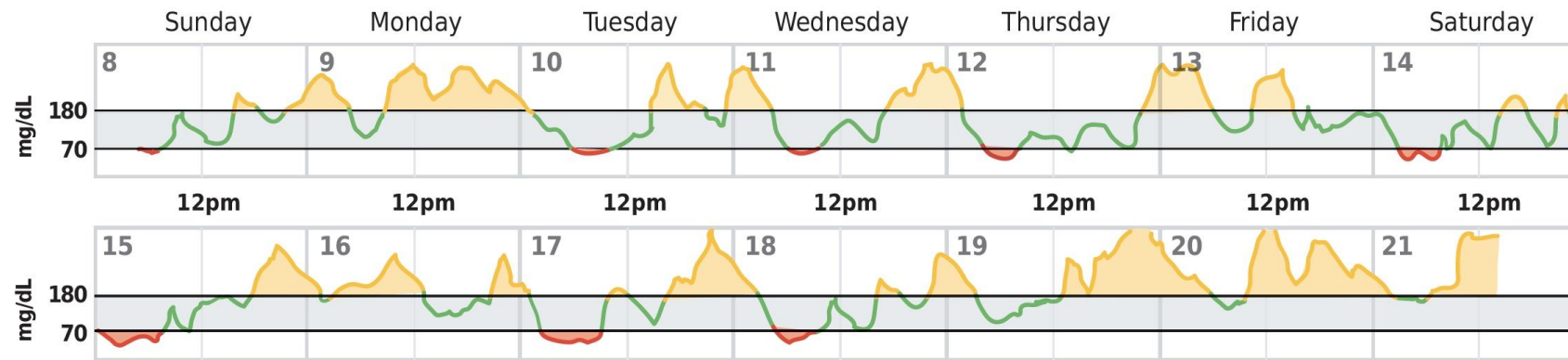


How Is Data From CGM Interpreted? Step 5

Individual Days

Daily Glucose Profiles

Each daily profile represents a midnight-to-midnight period.



Alarm Settings: Adjust to Avoid Over-Alerting

Example: Dexcom RT-CGM

Alert Settings for Device

General

Low	<input checked="" type="radio"/>	70 mg/dL
Low Repeat	<input checked="" type="radio"/>	15 min
High	<input type="radio"/>	200 mg/dL
High Repeat	<input type="radio"/>	30 min
Fall Rate	<input checked="" type="radio"/>	3 mg/dL/min
Rise Rate	<input checked="" type="radio"/>	3 mg/dL/min
Urgent Low	<input checked="" type="radio"/>	55 mg/dL
Urgent Low Repeat	<input checked="" type="radio"/>	30 min
Urgent Low Soon	<input checked="" type="radio"/>	55 mg/dL
Urgent Low Soon Repeat	<input checked="" type="radio"/>	30 min
Signal Loss	<input type="radio"/>	20 min

Scheduled - Bedtime

Status:
Sun, Mon, Tue, Wed, Thu, Fri, Sat
10:30 PM - 7:00 AM

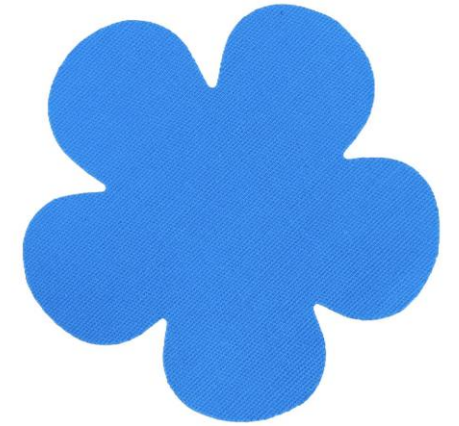
Low	<input checked="" type="radio"/>	70 mg/dL
Low Repeat	<input checked="" type="radio"/>	15 min
High	<input checked="" type="radio"/>	250 mg/dL
High Repeat	<input checked="" type="radio"/>	60 min
Fall Rate	<input checked="" type="radio"/>	3 mg/dL/min
Rise Rate	<input checked="" type="radio"/>	3 mg/dL/min
Urgent Low	<input checked="" type="radio"/>	55 mg/dL
Urgent Low Repeat	<input checked="" type="radio"/>	30 min
Urgent Low Soon	<input checked="" type="radio"/>	55 mg/dL
Urgent Low Soon Repeat	<input checked="" type="radio"/>	30 min
Signal Loss	<input type="radio"/>	20 min

