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Ohio Cardiovascular and Diabetes Health Collaborative

School of Medicine
Case Western Reserve University

In partnership with:

The Ohio State University College of Medicine

College of Medicine and Life Sciences, The University of Toledo

Ohio University Heritage College of Osteopathic Medicine

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University of Cincinnati College of Medicine

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Interpretation of Continuous Glucose Monitoring in Primary Care:
A Case-Based Approach

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For more information, head to Cardi-OH.org.

Objectives

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1. Identify basic elements of the Ambulatory Glucose Profile
2. Use Continuous Glucose Monitoring (CGM) examples to identify glucose monitoring patterns
3. Address common pitfalls of CGM use

Introduction

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- Continuous glucose monitoring (CGM) results in
  - Reduction in HbA1C[1,2]
  - Improved percentage of Time in Range (TIR), defined as 70-180 mg/dL[2]
  - Lower risk of hypoglycemia[2]
  - High patient satisfaction[2,3]
  - Lower risk of diabetes-related hospitalizations[4,5]
- Increasingly utilized in primary care practices as coverage and access expands.[6]

1. Yaron M, et al. Diabetes Care. 2019;42(7):1178-1184
2. Martens T, et al. JAMA. 2021;325(22):2262-2272
3. Gilbert TR, et al. Diabetes Technol Ther. 2021;23(S1):S35-S39
4. Bergenstal RM, et al. J Endocr Soc. 2021;5(4):bvab013
5. Roussel R, et al. Diabetes Care. 2021: 44(6):1368-1376
6. Martens TW. Curr Opin Endocrinol Diabetes Obes. 2022;29(1):10-16

Assessing Overall Glucose Management
American Diabetes Association (ADA)

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Rec #	Population	Method	Frequency
6.1	Meeting treatment goals and *stable* glycemic control	A1C *OR* TIR *OR* GMI	At least 2x/year
6.2	*Not* meeting treatment goals and/or recent change in therapy	A1C *OR* TIR *OR* GMI	At least quarterly

TIR: Time in Range, % time between 70-180 mg/dL
GMI: Glycemic Management Indicator, estimated A1C

7. American Diabetes Association Professional Practice Committee. Diabetes Care. 2022;45(Supplement_1):S83–S96

Standardized Metrics for Clinical Care
International Consensus on TIR

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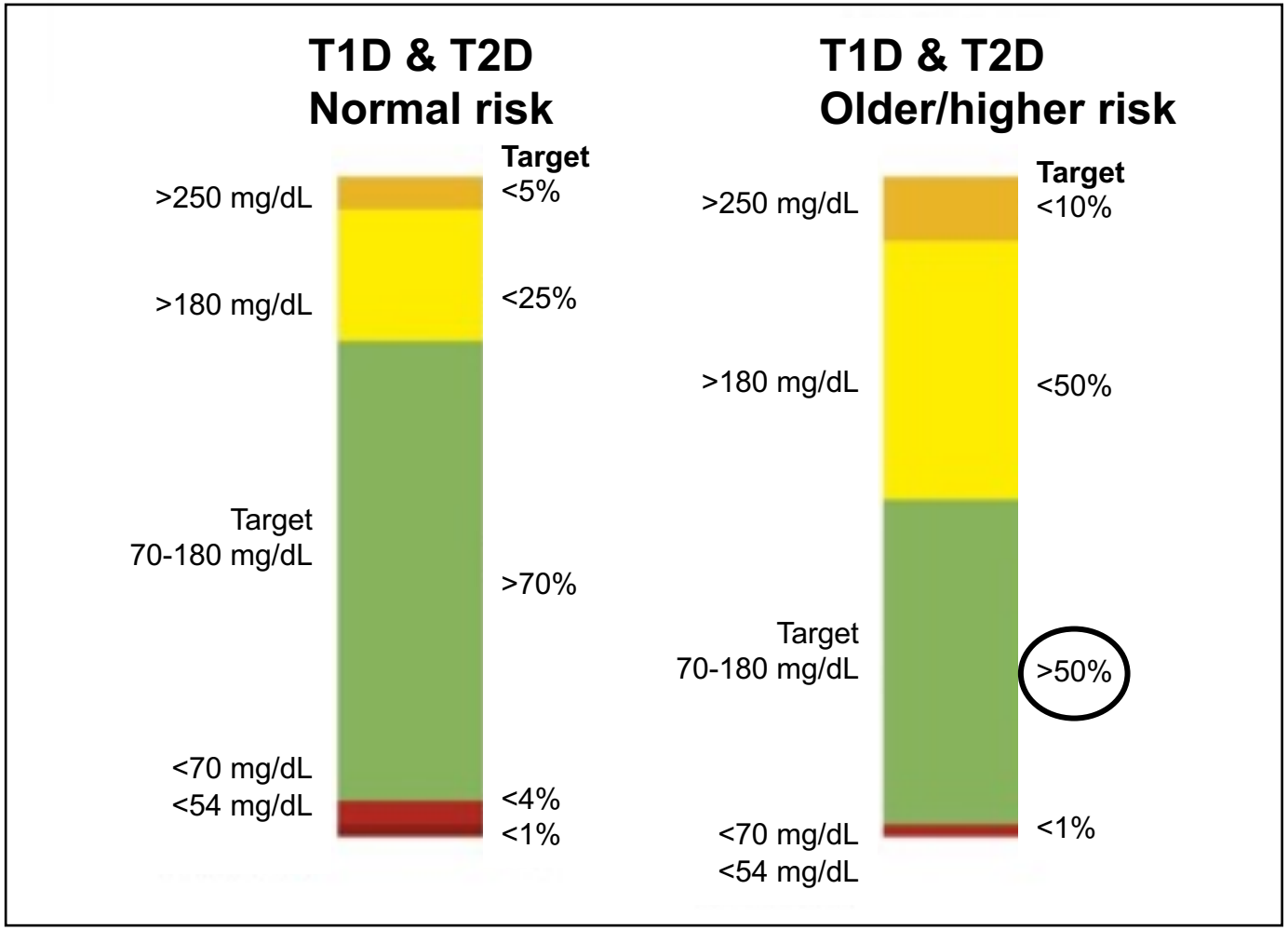
Metric	Comment
# Days worn/reported*	Goal 14 days
% Time with active data*	Goal >70%
Mean Glucose	
Glucose Management Indicator (GMI)	Estimated A1C
Glycemic Variability (% CV)	Goal ≤36%
Time above Range (TAR): % of Time ▪ >250 mg/dL ▪ 181-250 mg/dL	Goals vary
Time in Range (TIR): % of Time 70-180 mg/dL	Goals vary
Time below Range (TBR): % of Time ▪ 54-69 mg/dL (Level 1 hypoglycemia) ▪ <54 mg/dL (Level 2 hypoglycemia)	Goals vary

Coefficient of Variation (CV): Standard deviation/mean
*A standardized CGM report should include 14 consecutive days during which there is active data at least 70% of the time in order to calculate an estimated HbA1C

8. Battelino T, et al. Diabetes Care. 2019;42(8):1593–1603

CGM Goals
International Consensus on TIR



T1D: Type 1 Diabetes; T2D: Type 2 Diabetes

- The goal TIR for most individuals is 70% with 4% TBR and 1% of time below 54 mg/dl
- The goal TIR for older or higher risk individuals is 50% with <1% TBR

