



# Diabetes State of the Art

High Impact Evidence-Based Pearls for  
Management

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DATE: May 2<sup>nd</sup>, 2026 Caroline Barrett, MD and Leah Baruch, MD



# Disclosures

- None



# Goals for today

- Review available pharmacotherapy and monitoring with continuous glucose monitors for Type 2 Diabetes
- Discuss evidence basis for newer therapies with a lens on:
  - Mortality
  - Cardiovascular risk
  - Chronic Kidney Disease
  - Quality of life

# Diabetes Management: Not that long ago...

Insulin



Sulfonylurea



Metformin



Diagnosed with Diabetes

# Diabetes Management: Current state

Diagnosed with Diabetes

Metformin

SGLT2

GLP1

DPP4

Thiazolidinediones

Sulfonylurea

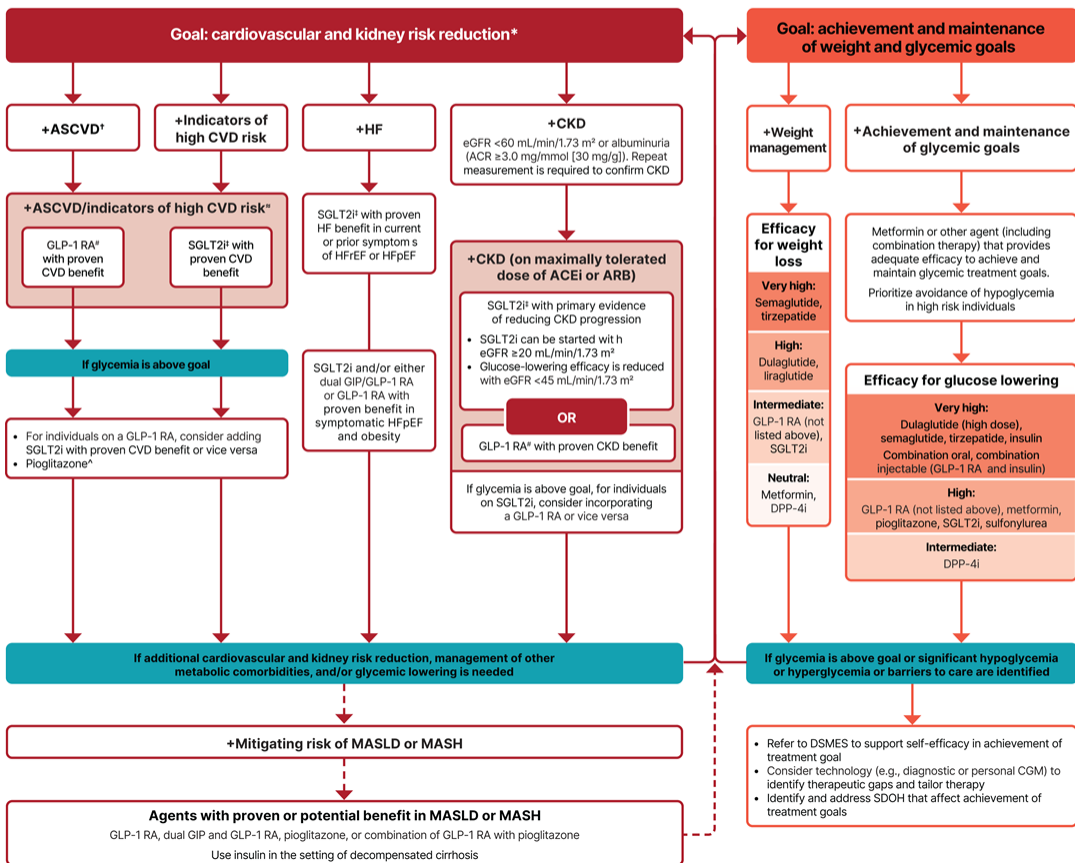
Insulin

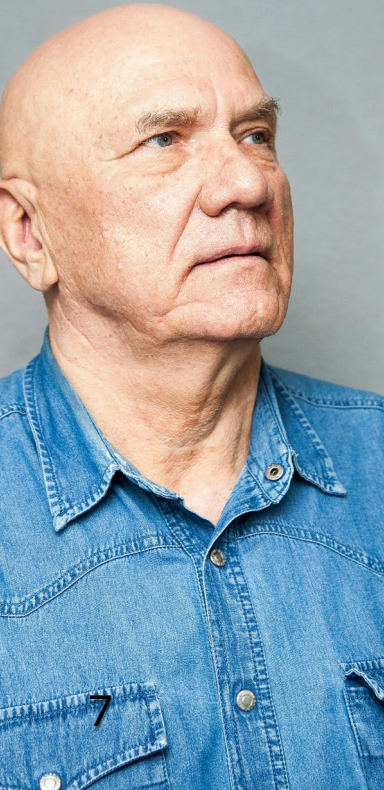
To avoid therapeutic inertia, reassess and modify treatment regularly (3-6 months)

Healthy lifestyle behaviors; diabetes self-management education and support; social determinants of health

From: **9. Pharmacologic Approaches to Glycemic Treatment: Standards of Care in Diabetes—2026**

Diabetes Care. 2025;49(Supplement\_1): S183-S215. doi:10.2337/dc26-S009





# Your Patient: "Frank"

- 60 y/o male with 20-year history of Type 2 Diabetes, coming to establish care with you
  - History CKD 3b, last urine microalbumin 150 mg/dL
  - BMI 32, recent dx of MASLD
  - A1c today is 7.6%
    - Reports hypoglycemia once a week
    - Dad had an MI at age 61
- “I need refills of my metformin and glipizide.”
  - On metformin 2000mg and glipizide 5mg once daily x 10 years

# What next?

- a) Refill current meds unchanged
- b) Increase the glipizide dose
- c) Start semaglutide
- d) Start tirzepatide
