# Advanced Diabetes Technology – Conversations and Collaborations

Live Webinar

# Commercial Support

This activity is supported by independent educational grants from Abbott Diabetes Care, Dexcom, Lilly, Medtronic, and Novo Nordisk.

# Disclosures

**Faculty**

- Matthew Levine, MD, FACE, Novo Nordisk, speakers' bureau on diabetes; Eli Lilly, speakers' bureau on diabetes; Mannkind, consultant
- Jeff Unger, MD, FAAFP, FACE, Abbott Diabetes, consultant and speakers' bureau; Dexcom, consultant
- Claire Ingram, PA-C, no relationships to disclose
- Lucy Thornton, MSN, APRN, FNP-BC, no relationships to disclose

All of the relevant financial relationships listed for these individuals have been mitigated.

**Planners**

- Amy Ogunsunlade, no relationships to disclose
- Diane Alberson, MEd, CAE, no relationships to disclose

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# Learning Objectives

Upon completion, participants will be able to:

- Assess differences between available continuous glucose monitors and the appropriate settings for implementing the use of diabetes technologies
- Identify interventions which can add value to A1c interpretation and optimize time-in-range glucose values to improve patient outcomes
- Integrate diabetes technologies into clinical practice and harness these devices to improve glycemia, guide patient education and empower patients to self-manage their diabetes

# Overview of Enduring Material

# Orientation to CGM

Sensor: a small wire inserted under your skin on the stomach or back of the arm and is responsible for measuring the blood glucose levels every minute or five minutes

Transmitter: a wireless component of the sensor and it sends the blood glucose levels to the receiver, reader, or a smart phone app

Receiver: also called reader, is a separate device that displays the data from the sensor

**Auto-applicator**

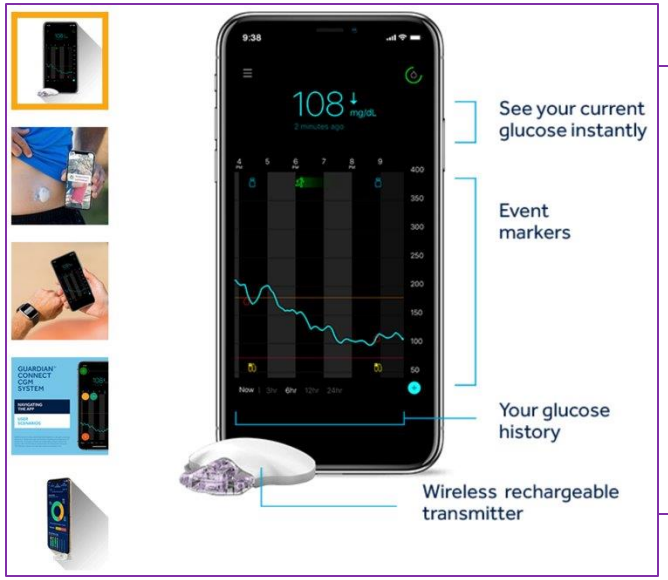
Provides simple sensor insertion at the push of a button. A patient can apply the sensor on their own by following the instructions for use.

**Sensor**

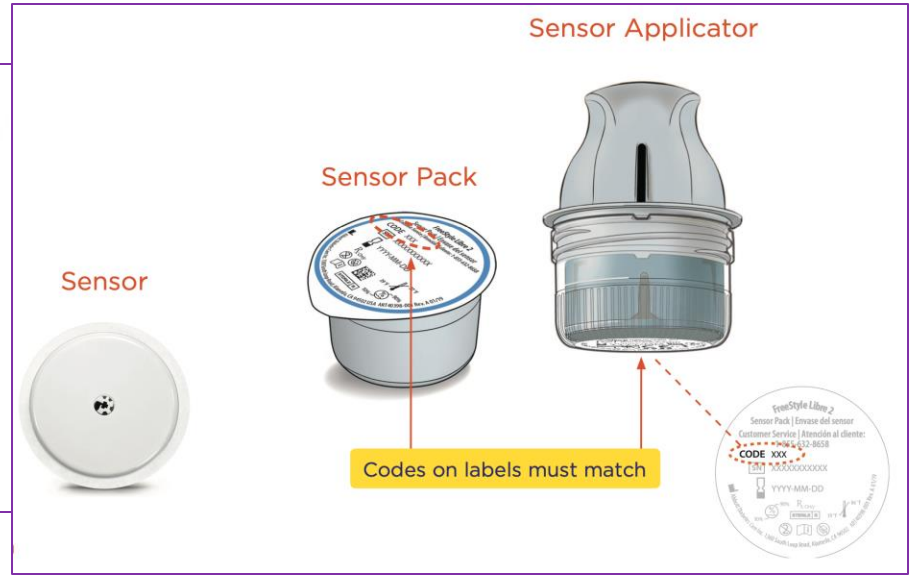
Monitors interstitial glucose levels through a small wire inserted just underneath the skin, sending a signal to the transmitter (10-day lifespan).

**Transmitter**

Fastened on top of the sensor; sends data wirelessly to the wearer's compatible display device* (3-month lifespan).





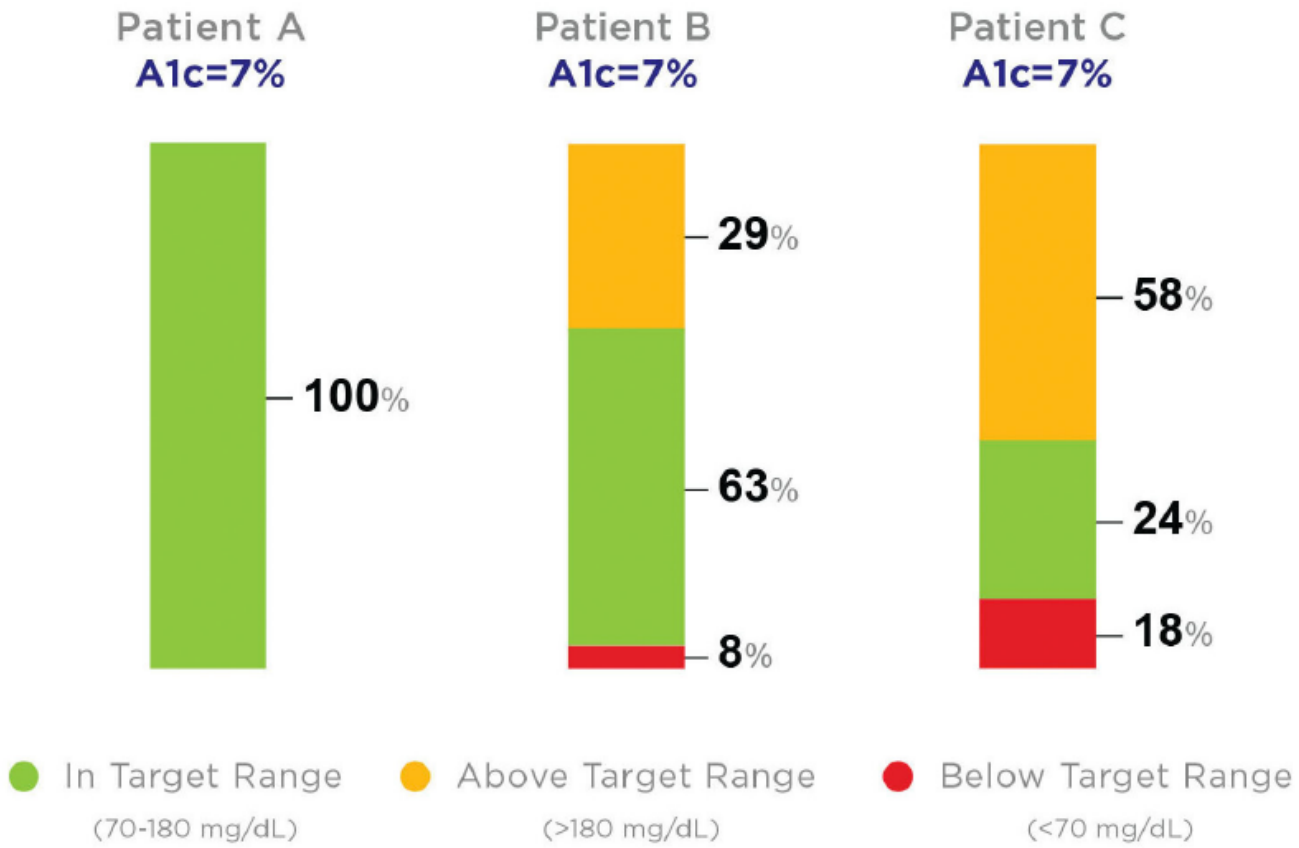


# CGM Comparison

| | Dexcom G6 ® | Guardian 3 ® | Libre 14-day ® | Libre 2 ® | Libre 3 ® | Eversense ® |
|---|---|---|---|---|---|---|
| Type of CGM | rtCGM | rtCGM | isCGM | isCGM | rtCGM | rtCGM |
| Days of Sensor Wear | 10 | 7 | 14 | 14 | 14 | Up to 180 |
| Warmup Time | 2 hours | 2 hours | 1 hour | 1 hour | 1 hour | 24 hours |
| Fingerstick calibration required? | No | Yes – minimum of twice daily | No | No | No | Yes – 24 hours after insertion 4 calibrations 2-12 hours apart, then twice daily 10-14 hours apart |
| Alarms | Yes | Yes | No | Yes | Yes | Yes |
| Integrations with Pump | Yes – Tandem t:slim X2 and OmniPod5 | Yes and No; The Guardian 3 is part of the Medtronic 670G/770G hybrid closed-loop insulin pump system. The Guardian Connect is a standalone CGM that does not connect to any pump. | No | No, but is compatible with Bigfoot smart pen cap | No | No |
| Smartphone Integration | Android, iOs, Apple Watch | Android, iOs, | Android, iOs, | Android, iOs, | iOs (Android pending at time of writing) | Android, iOs, Apple Watch |
| Data sharing (only available if using app) | Up to 10 people with Dexcom Follow app (Apple, Google) | Up to 4 people with CareLink™ Connect web app (Apple, Google) | Up to 20 people with LibreLinkup app (Apple, Google) | Up to 20 people with LibreLinkup app (Apple, Google) | Up to 20 people with LibreLinkup app (Apple, Google) | Up to 5 people with Eversense Now app |
| Separate Receiver Available | Yes | No | Yes | Yes | Not at time of writing | No |
| Water Resistance (SENSOR ONLY) | 8 feet for up to 24 hours | 7.5 feet for 10 minutes | 3 feet for 30 minutes | 3 feet for 30 minutes | 3 feet for 30 minutes | 1 meter (~3 feet) for 30 minutes |
| Interferences | Hydroxyurea – may falsely elevate sensor readings) | Tylenol – may falsely elevate sensor readings) | Vitamin C – may falsely elevate sensor readings Aspirin – may falsely lower sensor readings | Vitamin C >500mg/day – may falsely elevate sensor readings | Vitamin C >500mg/day – may falsely elevate sensor readings | Tetracyclines – may falsely lower sensor readings |

# Not All A1cs Are Created Equal

A1c only provides a broad look at a patient's glucose history. Time in Range provides more actionable information than A1c alone and should complement A1c.[1]




Not actual patient data; for illustrative purposes only.

1. Battelino T, Danne T, Bergenstal RM, et al. Clinical targets for continuous glucose monitoring data interpretation: recommendations from the international consensus on time in range. *Diabetes Care.* 2019;42(8):1593-1603.