8. Battelino T, et al. Diabetes Care. 2019;42(8):1593–1603

Ambulatory Glucose Profile

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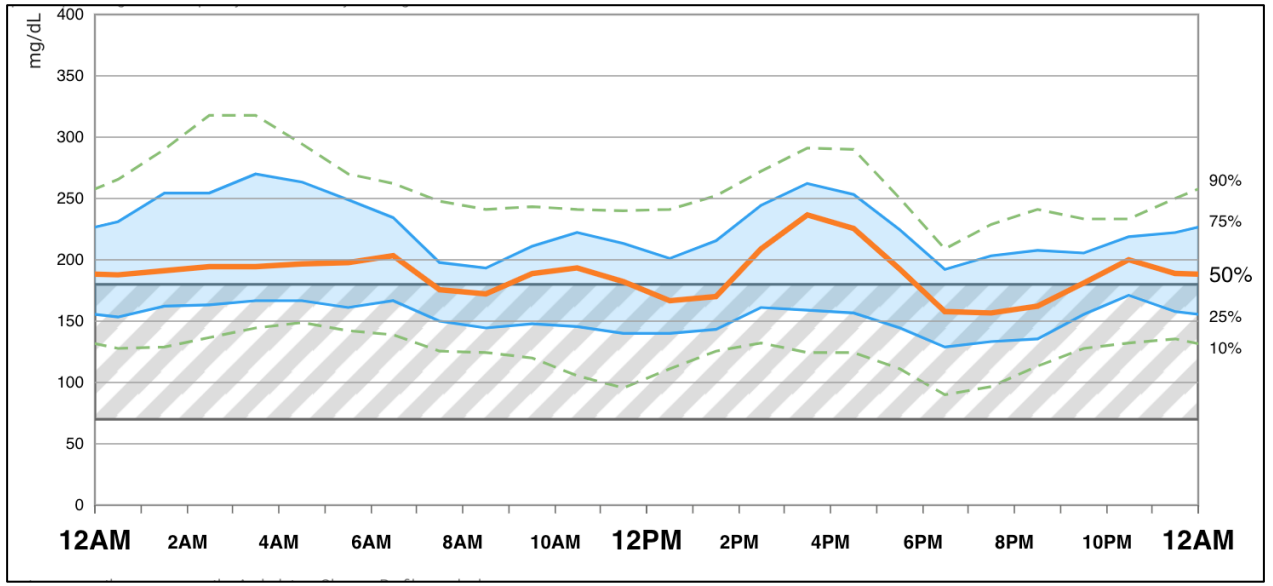
TBR <70 | **TIR 70-180** | **TAR >180** | **CV Goal <36%**

Glucose Statistics

Avg Glucose mg/dL	Very Low	Low	In Target Range	High	Very High	Coefficient of Variation	SD mg/dL	% Time CGM Active
192	< 54 mg/dL	< 70 mg/dL	70 - 180 mg/dL	> 180 mg/dL	> 250 mg/dL	30.3%	58	95.2%
Glucose Exposure	0.0%	0.6%	45.3%	54.1%	14.2%	Glucose Variability		Data Sufficiency
	Glucose Ranges							

Goal >70% over 14 days

Check that target set to 70-180 mg/dL



- TIR (Time in Range)
- TAR (Time above Range)
- TBR (Time below Range)

Pattern Management

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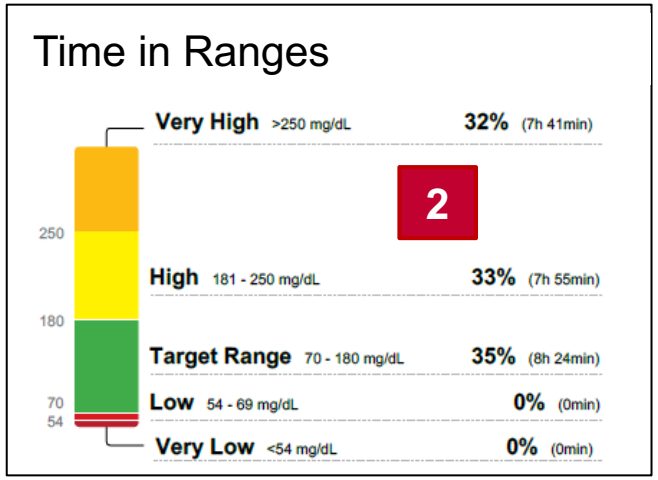
1. Review medication taking behaviors.
2. Assess meal times, snacks, particularly overnight.
3. Assess overall glycemic status (TIR, mean glucose).[9]
4. Address hypoglycemia first if Time below Range (TBR) is above target.[9]
5. Address AM/fasting glucose.
6. Assess non-fasting glucose.
7. Evaluate patterns related to physical activity or work.

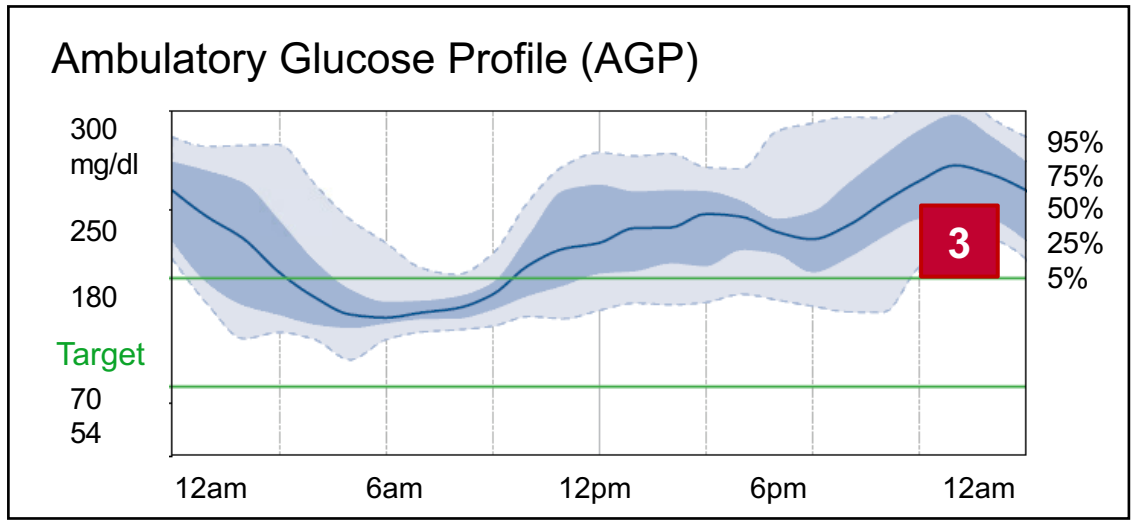
9. Grunberger G, et al. Endocr Pract. 2021;27(6):505-537

