Continuous Glucose Monitors in Practice

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Disclosures

- I have no actual or potential conflict of interest in relation to this program/presentation.
- I will mention off-label medication use.
- I do serve as a principal investigator for current investigational studies with
  - Eli Lilly
  - Novo Nordisk

History

Advantages and Disadvantages of SMBG

ADVANTAGES

- Accurately measures capillary glucose (with proper technique)
- Relatively inexpensive
- Easy for patients to learn
- Widely used
- People are familiar with it

DISADVANTAGES

- Training required
- Prone to user error
- Data limited to single point in time
- Requires multiple tests per day for effective clinical use
- Inconvenient and painful
- Quality of strip/meters vary

Fewer than 1/3 of people with diabetes adhere to the recommended amount of SMBG testing

a. [illegible]gan R, et al. *Adv Ther*. 2019;36:579-596; b. American Diabetes Association. *Diabetes Care*. 2021;44(Suppl 1):S85-S99.

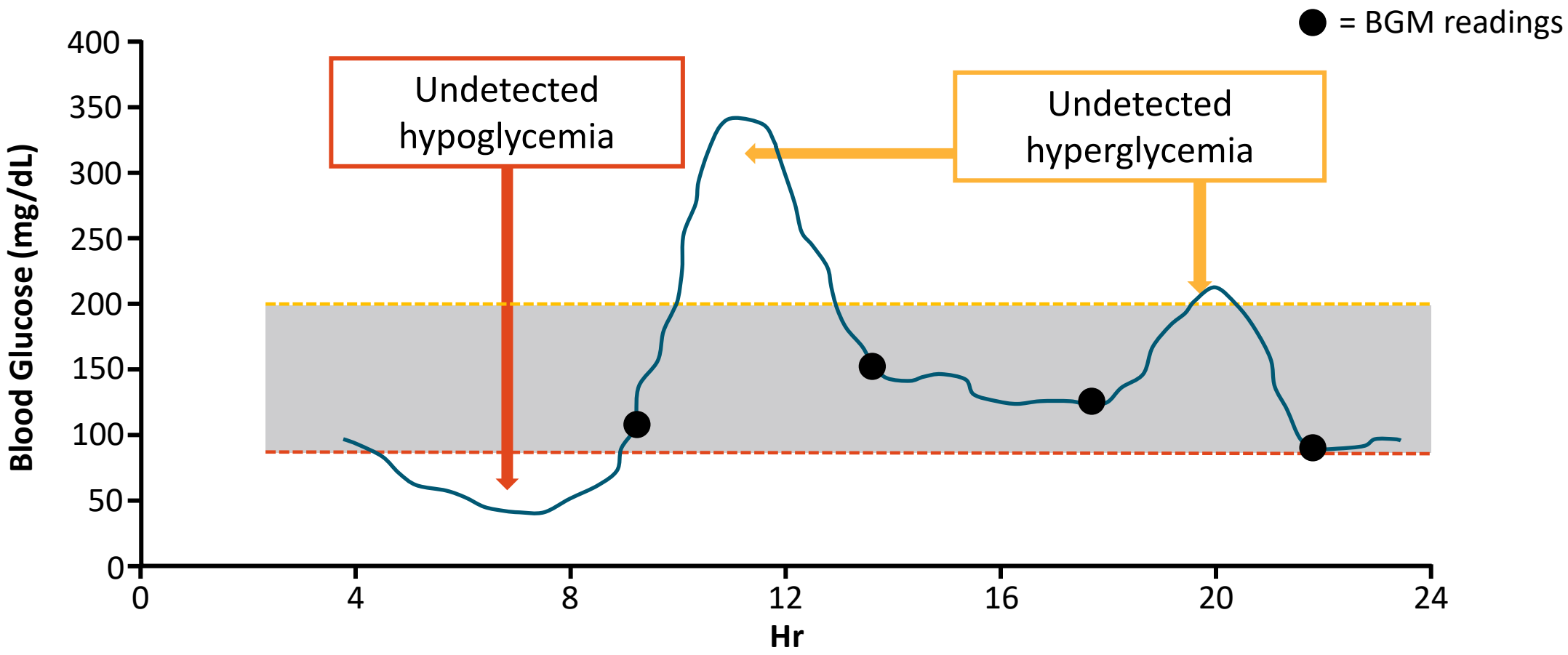
Poor Testing Technique Can Negatively Affect Accuracy

- Median blood glucose levels measured by portable analyzer in 10 volunteers with normal glucose tolerance after peeling fruit, followed by washing hands with tap water, cleaning fingertip with alcohol wipe, or no action
- Skin contaminants reduce meter accuracy 1 hr after peeling fruit

Median Blood Glucose, mg/dL	Washed Hands	Exposed Finger (No Washing)	1 Alcohol Wipe	5 Alcohol Wipes
Peeling an orange (n = 10)	90	171	118	119
Peeling a grape (n = 10)	87	360	274	131
Peeling a kiwi (n = 10)	92	183	144	106

Hirose. Diabetes Care. 2011;34:596.

Blood Glucose vs Continuous Glucose Monitoring



Limitations to A1C

The Fallacy of Average: How Using HbA_{1c} Alone to Assess Glycemic Control Can Be Misleading

Diabetes Care 2017;40:994–999 | https://doi.org/10.2337/dc17-0636

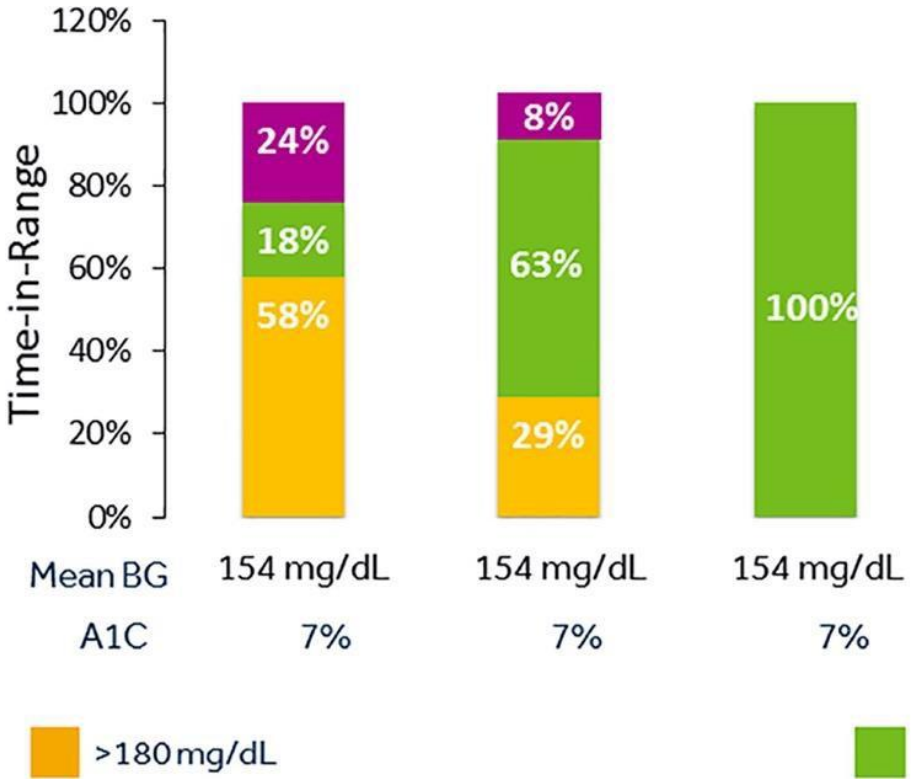
Roy W. Beck,[1] Crystal G. Connor,[1] Deborah M. Mullen,[2] David M. Wesley,[2,3] and Richard M. Bergenstal[2]

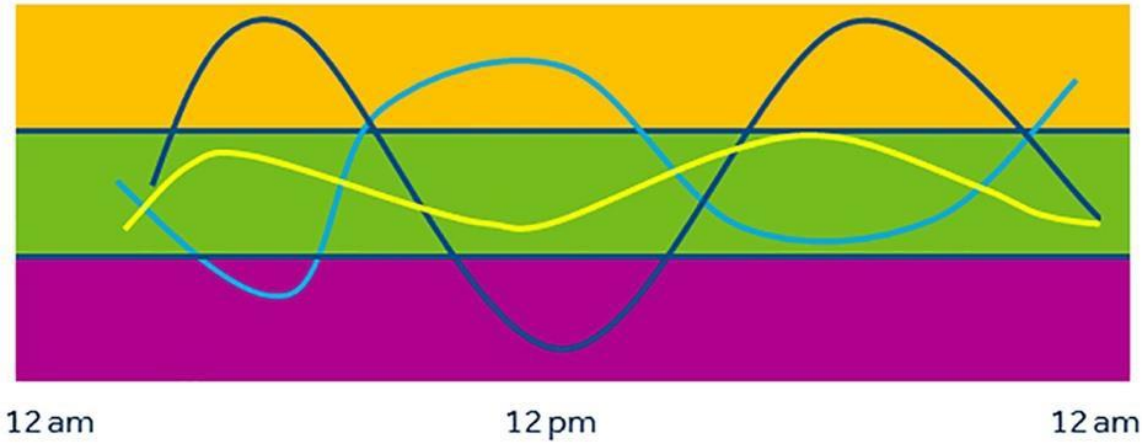
- It is a surrogate marker
- Based on an average, without information on glycemic variability
- Factors that affect red blood cell turnover can make this inaccurate
- Anemia and other conditions may falsely elevate or decrease
- Large interindividual variability

HbA1c, %	mg/dL	95% CI
5	97	(76 to 120)
6	126	(100 to 152)
7	154	(123 to 185)
8	183	(147 to 217)
9	212	(170 to 249)
10	240	(193 to 282)
11	269	(217 to 314)
12	298	(240 to 347)

Beck. Diabetes Care. 2017;40:994.

A1c is a poor metric for outcomes and decisions for therapy adjustments





>180 mg/dL

70 - 180 mg/dL

<70 mg/dL

Brown, Journal of Diabetes, 2018

History of CGM

- 1999: First CGM approved; blinded 3-day sensor
- 2004: First CGM released for personal use by Medtronic
- 2006: First pump and CGM working together by Medtronic; first Dexcom available
- 2008: First Freestyle CGM available
- 2016-2017: First CGM that requires no calibration, Freestyle Libre; first hybrid-closed loop pump that adjusts insulin by Medtronic (670 g)
- 2018: First implantable sensor, Eversense available

Hirsch. History of glucose monitoring. Role of Continuous Glucose Monitoring in Diabetes Treatment. American Diabetes Association. 2018.

Current Options for Personal CGM Systems

Dexcom G6

Change every 10 days

Guardian Connect Guardian Sensor 3

Change every 7 days

FreeStyle Libre 2/3

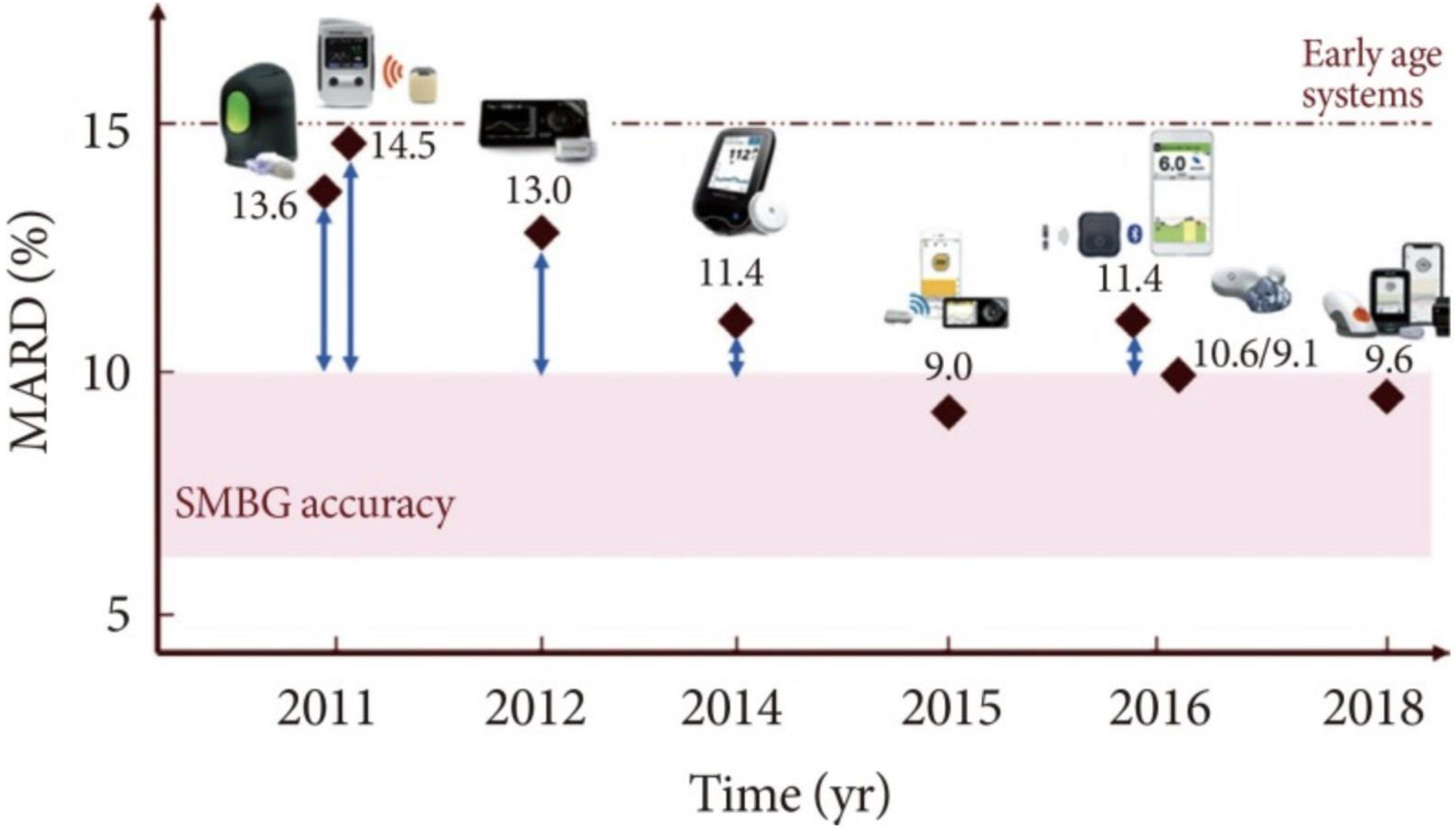
Change every 14 days

Eversense

Implantable

Change every 180 days

Accuracy of CGM is approaching that of SMBG



Patient Selection: Type 1 and Type 2 Diabetes

- **Type 1 diabetes**
  - CGM recommended for all individuals with T1D, particularly those who are not meeting glycemic targets, have hypoglycemia unawareness, and/or have episodes of hypoglycemia[1-3]
  - CGM is preferred mode of glucose monitoring in T1D[4]
  - Consider for patients with variable/intensive activity and those with excessive glucose variability
- **Type 2 diabetes**
  - CGM recommended for adults with T2D on MDI[1-3]
  - CGM also recommended for adults with T2D who are not meeting glycemic targets[1-3]

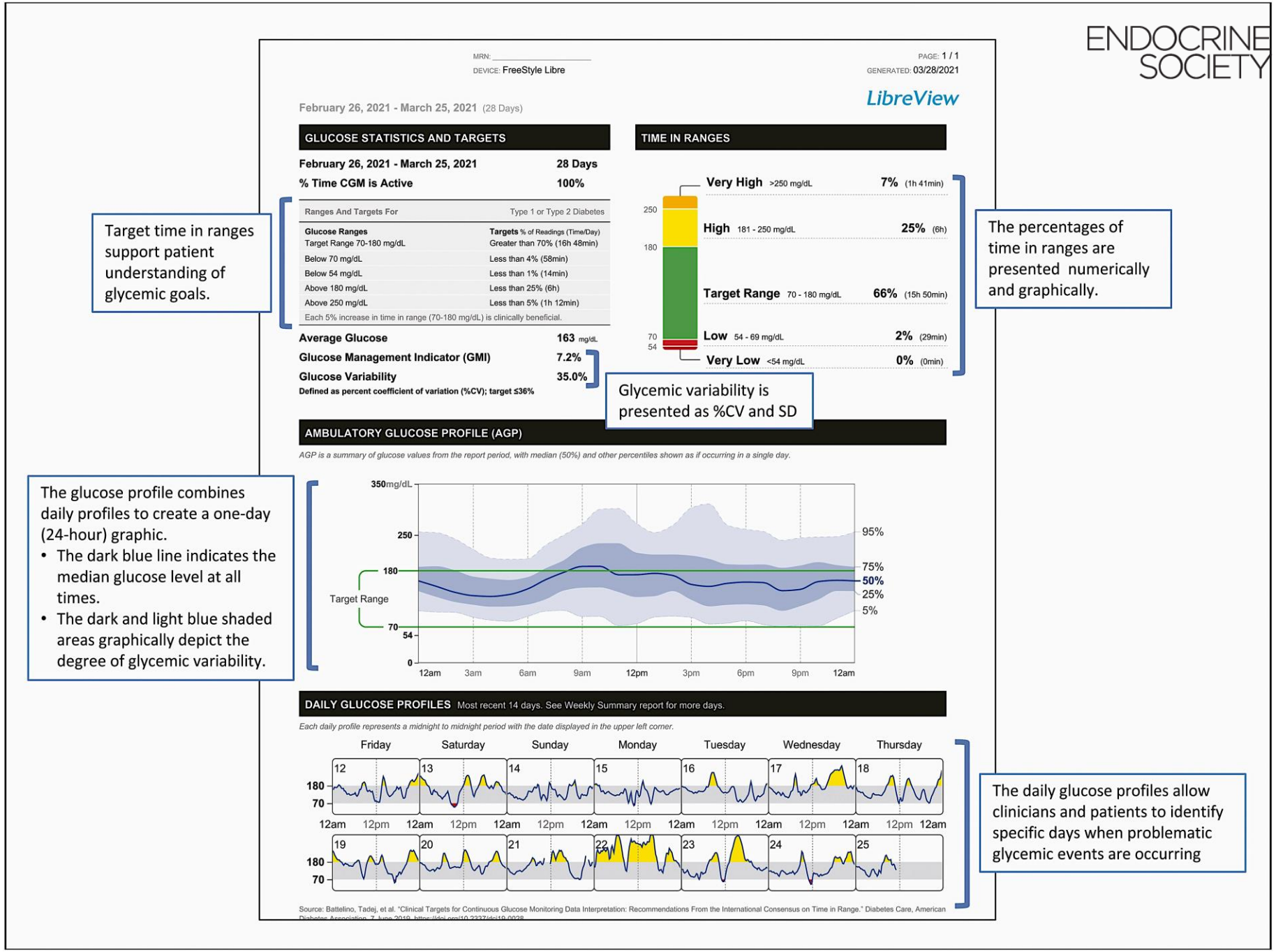
1. Peters. J Clin Endocrinol Metab. 2016;101:3922. 2. ADA. Diabetes Care. 2020;43:S77. 3. Fonseca. Endocr Pract. 2016;22:1008. Holt et al. Diabetes Care 2021; 44:2589

Patient Selection: Other Populations

- **Pregnancy**
  - ADA recommends real-time CGM for pregnant women with T1D to improve A1C levels, time in range, and neonatal outcomes[1]
  - In CONCEPTT trial, CGM during pregnancy significantly decreased incidence of LGA, neonatal hypoglycemia, and NICU admissions[2]
- **Elderly patients**
  - CGM may help identify hypoglycemia in elderly patients and in those with hypoglycemia unawareness[3]

1. ADA. Diabetes Care. 2020;43:S77. 2. Feig. Lancet. 2017;390:2347. 3. Fonseca. Endocr Pract. 2016;22:1008.

Ambulatory Glucose Profile (AGP)



MRN: _____
DEVICE: FreeStyle Libre

PAGE: 1 / 1
GENERATED: 03/28/2021

LibreView

February 26, 2021 - March 25, 2021 (28 Days)

GLUCOSE STATISTICS AND TARGETS

February 26, 2021 - March 25, 2021	28 Days
% Time CGM is Active	100%

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	163 mg/dL
Glucose Management Indicator (GMI)	7.2%
Glucose Variability	35.0%

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

TIME IN RANGES

Very High	>250 mg/dL	7% (1h 41min)
High	181 - 250 mg/dL	25% (6h)
Target Range	70 - 180 mg/dL	66% (15h 50min)
Low	54 - 69 mg/dL	2% (29min)
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 Most recent 14 days. See Weekly Summary report for more days.