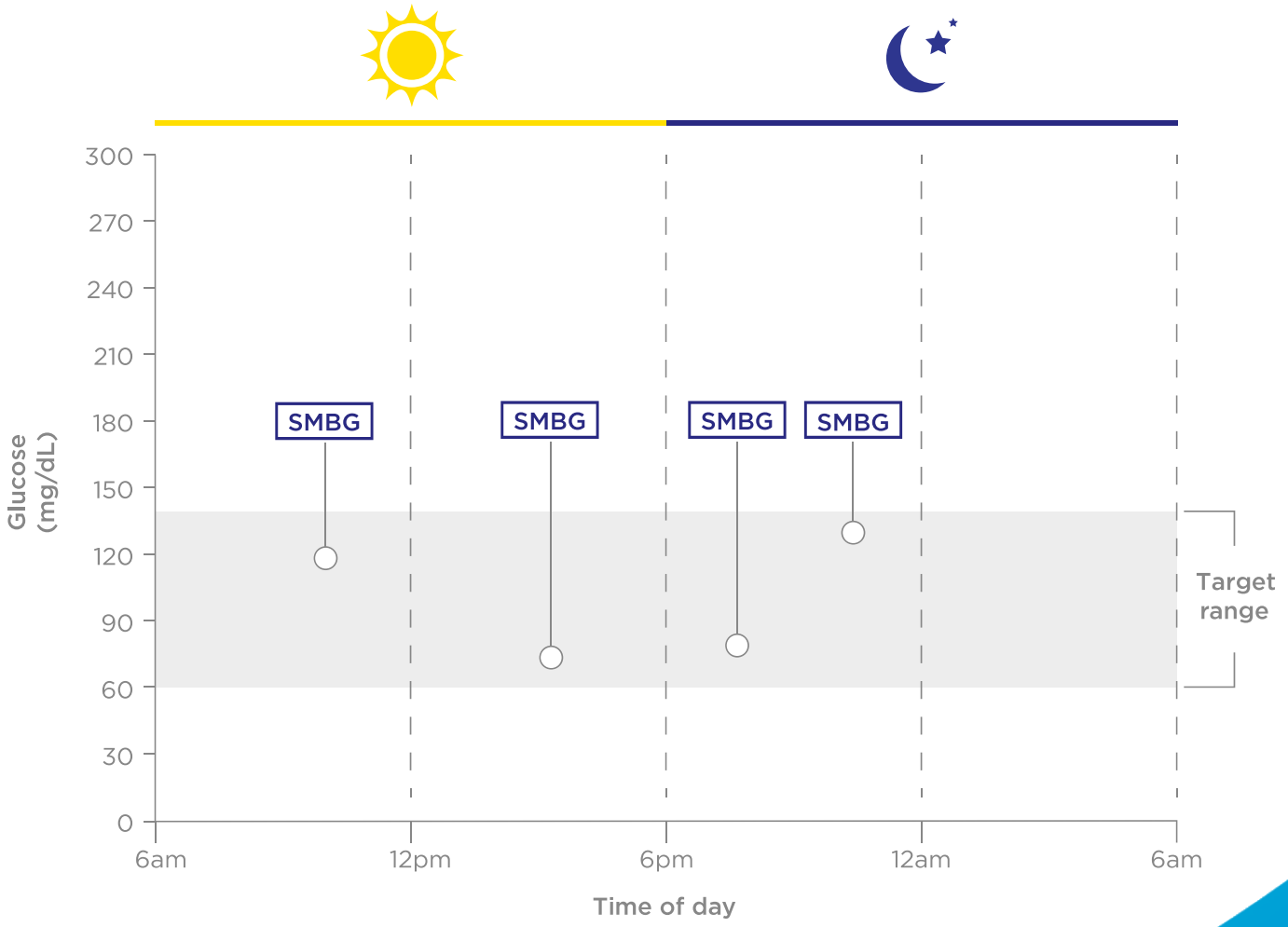
# How CGM Can Help Reduce Diabetes Management Challenges

## Self-monitoring of blood glucose (SMBG) limitations

Even with multiple daily fingersticks, SMBG can leave highs & lows undetected[1]

Patients using SMBG could be spending significant time outside of range

**SMBG only provides readings for a single point in time**




*Not actual patient data; for illustrative purposes only.*

**1.** Janapala Rajesh Naidu, et al. "Continuous Glucose Monitoring Versus Self-monitoring of Blood Glucose in Type 2 Diabetes Mellitus: A Systematic Review with Meta-analysis." *Cureus* 11, no. 9 (September 2019):e5634.

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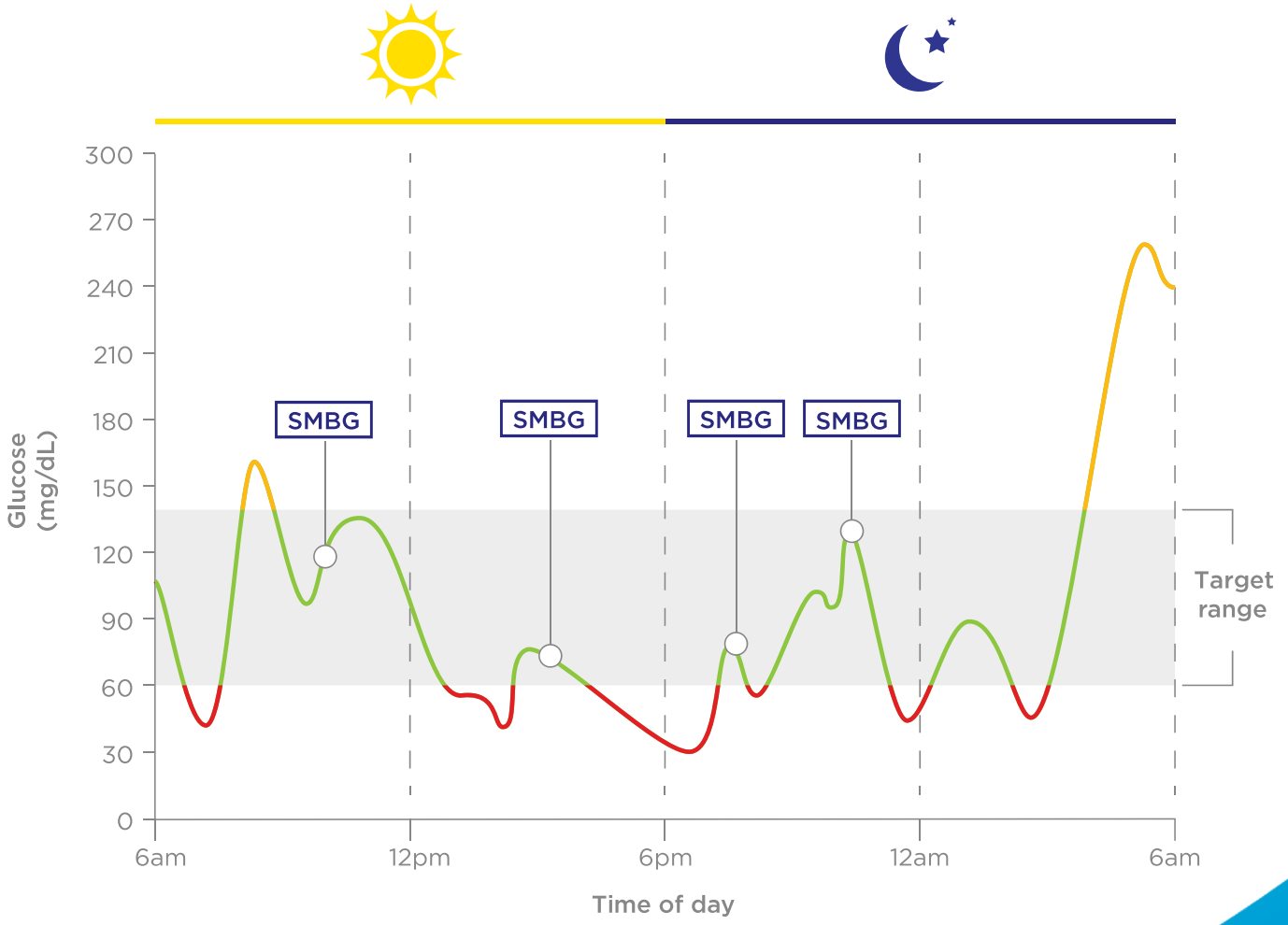


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# Glucose Variability is not Apparent from A1c

**If basal insulin is increased by 20 % which patient is likely to develop treatment emergent hypoglycemia?**

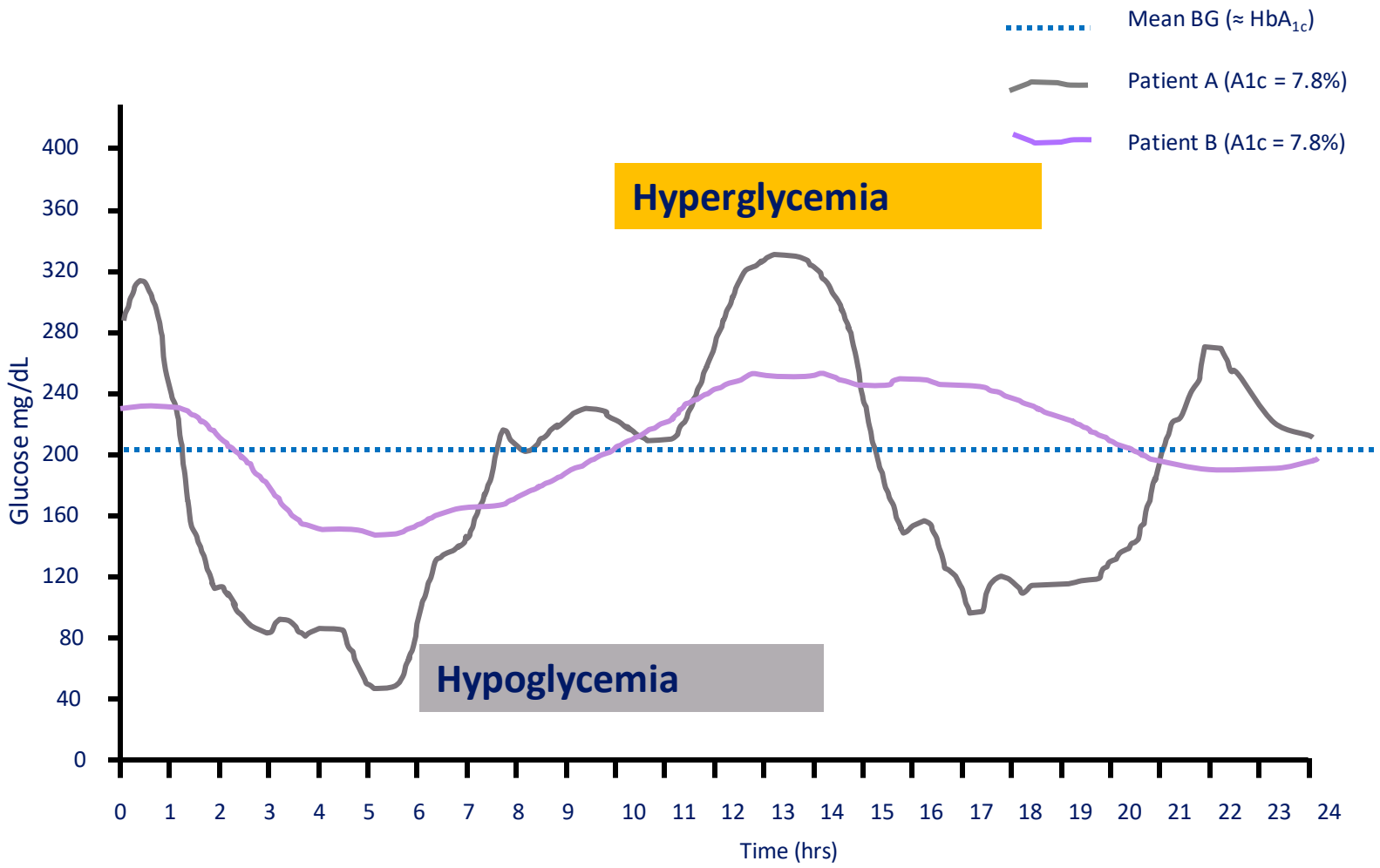


Image adapted from Penckofer S, Quinn L, et al. Does glycemic variability impact mood and quality of life? Diabetes Technol Ther. 2012 Apr;14(4):303-10.

# Benefits of CGM

Insights into effects of food, exercise, illness and medication on real-time diabetes management

Improved Time in Range (TIR)

Directional arrows

Audible alarms for highs and lows

Approved for children and adults with diabetes

Connectivity to insulin pumps

- Predictive alerts for highs and lows can automatically adjust insulin delivery rates

Connectivity with clinicians and family members

Data can be easily downloaded to the clinician's office and reviewed during a face to face or virtual visit

Improved A1c

Reduced absenteeism from work

Reduced ED Visits

Reduction in Hypoglycemia

Reduction in long and short-term DM related complications

1) ADA 2020 Scientific Sessions. Presented 6/13/20. Abstract 898-P. Grunberger G, Sherr J, Allende M, Blevins T, Bode B, Handelsman Y, Hellman R, Lajara R, Roberts VL, Rodbard D, Stec C, Unger J. AACE Guideline. American Association of Clinical Endocrinology Clinical Practice Guideline: The Use Of Advanced Technology in the management of persons with diabetes Mellitus. Endocrine Practice. 2021. 27. 505-537 2) ADA 2020 Scientific Sessions. Abstract 898-P. 3) Unger J, Kushner P, Anderson JE. Practical guidance for using the Freestyle Libre Flash continuous glucose monitoring in primary care. Postgraduate Medicine. https://doi.org/10.1080/00325481.2020.1744393 . March 30, 2020.

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# Tricks to Successful Initiation of CGM In Primary Care

## Role of the Clinician

- Make it simple!
- Consider putting the first sensor on in the office for the patient. Subsequent sensors can be placed by the patient with guidance from MA
- Explain how the CGM may benefit patients' diabetes control
  - More time in prescribed range
  - Reduced incidence of hypoglycemia
  - Improved glycemic variability
  - Access to data while sleeping
  - Improve A1c
  - Reduce risk of hospitalizations
  - Improved rates of work absenteeism

## Role of the Patient

- Confidence in applying the sensor appropriately
- Scan frequently
- Minimize gaps in sensor wear
- Contact Customer Service if sensors fail or fall off
- Bring data to each visit
- Understand glycemic patterns related to food, sleep, exercise, travel, etc.