Sensor: Skin Issues

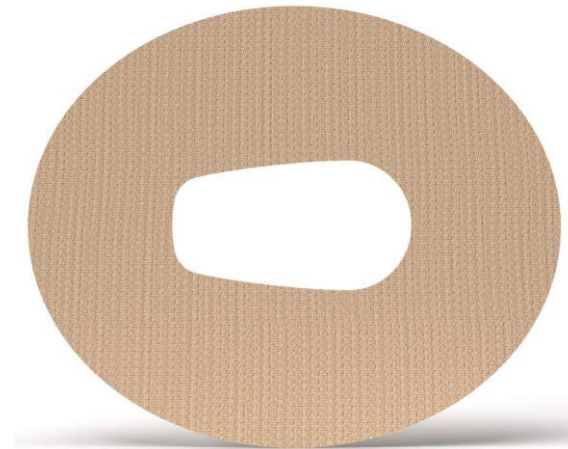


Sensors Fall Off

Many Over-Bandages Available



Liquid adhesives can make sensor stick better



Devices Must Be Downloaded for Interpretation

- However, many offices don't download data; staff needed to do so for each patient
 - Devices are not compatible with every data platform
 - Need USB cords for people using receivers
 - Many pages can print out, need to streamline most useful reports to optimize time in visit
- Many devices now have cloud-based programs with continuous data streams
- Increasing numbers of EHR's are able to capture CGM data
- Work with your local device company reps to set up systems that work
- Diabetes educators often can make this happen

Billing Codes for CGM

- **95251:** Interpretation of personal or professional CGM, requires at least 72 hours of data to be reviewed and a report by a prescribing HCP
 - Does not require face-to-face contact, up to 1 a month by many payors
- **95250:** Professional study – office-provided equipment, sensor placement, hook-up, calibration of monitor, patient training, removal of sensor, and printout of recording
- **95249:** Training on personal patient-provided equipment and sensor placement and initiation, once per unit

Education and Follow-up Are Vital

- Diabetes educators can be extremely helpful
- Companies can provide educators
- Devices apps can be programed to give weekly feedback to patients

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CGM Patient Cases

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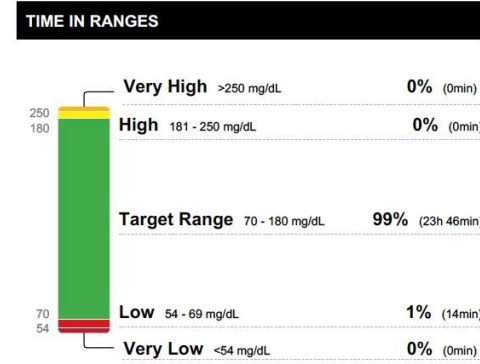
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Prediabetes and Type 2 Diabetes

Prediabetes

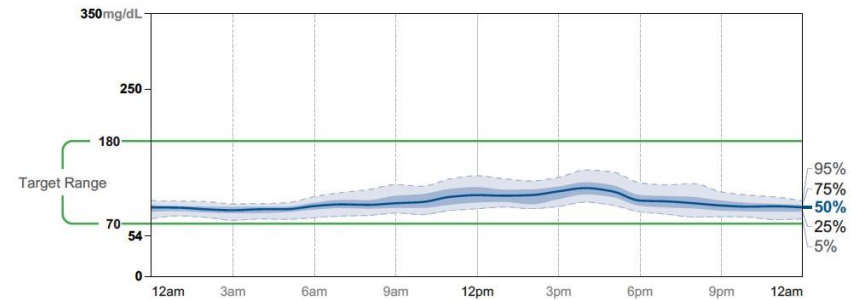
50 yo female with an FPG = 98 and an A1C = 5.7%
Lean, no FH of diabetes,
negative antibodies.