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

Target time in ranges support patient understanding of glycemic goals.

The percentages of time in ranges are presented numerically and graphically.

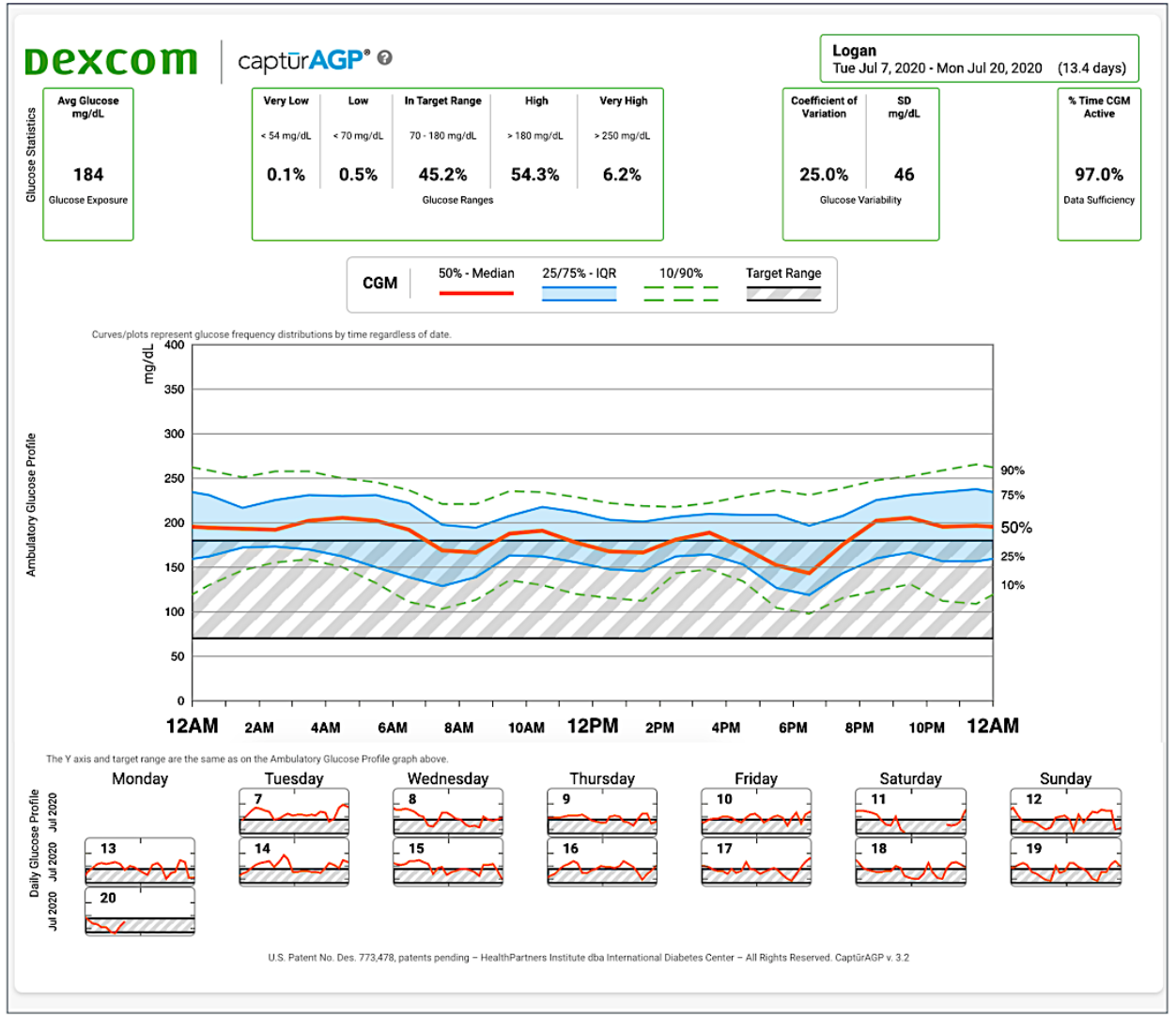
Glycemic variability is presented as %CV and SD

The glucose profile combines daily profiles to create a one-day (24-hour) graphic.

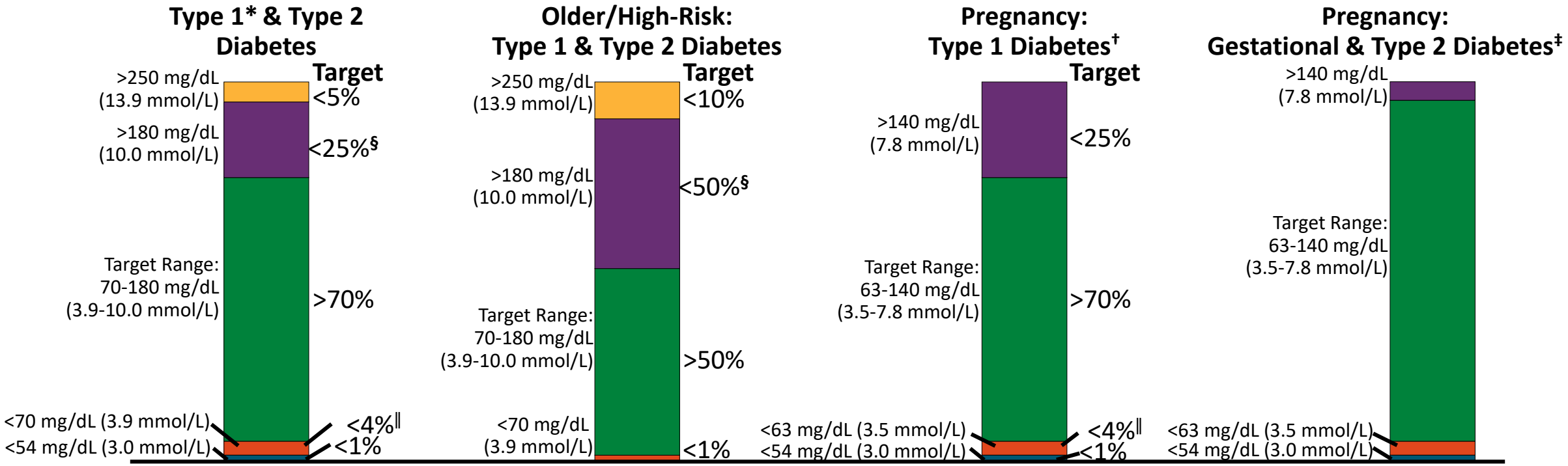
- The dark blue line indicates the median glucose level at all times.
- The dark and light blue shaded areas graphically depict the degree of glycemic variability.

The daily glucose profiles allow clinicians and patients to identify specific days when problematic glycemic events are occurring

Ambulatory Glucose Profile: Dexcom Clarity



Different Populations Have Different Targets



*For age <25 yr, if the A1C goal is 7.5%, then set TIR target to approximately 60%. (See *Clinical Applications of Time in Ranges section* in the text for additional information regarding target goal setting in pediatric management.)

†Percentages of time in ranges are based on limited evidence. More research is needed.

‡Percentages of time in ranges have not been included because there is very limited evidence in this area. More research is needed. Please see *Pregnancy* section in text for more considerations on targets for these groups.

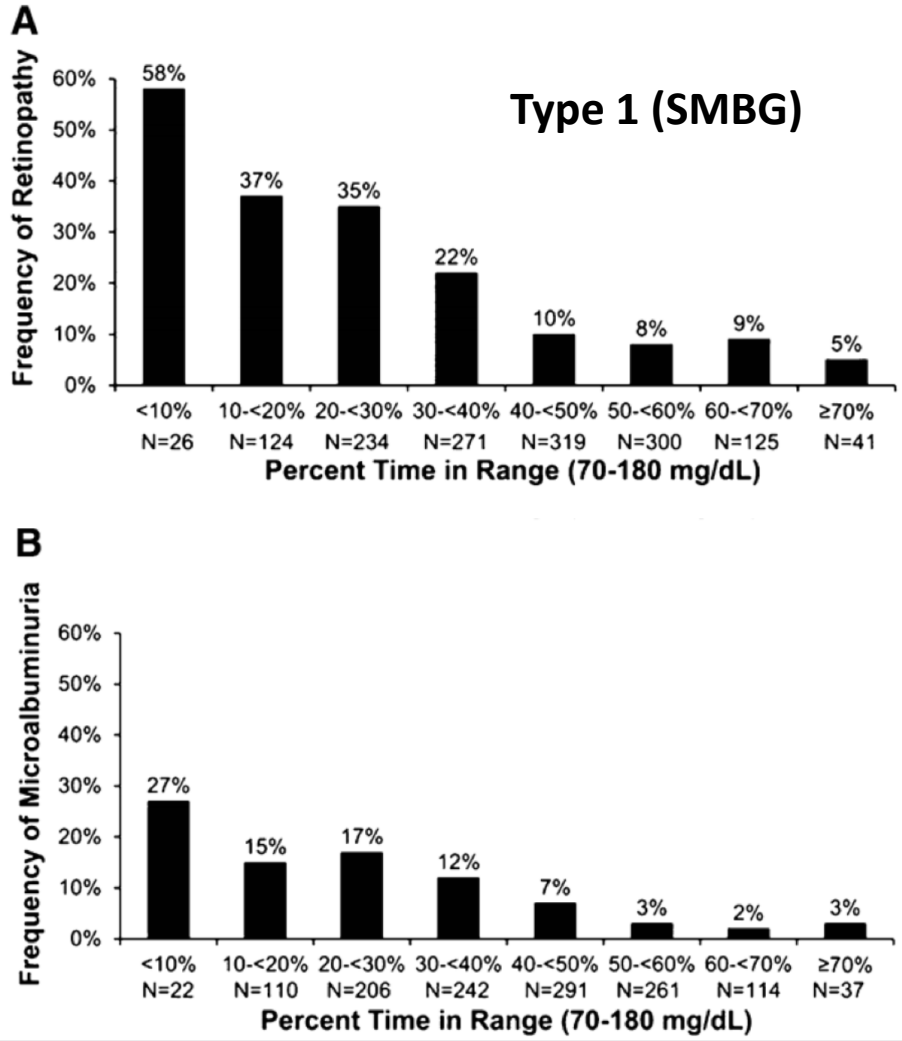
§Includes percentage of values >250 mg/dL (13.9 mmol/L).

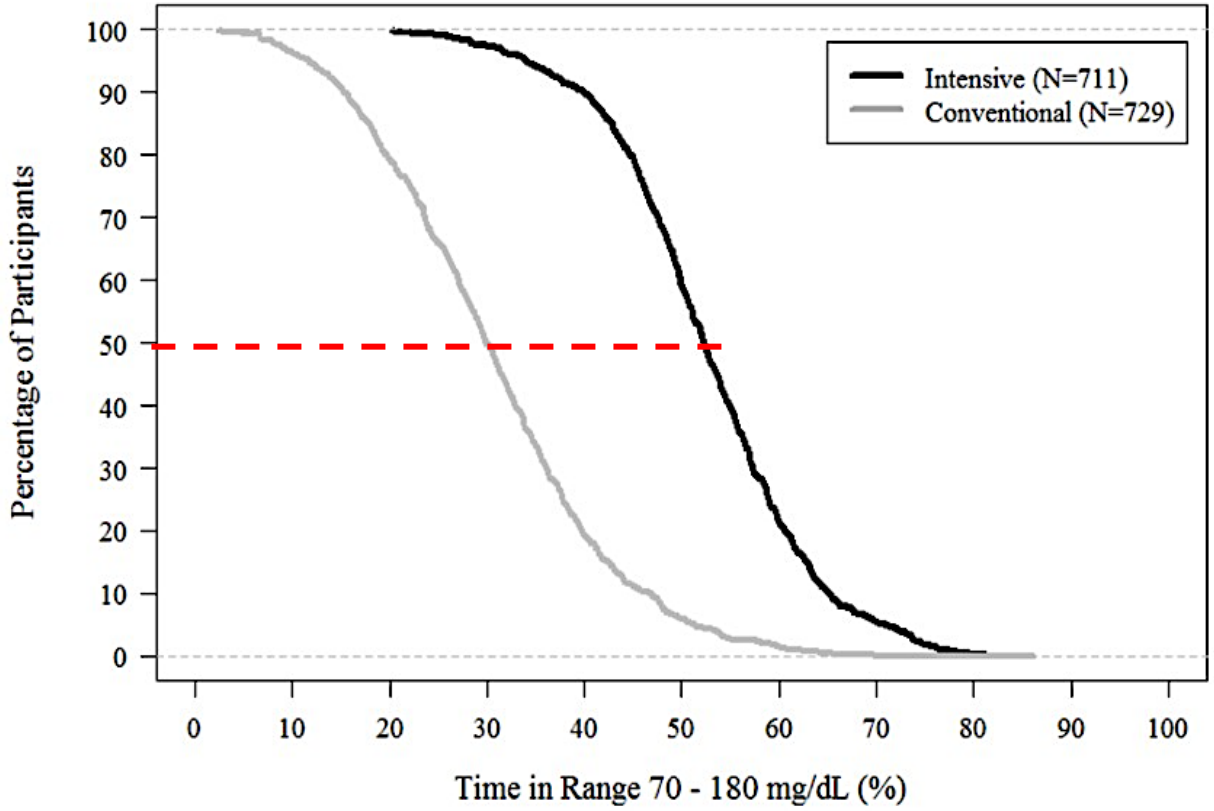
‖Includes percentage of values >54 mg/dL (3.0 mmol/L).

Every 10% change in TIR, equates to change in A1c of about 0.6%

Battelino. Diabetes Care. 2019;42:1593.

What data do we have on Time in Range (TIR) and risk for complications in T1D?