# CPT Codes For Professional Reimbursement

| CPT code | Descriptor | Medicare Allowable for Florida |
|---|---|---|
| 95249 | Patient-owned (non-professional) CGM sensor placement, hook-up, calibration, patient training, removal of sensor, and printout of recording<br>- Requires minimum of 72 hours of data collection<br>- Can only be billed once for the duration the patient owns the device | $55.74 - $62.21 |
| 95250 | **Professional** CGM sensor placement, hook-up, calibration, patient training, removal of sensor, and printout of recording<br>- Requires minimum of 72 hours of data collection<br>- Can be billed once per month | $148.46 - $163.23 |
| 95251 | CGM download and interpretation<br>- Patient does not have to be physically in the office<br>- Can be billed once a month<br>- Requires minimum of 72 hours of data for review | $35.60 - $38.09 |
| 99091 | Download and interpretation of insulin pump data<br>- Can be billed once a month<br>- CPT codes 95249, 95250, and 95251 cannot be billed in addition to this code | $56.79 - $60.66 |

https://www.cms.gov/medicare/physician-fee-schedule/search

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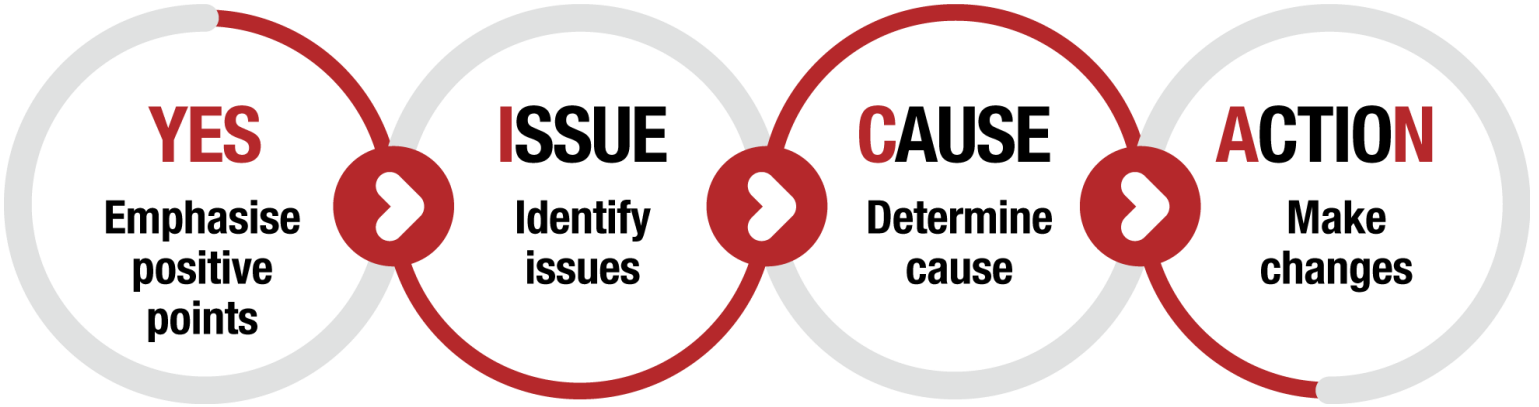
# Questions?

# Interpretation of CGM Reports

# Interpreting the AGP Report in the Clinic

1. Check for adequate data: has CGM been used at least 70% of the time during the report period?
2. Review TIR and TBR.
3. Review mean glucose, glucose management index (GMI) and glycemic variability (coefficient of variation [CV]).
4. Review the AGP graph to identify any patterns of hypoglycemia and hyperglycemia.
5. Discuss the key data from the AGP report and what they mean with the patient.
6. Identify one or two issues on which to focus, and make an action plan.

**Yes I Can Approach:**



# AACE Recommendations For Interpreting AGP Data

Use a systematic approach

- Review overall glycemic status (GMI-glucose management indicator, average glucose)
- Check Time In Range (TIR), Time below range (TBR) and Time above range (TAR)
  - TBR should be < 4 %
  - TIR should be > 70 %
- Review 24-hour glucose profile to ID problematic times as well as the magnitude of the problem (hypos and hyperglycemic events)
- Review treatment regimen and adjust as needed

Grunberger G, Sherr J, Allende M, et al. American Association of Clinical Endocrinology Clinical Practice Guideline: The Use of Advanced Technology in the Management of Persons With Diabetes Mellitus. Endocr Pract. 2021 Jun;27(6):505-537.

# Benefits Of Improving Time In Range (TIR) Using CGM

| Population | Outcome | Results |
|---|---|---|
| 3262 T2DM Patients | Retinopathy | Each 10 % increase in TIR from baseline reduces risk by 8 % |
| 2215 T2DM Patients | Carotid intima media thickness (CVD) | Each 10 % increase in TIR improves CIMT thickness by 6.4 % |
| 866 T2DM Patients | Albuminuria | Each 10 % increase in TIR reduces risk of albuminuria by 6 % |
| 26 T1DM Patients | Albuminuria | Each 10 % increase in TIR reduces albuminuria risk by 19 % |
| 364 Patients with Diabetic neuropathy | Painful neuropathy | TIR is correlated with painful neuropathy independent of A1c glucose variability metrics and risk factors in patients with DM |

Yang J, Yang X, Zhao D, Wang X, Wei W, Yuan H. Association of time in range, as assessed by continuous glucose monitoring, with painful diabetic polyneuropathy. *J Diabetes Investig*. 2021;12(5):828-836. doi:10.1111/jdi.13394

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# CGM CLINICAL EVIDENCE & REAL-WORLD PORTFOLIO STUDIES

## Increased Time in Range (TIR)

By improving TIR, FreeStyle Libre 2 system may deter from microvascular and macrovascular complications[1,2]

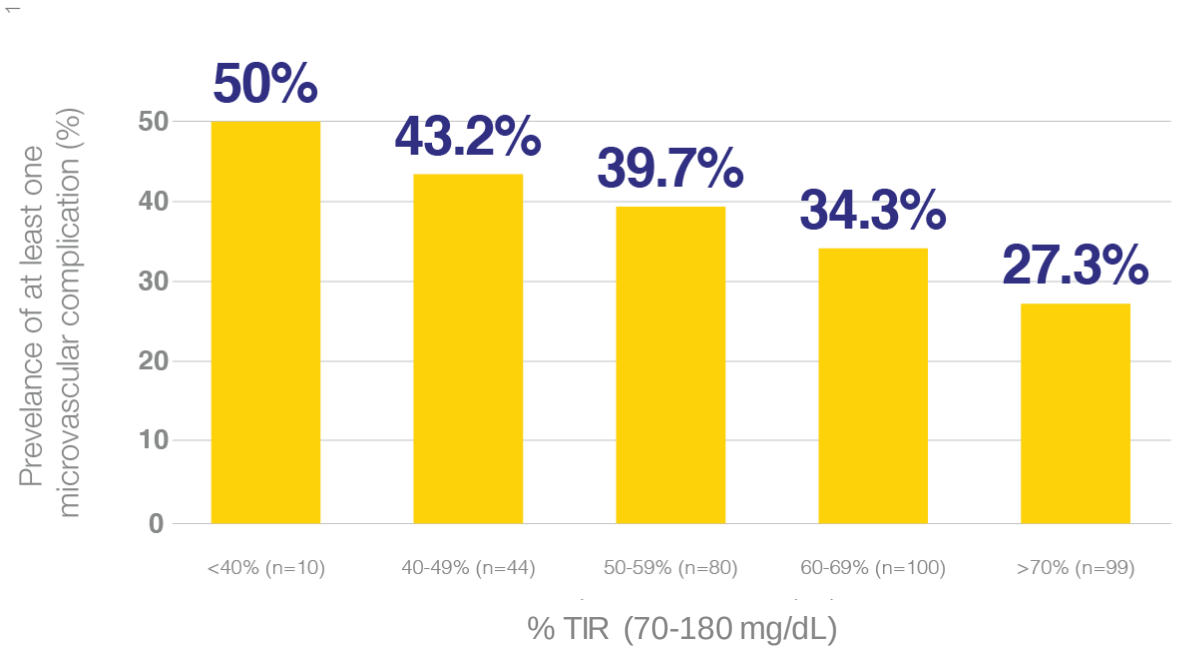
**50 % reduction in Micro and Macrovascular risk is associated with a 50 % improvement in TIR**

### Microvascular complications*[1]

Patients who spend less TIR are more likely to experience complications such as retinopathy, nephropathy, and neuropathy.

### Macrovascular complications†[2]

Patients who spend more TIR are more likely to experience a lower rate of first major adverse cardiac events (MACE).




*Results from a study of 515 adults with T1D using real-time CGM. †Results from a study of 7637 patients with T2D with cardiovascular disease or at high risk.

**1.** El Malahi, Anass, et al. "Chronic Complications Versus Glycaemic Variability, Time in Range and HbA1c in People with Type 1 Diabetes: Sub Study of the RESCUE-trial." European Association for the Study of Diabetes 56th Congress, Vienna, Austria, September 22, 2020. DOI: https://doi.org/10.1530/endoabs.71.012. **2.** Berganstal Richard M, Elise Hachman-Nielsen, Kajsa Kvist, John B. Buse. "Derived Time-in-range is Associated with MACE in T2D: Data From the DEVOTE Trial." *Diabetes* 69 (suppl 1) (June 2020). DOI: https://doi.org/10.2337/db20-21-LB.

# Addressing Problematic Glycemic Patterns

## Hypoglycemia (> 4 % )

- Review potential meal skips
- Stop or reduce SUs
- Consider use of meds which do not increase likelihood of hypoglycemia
- Reduce basal or pre-meal insulin dose
- Modify exercise timing related to insulin dosing
- Reduce or stop alcohol consumption
- Mismatch of prandial insulin dose and carbohydrate intake

## Time in Range < 70 %

- Discuss med adherence
- Add basal insulin, GLP-1RA, SGLT2, or prandial insulin
- Discuss carb counting (identification) or meal size as related to prescribed insulin dosing

Unger J, Kushner P, Anderson JE. Practical guidance for using the FreeStyle Libre flash continuous glucose monitoring in primary care. Postgrad Med. 2020 May;132(4):305-313.

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# Meet Lee

48-year-old man with multiple medical concerns:

- Anticardiolipin antibody syndrome with complete occlusion of his IVC
- Opioid use dependency
- Portal hypertension
- Fatty liver
- And…newly diagnosed diabetes with a baseline A1c of 10.2 %

*Note: Lee is a managed within primary care with specialty referrals as needed*

**CGM implemented**

# Lee's baseline CGM report

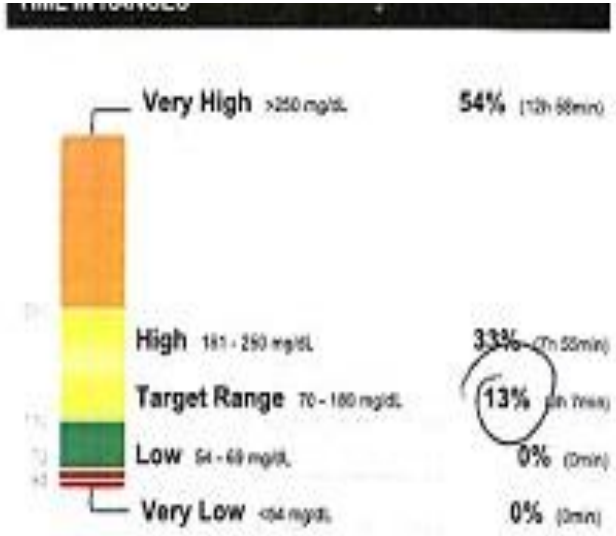
(2/19/2021 - 3/4/2021)

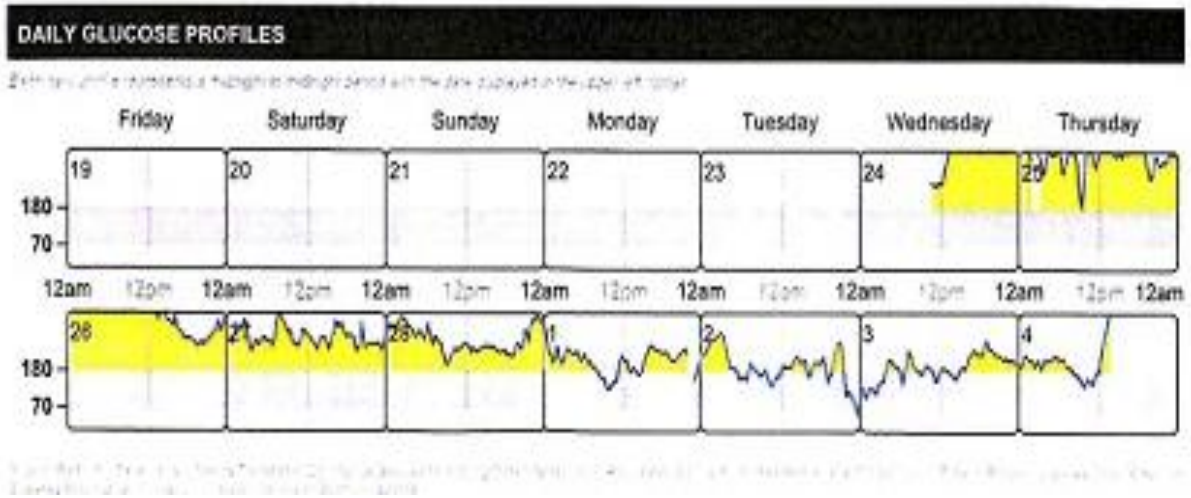
| | |
|---|---|
| February 19, 2021 - March 4, 2021 | 14 Days |
| % Time CGM is Active | 60% |