GLUCOSE STATISTICS AND TARGETS	
April 28, 2021 - May 11, 2021	14 Days
% Time CGM is Active	96%
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	99 mg/dL
Glucose Management Indicator (GMI)	5.7%
Glucose Variability	14.5%
Defined as percent coefficient of variation (%CV); target ≤36%	



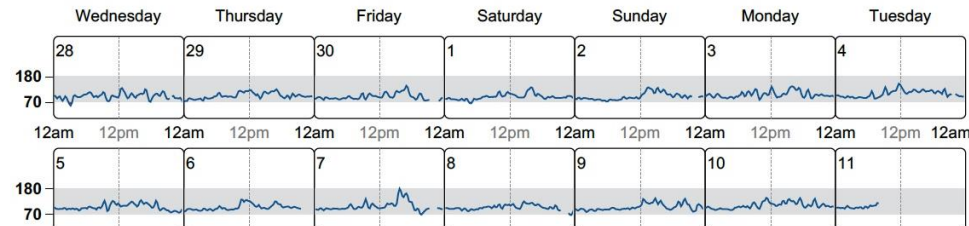
AMBULATORY GLUCOSE PROFILE (AGP)

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.



T2DM + CVD: On semaglutide, empagliflozin, metformin

64 yo male with a 10-year h/o T2DM, +neuropathy, s/p LAD stent. On max medical management.

CGM Glucose Pattern Summary

September 21, 2018 - October 2, 2018 (12 Days)