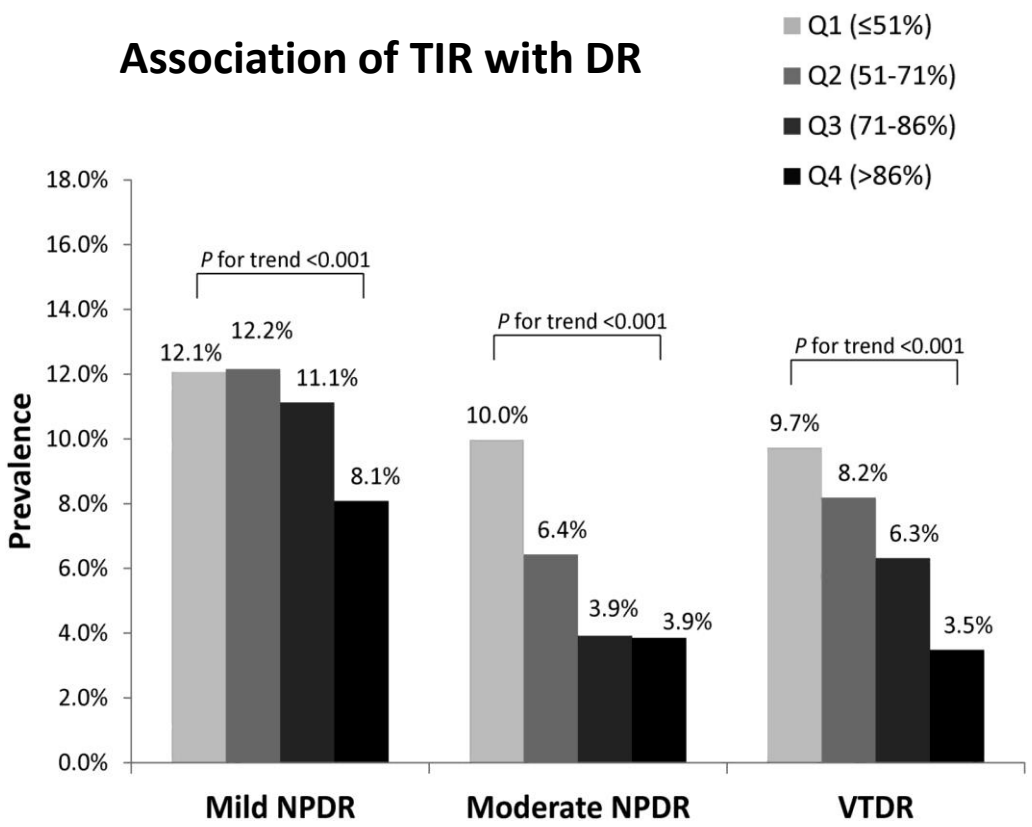




Beck R et l. Dia Care 2019;42:400 - 405

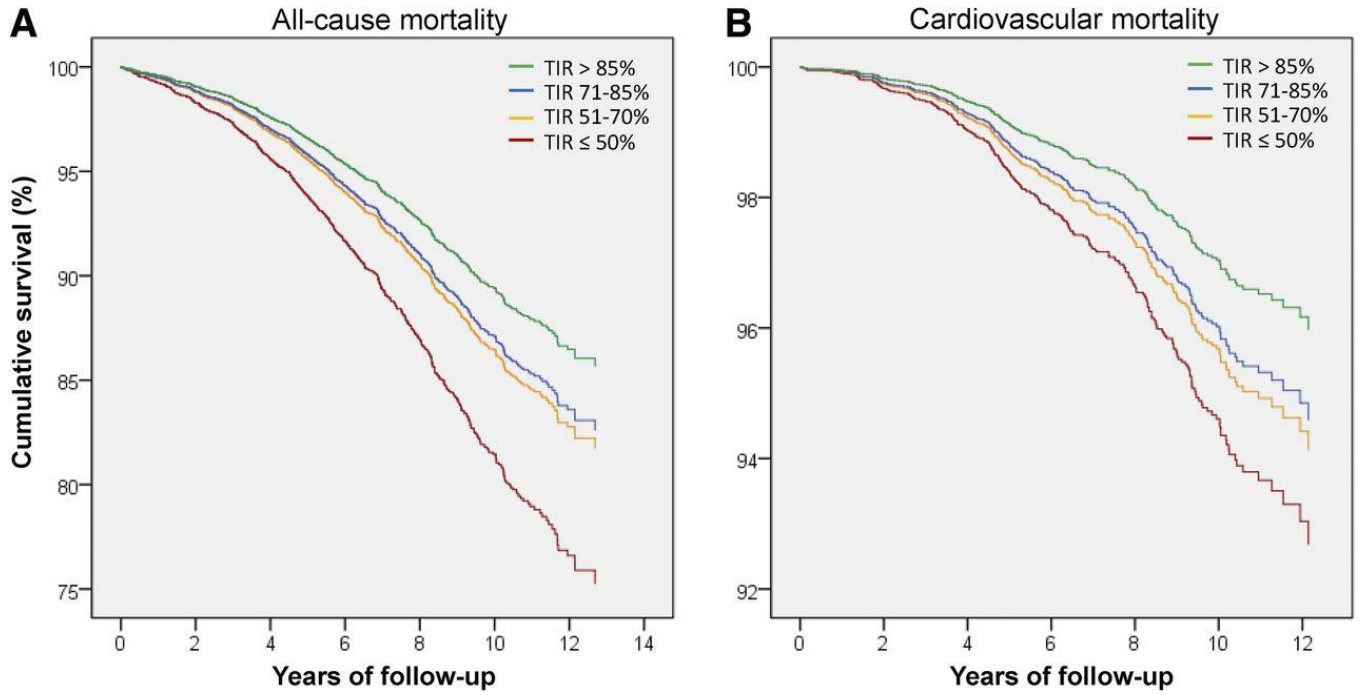
Time in range predicts risk for retinopathy and mortality in T2D

Association of TIR with DR



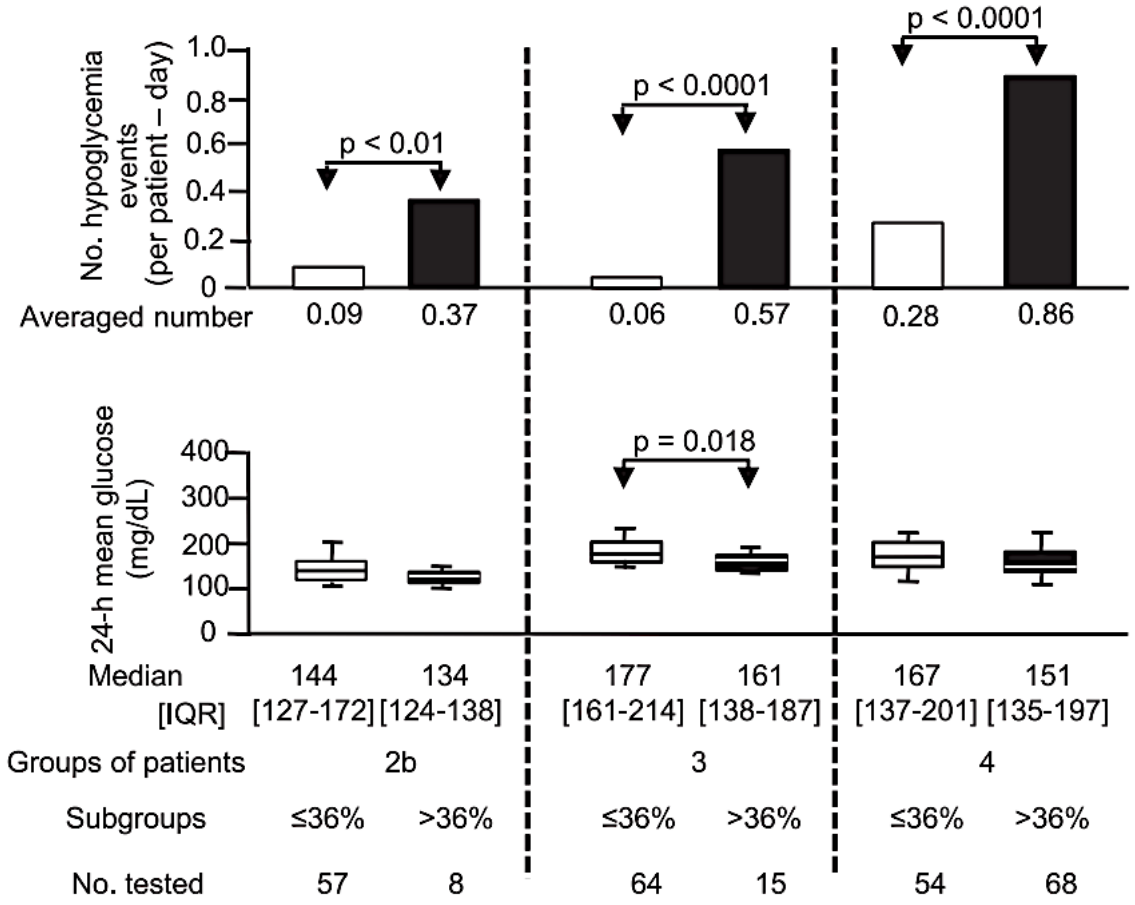
Lu J et al. *Diabetes Care* 2018;41:2370-2376

Association of TIR with All cause and CV mortality



Lu J et al. *Diabetes Care* 2021 Feb; 44(2): 549-555

Coefficient of variability (CV) on CGM predicts risk for hypoglycemia better than mean glucose



- Group studied
  - 2b = T2D on sulfonylurea
  - 3 = T2D on insulin
  - 4 = T1D
- Conclusion there was minimal correlation between mean glucose and risk for hypoglycemia.
- CV > 36% had greater predictive value

Monnier L et al. Diabetes Care 2017;40:832-838

Landmark Trials for CGM in Type 1 DM

Trial	Population	Intervention	Findings
DIAMOND[1]	T1D (using MDI)	CGM	Significantly greater decrease in A1C vs usual care
GOLD[2]	T1D (using MDI and A1C > 7.5%)	CGM	Improved glycemic control vs conventional treatment
IMPACT[3]	Well controlled T1D	Flash CGM	Reduced time in hypoglycemia, effect lost when DC'd
CONCEPTT[5]	T1D, pregnant or planning pregnancy	CGM	More time in target, less time hyperglycemic; Neonatal health outcomes significantly improved
COMISAIR[6]	T1D (A1C 7%-10%)	SAIR	Decrease in A1C and hypoglycemia, with sensor-augmented insulin regimen (SAIR)

UK study (presented at EASD 2021) demonstrated decrease in DKA and severe hypoglycemia with CGM use

FUTURE study (presented at EASD 2021) > 50% decrease in severe hypoglycemia and 70% decrease in work absenteeism

1. Beck. JAMA. 2017;317:371. 2. Lind. JAMA. 2017;317:379. 3. Bolinder. Lancet. 2016;388:2254.
4. Haak T. Diabetes Ther. 2017;8:55. 5. Feig. Lancet. 2017;390:2347. 6. Soupal. Diabetes Technol Ther. 2016;18(9):532.

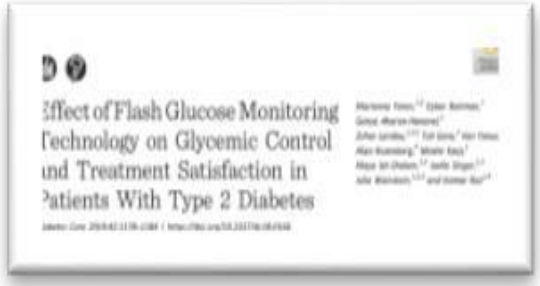
Identifying patient populations with T2D who benefit most from diabetes technology: What does literature say?

CGM use either improves A1C or decreases time in hypoglycemia in individuals with T2D on multiple daily dose insulin

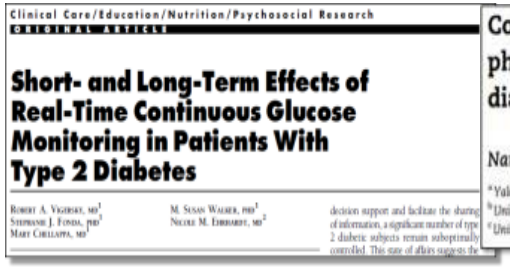

nnals of Internal Medicine ORIGINAL RESEARCH

ontinuous Glucose Monitoring Versus Usual Care in Patients With
ype 2 Diabetes Receiving Multiple Daily Insulin Injections
Randomized Trial


lash Glucose-Sensing Technology as a Replacement
or Blood Glucose Monitoring for the Management
f Insulin-Treated Type 2 Diabetes: a Multicenter,
pen-Label Randomized Controlled Trial


Effect of Flash Glucose Monitoring
Technology on Glycemic Control
nd Treatment Satisfaction in
Patients With Type 2 Diabetes

CGM use improves A1C for individuals with T2D on basal insulin

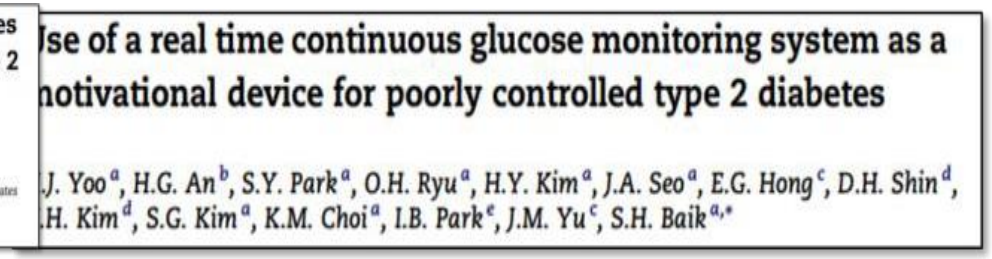

Clinical Care/Education/Nutrition/Psychosocial Research
ORIGINAL ARTICLE

Short- and Long-Term Effects of Real-Time Continuous Glucose Monitoring in Patients With Type 2 Diabetes


Continuous glucose monitoring counseling improves physical activity behaviors of individuals with type 2 diabetes: A randomized clinical trial

Nancy A. Allen[a,*], James A. Fain[b,1], Barry Braun[c,2], Stuart R. Chipkin[c,2]

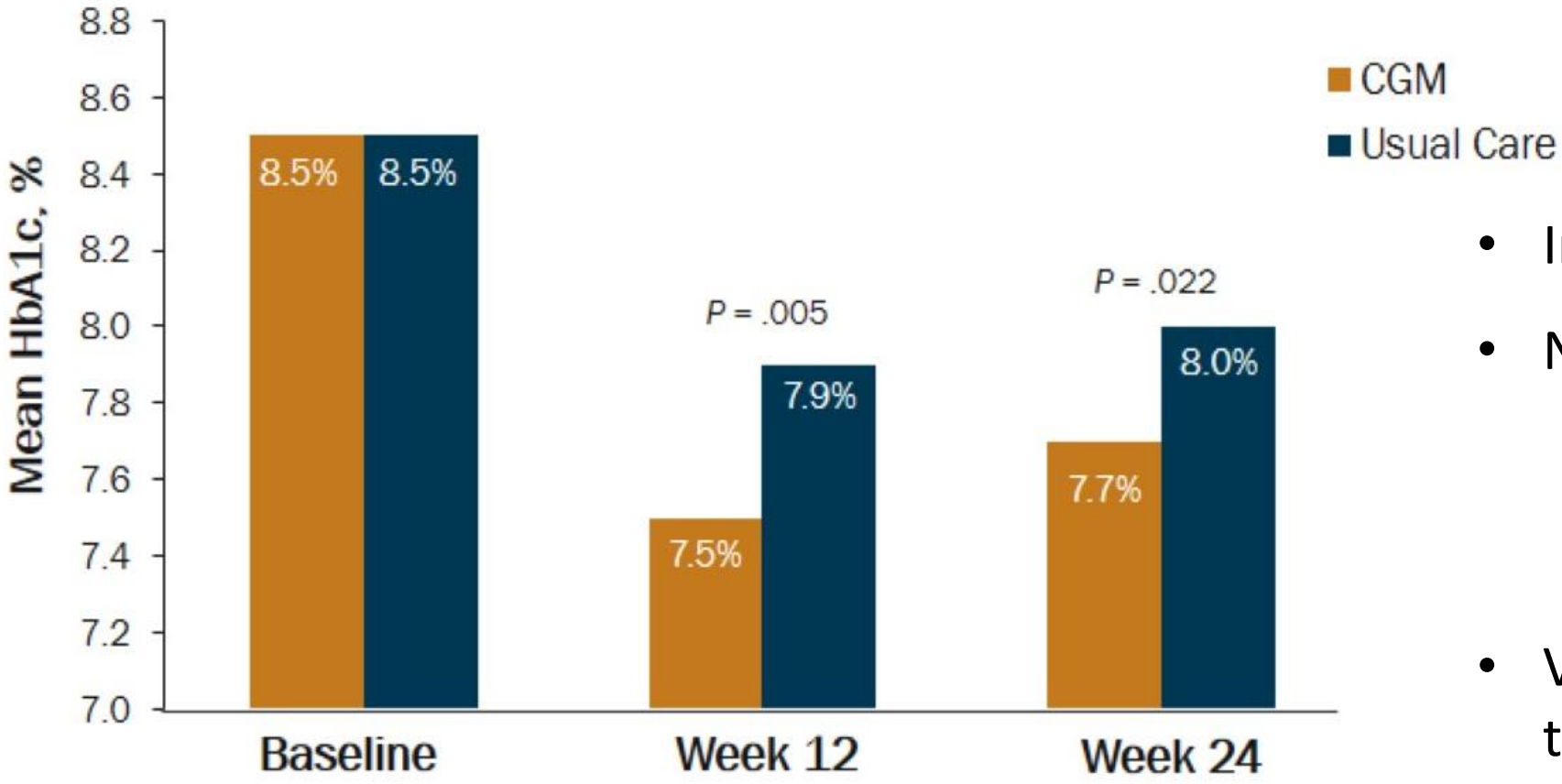
[a] Yale University School of Nursing, 100 Church Street South, P.O. Box 9740, New Haven, CT 06536-0740, United States
[b] University of Massachusetts Dartmouth, 285 Old Westport, North Dartmouth, MA 02747, United States
[c] University of Massachusetts Amherst, 25 Totman Building, 30 Eastman Lane, Amherst, MA 01003, United States


Use of a real time continuous glucose monitoring system as a motivational device for poorly controlled type 2 diabetes

J.J. Yoo[a], H.G. An[b], S.Y. Park[a], O.H. Ryu[a], H.Y. Kim[a], J.A. Seo[a], E.G. Hong[c], D.H. Shin[d], H. Kim[d], S.G. Kim[a], K.M. Choi[a], I.B. Park[e], J.M. Yu[c], S.H. Baik[a,*]

Non-insulin therapies: Intriguing small and older studies, lots of interest, level of evidence suboptimal

DIAMOND Study (T2D on MDI): A1c Results



N = 158; Mean age = 60 years; Mean duration of diabetes = 17.5 years; Mean BMI = 36; Insulin dose = 1.2 units/kg/day.

- Increased Time in Range
- No differences in:
  - Hypoglycemia
  - Insulin doses
- Very little change in therapy occurred in either group, suggests effect of data on behavior change
- High satisfaction

Beck RW et al *Ann Intern Med* 2017; 365-374

JAMA Network™

Mobile Study

QUESTION For adults with poorly controlled type 2 diabetes treated with basal insulin without prandial insulin in primary care practices, does continuous glucose monitoring (CGM) improve hemoglobin A_{1c} (HbA_{1c}) levels compared with blood glucose meter (BGM) monitoring?

CONCLUSION This randomized clinical trial found there was a significantly greater decrease in HbA_{1c} level over 8 months with CGM than with BGM monitoring.