Case 1: Need for Prandial Insulin

- % Time CGM Active: 76%
- Mean Glucose: 219 mg/dL
- GMI: 8.5%
- % CV: 30.5%

1





Patient Summary
- 52-year-old female with T2D, no complications
- Weight: 90 kg

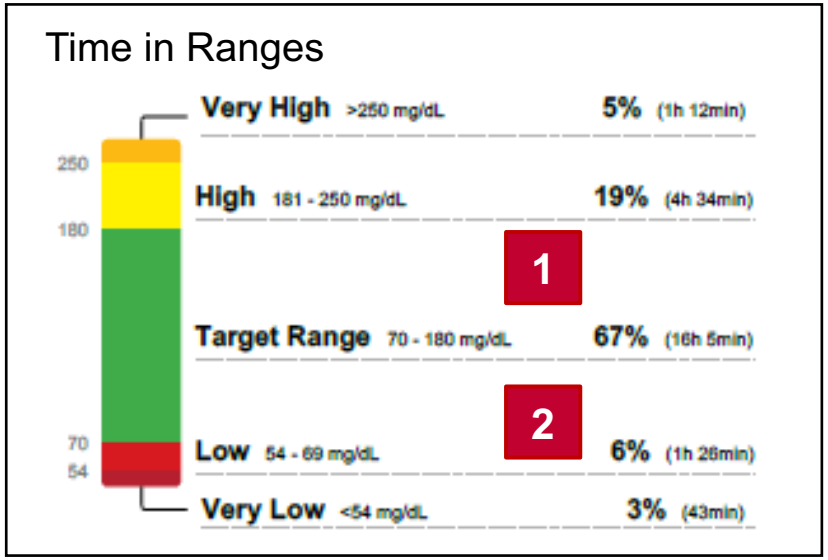
Current Treatment
- Metformin, Glimepiride
- Dulaglutide 1.5 mg weekly
- Glargine U300 60 units daily

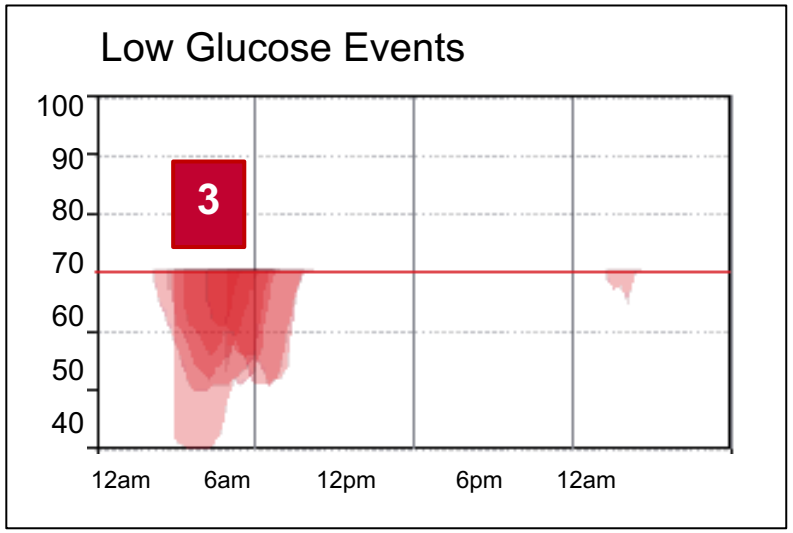
CGM Interpretation (*red boxes* ☐)
- (1) Adequate amount of data
- (2) TIR is 35% (goal >70%)
- (3) Pattern is predominantly post-prandial hyperglycemia

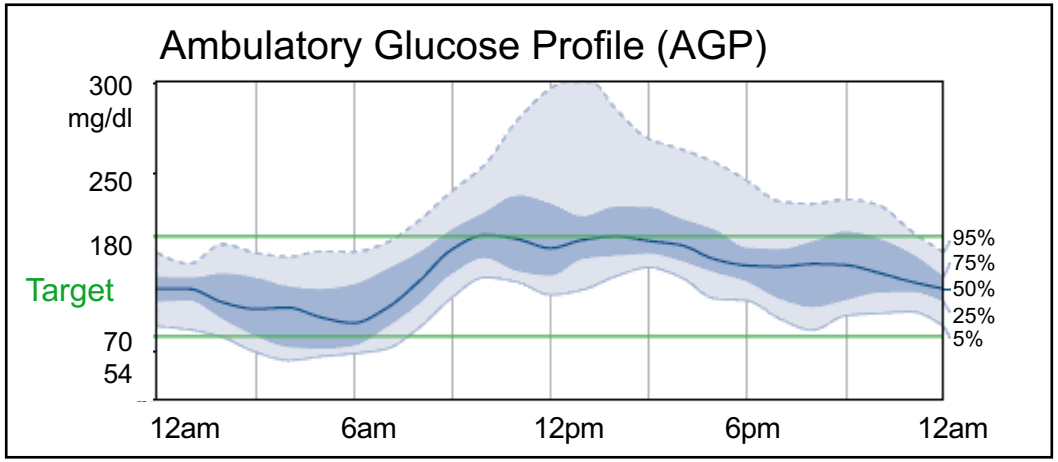
Plan
- Titrate dulaglutide
- Stop glimepiride
- Start prandial insulin at largest meal of the day
- *Do not increase basal insulin because the dose is already >0.5 unit/kg and there is a high bedtime to morning differential.*[10]

10. American Diabetes Association Professional Practice Committee. Diabetes Care. 2022;45(Supplement_1):S125–S143

Case 2: “Overbasalization”







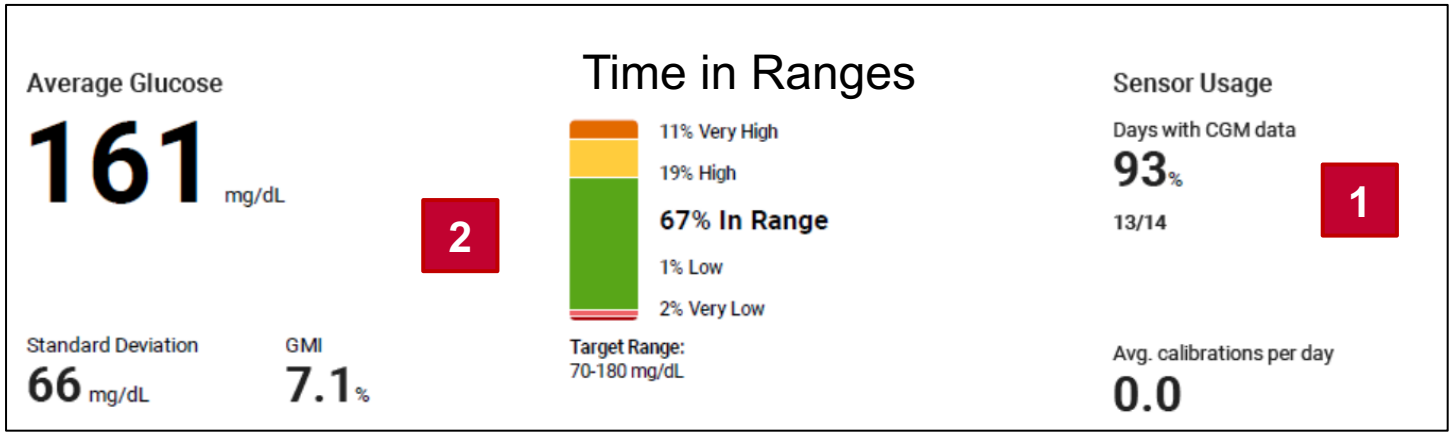
Patient Summary
- 29-year-old female with T2D