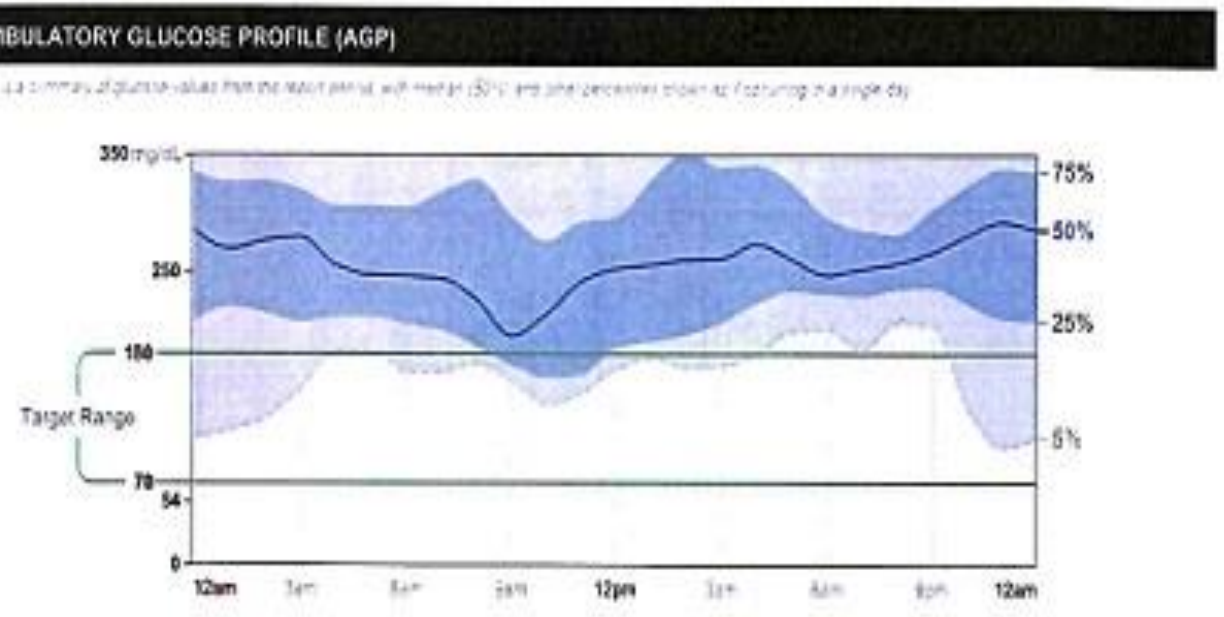
| Glucose Ranges | Targets % of Readings (Time/Day) |
|---|---|
| Target Range 70-180 mg/dL | Greater than 70% (16h 48min) |
| Below 70 mg/dL | Less than 4% (58min) |
| Below 54 mg/dL | Less than 1% (14min) |
| Above 180 mg/dL | Less than 25% (6h) |
| Above 250 mg/dL | Less than 5% (1h 12min) |

| | |
|---|---|
| Average Glucose | 265 mg/dL |
| Glucose Management Indicator (GMI) | 9.6% |
| Glucose Variability | 29.1% |

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



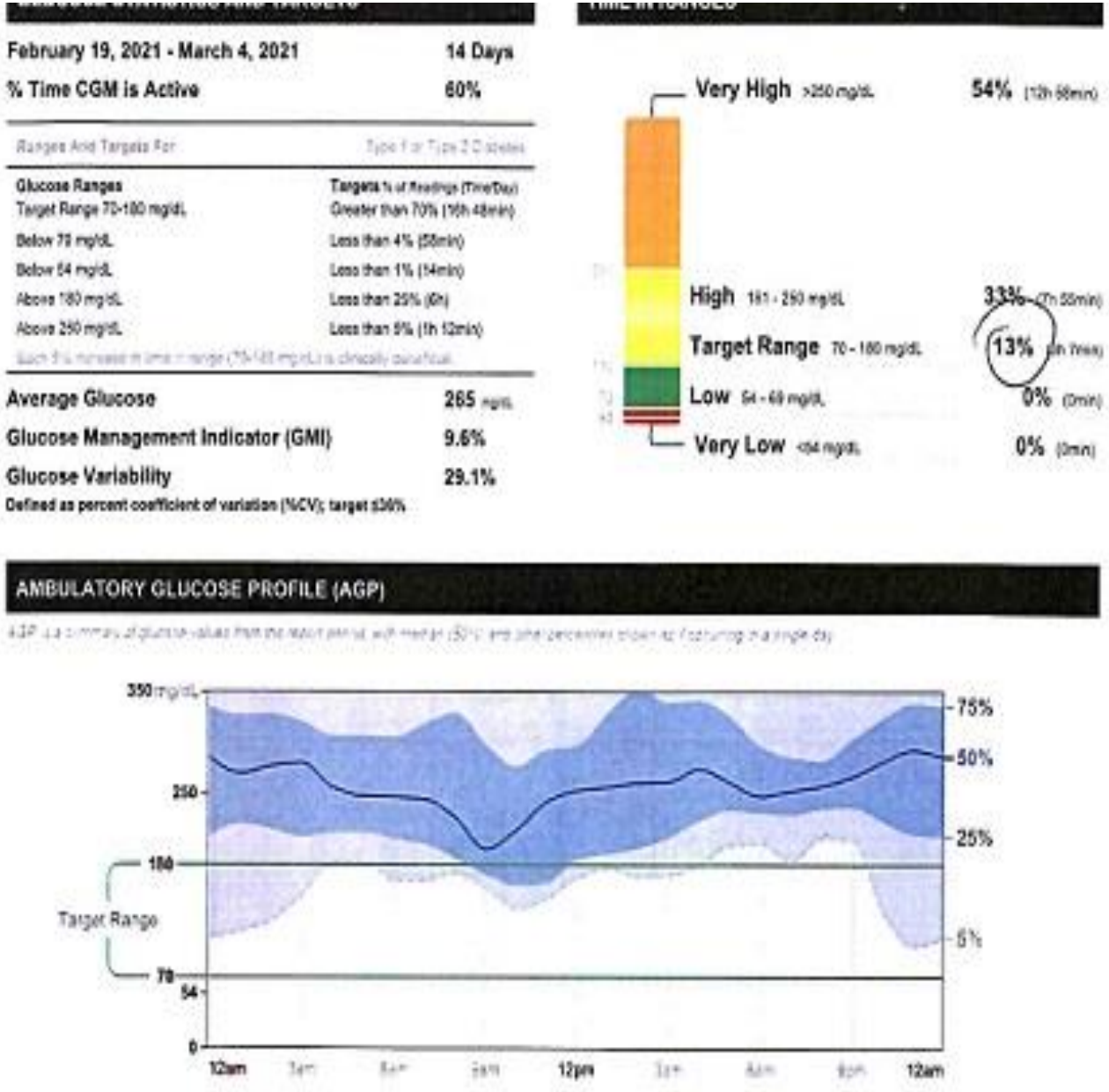



# Lee's baseline CGM report – Let's Discuss

Questions?

- How often is Lee achieving the prescribed in range target (70-180 mg/dL)?
- How do the GMI (9.6%) and A1c (10.2%) correlate with each other?
- What treatments will you recommend?



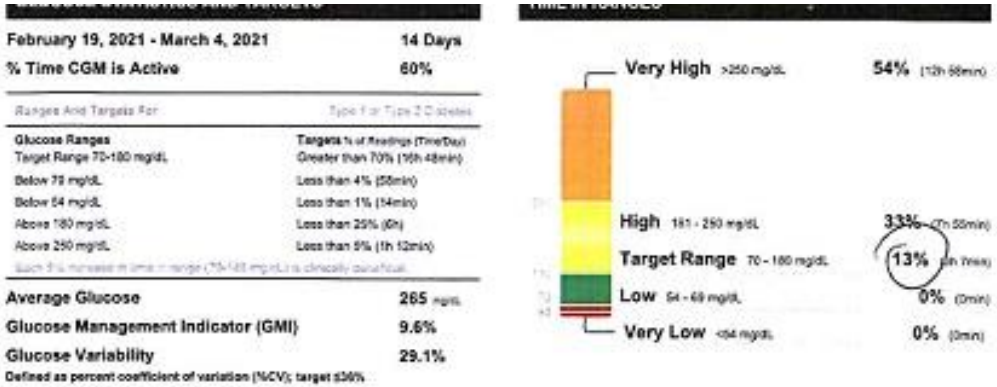
# Intervention

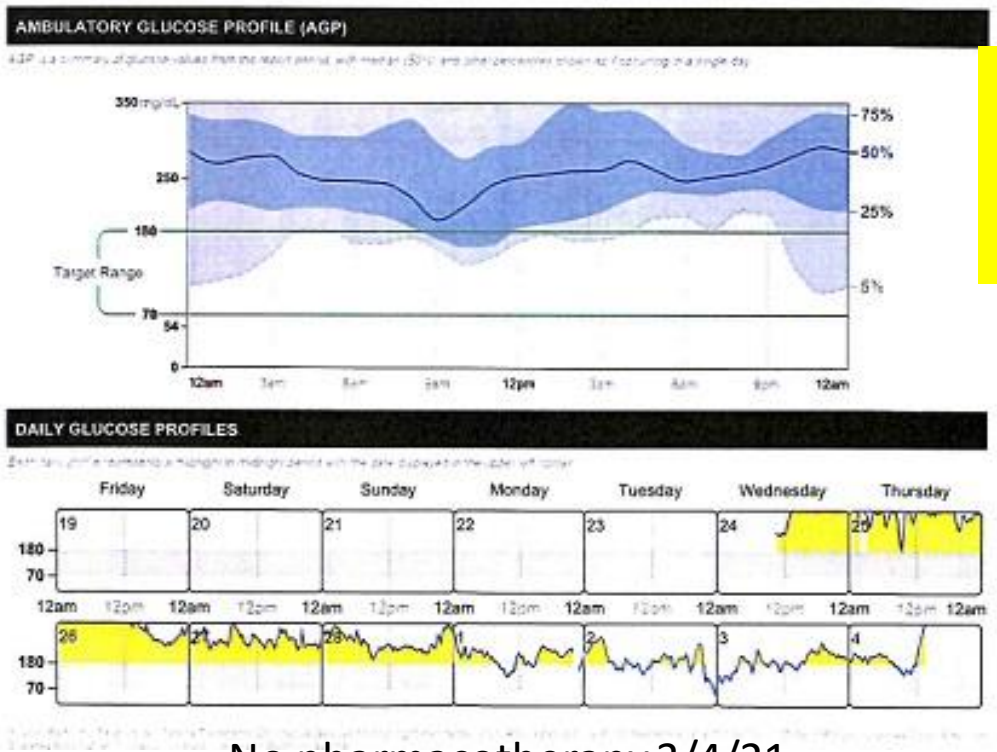
- Patient counseled on lifestyle interventions and referred for formal education with certified diabetes care and education specialist (CDCES)
- Pharmacotherapy initiated:
  Insulin degludec 20 units daily + liraglutide 0.6mg daily

**After 4 weeks**

- Pharmacotherapy revised:
  Insulin degludec 10 units daily + liraglutide 1.2mg daily

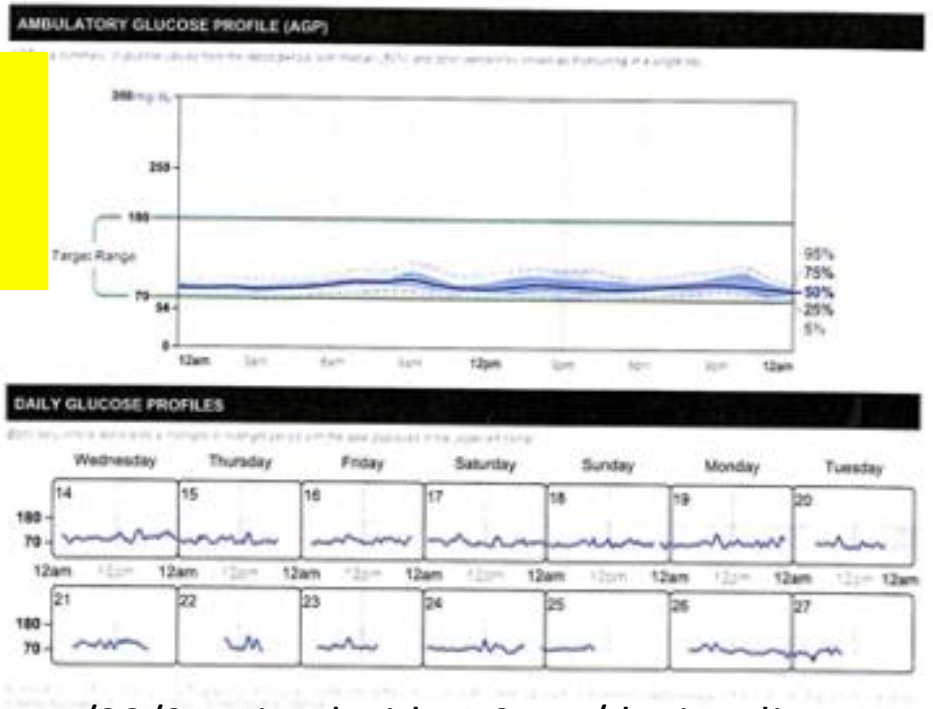
# Lee – Before and After




No pharmacotherapy 3/4/21

8 weeks until patient achieved target glycemic control!