POPULATION

88 Women
87 Men

Adults with type 2 diabetes treated with basal insulin without prandial insulin

Mean age: **57 years**

LOCATIONS

15
Primary care practices in the US

INTERVENTION

175 Patients randomized

116
Continuous glucose monitoring
CGM with BGM testing performed as needed

59
Blood glucose meter monitoring
BGM testing performed when fasting and postprandial 1 to 3 times daily

PRIMARY OUTCOME

HbA_{1c} level at 8 months adjusted for the baseline value

FINDINGS

Mean HbA_{1c} level at 8 months

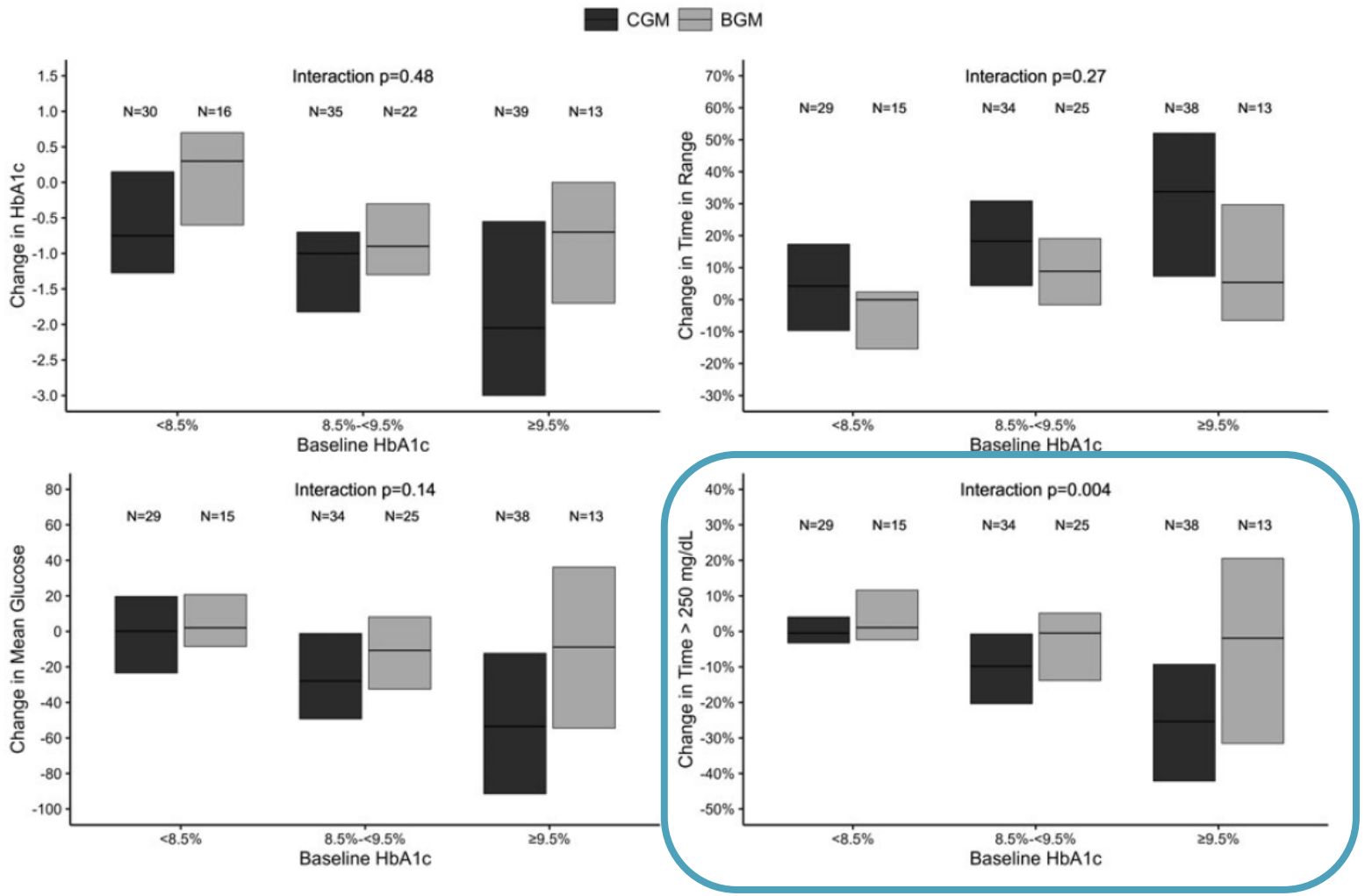
Continuous glucose monitoring		Blood glucose meter monitoring	
HbA_{1c}		HbA_{1c}	
Baseline	8 Months	Baseline	8 Months
9.1% ▶	8.0%	9.0% ▶	8.4%

Risk-adjusted difference was significant,
−0.4% (95% CI, −0.8% to −0.1%)

TIR CGM: 62%, BGM – 43%

Martens T, Beck RW, Bailey R, et al; MOBILE Study Group. Effect of continuous glucose monitoring on glycemic control in patients with type 2 diabetes treated with basal insulin: a randomized clinical trial. *JAMA*. Published online June 2, 2021. doi:10.1001/jama.2021.7444

Change in Glycemic Outcomes with CGM by Baseline HbA1c

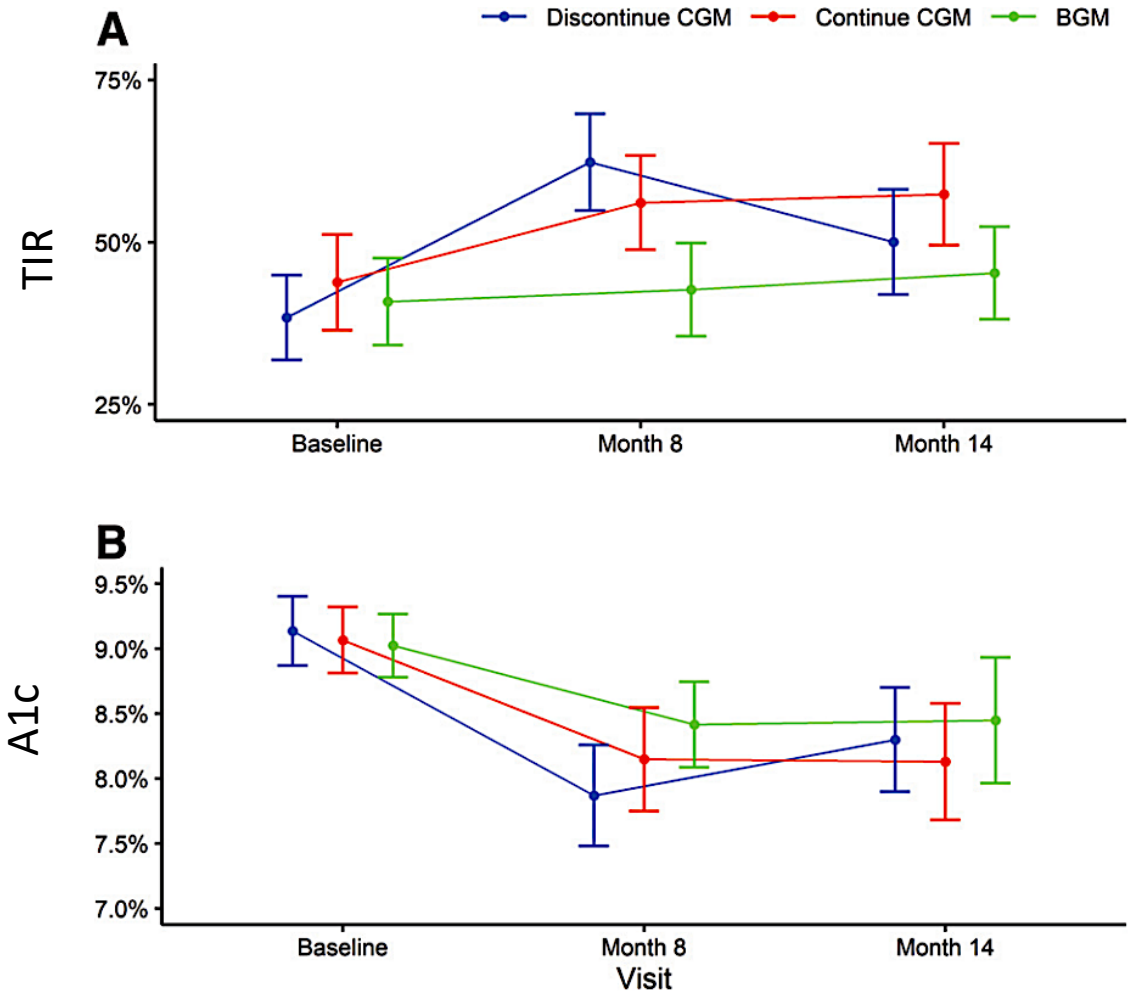


Change in HbA1c, TIR, mean glucose, and TAR (>250 mg/dL) by baseline HbA1c

EMORY UNIVERSITY SCHOOL OF MEDICINE
Department of Medicine

Davis G, et al. Diabetes Technol Ther, 2022. PMID: 34962151

Mobile Study: Effect of Discontinuing CGM in T2DM on Basal Insulin



Aleppo G et al *Diabetes Care*. Published online before print: Sept 29, 2021. https://doi.org/10.2337/dc21-1304

Challenges to insulin use in primary care

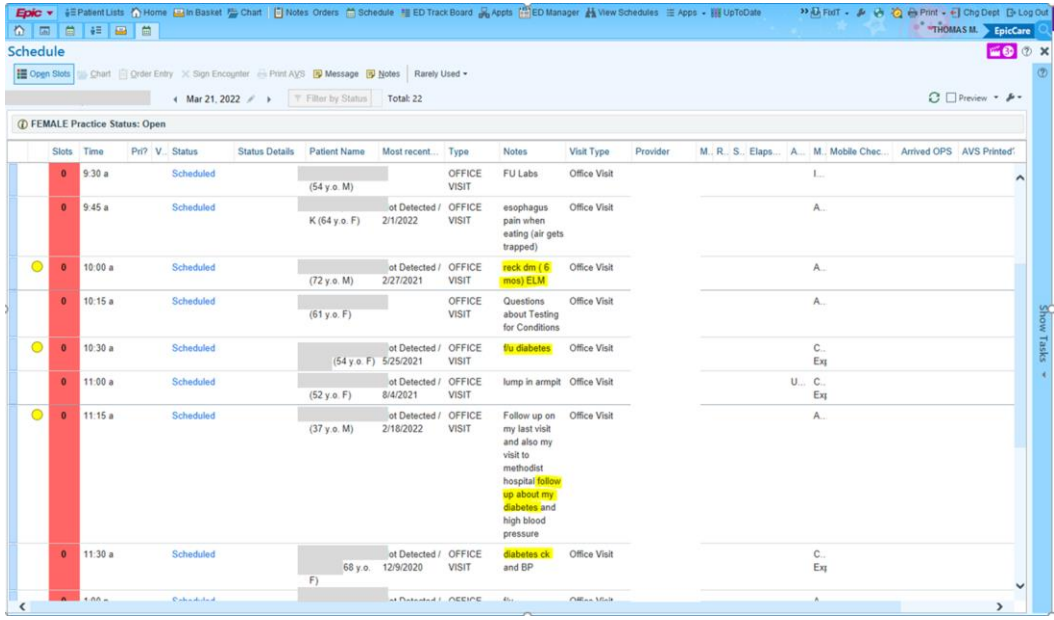
T2D Management in America

- Predominantly managed in primary care (T1D = Endo)
- Around 37,300,000 people in the US have diabetes (about 1:10 Americans)
- 90-95% have T2D
- ~25% use insulin (~2/3 basal insulin without prandial insulin)
  - 69% with A1c > 7%
  - 38% with A1c >8%

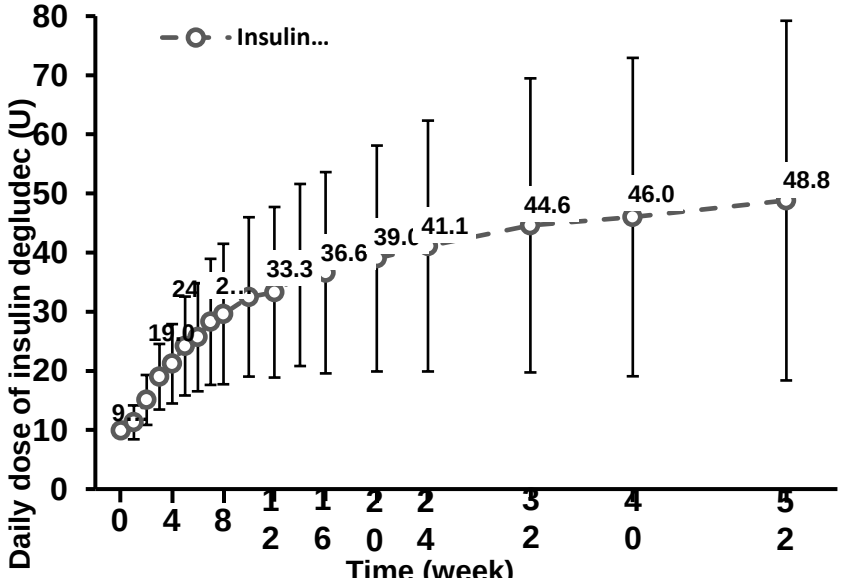
Fang M, Wang D, Coresh J, Selvin E. Trends in Diabetes Treatment and Control in U.S. Adults, 1999-2018. N Engl J Med. 2021 Jun 10;384(23):2219-2228.

https://www.cdc.gov/diabetes/library/spotlights/diabetes-facts-stats.html#:~:text=Key%20findings%20include%3A,t%20know%20they%20have%20it.

Insulin management in primary care settings is challenging

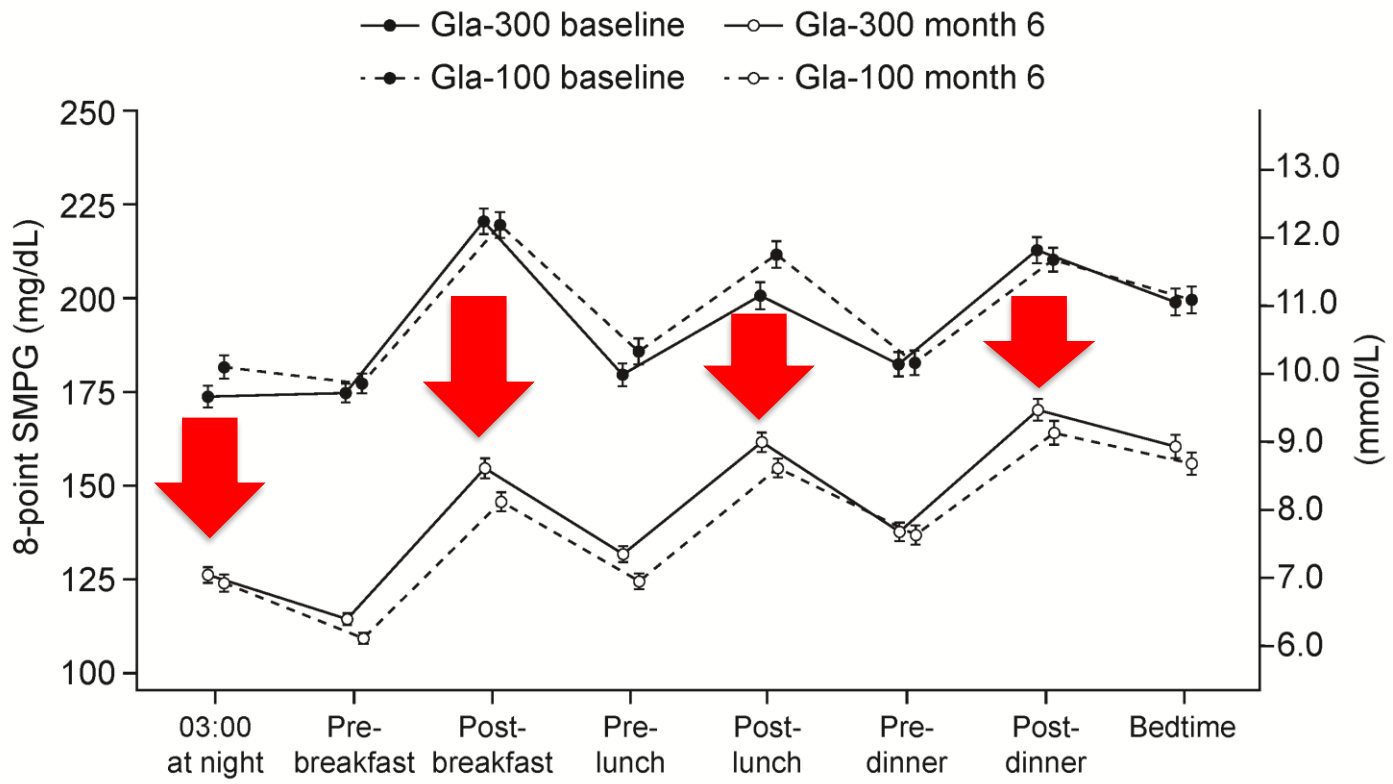


- Lack of time
- Lack of systems of support
- Too few “touchpoints” for titration



The Effect of Basal Insulin on a Glucose Profile

Glargine U300 vs U100:



EDITION 3: Insulin-naïve people with type 2 diabetes previously using oral glucose-lowering drugs

Addition of analog basal insulin uniformly drops the glycemic profile

- Similar effect with daily analogs, long-acting analogues, and weekly analogs

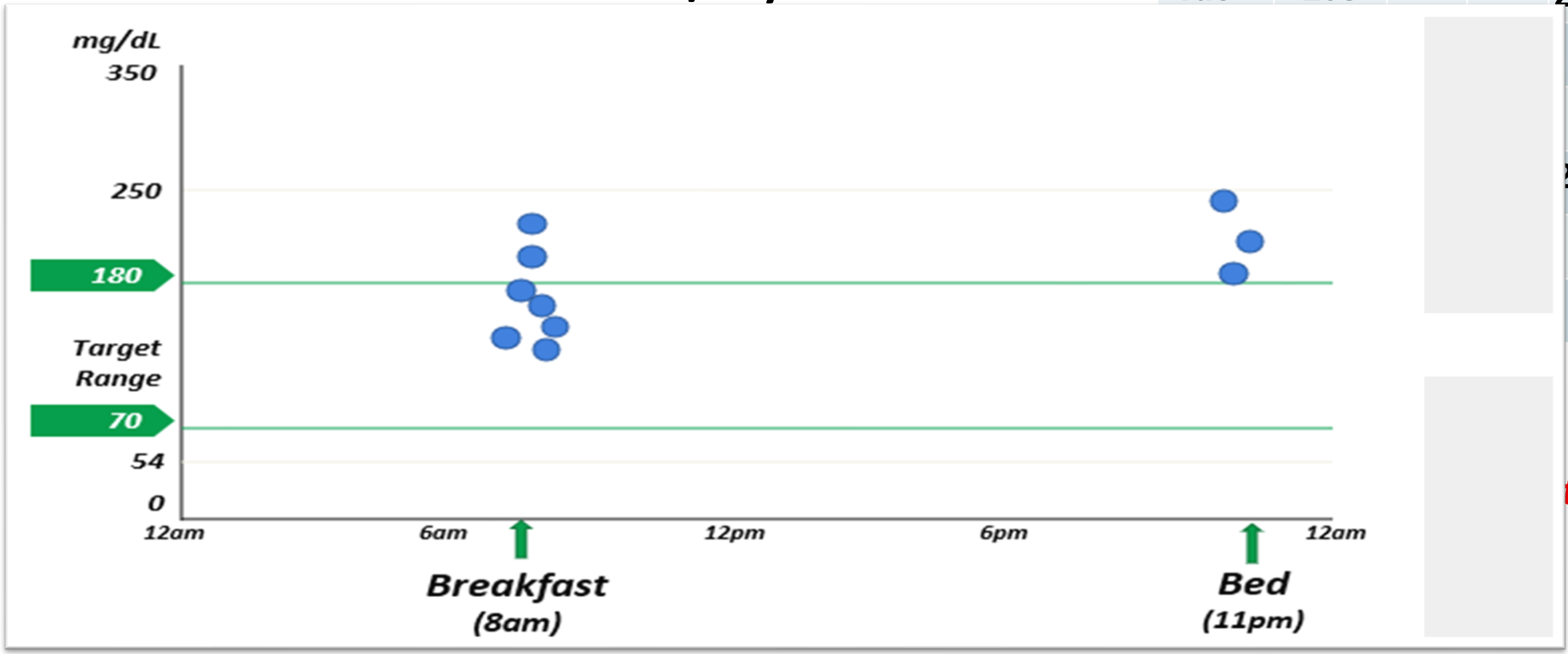
Bolli GB, Riddle MC, Bergenstal RM, Ziemen M, Sestakauskas K, Goyeau H, Home PD; on behalf of the EDITION 3 study investigators. New insulin glargine 300 U/ml compared with glargine 100 U/ml in insulin-naïve people with type 2 diabetes on oral glucose-lowering drugs: a randomized controlled trial (EDITION 3). Diabetes Obes Metab. 2015 Apr;17(4):386-94.