- e) Start empagliflozin
- f) Start sitagliptin
- g) Start pioglitazone

60 y/o male with 10-year history of Type 2

Diabetes

- History CKD 3b
- BMI 32
- MASLD
- A1c 7.6%
- Hypoglycemia
- Family history MI
- On metformin 2000mg and glipizide 5mg once daily x 10 years

# What are the goals in diabetes treatment?

- **Reduce mortality**
- **Prevent complications related to diabetes**
  - CKD, MI, Stroke, CHF, DM retinopathy, peripheral neuropathy
- **Maintain/maximize quality of life**
  - Tolerability of treatment
  - Achievement of secondary goals (i.e. weight loss)
- **Avoid adverse events**
  - Severe hypoglycemia, treatment-related side effects
- **Normalize blood sugar**

# One way we can classify medication

DPP4 inhibitor (Sitagliptin)  
Sulfonylurea (Glipizide)  
Insulin (Glargine, NPH)

"Just for Glucose"

Metformin  
TZD (pioglitazone)

"Glucose plus one"

SGLT2 inhibitor  
GLP1 agonist  
GLP1/GIP agonist

"Swiss Army Knife"

# Tools in the toolbox: Just for Glucose

Drug Class	Examples	Specific Indications	Adverse effects
<b>Short-acting insulin</b> <b>Long-acting insulin</b>	Lispro (Humalog) Aspart (Novolog) Humulin (70/30, Regular, N) NPH Glargine Toujeo (U-300)	Glucose lowering	Hypoglycemia Weight gain
<b>Sulfonylurea</b>	Glipizide Glyburide Glimepiride	Glucose lowering	Hypoglycemia Weight gain
<b>DPP4 inhibitor</b>	Sitagliptin (Januvia) Saxagliptin (Onglyza) Linagliptin (Tradjenta)	Glucose lowering	Pancreatitis

# Tools in the toolbox: Glucose plus One

Drug Class	Examples	Specific Indications	Adverse effects
<b>Metformin</b>	Metformin	Glucose lowering CV Risk reduction	GI side effects B12 deficiency
<b>TZDs</b>	Pioglitazone	Glucose lowering MASH	Fluid retention CHF exacerbation Bladder cancer