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

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

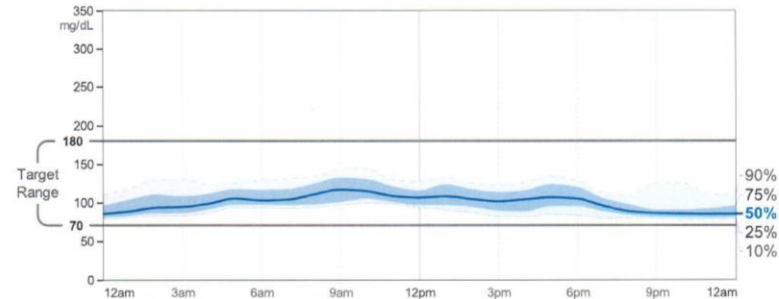
Summary



**Reference ranges calculated from population without diabetes.*

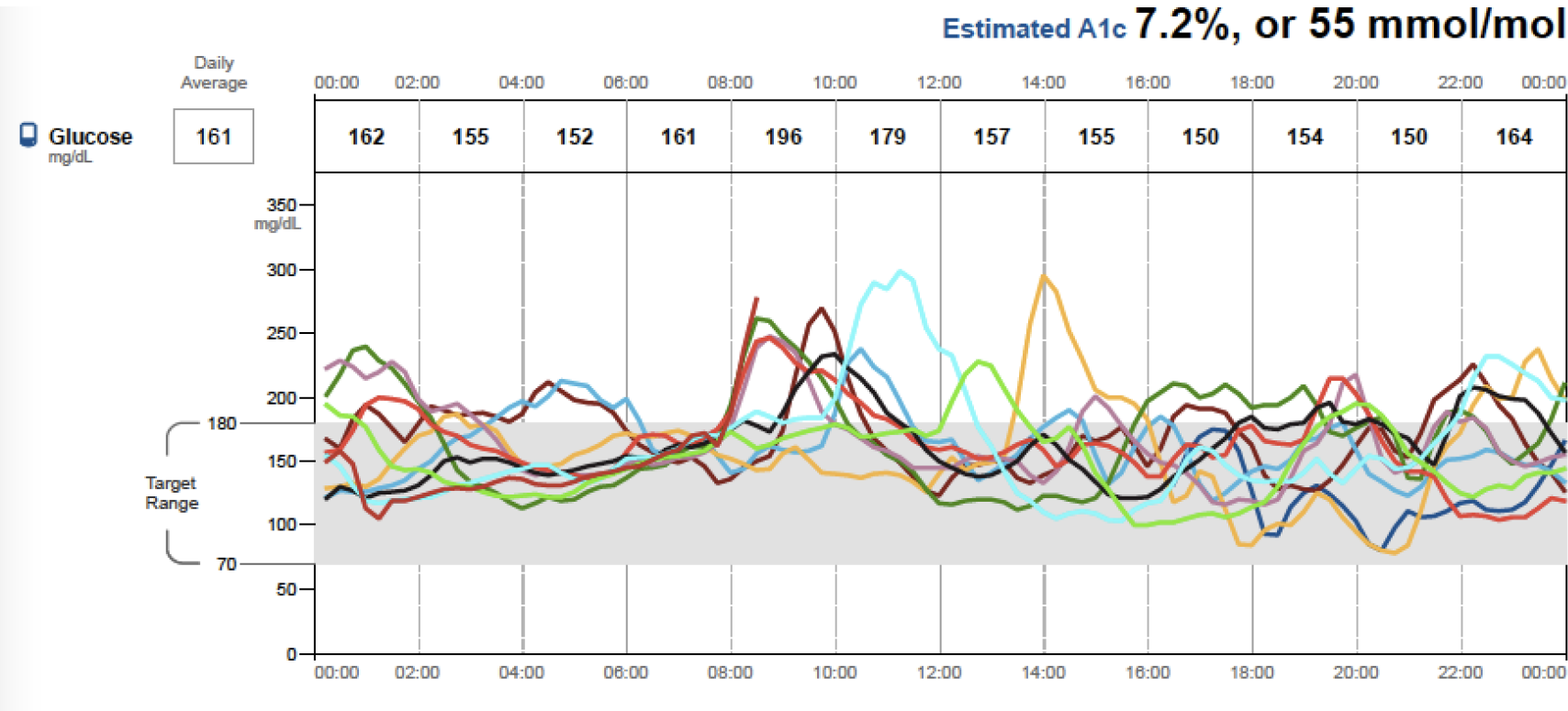
Ambulatory Glucose Profile

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



Patient #2: T2DM on Metformin Alone

68 yo female with T2DM, BDR and an eGFR = 58,
A/C ratio = 98.



Patient #2: T2DM with an SGLT-2 Added

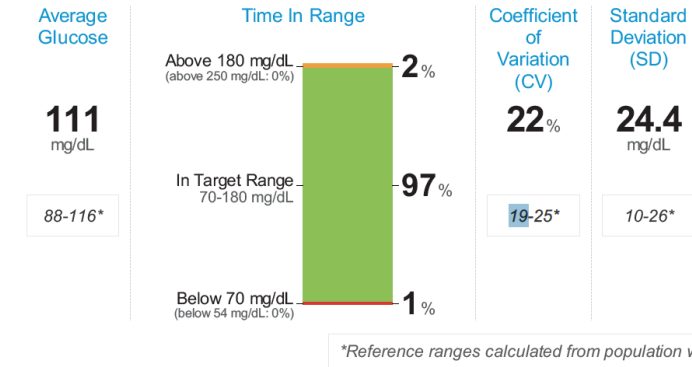
CGM Glucose Pattern Summary

February 7, 2019 - February 21, 2019 (15 Days)

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

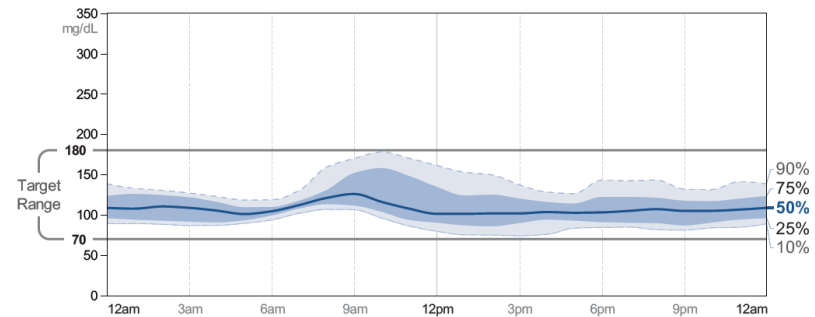
*Not applicable to FreeStyle Libre or FreeStyle Libre Pro which do not require calibration.