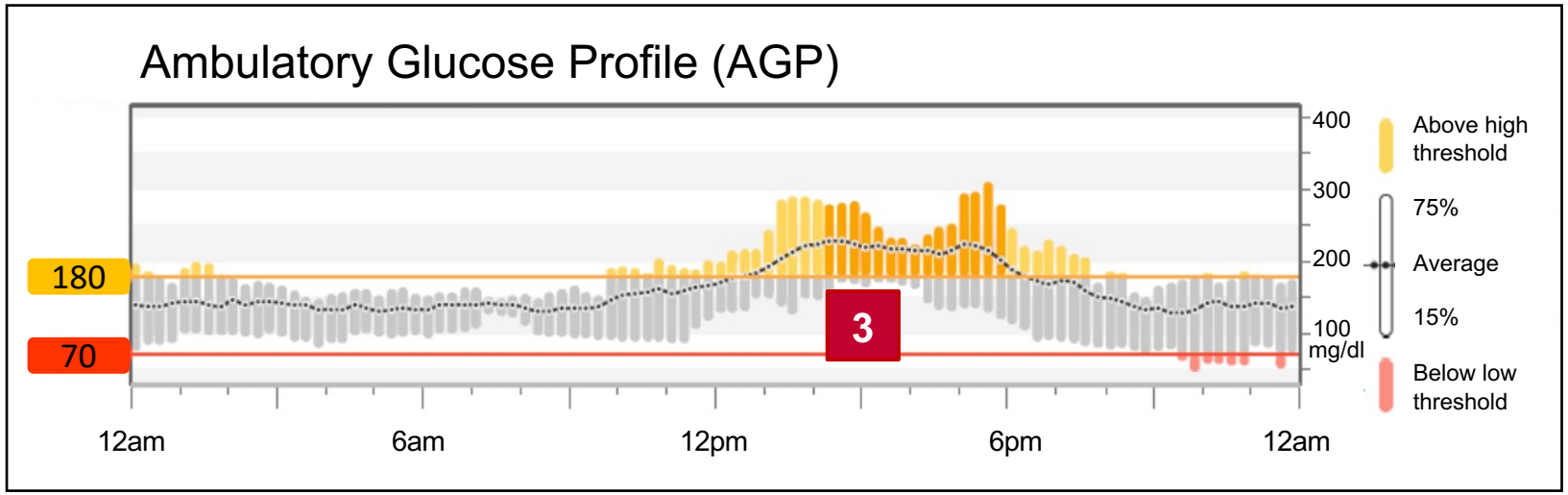
Current Treatment
- Empagliflozin
- Glargine 45 units daily
- Lispro correction dosing only
- Intolerance to metformin, GLP-1 RA

Interpretation (*red boxes* ☐)
- (1) Overall glucose (TIR) is close to goal
- (2,3) Hypoglycemia

Plan
- Reduce glargine by 20%
- Add lispro with breakfast

Case 3: Assessing Post-Meal Glucose and Insulin Stacking





Patient Summary

- 52-year-old male with chronic pancreatitis (c-peptide 0.2), coronary artery disease, heart failure

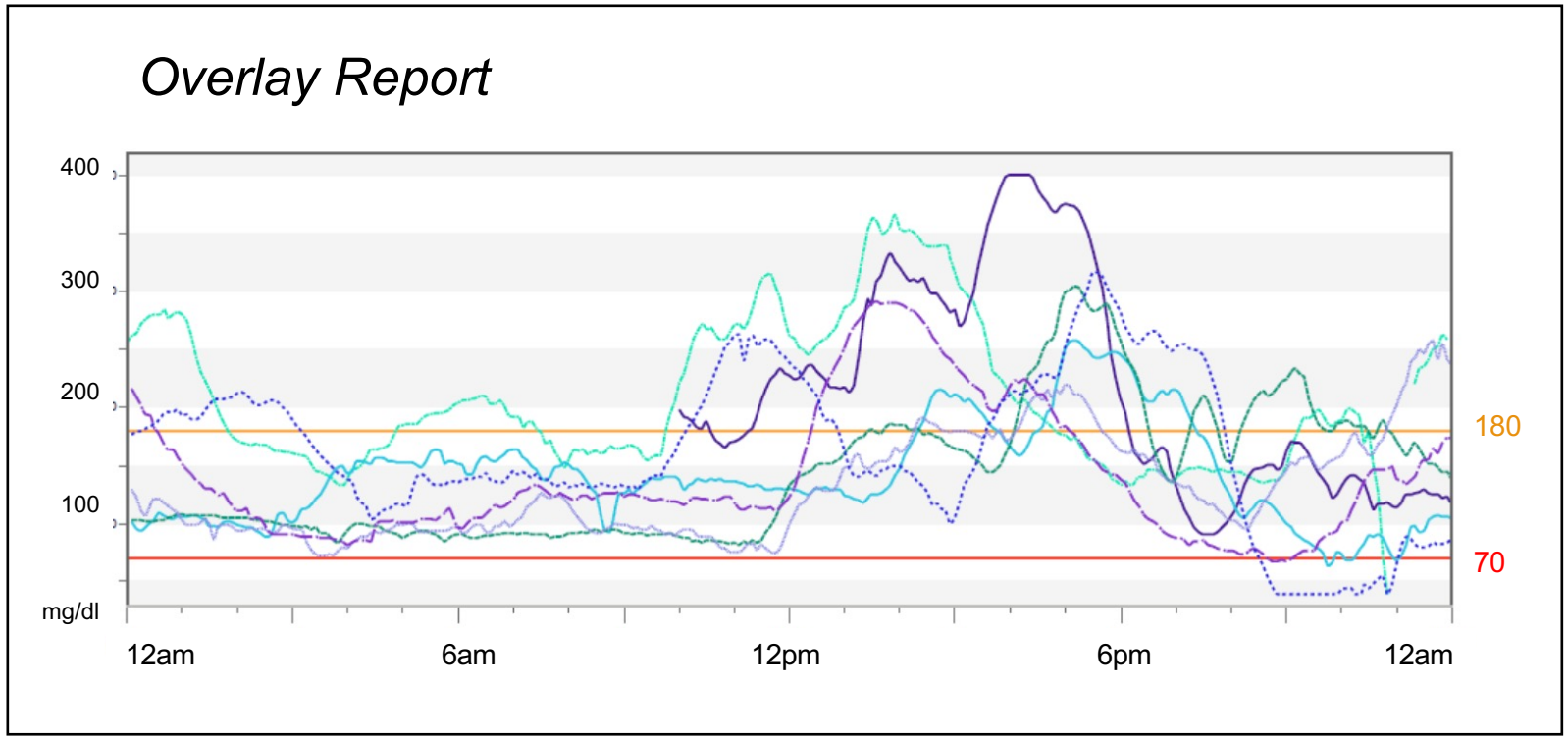
Current Treatment

- Degludec 18 units QAM
- Aspart 5-6 units QAC + correction

Interpretation (*red boxes ☐*)

- (1) Adequate data
- (2) Overall glucose level (TIR, GMI) is at goal given comorbidities
- (3) Pattern shows postprandial hyperglycemia mid-day, bedtime hypoglycemia

Case 3: Assessing Post-Meal Glucose (continued)



Plan

- Increase lunchtime insulin, bolus **pre**-meal
- Avoid stacking doses after meals
- Refer to education
- Consider SGLT2-inhibitor with appropriate precautions to prevent diabetic ketoacidosis