# Tools in the Toolbox: Swiss Army Knives

Drug Class	Examples	Specific Indications	Adverse effects
<b>SGLT2 inhibitor</b>	Empagliflozin (Jardiance) Dapagliflozin (Farxiga) Canagliflozin (Invokana)	ASCVD risk reduction CKD MASH Weight loss Glucose lowering	Genitourinary infection Fournier's gangrene <b>DKA</b> Possible incr. risk amputation
<b>GLP-1 Receptor Agonist</b>	Semaglutide (Ozempic/Rybelsus) Dulaglutide (Trulicity) Liraglutide (Victoza)	ASCVD risk reduction CKD MASH (semaglutide) Weight loss Glucose lowering	GI side effects Weight loss Pancreatitis Non-arteritic ischemic optic neuritis Gastroparesis
<b>GLP-1/GIP Receptor Agonist</b>	Tirzepatide (Mounjaro)	ASCVD risk reduction CKD (maybe) MASH Weight loss Glucose lowering OSA	Same as GLP-1 RA

*Drake T, Landsteiner A, Langsetmo L, et al. Newer pharmacologic treatments in adults with type 2 diabetes: a systematic review and network meta-analysis for the American College of Physicians. Ann Intern Med 2024 May;177(5):618-632.*

Trials were eligible if they enrolled **adult participants aged 18 years or older** with T2DM; evaluated **SGLT2 inhibitors, GLP1 agonists, DPP4 inhibitors, or long-acting insulins**; had treatment **duration of at least 52 weeks**; enrolled at least **500 participants**; and reported any outcome of interest.

For **medications approved after protocol development (for example, GLP1/GIP agonists)**, RCTs lasting 6 months or longer were eligible for inclusion.

- Outcomes compared to usual care
- Most study participants were **also taking metformin and ACEi or ARB**

# Comparing the evidence: Usual Care

Drug class	All-Cause Mortality	Major Adverse Cardiovascular Event	CHF Hospitalization	CKD Progression	Serious Adverse Events	Severe Hypoglycemia	Weight Loss
SGLT2 inhibitor	+ (RR 0.86)	+ (RR 0.90)	++ (RR 0.64)	++ (RR 0.66)	+ (RR 0.98)	+ (RR 0.85)	+ (mean loss of 2.48 kg)
GLP-1 agonist	+ (RR 0.88)	+ (RR 0.91)		++ (RR 0.76)**			+ (mean loss of 2.22 kg)
GLP1-GIP agonist							++ (mean loss of 8.47 kg)

= \*\*Data from newer study not included in meta-analysis

# Comparing the benefits: Head to Head

Drug class	All-Cause Mortality	Major Adverse Cardiovascular Event	CHF Hospitalization	CKD Progression	Serious Adverse Events	Severe Hypoglycemia
<b>SGLT2 inhibitor</b> Vs <b>GLP-1 agonist</b>	No difference	No difference	<b>+ Favors SGLT2 inhibitor (RR 0.69)</b>	Insufficient evidence	No difference	No difference
<b>SGLT2 inhibitor</b> Vs <b>GLP1-GIP agonist</b>	Insufficient evidence	Insufficient evidence	Insufficient evidence	Insufficient evidence	No difference	No difference
<b>GLP1 agonist</b> Vs <b>GLP1 – GIP agonist</b>	No difference	No difference	Insufficient evidence	Insufficient evidence	<b>- Favors GLP-1 agonist (RR 0.57)</b>	No difference