62-year-old man with T2D for 7 years

T2D Meds: Metformin 2000 mg/day
Basal insulin 42 U/day

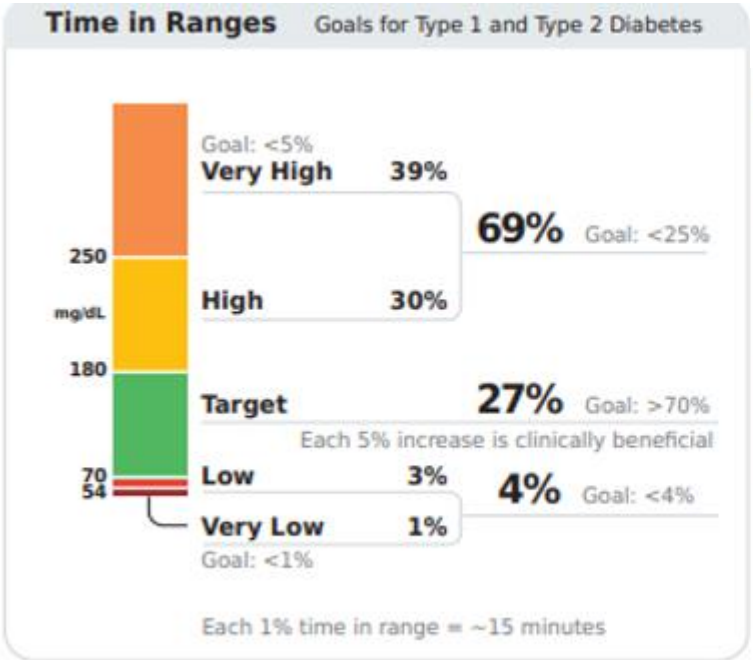
A1c 9.0%

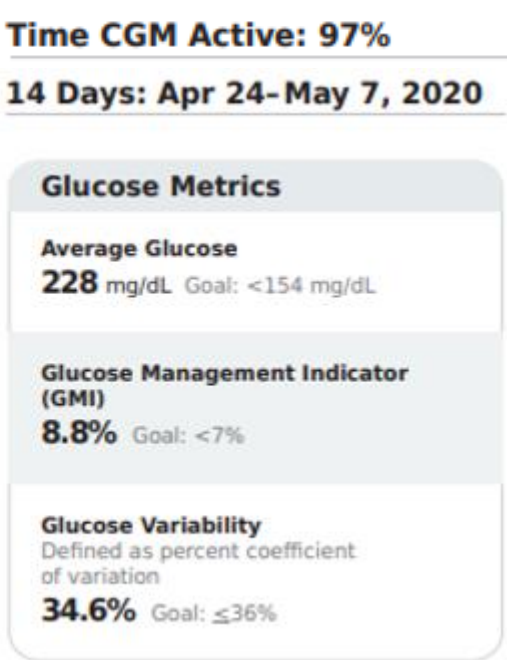
	Break-fast	Lu n	Din	Bed
Mon	176			184
Tue	208			215
				236

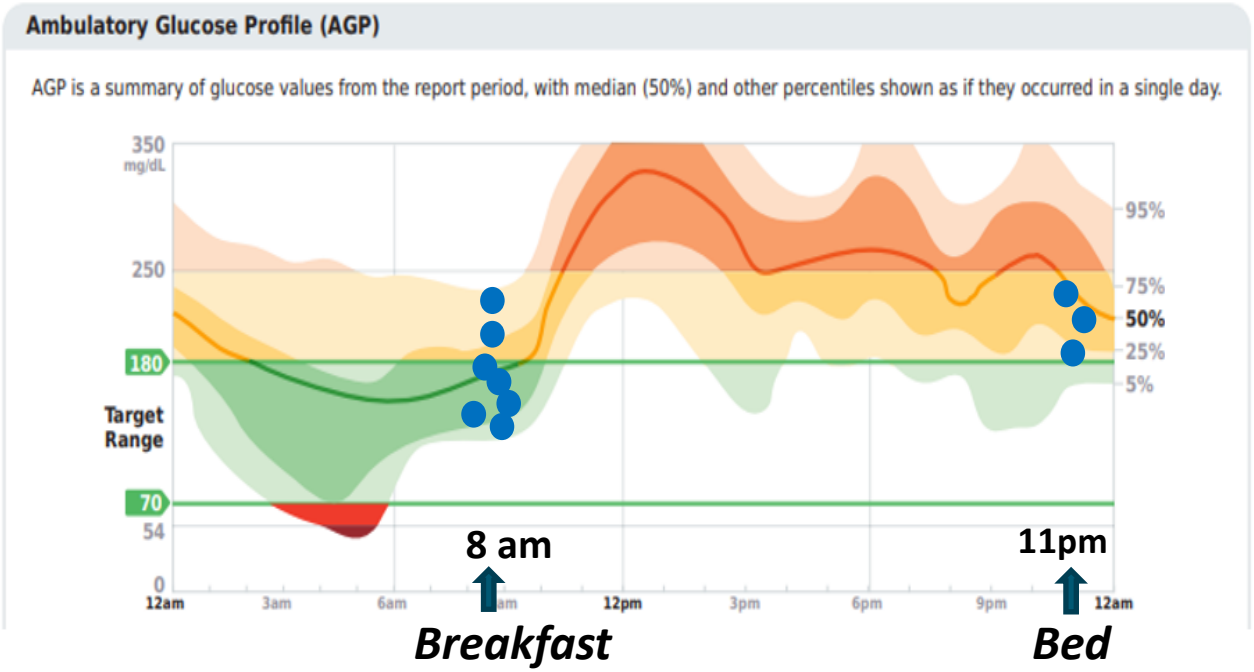


t goal

AGP Report: Continuous glucose monitoring







Do we stick with treating to fasting AM targets, assuming:

PwD: will do the fingerstick testing required

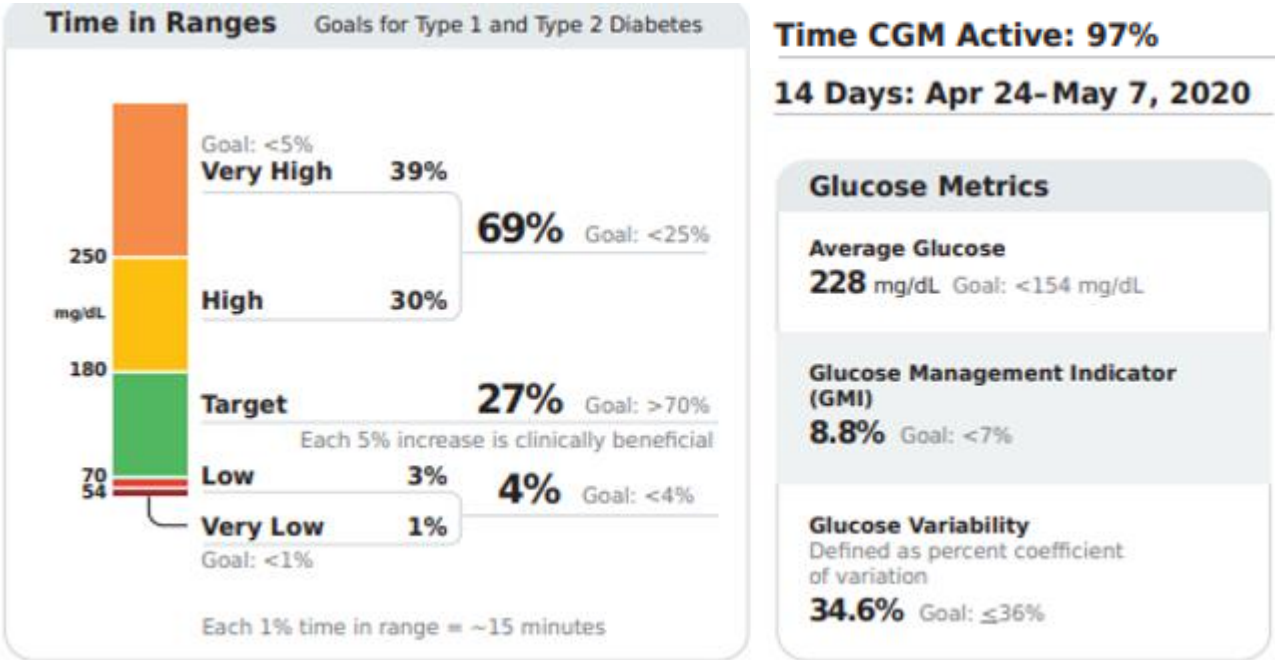
HCPs: will do the overbasalization calculations

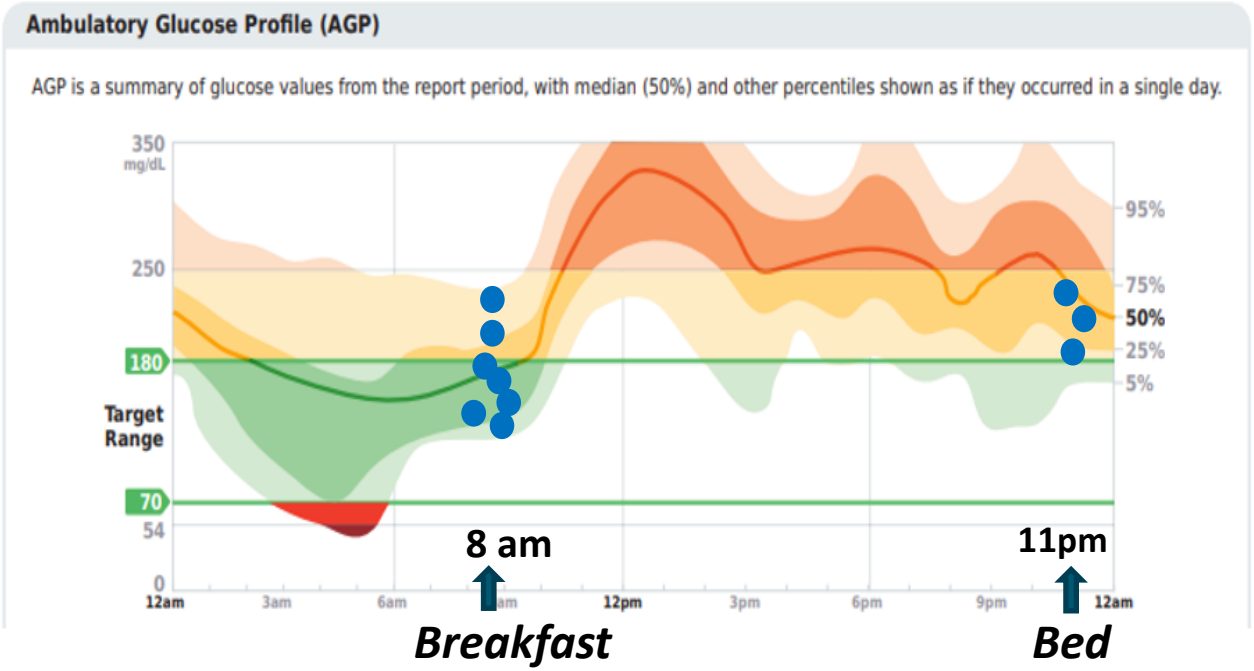
HCPs: are confident that fasting will be the first hypoglycemia point...

Is the current paradigm for basal insulin titration an optimal path to holistic glycemic management?

Or . . . Is it time for a new management paradigm?

AGP Report: Continuous glucose monitoring





Observations:

Nocturnal Hypoglycemia

Marked hyperglycemia after meals, especially breakfast

High glycemic variability

Lower basal insulin by 10 – 20%%

Consider nonadherence with prandial insulin

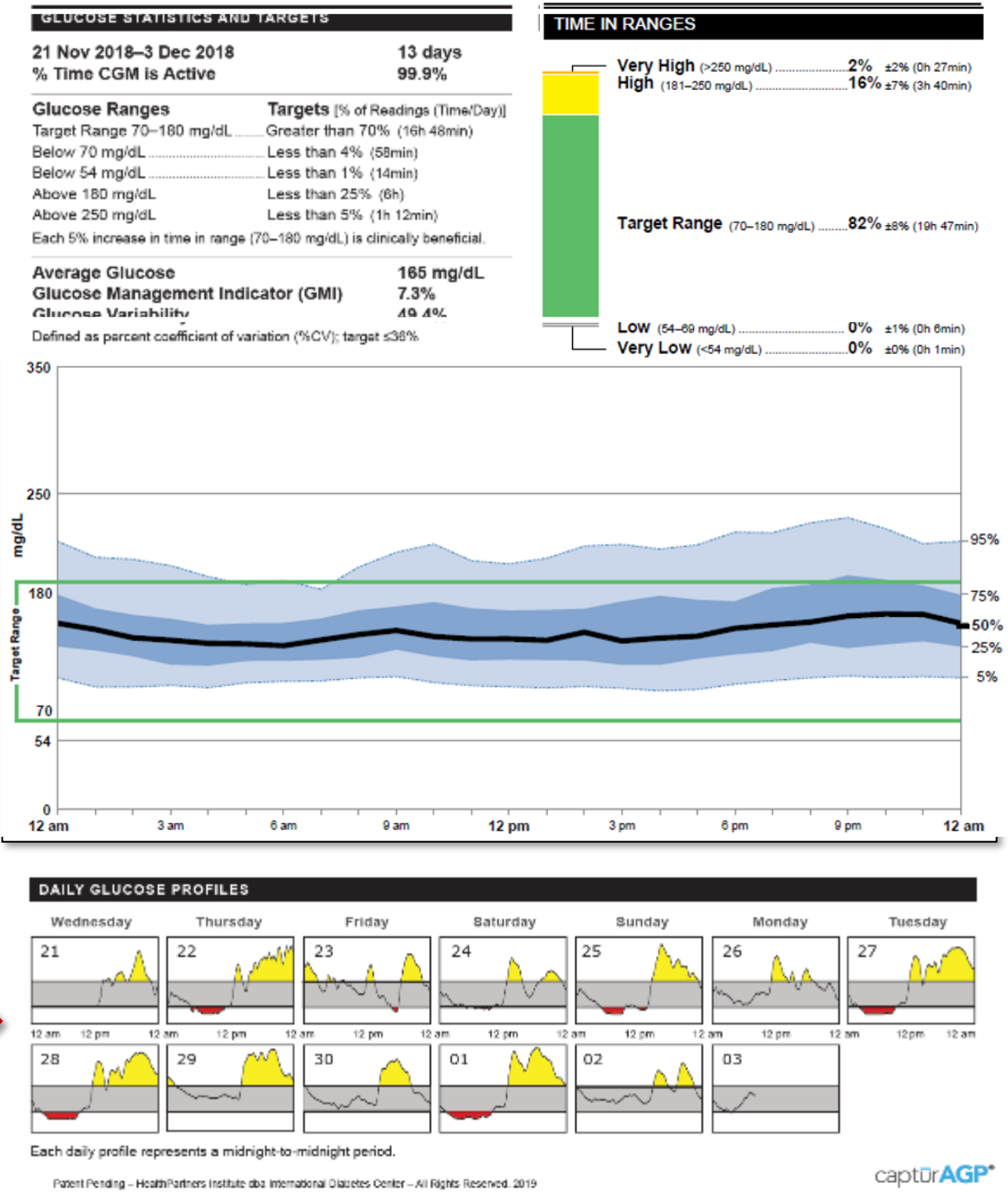
Add GLP-1 RA (if T2D), add or increase prandial insulin &/or decrease carbohydrate content with meals

AGP report

Metrics and targets

AGP profile (14 days)

Daily views



http://www.agpreport.org/agp/agpreports

Do I need to take action?

MORE GREEN

LESS RED

What action do I need to take?