Summary



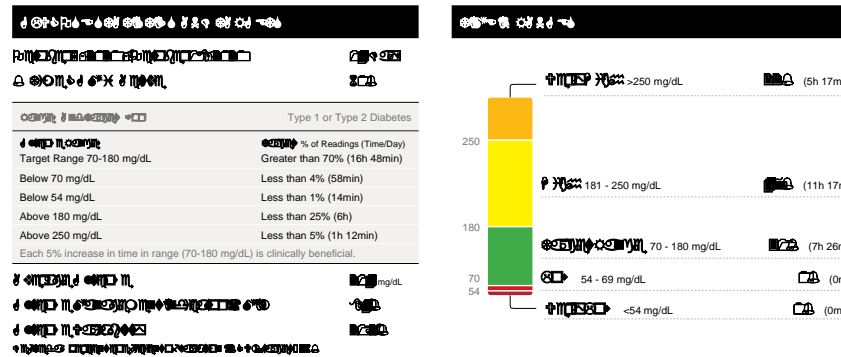
Ambulatory Glucose Profile

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

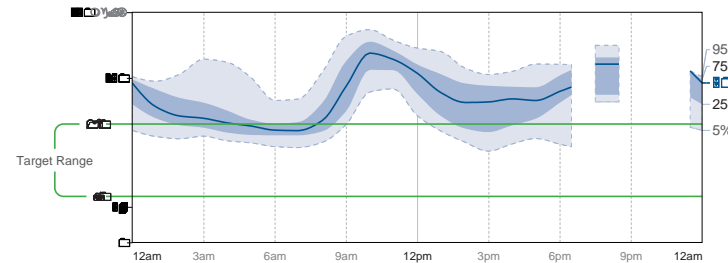


Pandemic—Related Increase in A1C

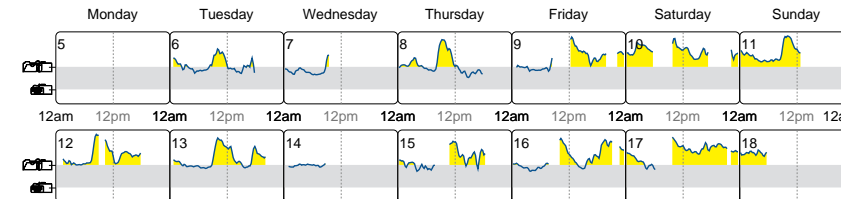
86 yo male on max oral therapy, A1C generally ~6.8%, nearly blind from macular degeneration.



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.



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>.

Changed His Lifestyle and Got Vaccinated!

AGP Report

March 9, 2021 - April 5, 2021 (28 Days)

GLUCOSE STATISTICS AND TARGETS

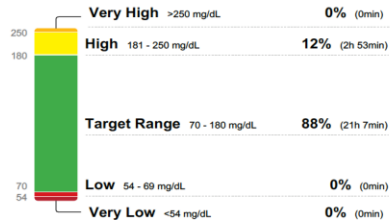
March 9, 2021 - April 5, 2021 **28 Days**
% Time CGM is Active 64%

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.

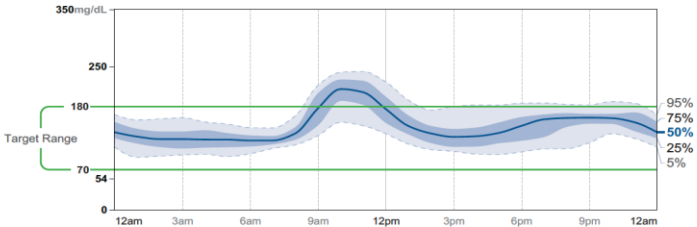
Average Glucose 140 mg/dL
Glucose Management Indicator (GMI) 6.7%
Glucose Variability 23.8%
 Defined as percent coefficient of variation (%CV); target ≤36%

TIME IN RANGES



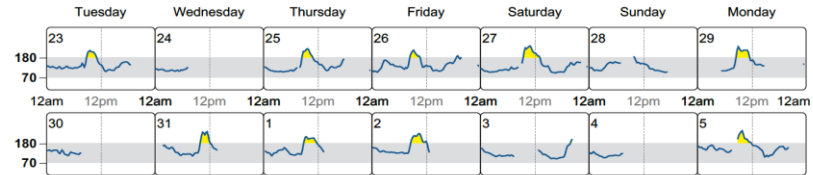
AMBULATORY GLUCOSE PROFILE (AGP)

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DAILY GLUCOSE PROFILES Most recent 14 days. See Weekly Summary report for more days.

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Source: Battelino, Tabej, 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>.