# Bottom Lines

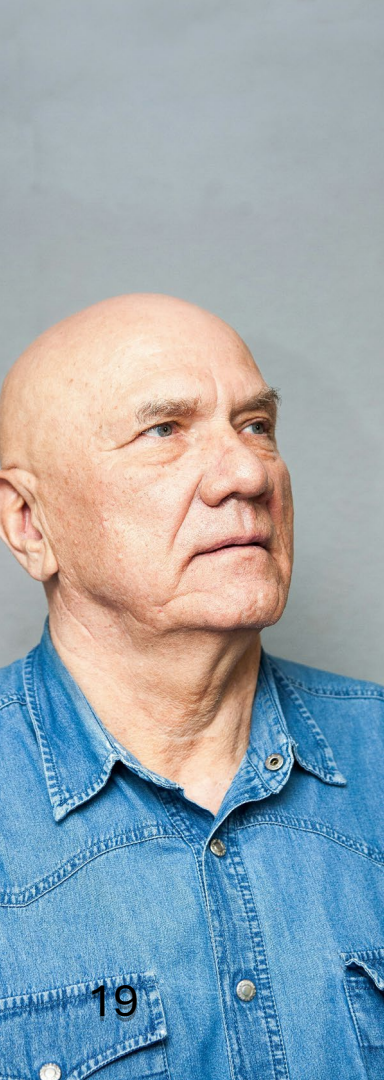
- **Avoid treatment inertia!**
  - Change from 'glucose-only' agents to newer pharmacotherapies when feasible
  - Assess patient goals beyond glucose control
- **Consider addition of SGLT2 in appropriate patients regardless of A1c**
  - Indicated for CKD, CHF, CVD risk
  - Glucose-lowering effects go down at lower GFR, but other benefits remain
- **Consider GLP1 RA in appropriate patients regardless of A1c**
  - Indicated for CKD, CHF, CVD risk
  - Oral and subcutaneous available
- **Don't forget about MASH/MASLD**
  - GLP1 RA, GLP1/GIP RA, SGLT2i, Pioglitazone have probable or proven benefit
- **Oregon Health Plan will cover these (if already on metformin):**
  - SGLT2i: Empagliflozin, Dapagliflozin
  - GLP1 RA: Dulaglutide, Liraglutide

## What next?

- a) Refill current meds unchanged
- b) Increase glipizide dose
- c) Start semaglutide
- d) Start tirzepatide
- e) Start empagliflozin
- f) Start sitagliptin
- g) Start pioglitazone
- h) Start empagliflozin AND semaglutide

## What if:

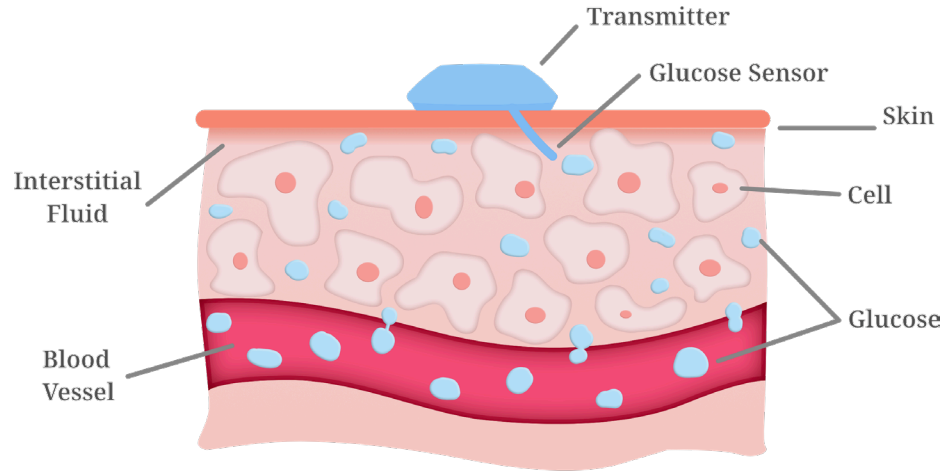
- Frank's goal is to avoid CKD progression?
- His goal is weight loss to help his knees and sleep apnea?
- Frank's A1c were 6.4%?
- Frank had biopsy-proven MASH?



# Back to Frank:

- Your patient starts empagliflozin as his primary goal is to keep his kidneys healthy and avoid dialysis.
- The next time you see him, he asks the following question:
  - My wife says I should get one of those glucose monitors that goes on my arm. What do you think?