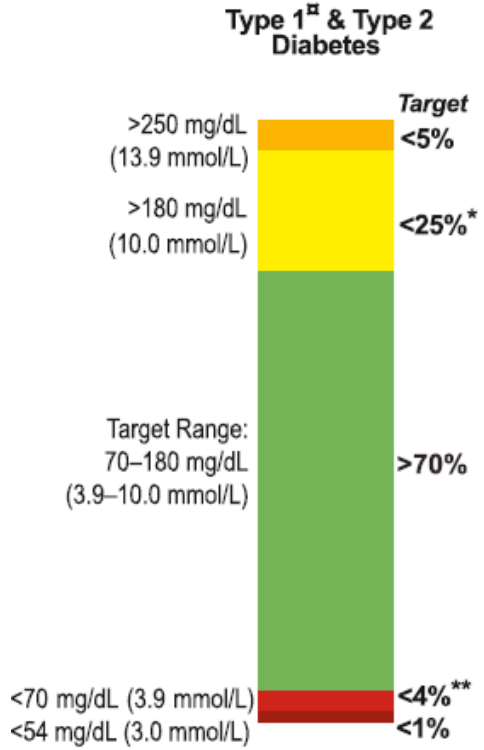
Modal Day: FNIR= Flat, Narrow, and In Range

Daily Views: Patterns, outliers, or artifacts?

Consensus TIR Targets

TIR $^{70\text{-}180}$ >70% ← **Hyper Adjustment Alert**

TBR $^{<70}$ < 4% ← **Hypo Adjustment Alert**



*Includes >250 mg/dL, ** includes <54 mg/dL

Battelino T, Danne T., Bergenstal R, et al
Diabetes Care 2019;42(8):1593-1603.

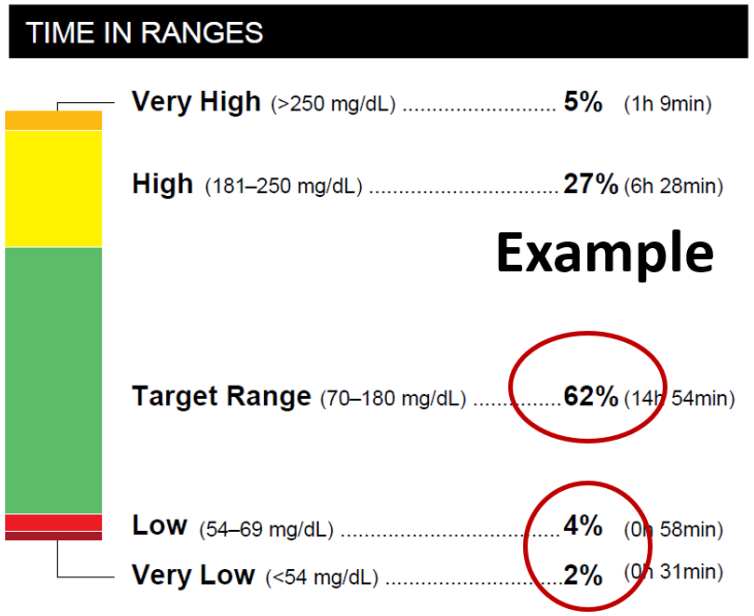
TIR/TBR Therapy Adjustment Category

TIR $^{70\text{-}180}$ < 70%

TBR $^{<70}$ > 2%

TIR/TBR Category	Action
Time in range >70% and Time below range ≤2%	Continue regimen
Time in range >70% and Time below range >2%	Address hypoglycemia
Time in range ≤70% and Time below range ≤2%	Address hyperglycemia
Time in range ≤70% and Time below range >2%	Address hypoglycemia today; consider referral to diabetes educator

TIR-based basal insulin management

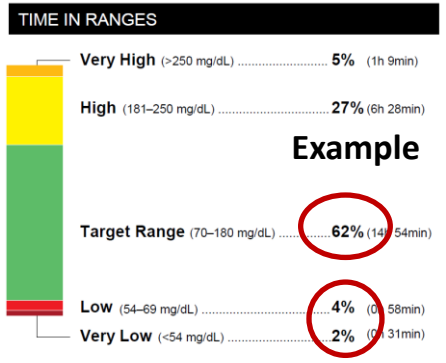


Step 1: Determine if patient has comorbidities (ASCVD, CHF, CKD) for which GLP-1 receptor agonist or SGLT2 inhibitor should be considered

Step 2: Find the %TIR and %TBR from the AGP Report:

- **Is time in range (TIR) [70-180 mg/dL] >70%?**
- **Is time below range (TBR) [< 70 mg/dL] ≤2%?**

Step 3: Find TIR/TBR category in table and adjust background insulin regimen; consider referral to diabetes educator



CGM Guided Background (Basal) Insulin Adjustment for Type 2 Diabetes

Step 1: Determine if patient has comorbidities (ASCVD, CHF, CKD) for which GLP-1 receptor agonist or SGLT2 inhibitor should be considered

Step 2: Find the %TIR and %TBR from the AGP Report (see example to left).

- Is time in range (TIR) [70-180 mg/dL] >70%?
- Is time below range (TBR) [< 70 mg/dL] ≤2%?

Step 3: Find TIR/TBR category in table and adjust background insulin regimen; consider referral to diabetes educator

TIR/TBR Category	Action	Medication Adjustment Considerations	Follow-up
Time in range >70% and Time below range ≤2%	Continue regimen	• Continue to optimize current therapy; reinforce lifestyle changes and taking insulin as prescribed	3-4 months
Time in range >70% and Time below range >2%	Address hypoglycemia	• Stop sulfonylurea if present and reduce background insulin by 10% if TBR is 8-12% or 15% if TBR is >12% • If not on sulfonylurea, decrease total background insulin dose by 10% if TBR >2-7%; 15% if TBR 8-12%; 20% if TBR >12%	2 weeks
Time in range ≤70% and Time below range ≤2%	Address hyperglycemia	• Consider adding or adjusting GLP-1 RA, otherwise increase background insulin dose by 10% if TIR 51-70%; 15% if TIR 30-50%; 20% if TIR <30% • If overnight hypoglycemia, consider smaller increase in insulin dose	2 weeks
Time in range ≤70% and Time below range >2%	Address hypoglycemia today; consider referral to diabetes educator	• Stop sulfonylurea if present and reduce background insulin dose by 10% if TBR is 8-12% or 15% if TBR is >12% • If not on sulfonylurea, decrease background insulin dose by 10% if TBR >2-7%; 15% if TBR 8-12%; 20% if TBR >12% • Refer to diabetes educator for options to treat hyperglycemia including: • Add or adjust GLP-1 RA ***(preferred)*** **or** add mealtime insulin before one or all meals; consider premixed insulin twice per day if cost or concern over insulin regimen complexity	2 weeks

TIR/TBR Category	Action	Medication Adjustment Considerations	Follow-up
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Time in range ≤70% **and** **Time below range ≤2%**	Address hyperglycemia	• Consider adding or adjusting GLP-1 RA, otherwise increase background insulin dose by 10% if TIR 51-70%; 15% if TIR 30-50%; 20% if TIR <30% • If overnight hypoglycemia, consider smaller increase in insulin dose	2 weeks
Time in range ≤70% **and** **Time below range >2%**	Address hypoglycemia today; consider referral to diabetes educator	• Stop sulfonylurea if present and reduce background insulin dose by 10% if TBR is 8-12% or 15% if TBR is >12% • If not on sulfonylurea, decrease background insulin dose by 10% if TBR >2-7%; 15% if TBR 8-12%; 20% if TBR >12% • Refer to diabetes educator for options to treat hyperglycemia including: • Add or adjust GLP-1 RA ***(preferred)*** **or** add mealtime insulin before one or all meals; consider premixed insulin twice per day if cost or concern over insulin regimen complexity	2 weeks

TIME IN RANGES

Very High (>250 mg/dL) 1% (0h 8min)
High (181–250 mg/dL) 5% (1h 10min)

Target Range (70–180 mg/dL) 93% (22h 20min)

TIR 93%

Low (54–69 mg/dL) 1% (0h 19min)
Very Low (<54 mg/dL) 0% (0h 4min)

TBR 1%

Time in range >70% **and** **Time below range ≤2%**	Continue regimen	• Continue to optimize current therapy; reinforce lifestyle changes and taking insulin as prescribed	3-4 months

AGP Report

GLUCOSE STATISTICS AND TARGETS

13 May 2019–23 May 2019	11 days
% Time CGM is Active	100.0%

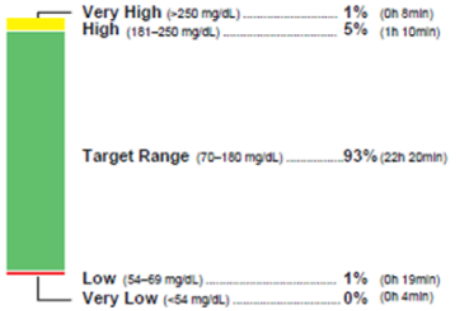
Glucose Ranges	Targets [% of Readings (Time/Day)]
Target Range 70–180 mg/dL	Greater than 70% (16h 48min)
Below 70 mg/dL	Less than 4% (58min)
Below 54 mg/dL	Less than 1% (14min)
Above 180 mg/dL	Less than 25% (6h)
Above 250 mg/dL	Less than 5% (1h 12min)

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

Average Glucose	116 mg/dL
Glucose Management Indicator (GMI)	6.1%
Glucose Variability	29.4%

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

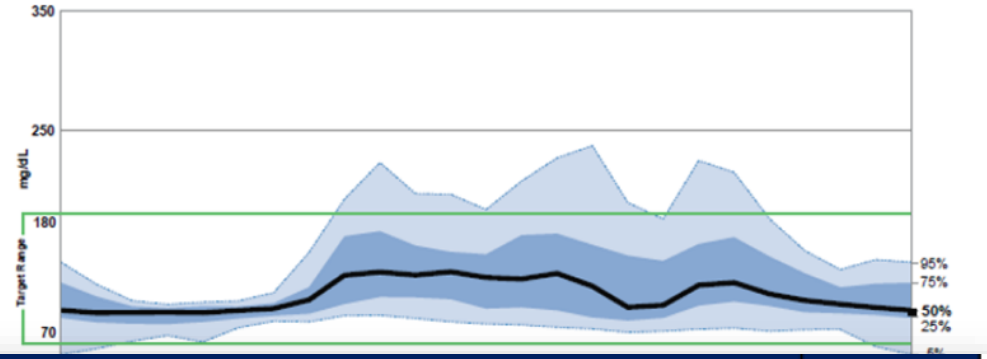
TIME IN RANGES

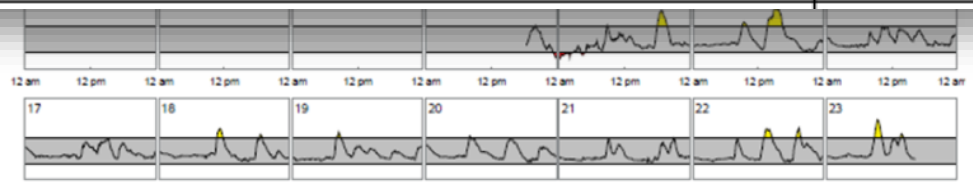


Very High (>250 mg/dL) 1% (0h 8min)
High (181–250 mg/dL) 5% (1h 10min)
Target Range (70–180 mg/dL) 93% (22h 20min)
Low (54–69 mg/dL) 1% (0h 19min)
Very Low (<54 mg/dL) 0% (0h 4min)

AMBULATORY GLUCOSE PROFILE (AGP)

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





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

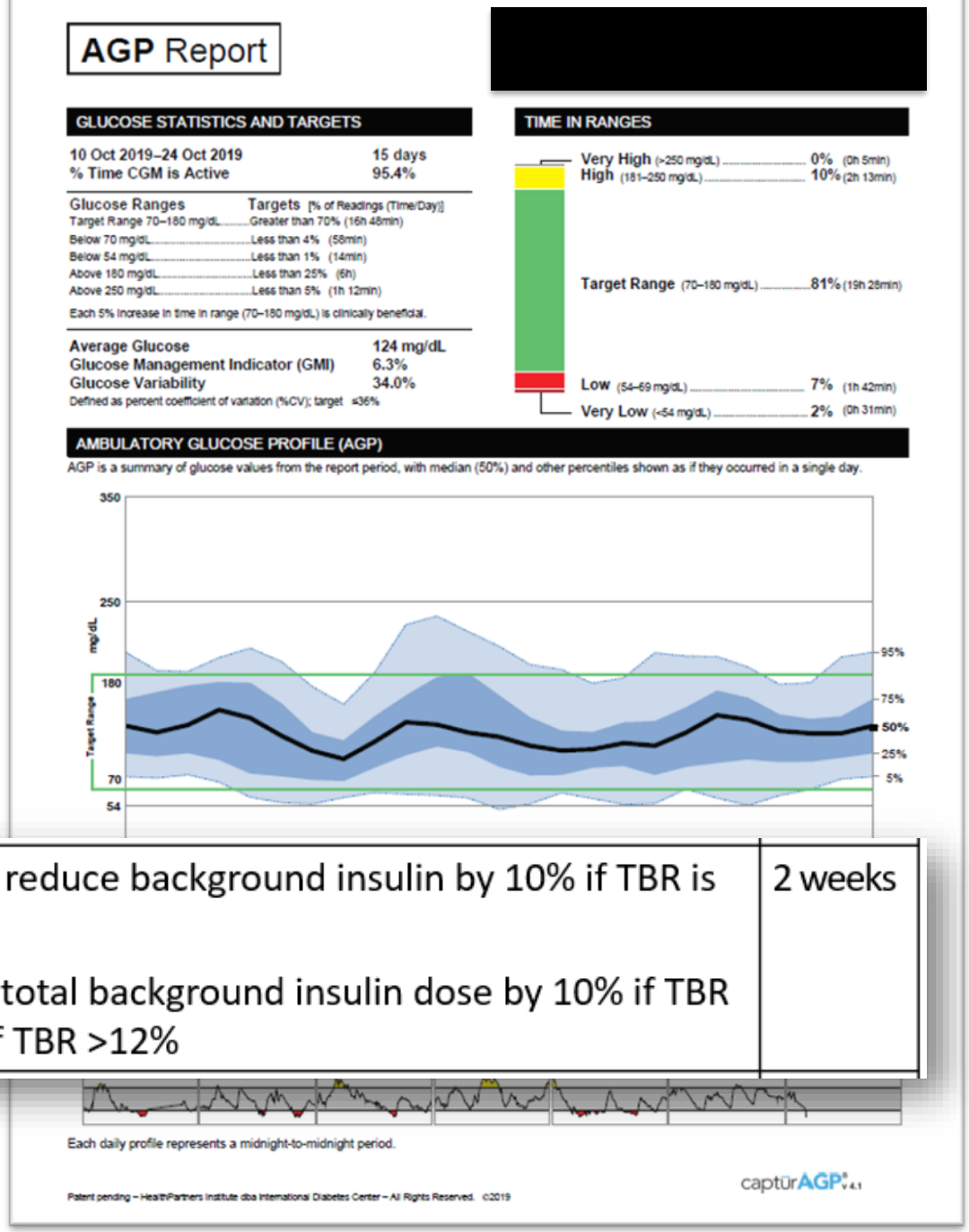
captürAGP v4.1

TIME IN RANGES

Very High (>250 mg/dL) 0% (0h 5min)
High (181–250 mg/dL) 10% (2h 13min)

Target Range (70–180 mg/dL) ..... 81% (19h 28min) **TIR 81%**

Low (54–69 mg/dL) ..... 7% (1h 42min) **TBR 9%**
Very Low (<54 mg/dL) 2% (0h 31min)



Time in range >70% **and** **Time below range >2%**	Address hypoglycemia	• Stop sulfonylurea if present and reduce background insulin by 10% if TBR is 8-12% or 15% if TBR is >12% • If not on sulfonylurea, decrease total background insulin dose by 10% if TBR >2-7%; 15% if TBR 8-12%; 20% if TBR >12%	2 weeks

Courtesy of Thomas Martens, M

TIME IN RANGES

Very High (>250 mg/dL) 16% (3h 44min)

High (181–250 mg/dL) 23% (5h 40min)

Target Range (70–180 mg/dL) 60% (14h 26min)

Low (54–69 mg/dL) 1% (0h 8min)

Very Low (<54 mg/dL) 0% (0h 3min)

TIR 60%

TBR 1%

AGP Report

GLUCOSE STATISTICS AND TARGETS

1 Dec 2019–15 Dec 2019	15 days
% Time CGM is Active	91.5%

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	175 mg/dL
Glucose Management Indicator (GMI)	7.5%
Glucose Variability	35.8%

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

TIME IN RANGES

Very High (>250 mg/dL) 16% (3h 44min)

High (181–250 mg/dL) 23% (5h 40min)

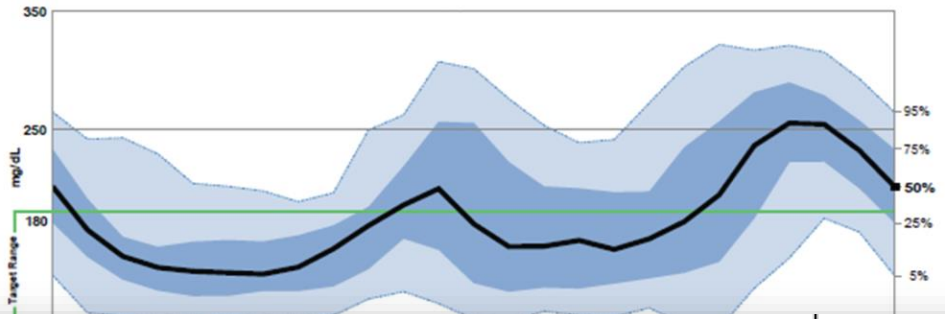
Target Range (70–180 mg/dL) 60% (14h 26min)

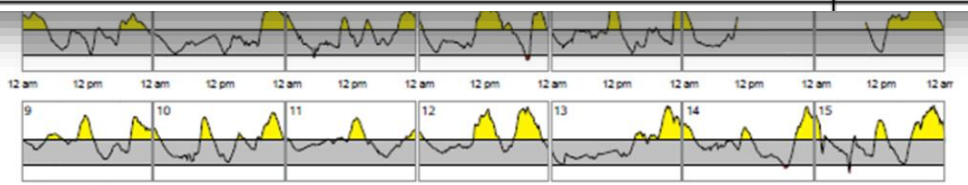
Low (54–69 mg/dL) 1% (0h 8min)

Very Low (<54 mg/dL) 0% (0h 3min)

AMBULATORY GLUCOSE PROFILE (AGP)

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

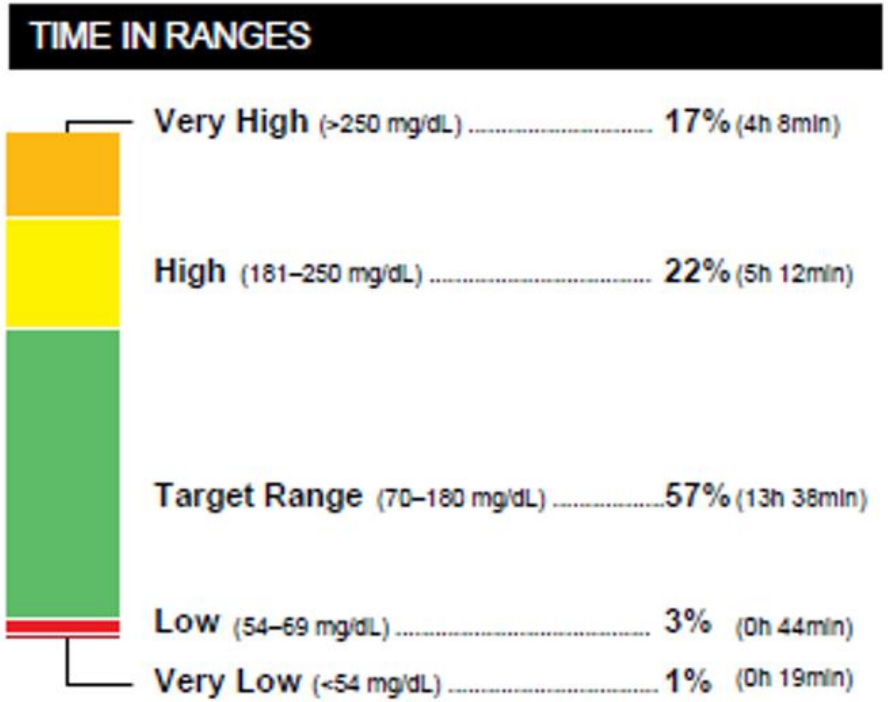




Each daily profile represents a midnight-to-midnight period.