Case 4: Intermittent Use to Assess Recent Adjustment

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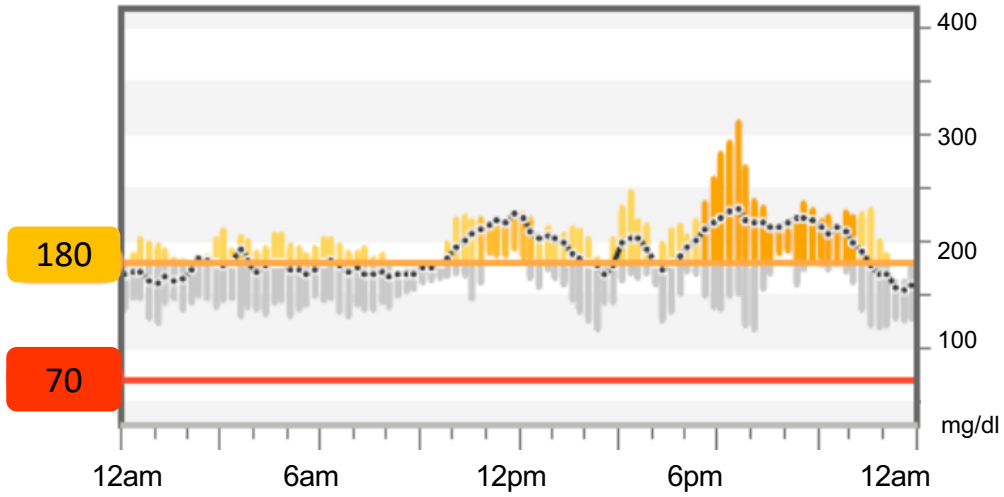
Off Semaglutide



Time in Range

9% Very High
44% High
47% In Range
0% Low
0% Very Low

Target Range:
70-180 mg/dL

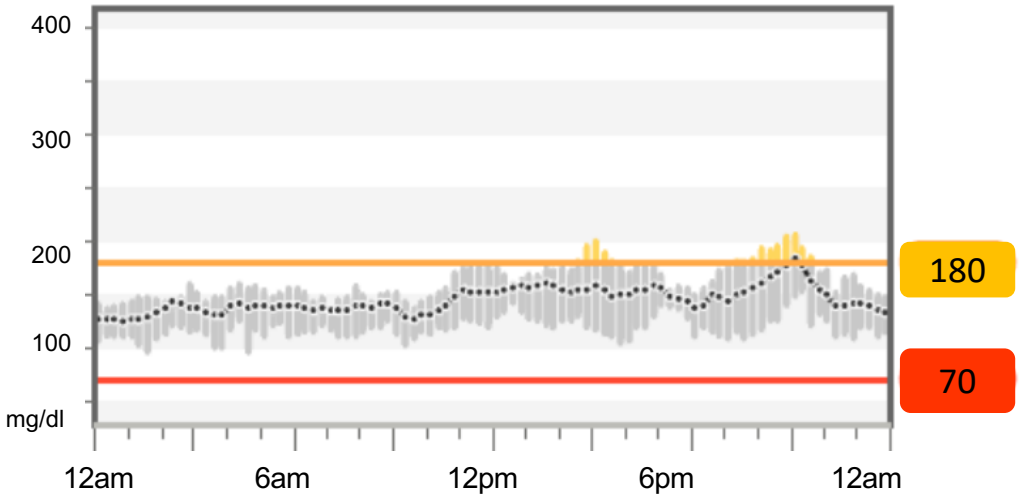
Average Glucose
190 mg/dL

Standard Deviation
43 mg/dL

GMI
N/A

GMI derived from at least 12 days of data

On Semaglutide



Time in Range

<1% Very High
12% High
87% In Range
<1% Low
0% Very Low

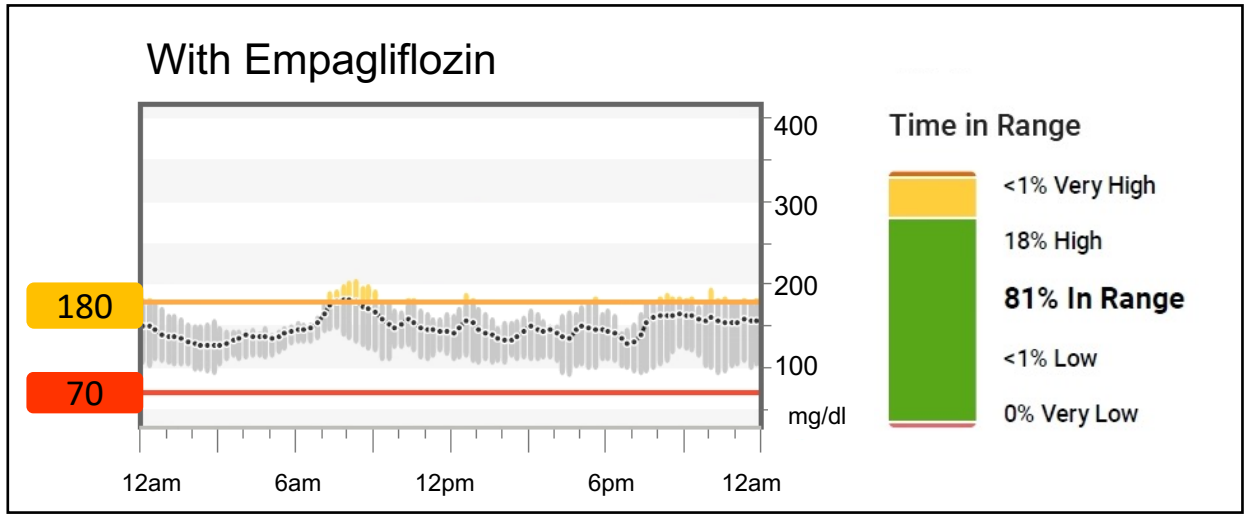
Target Range:
70-180 mg/dL

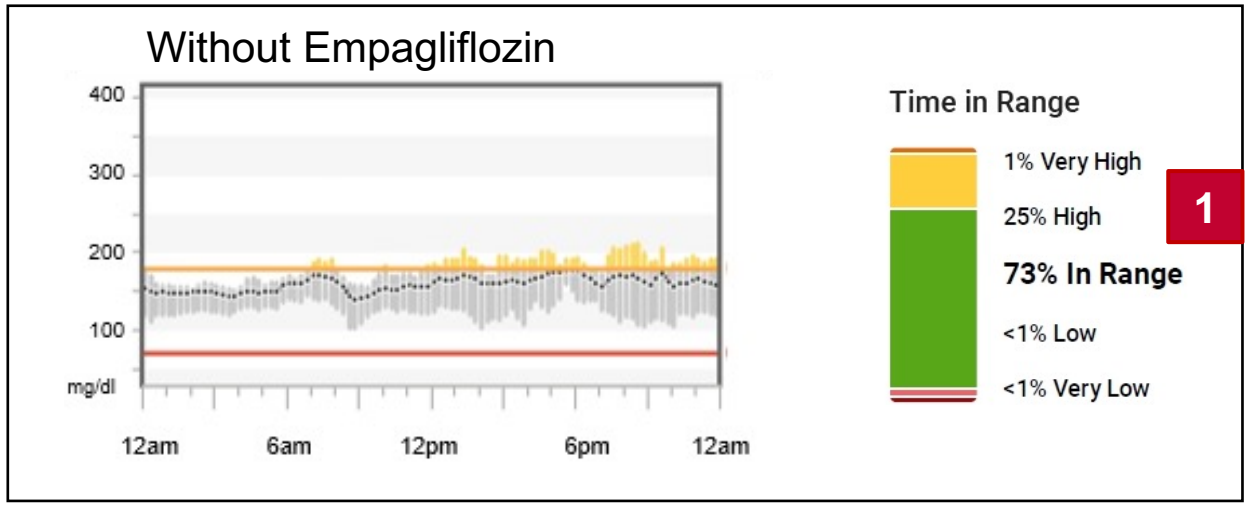
Average Glucose
145 mg/dL

Standard Deviation
30 mg/dL

GMI
6.8%

Case 5: Assessing Overnight Glucose





Patient Summary

- 65-year-old male with T2D, chronic kidney disease
- Empagliflozin discontinued due to balanitis
- Concerned about hyperglycemia, performing extra injections post-meal