# How it works



- Measures glucose in interstitial fluid through filament sensor inserted into skin

# Patients to consider



- Any patients on insulin
- Non-insulin medication use but not at A1c target
- Frequent, severe hypoglycemia or hypoglycemia unawareness
- Patients needing motivation and/or lifestyle pattern recognition

# Real Time vs Intermittent Scanning

Pros	Cons	Pros	Cons
Offers alerts	Requires set up and programming	Easy to use, discreet	No alerts
Transmits data continuously	Alarm fatigue	More affordable	Requires intent
Shares data	Can be expensive	Eliminates fingersticks	No option to calibrate
Can calibrate with fingersticks	False lows and highs	Shares data	False lows and highs

# The Evidence: Efficacy and safety of continuous glucose monitoring and intermittently scanned continuous glucose monitoring in patients with type 2 diabetes: a systematic review and meta-analysis of interventional evidence. Seidu Et al. Diabetes Care 2024

Outcome	Real-Time	Intermittent Scan
A1c reduction	<b>Yes</b> at longest time point measured but not at time points of 12, 24 & 30 weeks. - <b>0.19% Mean difference</b>	<b>Yes</b> at longest time point measured and at 12 & 30 weeks. - <b>0.31% Mean difference</b>
Time in Range (70-180)	No difference	<b>Increased % Time in Range</b>
Time Below Range	No difference in time <54 or time < 70	No difference
Time Above range	<b>Increased time &gt; 140, reduced time &gt; 180, no difference &gt; 250</b>	No difference > 180, <b>reduced time &gt; 250</b>
Glucose Variability (coefficient of variation)	No difference	No difference
Weight/BMI/ waist circumference	No difference	No difference
Blood pressure	No difference	<b>Single study increase in systolic BP, no change diastolic</b>

# The Evidence Continued

Outcome	Real-Time	Intermittent Scan
Lipids	No change	No change
Medication Changes	<b>Reduction in glycemc medications</b>	Not reported
Adverse events (insertion site symptoms/infection, hypoglycemia, headache, GI sx)	<b>Increased</b> with no difference in hypoglycemia, severe hypoglycemia and DKA	<b>Increased</b> with no difference in hypoglycemia, severe hypoglycemia and DKA
Psychological measures (ie diabetes distress score, quality of life score, well being score, depression score)	No difference. However <b>CGM reduced satisfaction scores</b> vs usual care	<b>Increased satisfaction scores</b> with no differences in diabetes distress, well-being or quality of life scores



# Interpreting CGMs: Ambulatory Glucose Profile

## GLUCOSE STATISTICS AND TARGETS

14 Days

% Time CGM is Active

100%

Ranges And Targets For	Type 1 or Type 2 Diabetes
<b>Glucose Ranges</b>	<b>Targets % of Readings (Time/Day)</b>
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

152 mg/dL

Glucose Management Indicator (GMI)

6.9%

Glucose Variability

29.7%

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

## TIME IN RANGES



# Time in Range

- Time in Range (glucose 70-180): Goal of 70% (16 hours, 48 minutes), correlates to A1c of 6.7-7%
  - For older/high risk individuals, goal of 50%
- Time below range
  - Level 1: 54-69, goal of < 4% (< 1 hour)
    - Older/high risk < 1% (<15 min)
  - Level 2: < 54, goal of < 1% (<15 min)
- Time above range
  - Level 1: > 180, goal of < 25 % (< 6 hours)
    - Older/high risk <50%
  - Level 2: >250, goal < 5% (1 hour)
    - Older/high risk, < 10%



# A1c vs GMI (Glucose Management Indicator)

- A1c & GMI not expected to perfectly align
  - 19% of the time identical value
  - 51% of the time differ by 0.3%
  - 28% of the time differ by 0.5%
  - 46% of the time differ by 0.6% or more
- Difference between lab A1c and GMI remains relatively stable for an individual over time
- GMI calculated value
  - $GMI (\%) = 3.31 + 0.02392 \times (\text{mean glucose in mg/dL})$
- In general, each 25 mg/dL increase in mean glucose corresponds to GMI increase of 0.6%