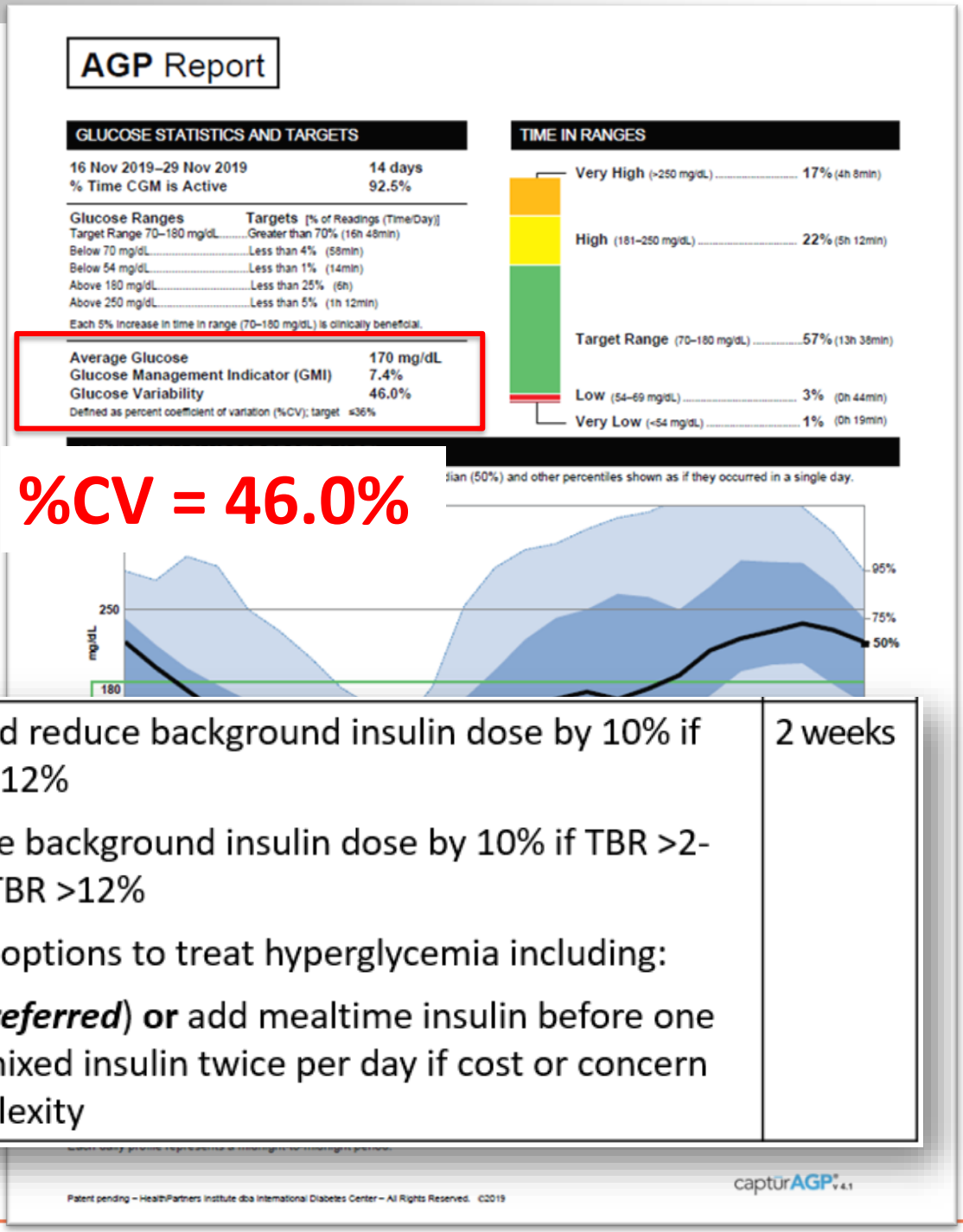
captürAGP® v4.1

Time in range ≤70% **and** **Time below range ≤2%**	Address hyperglycemia	• Consider adding or adjusting GLP-1 RA, otherwise increase background insulin dose by 10% if TIR 51-70%; 15% if TIR 30-50%; 20% if TIR <30% • If overnight hypoglycemia, consider smaller increase in insulin dose	2 weeks



TIR 57%

TBR 4%



Time in range ≤70% **and** **Time below range >2%**	Address hypoglycemia today; consider referral to diabetes educator	• Stop sulfonylurea if present and reduce background insulin dose by 10% if TBR is 8-12% or 15% if TBR is >12% • If not on sulfonylurea, decrease background insulin dose by 10% if TBR >2-7%; 15% if TBR 8-12%; 20% if TBR >12% • Refer to diabetes educator for options to treat hyperglycemia including: • Add or adjust GLP-1 RA ***(preferred)*** **or** add mealtime insulin before one or all meals; consider premixed insulin twice per day if cost or concern over insulin regimen complexity	2 weeks

Courtesy of Thomas Martens, M

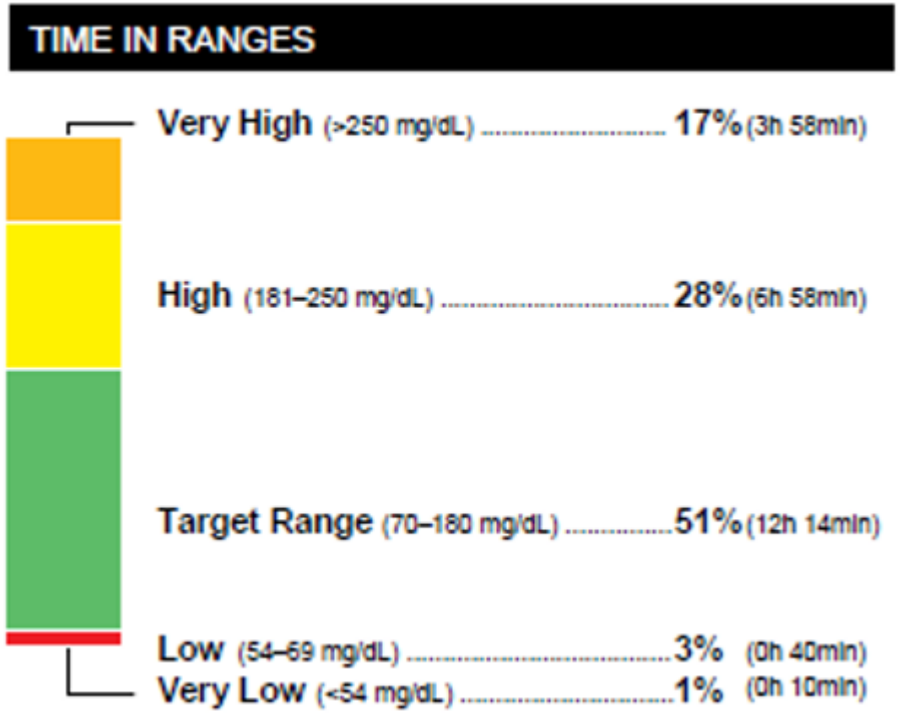
On beyond basal insulin . . .

1. Basal insulin therapy is complex and somewhat high risk, MDI is even more complex and even higher risk
2. MDI titration requires attention to multiple potential points of intervention, plus needs to account for the impact of diet and activity
3. When moving from basal insulin to MDI therapy: **As the level of complexity increases, the likelihood of successful management in primary care decreases**

Guiding principles:

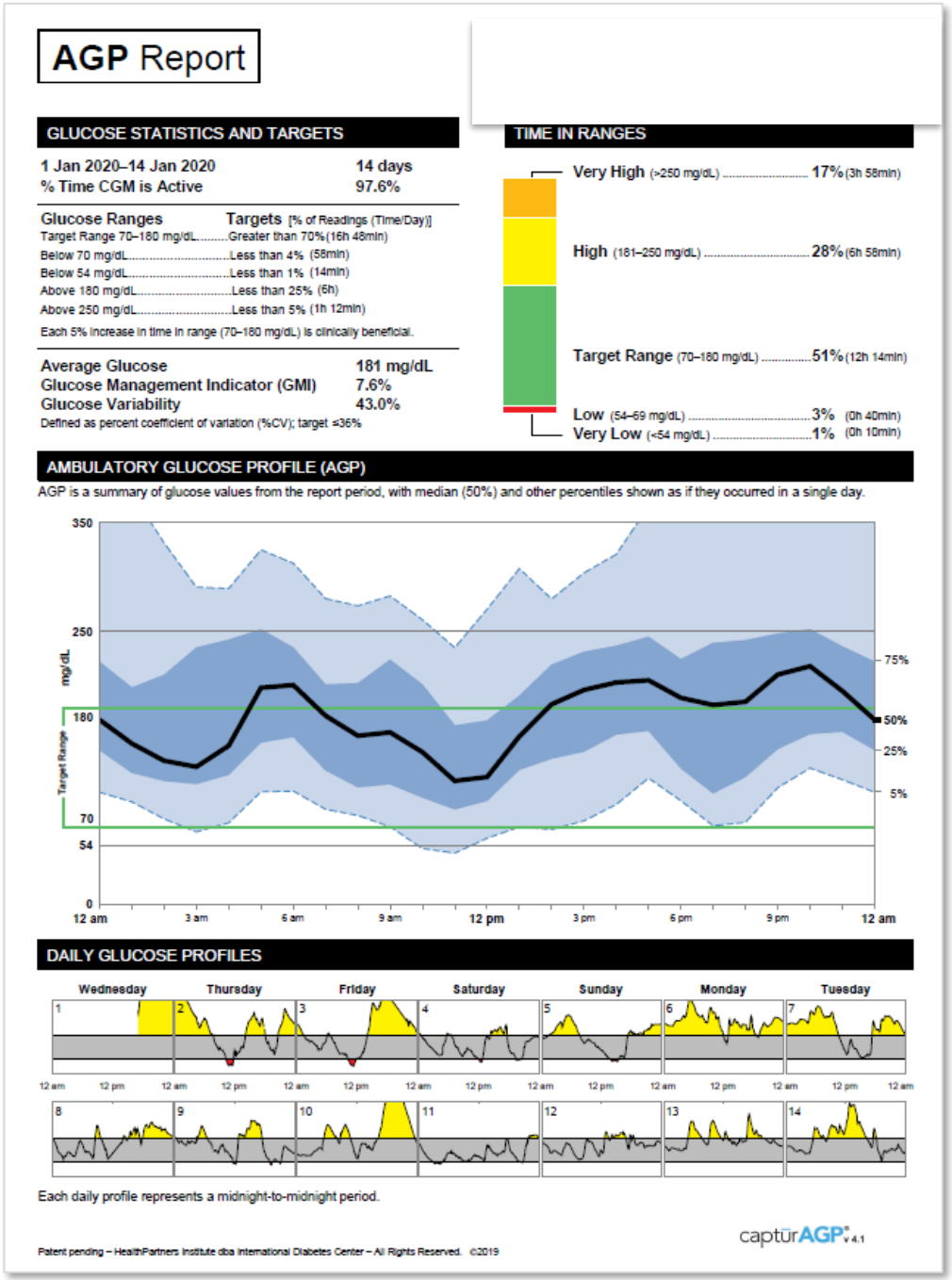
1. Consider addition of GLP 1 therapy (if not on) prior to mealtime insulin therapy
2. Consider the range of options of prandial insulin therapy (basal + 1 or 2, MDI, Premixed) based on patient preference, ability, and cost considerations
3. **Likelihood of successful management much higher with team-based assistance**
   - **I recommend referral to Diabetes Education for initiation of GLP 1 therapy, and for management / titration of any basal + regimen**

Why team-based management?

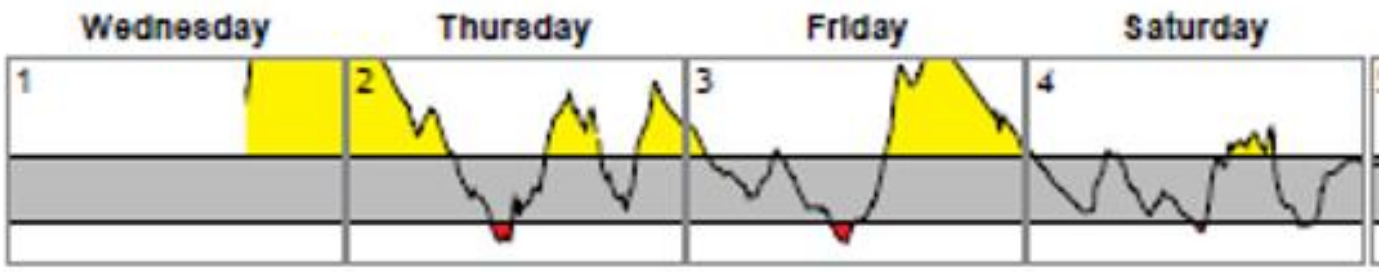


Multiple potential titration points

- 1-2 basal insulin doses
- 3+ mealtime and correction doses
- Fixed combinations, older insulins

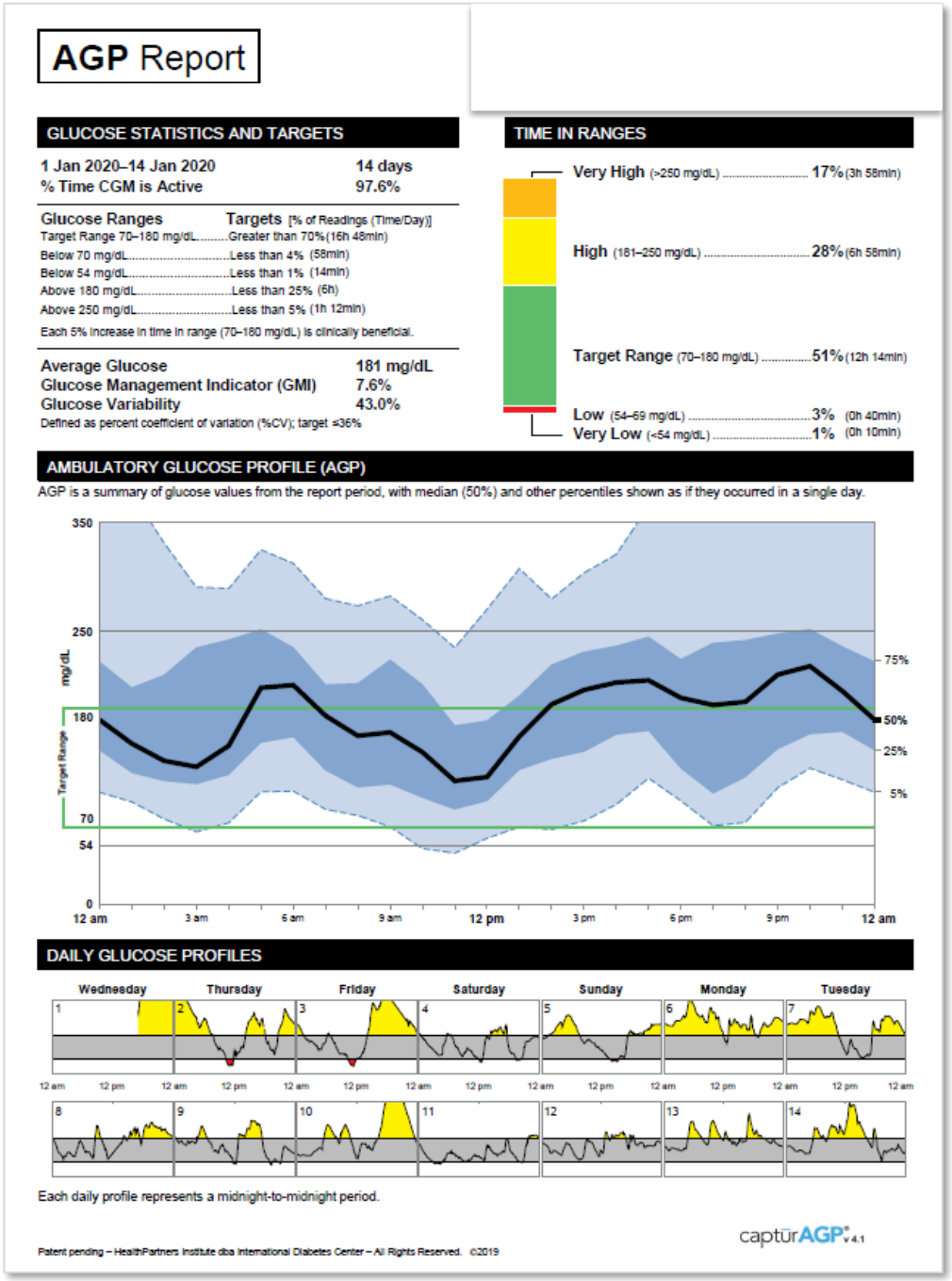


Why team-based management?