4/29/21: Liraglutide 1.2 mg/d + insulin degludec 10 units/d

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# Applying Diabetes Technology to Achieve Targeted Treatment Goals

# How CGM Can Help Reduce Diabetes Management Challenges

## Moving beyond A1c

**Using a combination of metrics allows for a more complete picture of glucose profile[1]**

### A1c + AGP (Ambulatory Glucose Profile)

Combining each patient's A1c with their ambulatory glucose profile (AGP) uncovers critical daily patterns

### TIR (Time in Range) + TBR (Time below range)

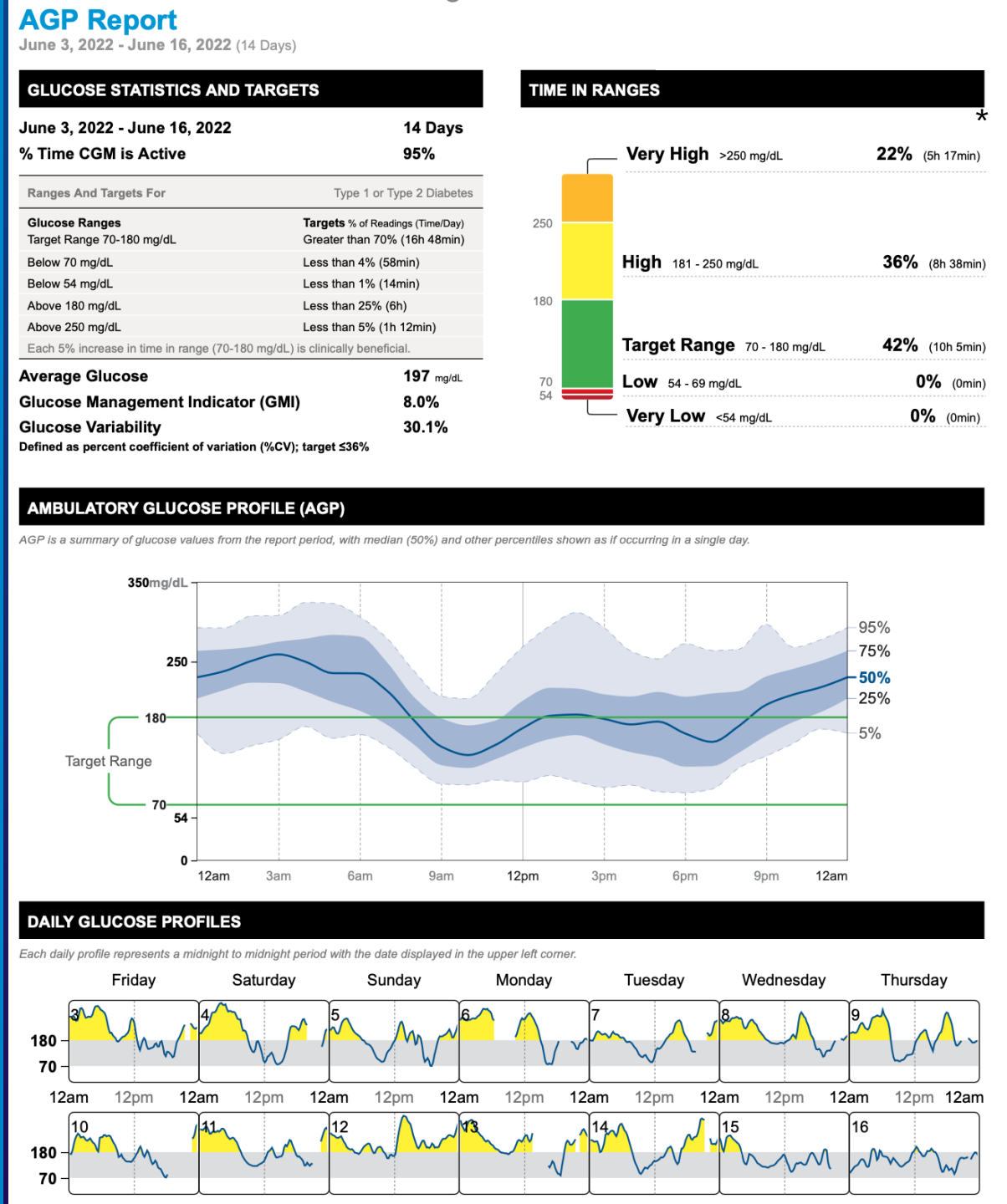
Monitoring TIR and TBR glucose variability helps show how closely readings of an individual patient fall within target range, or below, in hypoglycemia

### Glucose data

Additional access to acute, daily, and long-term (90 days) data allows for more informed treatment decisions

***AGP** provides a standardized visualization that condenses glucose data generated from CGM over several days or weeks into a single, 24-hour window.*

**1.** Battelino T, Danne T, et al. Clinical Targets for Continuous Glucose Monitoring Data Interpretation: Recommendations From the International Consensus on Time in Range. Diabetes Care. 2019 Aug;42(8):1593-1603.



AGP Report

June 3, 2022 - June 16, 2022 (14 Days)

GLUCOSE STATISTICS AND TARGETS

| | |
|---|---|
| June 3, 2022 - June 16, 2022 | 14 Days |
| % Time CGM is Active | 95% |

| Ranges And Targets For | Type 1 or Type 2 Diabetes |
|---|---|
| **Glucose Ranges** Target Range 70-180 mg/dL | **Targets** % of Readings (Time/Day) 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 | 197 mg/dL |
| Glucose Management Indicator (GMI) | 8.0% |
| Glucose Variability | 30.1% |

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

TIME IN RANGES *

| | | |
|---|---|---|
| Very High | >250 mg/dL | 22% (5h 17min) |
| High | 181 - 250 mg/dL | 36% (8h 38min) |
| Target Range | 70 - 180 mg/dL | 42% (10h 5min) |
| Low | 54 - 69 mg/dL | 0% (0min) |
| Very Low | <54 mg/dL | 0% (0min) |

AMBULATORY GLUCOSE PROFILE (AGP)

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



DAILY GLUCOSE PROFILES

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

# Meet R.T.

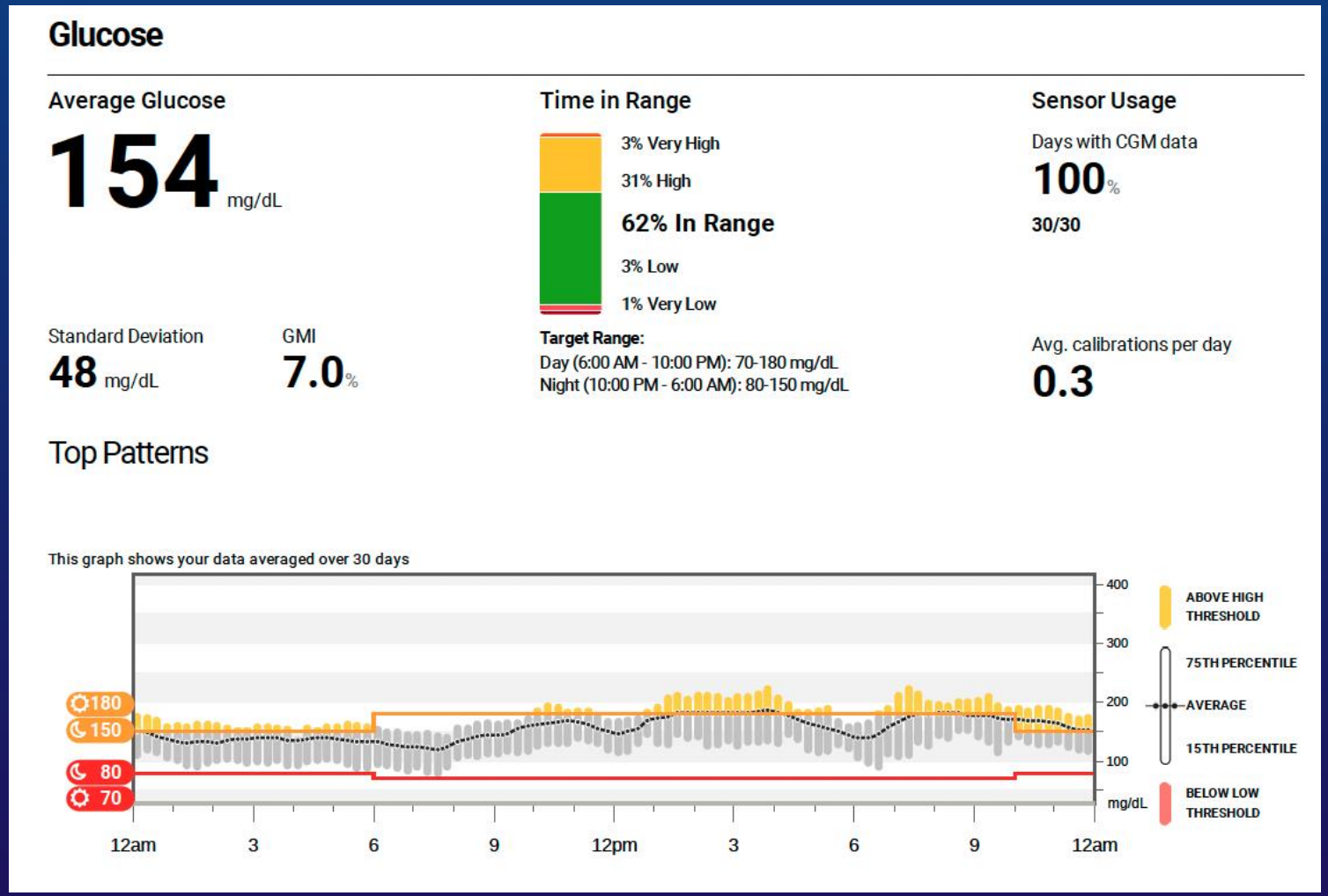
- 53-year-old man with type 1 diabetes mellitus, using basal bolus insulin regimen and using a continuous glucose monitor
- R.T. is having a difficult time with post meal glucose excursions. Approximately 25% of all post meal glucose levels are above 180 mg/dL
- On occasion, he “overcorrects” the post meal excursions with an additional rapid acting insulin injection which can result in nocturnal hypoglycemia (interstitial glucose readings < 70 mg/dL)
- A1c = 6.7%

# R.T.'s Regimen

- Basal: Insulin degludec 30 units daily

- Bolus: Insulin lispro dosed via carbohydrate counting with anticipatory carbohydrate ratio of 1 unit per 8 grams for breakfast, 1 unit per 12 grams for lunch and dinner. Corrects with an insulin sensitivity factor (correction factor) of 1 unit to lower glucose 30 mg/dL to target of 120 mg/dL

# R.T's Ambulatory Glucose Profile (AGP)




- 62% time in range with 34% high
- Rise in glucose after meals but particularly after lunch and dinner with average of 150-170 mg/dL but variability around this
- Customized target glucose range from 10 PM-6 AM of 80-150 mg/dL

# AGP Targets (per guidelines)

| AACE Guideline Targets For Ambulatory Glucose Monitoring | Suggestions For Achieving Glycemic Targets |
|---|---|
| < 4 % in hypoglycemia range | • Reduce basal insulin by 2 units<br>• Make certain dose is given at a consistent time<br>• Target AM glucose levels 70-110 mg/dL.<br>• Do not stack insulin. Remember the importance of “insulin on board” |
| 70 % of CGM readings should be within the targeted range of 70-180 mg/dL | • Timing of prandial insulin is important |
| Reduce glycemic variability (standard deviation; flatten the median curve) | • Consider adjusting prandial insulin doses based on meal size<br>• Add correction factor dosing if pre meal glucose levels are > 180 mg/dL |

Grunberger G, Sherr J, Allende M, Blevins T, Bode B, Handelsman Y, Hellman R, Lajara R, Roberts VL, Rodbard D, Stec C, Unger J. American Association of Clinical Endocrinology Clinical Practice Guideline: The Use of Advanced Technology in the Management of Persons With Diabetes Mellitus. Endocr Pract. 2021 Jun;27(6):505-537. doi: 10.1016/j.eprac.2021.04.008. PMID: 34116789.

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# AGP Targets (per AACE guidelines)

- 70% time in range – his tighter glucose target range overnight will influence his TIR
- No more than 25% time spent in hyperglycemia – his post-prandial glucose elevations put him above this goal
- No more than 4-5% time spent in hypoglycemia

Grunberger G, Sherr J, Allende M, Blevins T, Bode B, Handelsman Y, Hellman R, Lajara R, Roberts VL, Rodbard D, Stec C, Unger J. American Association of Clinical Endocrinology Clinical Practice Guideline: The Use of Advanced Technology in the Management of Persons With Diabetes Mellitus. Endocr Pract. 2021 Jun;27(6):505-537. doi: 10.1016/j.eprac.2021.04.008. PMID: 34116789.