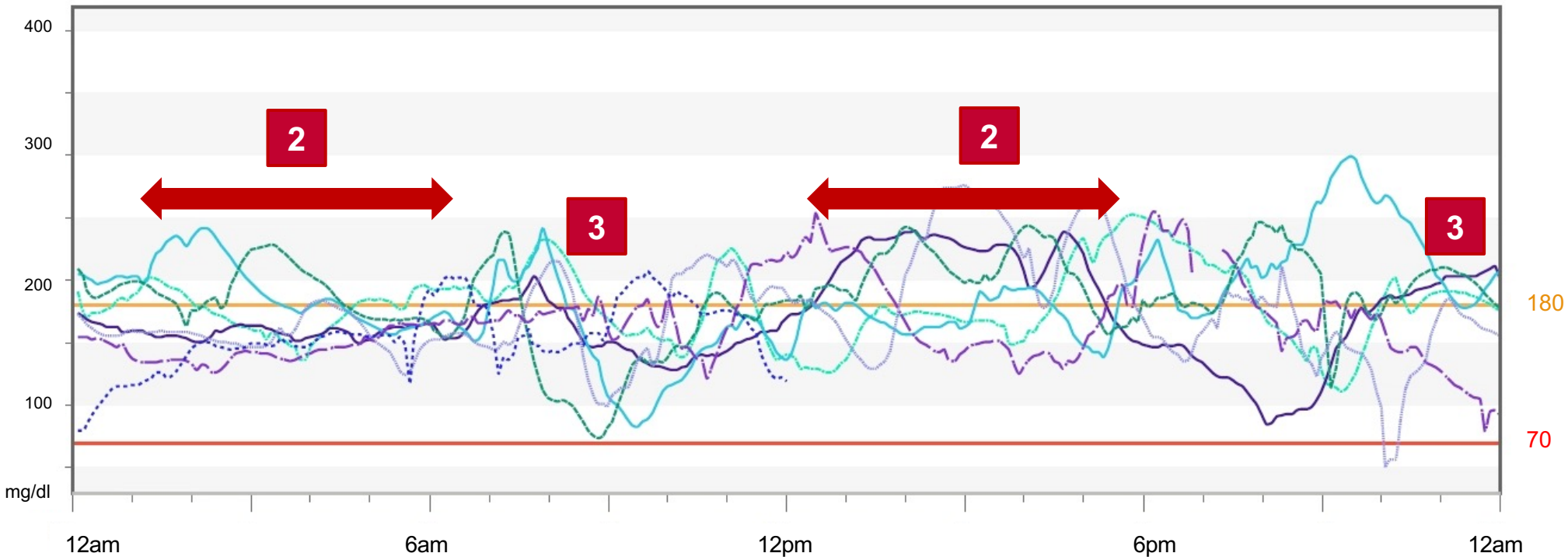
Current Medications

- Detemir 42 units daily
- Aspart 1 unit per 3 grams of carbs plus correction
- Semaglutide 1 mg weekly

Interpretation (*red boxes* ☐)

- (1) Overall glucose has increased though still acceptable given age and comorbidity

Case 5: Assessing Overnight Glucose (continued)



Interpretation (*red boxes* ☐)

Overlay report shows:

- (2) Overnight and premeal hyperglycemia
- (3) Overcorrection of hyperglycemia

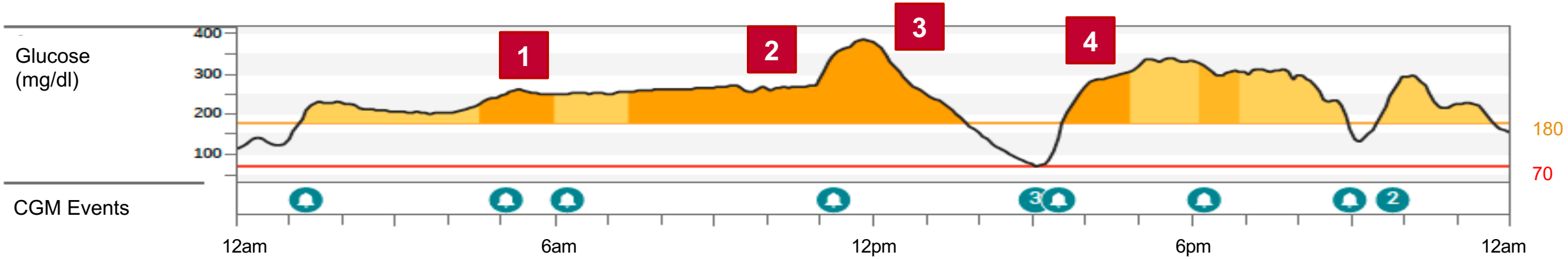
Plan

- Increase Detemir **<u>slightly</u>**
- Bolus pre-meal only
- Do not perform post-meal corrections

Case 6: Dawn Phenomenon, Rebound Hyperglycemia

Patient Summary
- 13-year-old female with T2D, trying to lose weight by skipping morning meals
- Checking fingerstick glucose infrequently at home, A1C 9%
- Professional CGM placed

Current Treatment:
- Metformin, glargine, lispro with meals



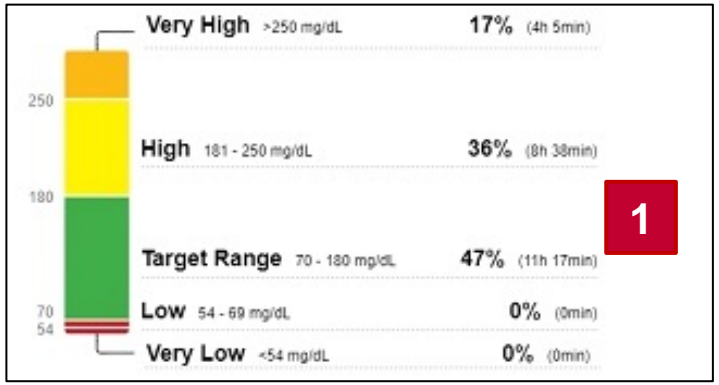
Interpretation (*red boxes* ☐)
- (1) Dawn phenomenon: early morning rise in glucose due to rise in counter-regulatory hormones
- (2) Lack of morning insulin results in persistent hyperglycemia
- (3) Initial postprandial rise with lunch due to late meal insulin dosing followed by hypoglycemia
- (4) Overtreatment of hypoglycemia leads to rebound hyperglycemia