# A1c vs GMI

CGM derived mean glucose (mg/dL)	GMI (%)
100	5.7
125	6.3
150	6.9
175	7.5
200	8.1
225	8.7
250	9.3
275	9.9
300	10.5
350	11.7



Bergental RM, Beck RW, Close KL, et al. Glucose Management Indicator (GMI): A New Term for Estimating A1C From Continuous Glucose Monitoring. *Diabetes Care*. 2018;41(11):2275-2280. doi:10.2337/dc18-1581

# Using CGMs: Glycemic variability



- Coefficient of Variation (Standard deviation ÷ mean) expresses degree of glycemic variability
  - Above goal of  $\leq 36$  percent has increased risk of hypoglycemia

# Ambulatory Glucose Profile

## GLUCOSE STATISTICS AND TARGETS

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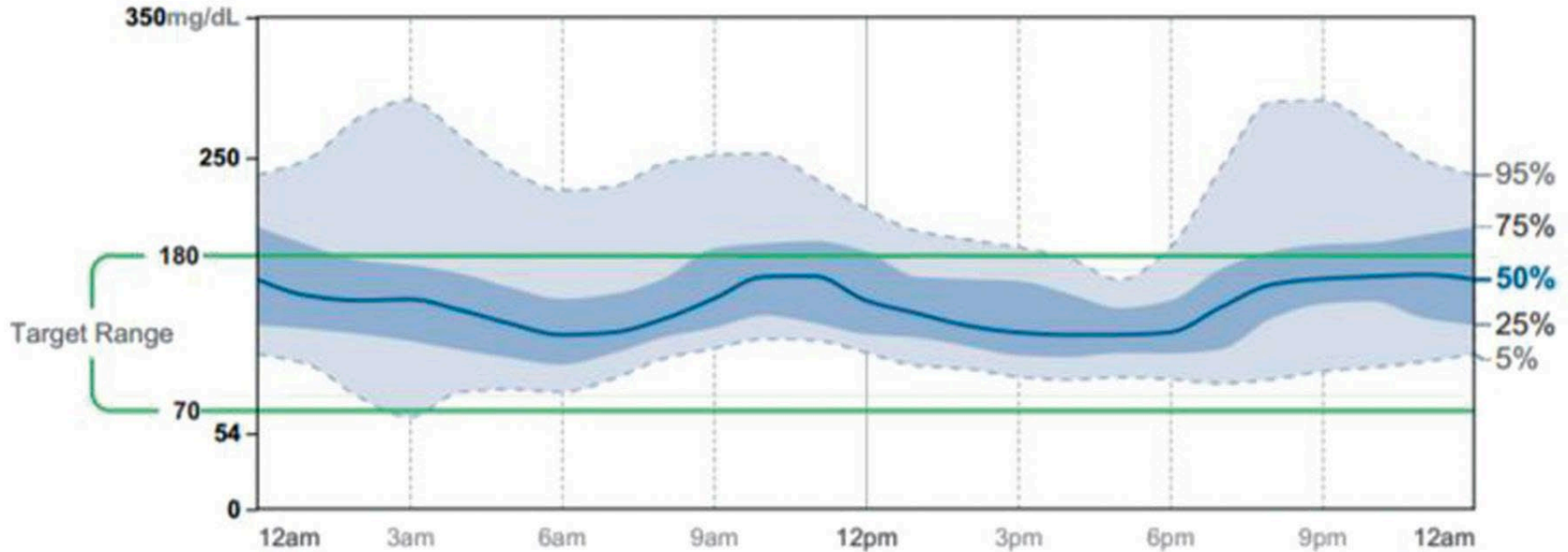
## TIME IN RANGES