# Intervention

- Tightening of carbohydrate ratio for lunch and dinner to 1 unit per 10 grams to blunt post-meal spiking after these meals
- Counseling about avoiding bedtime correction unless glucose over 200 mg/dL
- Explain the importance of bolusing meal time insulin 15 minutes prior to beginning the meal
- Make certain that patient has CGM alarms for lows and highs activated
- Felt to be doing reasonably well overall

# Meet J.M.

- J.M. is a 58-year-old female with a past medical history of type 2 diabetes mellitus, hypertension, coronary artery disease, multiple transient ischemic attacks, chronic kidney disease, and heart failure with reduced ejection fraction.
- 7-year history of diabetes
- Current A1c: 8.1%
- Outpatient diabetes regimen: Empagliflozin 10mg daily, insulin detemir 45 units daily in the morning, and insulin detemir 35 units nightly
- BG monitoring: Freestyle Libre 2

# Ambulatory Glucose Profile (AGP) Report

## AGP Report

### GLUCOSE STATISTICS AND TARGETS

**% Time CGM is Active** **81%**

| Ranges And Targets For | Type 1 or Type 2 Diabetes |
|---|---|
| **Glucose Ranges**<br>Target Range 70-180 mg/dL | **Targets** % of Readings (Time/Day)<br>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. | |

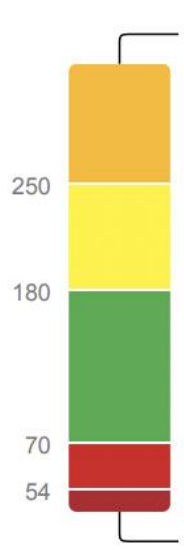
**Average Glucose** **192** mg/dL

**Glucose Management Indicator (GMI)** **7.9%**

**Glucose Variability** **51.6%**

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

### TIME IN RANGES




**Very High** >250 mg/dL **28%** (6h 43min)

**High** 181 - 250 mg/dL **24%** (5h 46min)

**Target Range** 70 - 180 mg/dL **36%** (8h 38min)

**Low** 54 - 69 mg/dL **9%** (2h 10min)

**Very Low** <54 mg/dL **3%** (43min)

# Review: What does all the data mean?

## AGP Report

Percentage of time the CGM sensor is collecting blood glucose data

### GLUCOSE STATISTICS AND TARGETS

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|---|---|
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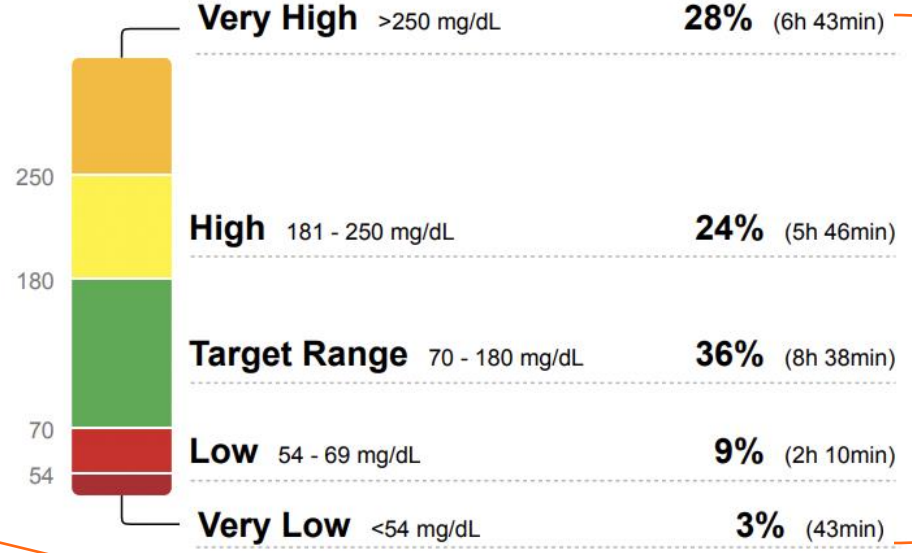
| **Average Glucose** | **192** mg/dL |
| **Glucose Management Indicator (GMI)** | **7.9%** |
| **Glucose Variability**<br>**Defined as percent coefficient of variation (%CV); target ≤36%** | **51.6%** |

Average glucose over selected time range

### TIME IN RANGES




Time in Range (TIR) shows the average amount of glucose values above, within, and below the target range in a given time period

GMI (Glucose Management Indicator) approximates a patient's A1c using at least 12 days of data

# Ambulatory Glucose Profile (AGP) Report

## AGP Report

### GLUCOSE STATISTICS AND TARGETS

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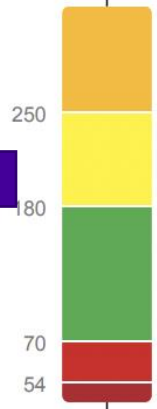
### TIME IN RANGES




| | | |
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| **Very High** | >250 mg/dL | **28%** (6h 43min) |
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| **Low** | 54 - 69 mg/dL | **9%** (2h 10min) |
| **Very Low** | <54 mg/dL | **3%** (43min) |

Patterns to consider from the AGP:

- Actual TIR versus Goal TIR
- GMI versus TIR
- Glucose Variability

# Review of Goal Time in Range: AACE

**Table 1**
Summary of Recommendations
**Q** = Question; **R** = Recommendation

**Question 1:**
**What glucose metrics should be used in clinical practice to assess glycemic status?**

**Q1.1 What are the priority metrics for clinical decision-making regarding the use of diabetes technology?**

**R1.1.1** Established clinical targets should be used to individualize glycemic targets and adjust therapy based on each individual's overall health status, concomitant medical condition (eg, pregnancy, frailty), and risk for hypoglycemia:

**All Persons with Diabetes**

- Number of days of active CGM use: 14 days preferred
- Percentage of data available from active CGM use: >70% of data from 14 days
- Mean glucose: Individualized to targets
- Glucose management indicator (GMI): Individualized to targets
- Glycemic variability, percent coefficient of variation (%CV [coefficient of variation]): ≤36%

**Type 1 Diabetes (T1D)/Type 2 Diabetes (T2D)**

- Percentage of time in range (%TIR) 70 to 180 mg/dL: >70%
- Percentage of time below range (%TBR) <70 mg/dL: <4%
- %TBR <54 mg/dL: <1%
- Percentage of time above range (%TAR) >180 mg/dL: <25%
- %TAR >250 mg/dL: <5%

**Older/High Risk T1D/T2D**

- %TIR 70 to 180 mg/dL: >50%
- %TBR <70 mg/dL: <1%
- %TBR <54 mg/dL: ~0%
- %TAR >250 mg/dL: <10%

**Pregnancy: T1D**

- %TIR 63 to 140 mg/dL: >70%
- %TBR <63 mg/dL: <4%
- %TBR <54 mg/dL: <1%
- %TAR >140 mg/dL: <25%

**Grade C; Low-Intermediate Strength of Evidence; BEL 2**

**R1.1.2** Two metrics, %TIR and %TBR, should be used as a starting point for the assessment of quality of glycemic control and as the basis for therapy adjustment, with emphasis on reducing %TBR when the percentages of CGM values falling below 54 mg/dL or 70 mg/dL are close to or exceed targets.

**Grade B; Low-Intermediate Strength of Evidence; BEL 1**

Grunberger G, Sherr J, Allende M, Blevins T, Bode B, Handelsman Y, Hellman R, Lajara R, Roberts VL, Rodbard D, Stec C, Unger J. American Association of Clinical Endocrinology Clinical Practice Guideline: The Use of Advanced Technology in the Management of Persons With Diabetes Mellitus. Endocr Pract. 2021 Jun;27(6):505-537. doi: 10.1016/j.eprac.2021.04.008. PMID: 34116789.

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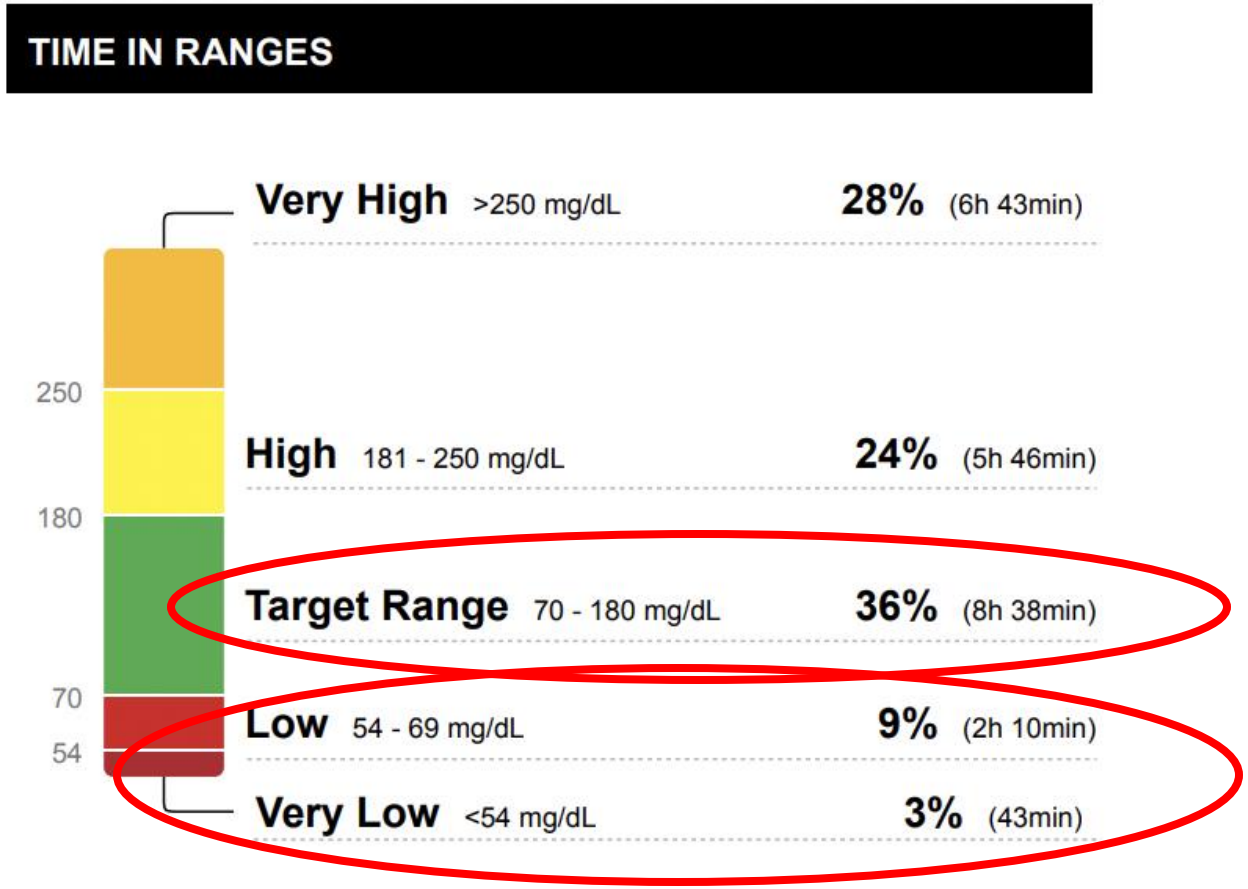
# Where to Start?

"Two metrics, %TIR and %TBR, should be used as the starting point for the assessment of quality glycemic control and as the basis of therapy adjustment, with emphasis on reducing %TBR when the percentage of CGM values falling below 54 mg/dL or 70 mg/dL are close to or exceed targets."




Grunberger G, Sherr J, Allende M, Blevins T, Bode B, Handelsman Y, Hellman R, Lajara R, Roberts VL, Rodbard D, Stec C, Unger J. American Association of Clinical Endocrinology Clinical Practice Guideline: The Use of Advanced Technology in the Management of Persons With Diabetes Mellitus. Endocr Pract. 2021 Jun;27(6):505-537. doi: 10.1016/j.eprac.2021.04.008. PMID: 34116789.

# How does GMI Compare With The A1c?

- Glucose Management Indicator (GMI) approximates a patient's A1c using at least 14 days of data
  - Mathematical algorithm based on between 2800 and 20,160 interstitial glucose values obtained during sensor wear of 10-14 days
- A1c is based on glycation to red blood cells assuming the RBC lifespan is 3 months. 50 % of the total A1c is based upon glycation which occurs within 4 weeks prior to testing.
- Limitations to A1c:
  - Checked quarterly. Does not provide details on acute glycemic excursions including hypoglycemia
  - Inaccurate/inconclusive in certain patient populations (ex. ESRD, anemia, hemoglobinopathy, pregnancy, liver disease)
    - Over glycation can occur with anemia
    - Underglycation can occur with rapid RBC turnover such as in patients undergoing dialysis

Hansen KW, Bibby BM. Glycemic Metrics Derived From Intermittently Scanned Continuous Glucose Monitoring. *Journal of Diabetes Science and Technology*. 2022;16(1):113-119. doi:10.1177/1932296820975822