What to adjust?

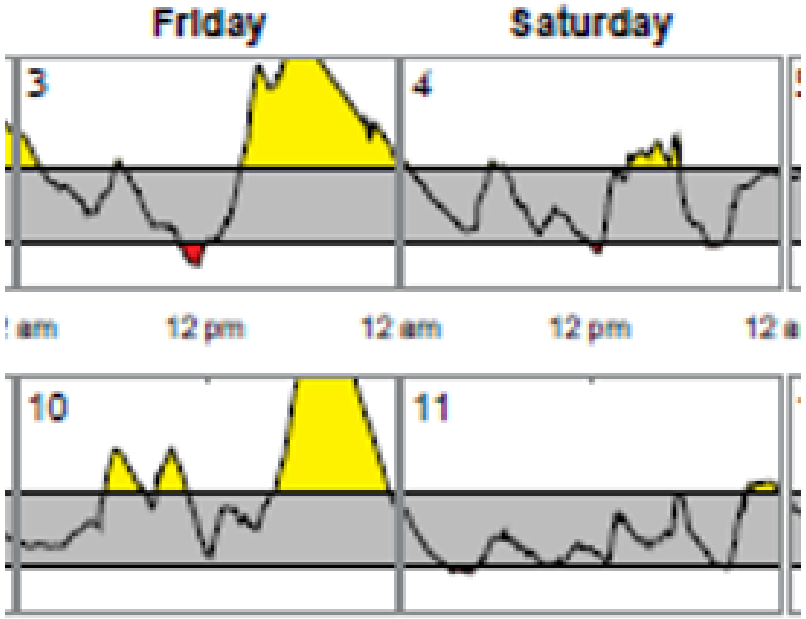
- Too little or too much of something in the evening?
- Too much basal insulin?
- Too much rapid acting insulin at breakfast?
- All of the above?

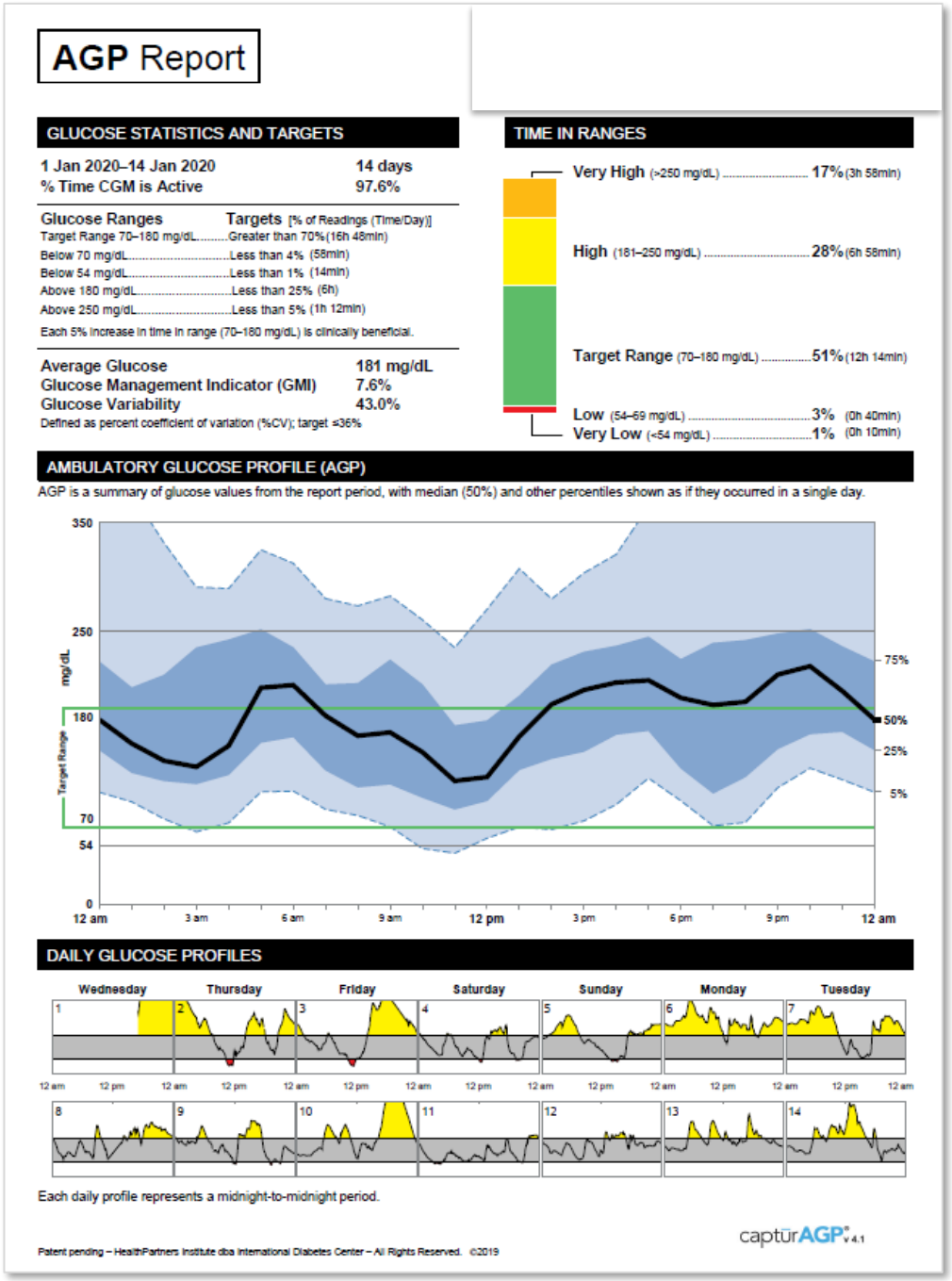


Why team-based management?

Impact of lifestyle

- Fridays vs. Saturdays



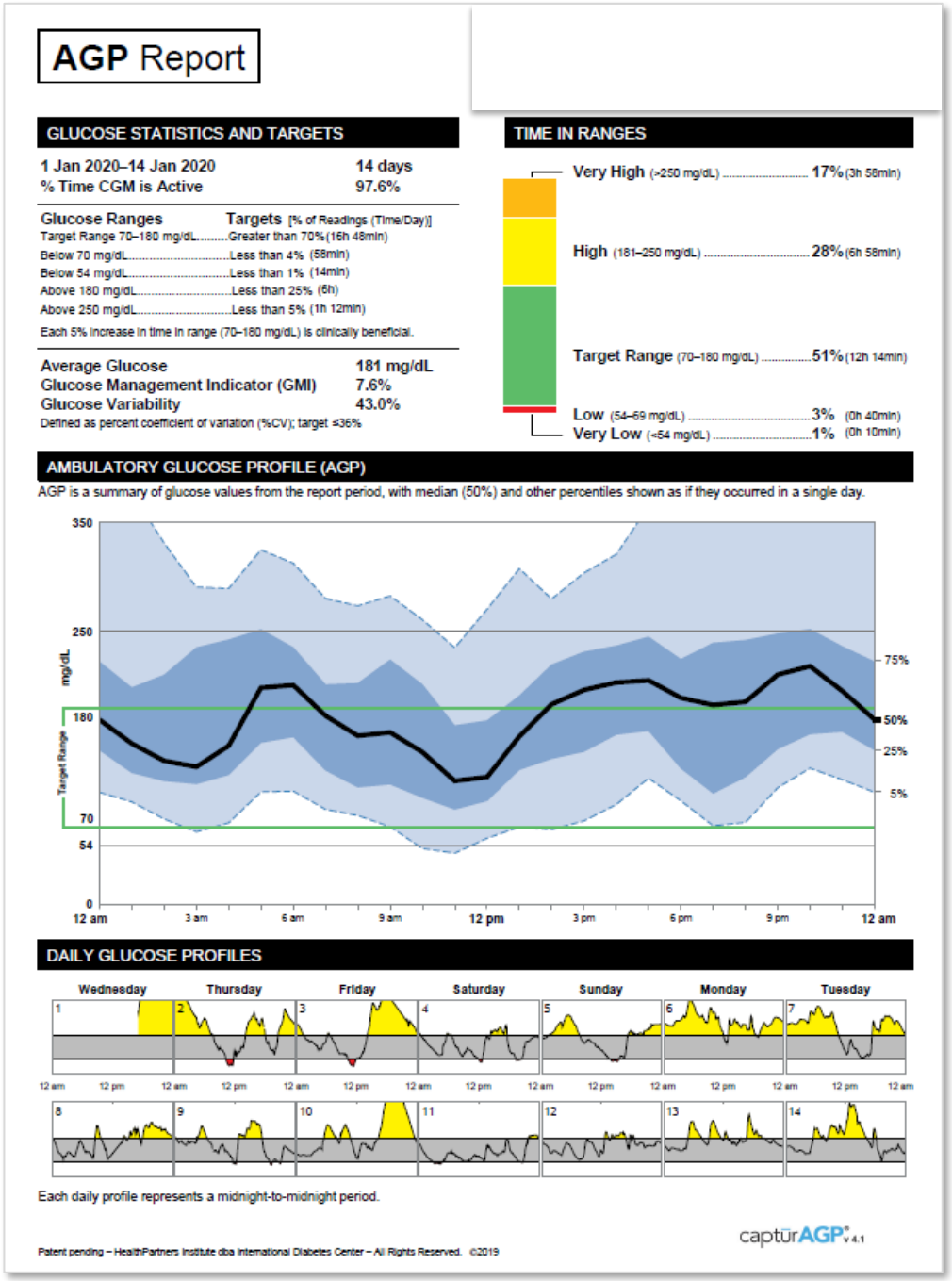


Why team-based management?

Average Glucose	181 mg/dL
Glucose Management Indicator (GMI)	7.6%
Glucose Variability	43.0%
Defined as percent coefficient of variation (%CV); target ≤36%	

High variability:

- Problems with the regimen: timing? adherence? diabetes distress? autoimmune diabetes?
- Need to advance therapy: GLP-1 RA? Mealtime insulin?



Considerations for Effective CGM-Based Insulin Titration

1. **Change therapy based on *patterns* of hypoglycemia or hyperglycemia, rather than isolated outlying values**
2. **If consistent rise in post-meal glucose**, consider if due to consumption of high carbohydrate foods/beverages
3. **Consider potential issues with insulin regimen:**
   - **Missed or rationed insulin or noninsulin therapies**
   - **Injecting incorrect insulin type**
   - **Timing of insulin dosing:**
     - **Not taking mealtime or premixed insulin before eating** (15 min for rapid-acting and 30 min for regular)
     - **Skipping meals** when using premixed insulin
     - **Timing of background insulin** (e.g**.** evening vs. morning)
   - **Lipohypertrophy** causing erratic absorption
   - **Possible need for mealtime insulin or GLP-1 RA** to treat post-meal hyperglycemia
   - **"Insulin stacking"** causing low glucose
4. **If sudden increase in time above range, consider acute reasons** including expired/degraded insulin, improperly stored insulin, acute infection/illness, initiation of steroid therapy, rationed insulin, vacation
5. **Verify if excessive alcohol intake** could be the cause of hypoglycemia
6. **Consider undiagnosed T1D**

Now, for some of the more practical issues:

Billing

Selecting patients

Selecting devices

How to get the data for review

Billing codes for CGM

- 95251 – interpretation of CGM (can be billed during or between visits)
  - Covered by medicare monthly
  - Commercial coverage is spotty
  - Requires a note, I use dot phrase:

    CGM Report
    Dates reviewed:
    Type of sensor:
    Statistics : see downloaded data
    Observations:
    Recommendations:

Remote Monitoring: Current codes

Service	CPT	Code Desscription
Patient Education & Training	99453	Remote monitoring of physiologic parameters, initial; set-up & patient education on use of equipment (95249 may be more appropriate for CGM)
Device Supply & Data Collection	99454	Remote monitoring of physiologic parameters; device supply with daily recordings or programmed alter, transmission, each 30 days
Data Analysis & Interpretation	99091	Collection and interpretation of physiologic data (e.g. glucose monitoring) digitally stored and/or transmitted by the patient to the physician requiring a minimum of 30 minutes of time, each 30 days
Treatment Management	99457	Remote physiologic monitoring treatment management services, clinical staff/physician/qualified health care provider, first 20 minutes (95251 may be more appropriate for CGM)
	+99458	Each additional 20 minutes

https://www.govinfo.gov/content/pkg/FR-2020-12-28/pdf/2020-26815.pdf

Remote Monitoring

CPT	Code Description	2021 RVUs (non-facility)	2022 Medicare Rate (non-facility)
99457	Remote physiologic monitoring treatment management services, clinical staff/physician professional time in a calendar month requiring interactive communication with the patient/caregiver during the month, first 20 minutes	1.46	$50
99458	Each additional 20 minutes	1.18	$41

- In addition to the physician or advanced practice provider, service can be performed by clinical staff, e.g. CNS, office RN
- Interactive communication must involve real-time audio with the person with diabetes
- The required 20 minute total is cumulative over the course of the month.
- Neither can be used for anything less than 20 minutes
- Unclear if subject to patient co-pay, you should obtain patient consent

Remote Monitoring
Interpretation of integrated insulin and glucose data, in addition to 99457/99458

- Remote analysis of insulin delivery data 99091
- Remote analysis of fingerstick glucose data 99091
- Under Medicare, the maximum number of units for 99091 is one, so only one is paid
- Remote analysis of CGM glucose data 95251
- Under Medicare, 99091 is bundled into code 95251 and only 95251 is paid

Selecting patients for CGM

- All willing patients with T1D, coverage is nearly universal
- Recommended for patients with T2DM on MDI
  - Covered by Medicare, if on 3+ insulin injections and adjusting insulin by glucose levels. I have a dot phrase: "Patient is taking 3 or more injections of insulin daily, is testing 4 times daily (technically not necessary), and is adjusting their insulin doses by their glucose readings. They would greatly benefit from personal CGM system"
  - For T2DM not on MDI, helpful. Can use Professional CGM, which is widely covered. Helps patient identify areas for improvement in lifestyle and/or need for more intensive therapy. Usually not covered by Medicare
    - For commercial patients, coverage for freeestyle Libre 2 is available for $75.00 for two sensors, even if not covered by insurance

Getting patients started on personal CGM

- Help patient select the best system for them, based upon individual characteristics and preferences
- Ensure they understand the concept of lag time and potential inaccuracies in SMBG testing
- Encourage them to look at sensor reading before and after meals to help with dosing (if on prandial insulin) or to evaluate effects of timing of insulin, high fat meals, etc. on glucose readings
- Importantly, they should not rely on the time it takes the CGM to show recovery after treating hypoglycemia (delayed up to 30 minutes)

Create an account for your clinic (1 per site), but each will need access to uploader on their computer

- https://clarity.dexcom.com/professional/
- https://pro.libreview.io/articles/create-an-account/

Train Your Patients and Staff

- If patients have a smart phone, encourage them to download the patient versions of Dexcom clarity or Freestyle Libreview.
  - You can invite them from your account.
  - Their data will be automatically uploaded to the cloud and accessible at the time of their visit (or for remote monitoring by you, RN or PharmD)
- If they do not have a smart phone, then anyone in the office can request their readers to upload to your account
- You can access the data online or ask your staff to print or to save a pdf in the media.

Effective Review of AGP With Patients

Mark Directly on Profile Sheet, if printed	▪ Type/duration of diabetes, age, weight, insulin dose ▪ Usual times for waking, meals, bed ▪ Medication times and doses on curve ▪ Times for consistent exercise or snacks
Look for Patterns of Low Glucose Readings	▪ If 10% line touches lower target line during a particular period, action should be taken ▪ Immediate action is required if 25% line touches or crosses below lower target line or if 10% line reaches 54 mg/dL
Look for Patterns of High Glucose Values	▪ Ask if medication was forgotten or if insulin is taken before meals ▪ Review meal markers and patterns for weekday, weekend, or special activities ▪ Discuss areas of high glucose values and strategies to reduce
Agree on Action Plan	▪ Always treat hypoglycemia first ▪ When treating hyperglycemia, observe data at least 12-18 hrs past the time window for hyperglycemia; if any curves are seen in hypoglycemia range, approach conservatively

Bergenstal. American Diabetes Association; 2018.

Tips for Success

- Teach patients their targets
- Help patient to understand how to evaluate in real time (thinking fast):
  - Effects of content of meal
  - Effects of exercise (up to 6 hours later)
  - How to correct high and low BG as they occur
- Encourage patients to evaluate their own AGP (thinking slow)
- Review effects of late boluses and post-insulin dose correction

Adhesion issues

- If sensor falls off early
  - Check location to minimize pulling on sensor when removing clothing
  - If excessive hair, patient may need to shave skin
  - Advise patient to use a blunt object to seal the edges of the sensor
  - Wait an hour before getting wet
  - Use preparation like Skin Tac when preparing site (available on Amazon)
- If skin reaction to sensor
  - Recommend trial of steroid spray or barrier tape
  - Messer L et al: DIABETES TECHNOLOGY & THERAPEUTICS Volume 20, Supplement 2, 2018

Summary

- CGM is an important advance in management of patients with diabetes. for helping patients improve glycemic control
  - Evidence demonstrates reduction in hypoglycemic episodes and improvement in A1C in children and adults with T1D
  - Evidence supports use of CGM for T2D in patients on multiple daily insulin injections and recently, in those on basal insulin
  - CGM provides insight for patient-specific management decisions about treatment and behavioral changes
  - CGM expands the ability to use telemedicine and for patients to be monitored remotely
  - CGM is increasingly being used in hospitalized patients