# Ambulatory Glucose Profile

## AMBULATORY GLUCOSE PROFILE (AGP)

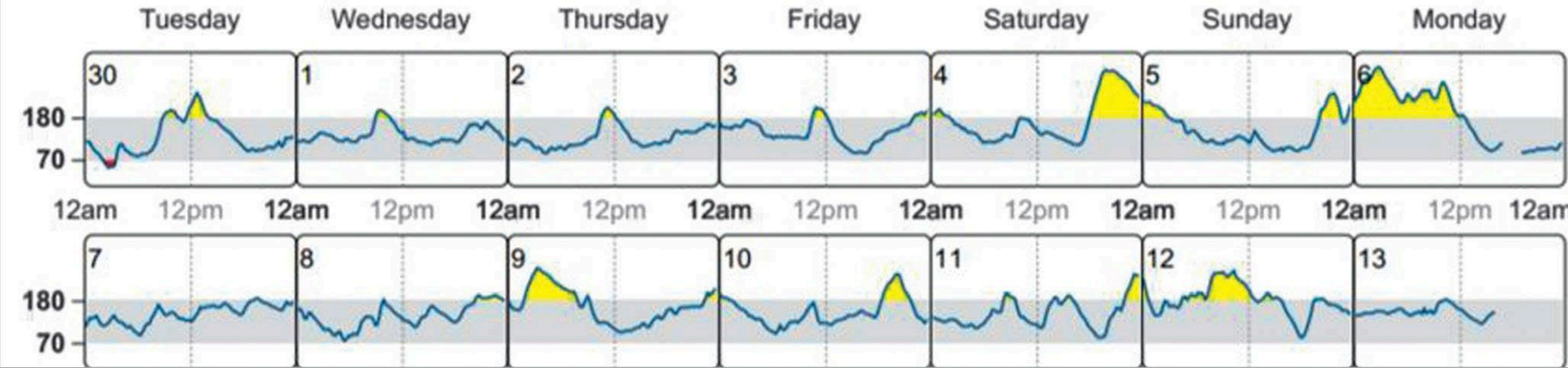
AGP is a summary of glucose values from the report period, with median (50%) and other percentiles shown as if occurring in a single day.



# Ambulatory Glucose Profile

## DAILY GLUCOSE PROFILES

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



## It's been 3 months. What next?

- a) Refill current meds unchanged
- b) Increase the empagliflozin dose
- c) Start semaglutide or tirzepatide depending on insurance
- d) Have a conversation about mid-day meals and Saturday night
- e) A & D

60 y/o male with 10-year history of Type 2 Diabetes. On metformin, glipizide & empagliflozin.

–GMI 6.9%

–Time in range 77%

–Time above range 23%

–Time below range < 1%

–Average glucose 152

–Glucose variability 29.7%

# Utility of CGMs:

- Can help identify trouble spots and patterns
  - Unidentified hypoglycemia
  - Unidentified postprandial spikes
  - Unknown of highs/lows (weekdays vs weekends, specific meals that trigger highs or lows, binge drinking on weekends)

# Device Details

Device Name	Frequency of Readings	Approved Ages	Placement Location	Sensor Life	Calibration	Warm up Time	Potential Interfering Substances	Alerts
Abbott FreeStyle Libre 2	Every 1 minute	≥4 years	Back of Upper arm	14 days	No	1 hour	➤ 500 mg Vitamin C per day	Yes
Abbott FreeStyle Libre 2 Plus	Every 1 minute	≥2 years	Back of Upper arm	15 days	No	1 hour	➤ 1000 mg Vitamin C per day	Yes
Abbott FreeStyle Libre 14 Day	Every 1 minute	≥18 years	Back of Upper arm	14 days	No	1 hour	Vitamin C, Salicylic acid	No; trend arrows
Abbott FreeStyle Libre 3	Every 1 minute	≥4 years	Back of Upper Arm	14 days	No	1 hour	➤ 500 mg Vitamin C per day	Yes