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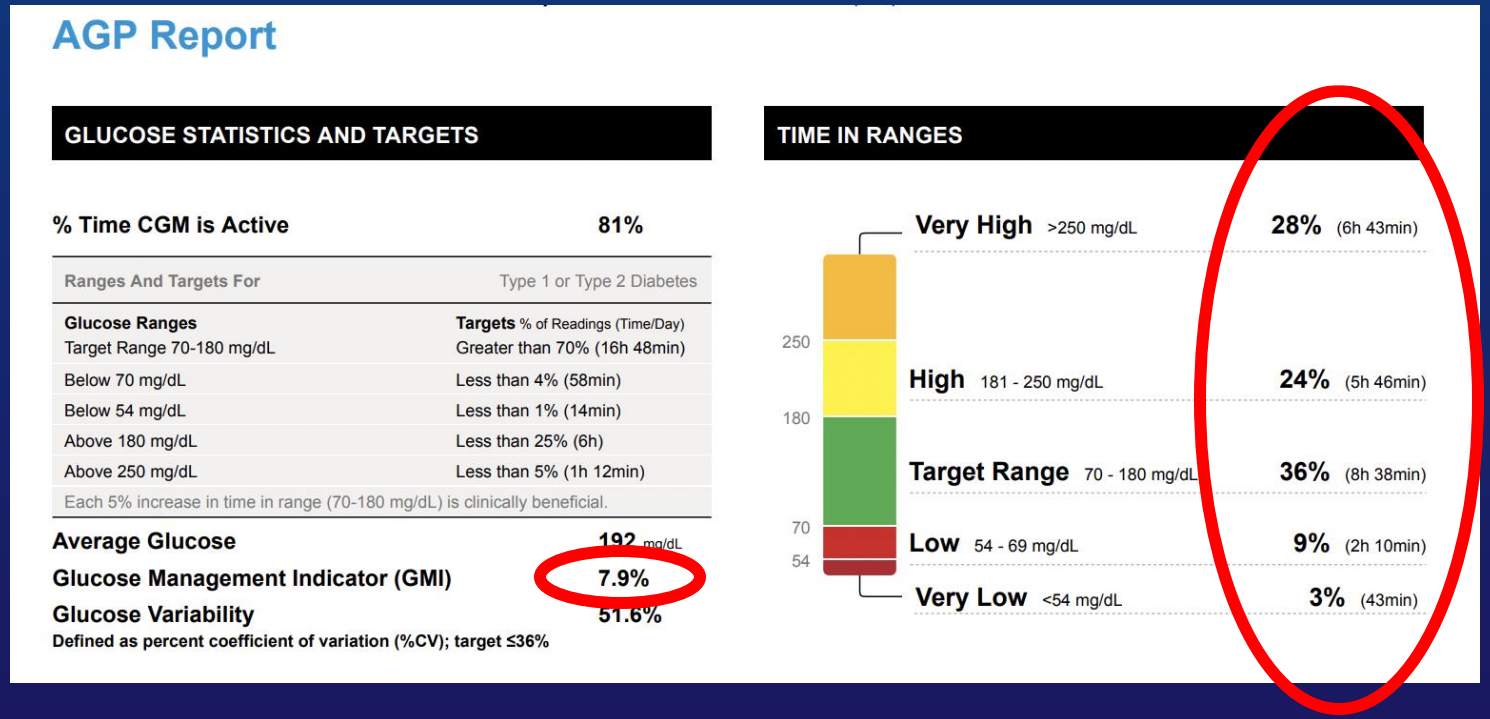
# A1c versus GMI versus TIR

- A1c: 8.1%
- GMI: 7.9%
- Target in range: 36%
  - Goal 70%
- Time above Range: 52%
  - Goal <25%
- Time below Range: 12%
  - Goal <5%



AGP Report

GLUCOSE STATISTICS AND TARGETS

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

| | |
|---|---|
| Average Glucose | 192 mg/dL |
| Glucose Management Indicator (GMI) | 7.9% |
| Glucose Variability | 51.6% |

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

TIME IN RANGES

| | | |
|---|---|---|
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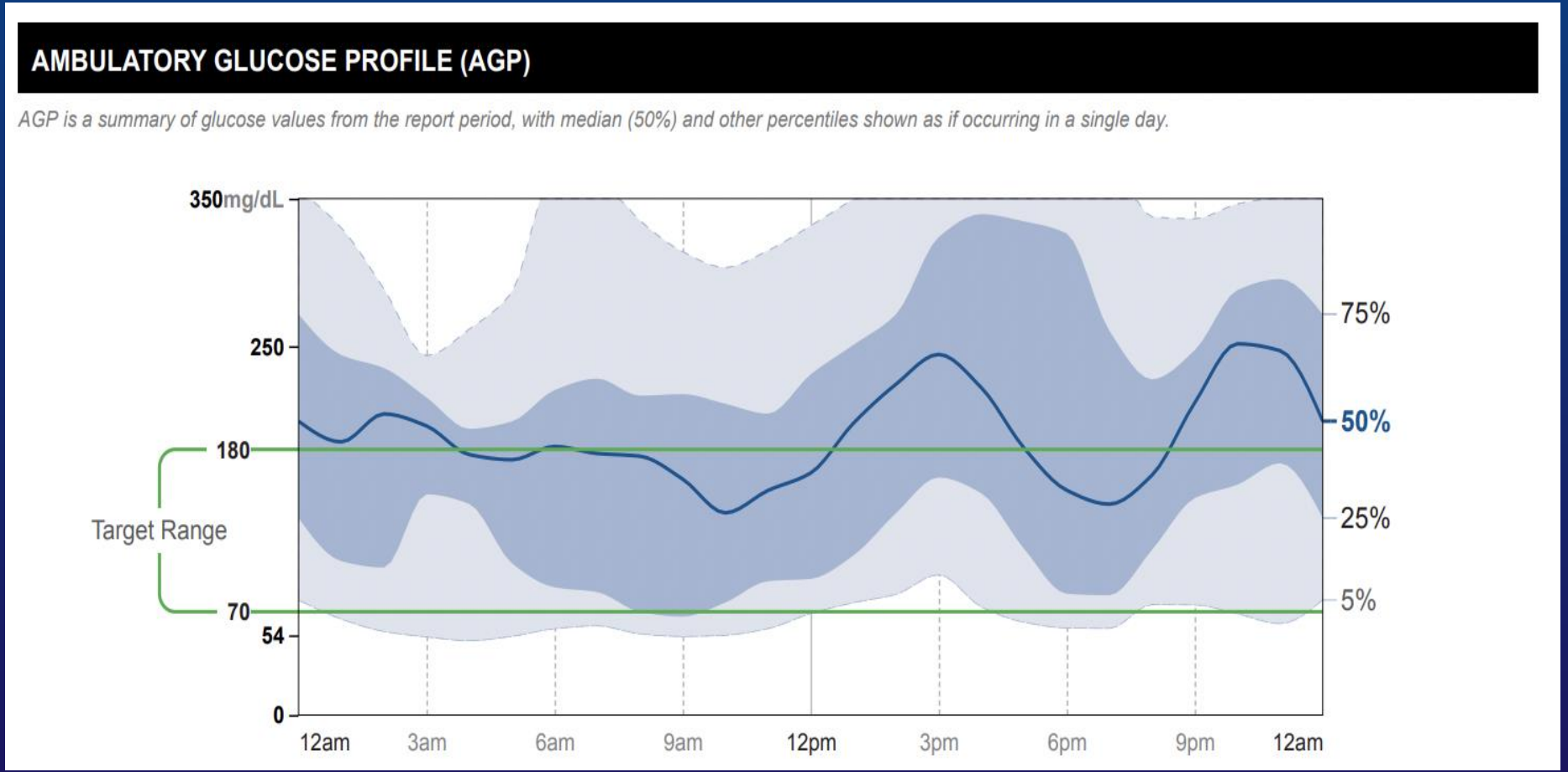
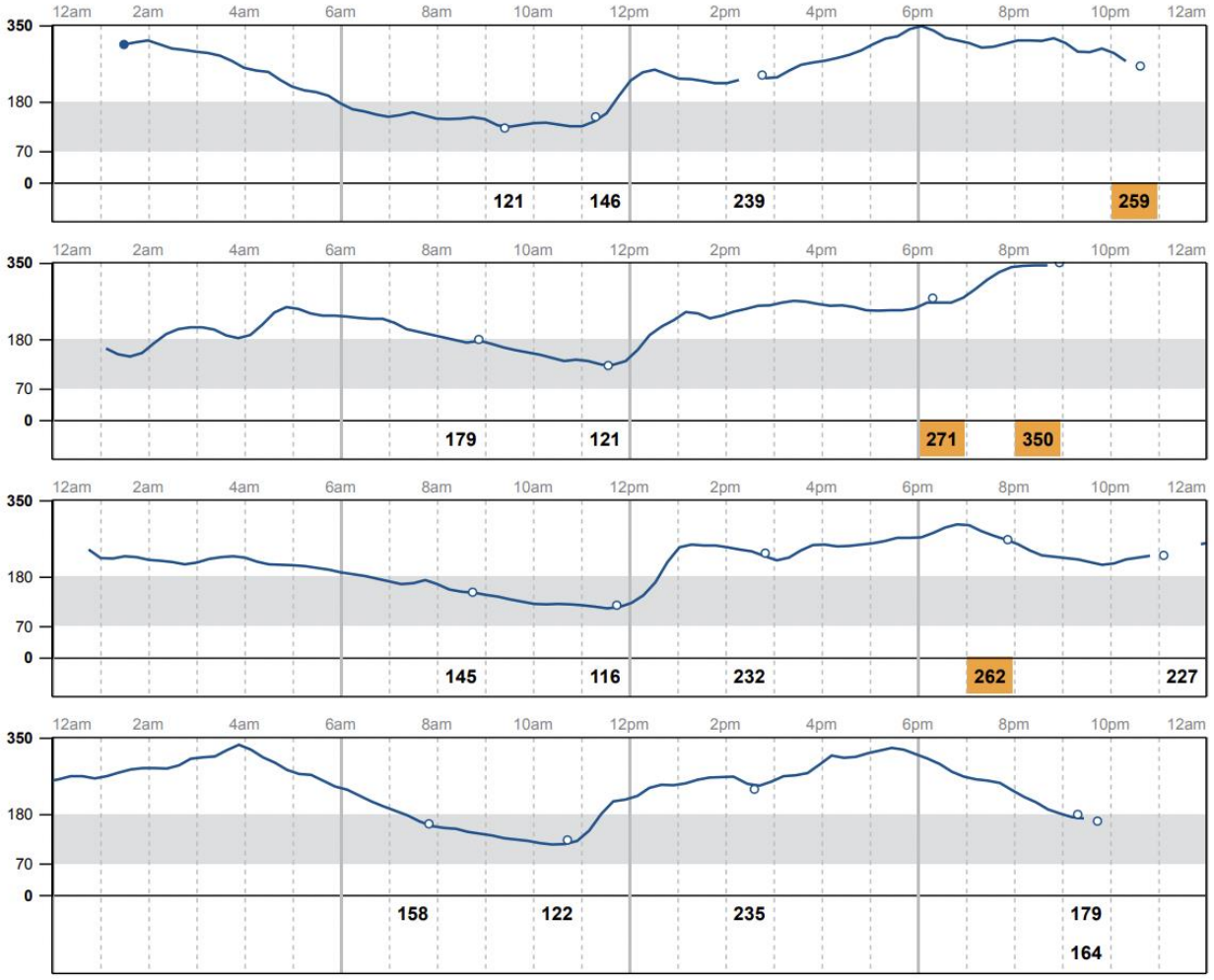
250
180
70
54

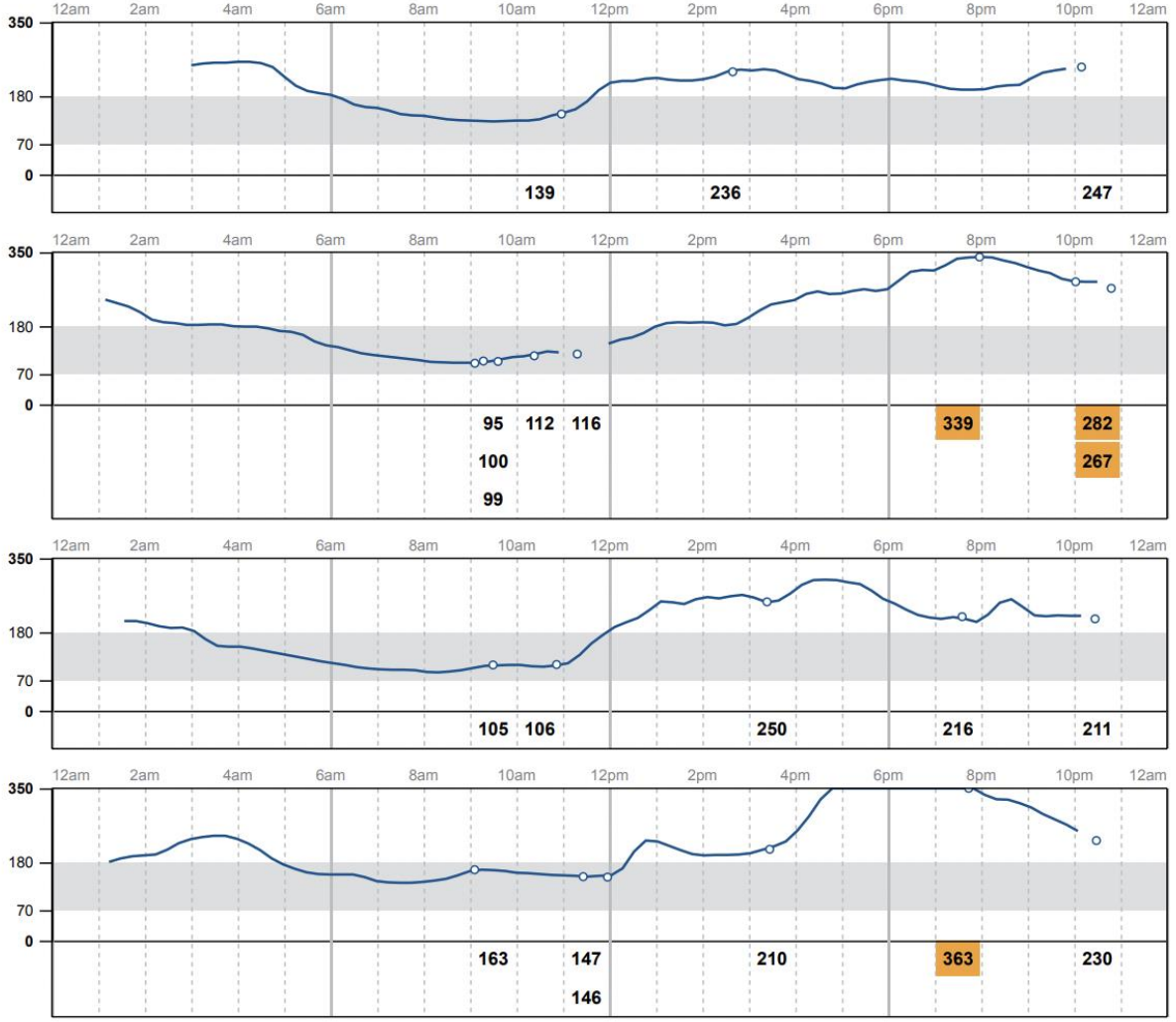
# Blood Glucose Variability




- Wide glucose excursions measured and quantified through glucose variability
- Not a detectable measure of A1c