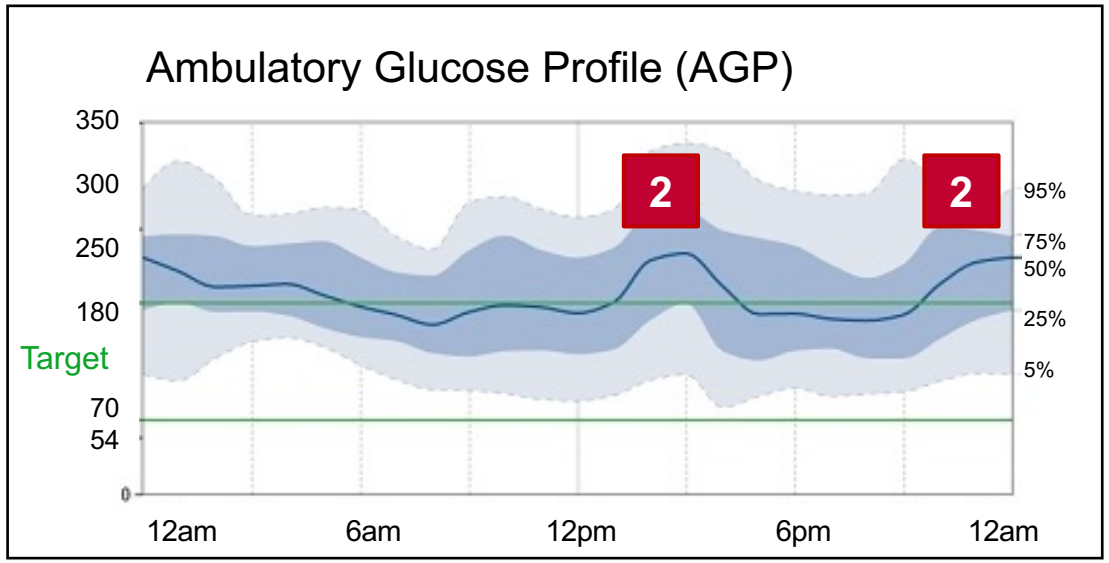
Plan
- Encourage regular meals (including breakfast!) with pre-meal bolus
- Personal CGM use; education on hypoglycemia treatment

Case 7: Resolving Discrepancies between A1C and Blood Glucose

- % Time CGM Active: 93%
- Mean Glucose: 191 mg/dL
- GMI: 7.9%
- % CV: 30.9%

1





Patient Summary

- 70-year-old female with T2D complicated by neuropathy and retinopathy
- A1C 10.2%, self-reported glucose ~100s, testing 1-2 times daily
- Referred to diabetes education, start CGM

Current Treatment

- Dulaglutide 1.5 mg weekly
- Glargine 36 units daily
- Lispro 4 units with meals plus correction

Interpretation (*red boxes* ☐)

- (1) GMI 7.9, TIR close to goal, 12 scans per day
- (2) Postprandial spikes in part due to snacking