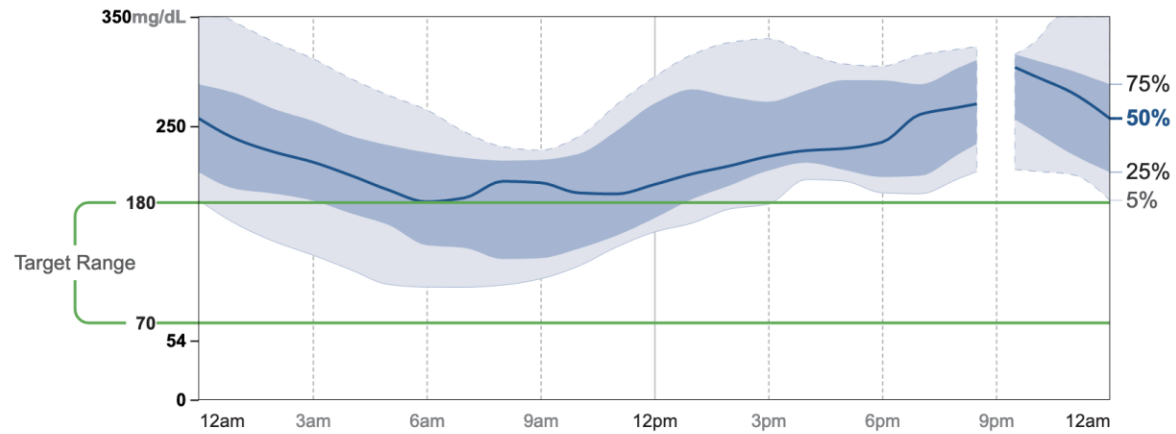
How CGM Can Help With Remote Management

- 74-year-old patient had been doing well on BIDO
- He called to say that his “sugars were out of control”
- A1C’s below 8.0% on metformin 1 gm BID, sitagliptin 50 mg, 12 units of basal insulin. Using CGM.
- Metformin had been stopped due to a fall in his eGFR to 22.
- I went into the cloud-based program for his CGM, pulled up his data and saw the following:

His CGM Data

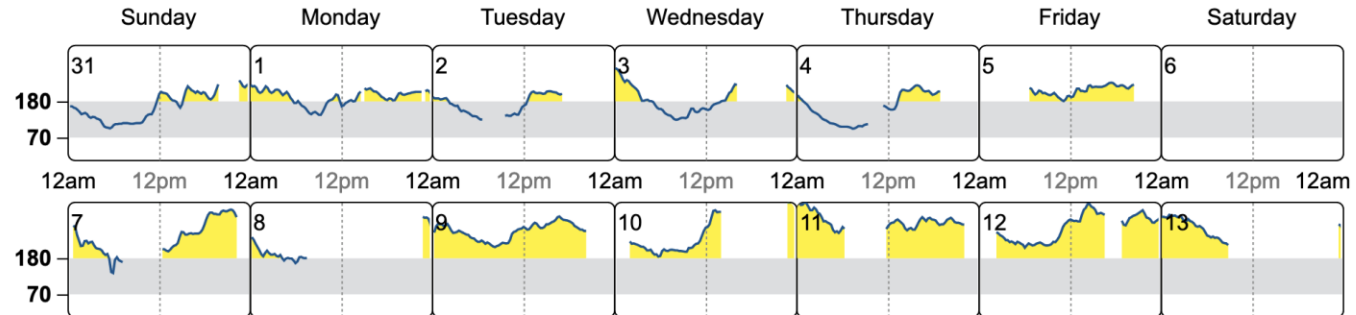
AMBULATORY GLUCOSE PROFILE (AGP)

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DAILY GLUCOSE PROFILES

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What I Did

- Increased his basal insulin
- Added glipizide 5 mg BID to avoid complexity of prandial insulin
- Reduced his sitagliptin to 25 mg
- Followed his BG's every 3 days and adjusted his medications until he improved

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CGM: Conclusions

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Conclusions

- CGM can be useful in a wide variety of settings
- Systems must be set-up for data downloading and analysis
- Training, education and follow-up are key to success
- Patients often find CGM preferable to performing BGM and increasing coverage has improved access for many

Thank You