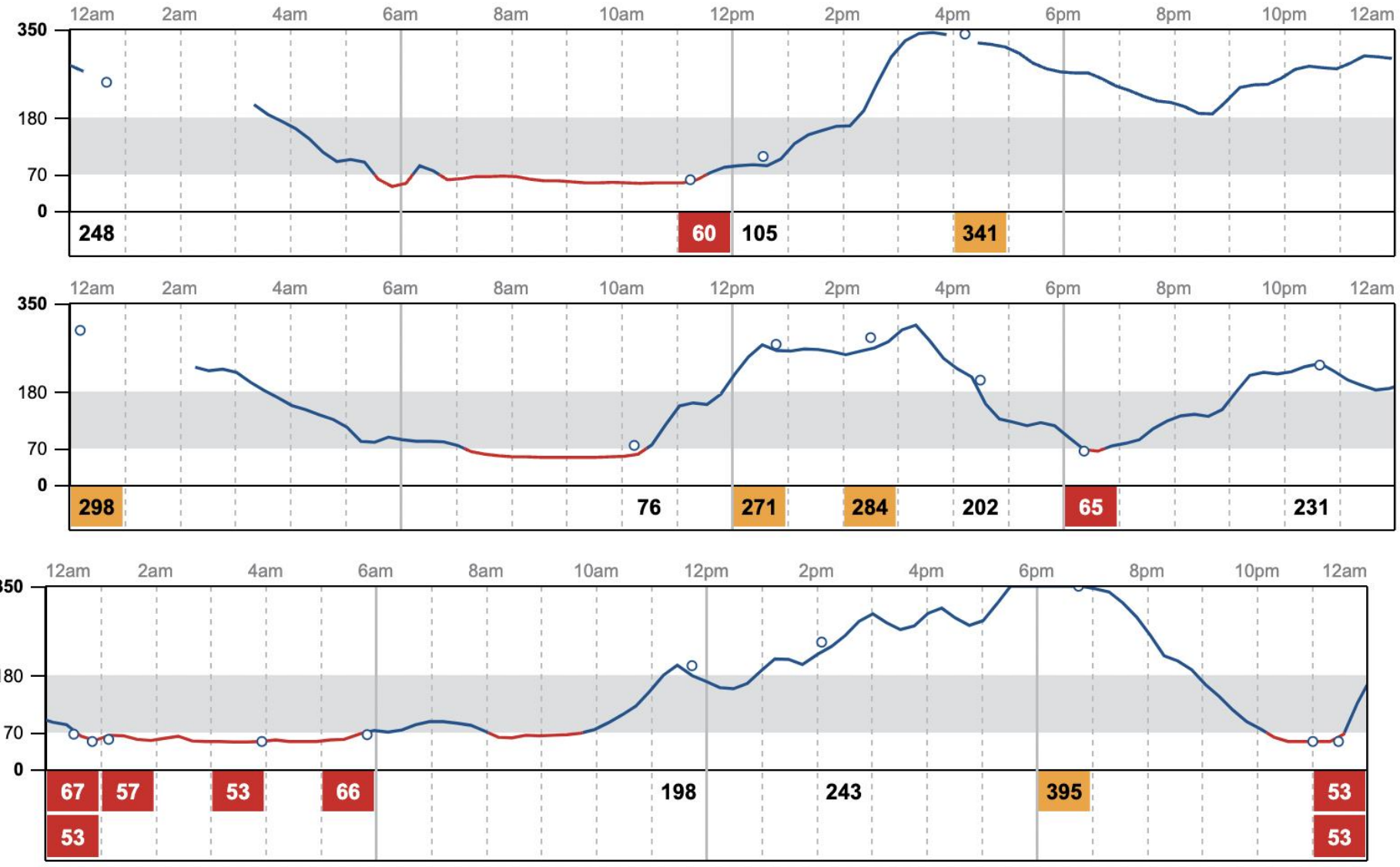
# Looking More Closely: Daily Log




Daily blood glucose day as collected by CGM sensor
Blood glucose on y axis and time of day on x axis

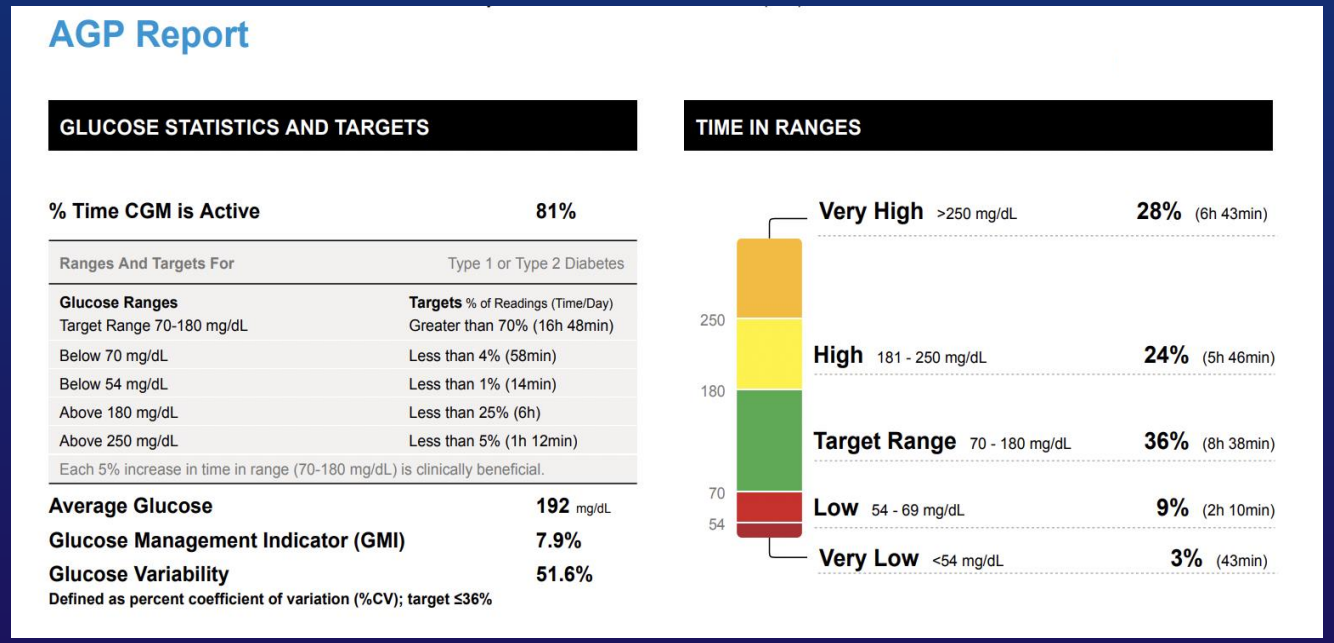
# Looking More Closely: Daily Log




- Daily CGM blood glucose trends to more specifically understand previous reports
  - Wide daily blood glucose values
  - Hypoglycemia occurrence and timing

# Back to J.M.

- Current regimen: Empagliflozin 10mg daily, insulin detemir 45 units daily in the morning, and insulin detemir 35 units nightly



## AGP Report

**GLUCOSE STATISTICS AND TARGETS**

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| | |
|---|---|
| **Average Glucose** | **192** mg/dL |
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| **Glucose Variability** | **51.6%** |

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

**TIME IN RANGES**



| | | |
|---|---|---|
| **Very High** | >250 mg/dL | **28%** (6h 43min) |
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| **Low** | 54 - 69 mg/dL | **9%** (2h 10min) |
| **Very Low** | <54 mg/dL | **3%** (43min) |

# Intervention

Strategic reduction in basal insulin doses to minimize recurrent hypoglycemia and specifically overnight hypoglycemia

Start GLP-1 RA and titrate up to optimal dosing for postprandial glycemic control

# J.M.’s CGM At Baseline And After 3 Months

GMI=7.9
GV=51.6%

LibreView

**TIME IN RANGES**

| | | | |
|---|---|---|---|
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| Very Low | <54 mg/dL | 3% | (43min) |

250 / 180 / 70 / 54

Empagliflozin 10 mg + insulin detemir 45 units daily and 35 units at 9 PM

**GLUCOSE STATISTICS AND TARGETS**

| | |
|---|---|
| January 19, 2022 - February 1, 2022 | 14 Days |
| % Time CGM is Active | 88% |

| Ranges And Targets For | Type 1 or Type 2 Diabetes |
|---|---|
| Glucose Ranges | Targets % of Readings (Time/Day) |
| Target Range 70-180 mg/dL | Greater than 70% (16h 48min) |
| Below 70 mg/dL | Less than 4% (58min) |
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Each 5% increase in time in range (70-180 mg/dL) is clinically beneficial.

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

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

**TIME IN RANGES**

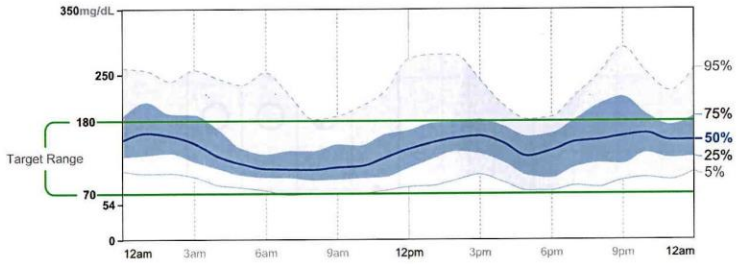
| | | | |
|---|---|---|---|
| Very High | >250 mg/dL | 4% | (58min) |
| High | 181 - 250 mg/dL | 17% | (4h 5min) |
| Target Range | 70 - 180 mg/dL | 77% | (18h 28min) |
| Low | 54 - 69 mg/dL | | |
| Very Low | <54 mg/dL | | |

250 / 180 / 70 / 54

GMI=6.8 %
GV 35.5 %

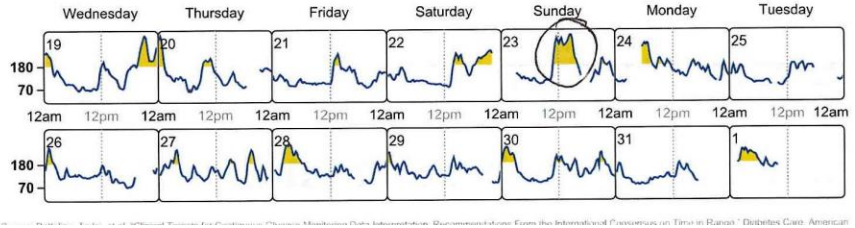
**AMBULATORY GLUCOSE PROFILE (AGP)**

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.




Empagliflozin 25 mg + Semaglutide 2 mg/week + insulin detemir 35 units at 9 PM

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# Summary

- CGM is a cost-effective technology which can successfully improve one's time in range, reduce hypoglycemia risk and reduce glycemic variability
- CGM should be encouraged within the primary care setting where 90 % of all diabetes management occurs
- Daily SBGM costs are 4.5 x higher/day than using CGM ($11.60 vs $2.59)[1]
- Health economic costs benefit CGM over SBGM
- Advanced diabetes technology holds the promise to be beneficial for all patients with diabetes
- Technologies provide insight in targeting a rational, safe and comprehensive approach to glycemic management
- Patients using advanced technology have been able to improve their time in range, reduce risk of and time spent within hypoglycemia, improve quality of life

[1]Unger, J. Continuous Glucose Monitoring Overview: Features and Evidence. American Journal of Managed Care. Vol 28, N. 4; S59-S67. 2022

# What about “Chuck”?

- 62-year-old man with T1DM x 20 years.
- Prescribed insulin regimen: NPH 70 u BID and regular insulin 70 u BID (280 u/day). Syringes and vials. Never trained on appropriate timing or administration of insulin.
- Non STEMI MI 2 years ago with stenting
- Does not do SBGM (“no one looks at the logs anyway”)
- In past 2 months, patient admitted to 4 hospitals 10 times due to “confusion, difficulty walking, weakness and chest pain”
- Fortunately, all 12 of his brain MRIs are “normal”
- Would he benefit from CGM?

**ABSOLUTELY!**

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# Resources

For a copy of these slides, additional diabetes education and resources, please visit

**https://aace.com/diabetes-technology**