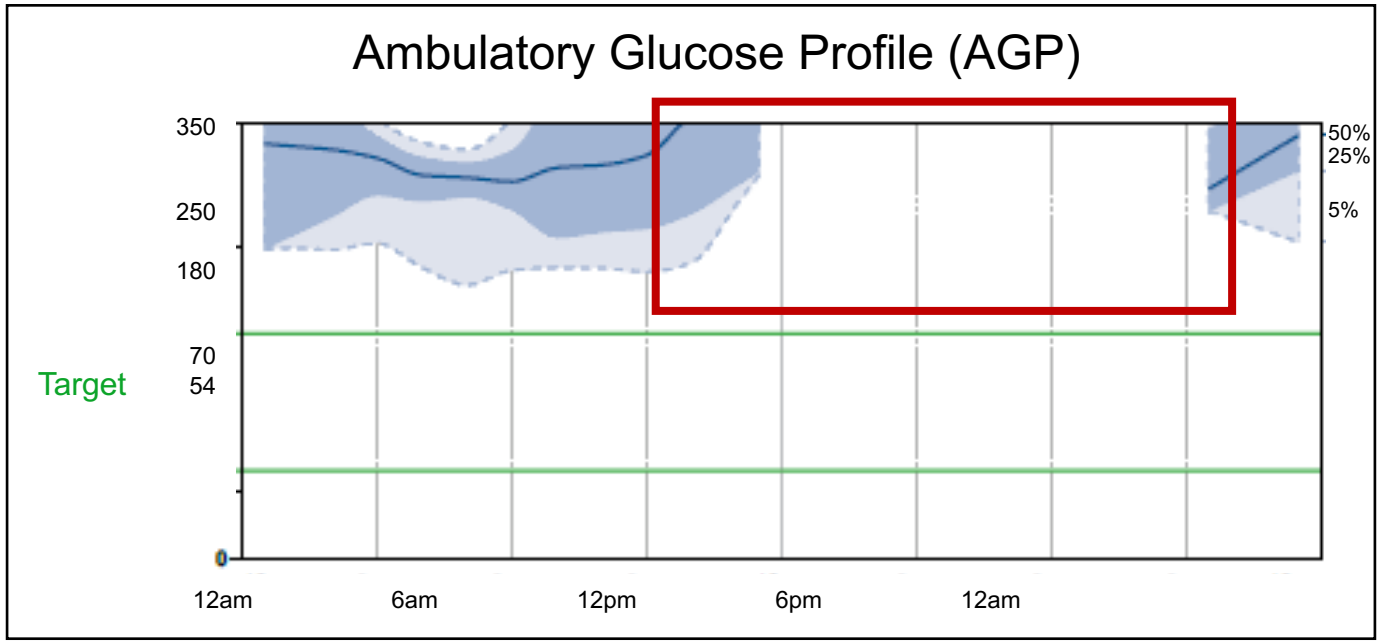
Plan

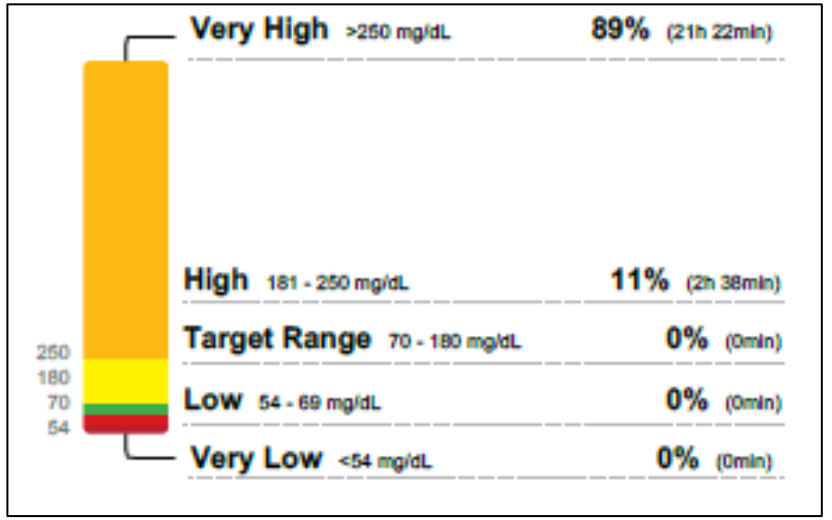
- Acknowledge success
- Add snack dose

Case 8: Missing Data

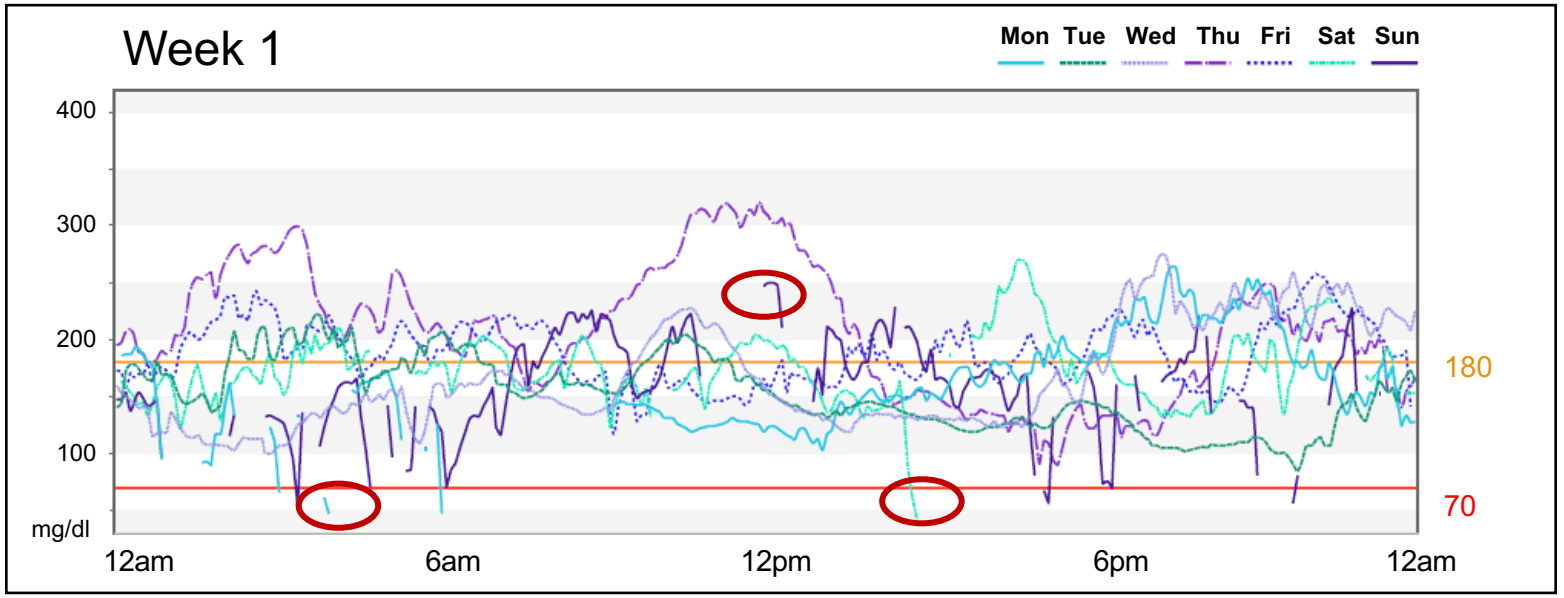
- % Time CGM Active: 29%
- Mean Glucose: 191 mg/dL
- GMI: 7.9%
- % CV: 30.9%

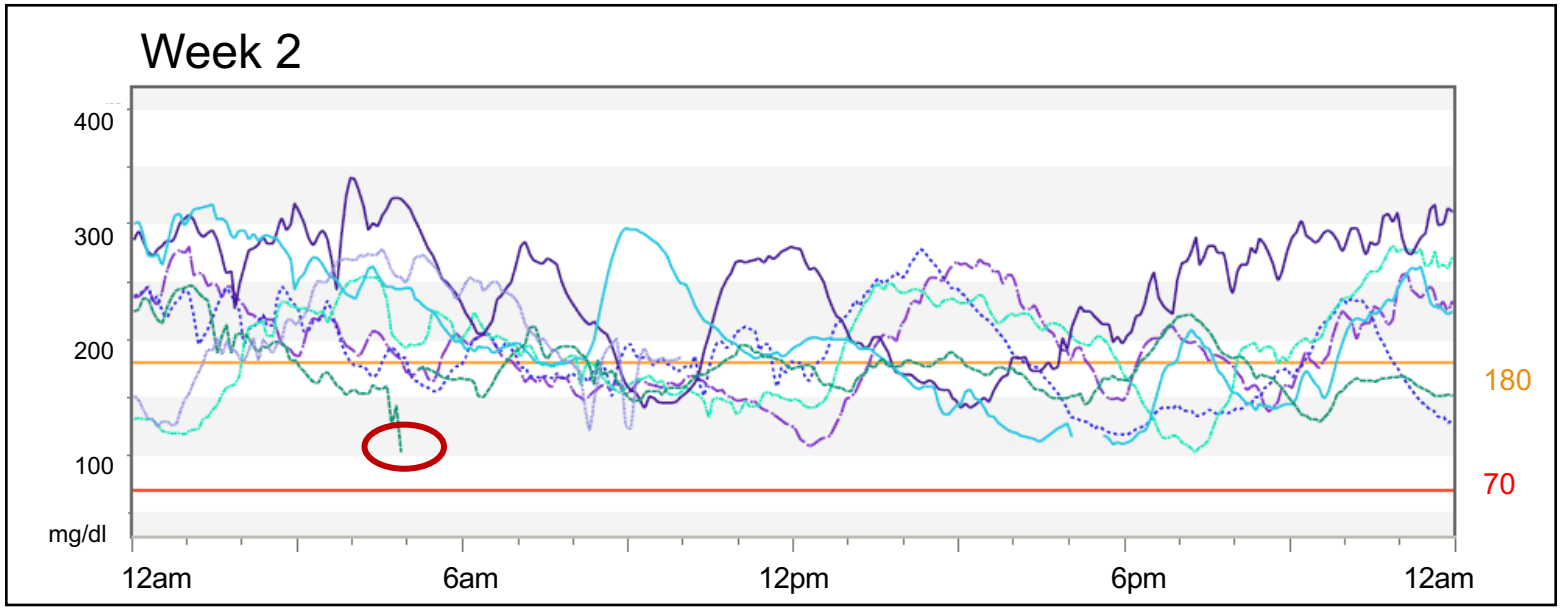
FreeStyle Libre memory is only 8 hours—missing data due to lack of scanning





Case 9: Artifact





- These are probably not real lows but are artifact.
- Multiple events with loss of signal which resolves after replacing sensor (Week 2).
- Check also that:
  - The receiver is in range of the transmitter.
  - Sensor is not being compressed.
- If not resolved could be transmitter issue.

Conclusion

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- CGM reports help clinicians guide patients with making lifestyle modifications and medication adjustments.
- A systematic approach can be useful for recognizing and addressing a variety of common clinical scenarios.

Additional Cardi-OH Resources

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- **Beyond the A1C: Targets for Blood Glucose and Methods of Measurement**
  cardi-oh.org/best-practices/diabetes-management/beyond-the-a1c-targets-for-blood-glucose-and-methods-of-measurement
- **Outpatient Diabetes Management for Primary Care Providers: Medications Intensification and Algorithm**
  cardi-oh.org/best-practices/diabetes-management/outpatient-diabetes-management-for-primary-care-providers-medications-intensification-and-algorithm
- **Optimizing the Telehealth Diabetes Visit: Glucose Monitoring Data**
  cardi-oh.org/best-practices/diabetes-management/optimizing-the-telehealth-diabetes-visit

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