# Device Details

Device Name	Frequency of Readings	Approved Ages	Placement Location	Sensor Life	Calibration	Warm up Time	Potential Interfering Substances	Alerts
Abbott FreeStyle Libre 3 Plus*	Every 1 minute	≥2 years	Back of Upper Arm	15 days	No	1 hour	➤ 1000 mg Vitamin C Per day	Yes
Dexcom G6	Every 5 minutes	≥2 years	Abdomen or upper buttocks for patients 2-17 years	10 days	No	2 hour	Hydroxyurea & APAP (> 1 g every 6 hours in adults)	Yes
Dexcom G7*	Every 5 minutes	≥2 years	Back of Upper arm or upper buttocks for patients 2-6 years	10 days plus a 12-hour grace period	Factory calibrated. Calibrate option also available	30 min	Hydroxyurea & APAP (>1 g every 6 hours in adults)	Yes

# Device Details

Device Name	Frequency of Readings	Approved Ages	Placement Location	Sensor Life	Calibration	Warm up Time	Potential Interfering Substances	Alerts
Stelo by Dexcom	Every 15 minutes	≥18 years, not on insulin and not at risk of hypoglycemia. <b>No Rx!</b>	Back of Upper Arm	15 days plus 12-hour grace period	No	30 min	APAP > 1 g every 6 hours; hydroxyurea	No; visual notifications and glucose insights provided
Medtronic Guardian Connect	Every 5 minutes	14-75 years	Abdomen or back of upper arm	7 days	Yes (at start & then at least every 12 hours)	2 hour	APAP or paracetamol	Yes
Eversense 365 CGM System	Every 5 minutes	≥18 years	Upper arm	365 days (implant)	Daily: days 2-13. Weekly: days 14+	24 hour warm up phase	Tetracycline class	Yes

# Accuracy of CGMs

- Traditionally measured by MARD (Mean Absolute Relative Difference), <10% is the goal
  - Libre 3: 7.9%
    - Single study 100 patients ≥6 years
  - Dexcom G7: 8.7% for adults, 8.5% pediatrics
    - Manufacturer data
  - Hospitalized patients admitted for diabetes hyperglycemic emergencies: 10.8%
    - Single study, adults
    - FreeStyle Libre 2 & 3

-Alva S, Brazg R, Castorino K, Kipnes M, Liljenquist DR, Liu H. Accuracy of the Third Generation of a 14-Day Continuous Glucose Monitoring System. *Diabetes Ther.* 2023;14(4):767-776. doi:10.1007/s13300-023-01385-6

-Dexcom. Dexcom G7 User Guide. Published 2024. Accessed Jan 4, 2026. [https://s3.us-west-2.amazonaws.com/dexcompdf/G7/AW-00046-06\\_UG\\_G7\\_OUS\\_en\\_MGDL.pdf](https://s3.us-west-2.amazonaws.com/dexcompdf/G7/AW-00046-06_UG_G7_OUS_en_MGDL.pdf)

-van Baal L, Heinemann L, Reinold J, et al. Accuracy and Reliability of Intermittent Scanning and Real-Time Continuous Glucose Monitoring Systems in Diabetes Emergencies. *Journal of Diabetes Science and Technology.* 2025;0(0). doi:10.1177/19322968251334633



# Differences between CGM and Glucometer Readings

- Hand Cleanliness
- Pressure on sensor
- Medications/supplements
  - False lows: salicylic acid
  - False highs: hydroxyurea, APAP/paracetamol, vitamin C
- Rapid glucose change
  - Blood glucose changes before interstitial fluid
- Test strips
  - Expired or not stored properly
- **Sensor's first day**
  - **Gets closer over the first 24 hours**

-Why BGM and CGM readings are sometimes different. Dexcom. Accessed Jan 4, 2026. <https://www.dexcom.com/all-access/clinical-corner/cgm-vs-bgm>

-Heinemann L. Interferences With CGM Systems: Practical Relevance?. *J Diabetes Sci Technol.* 2022;16(2):271-274. doi:10.1177/19322968211065065

-Setford SJ. The Impact of Interfering Substances on Continuous Glucose Monitors: Part 2: Marketed CGM Designs, Labeled Interfering Substances, and Design Mitigations. *J Diabetes Sci Technol.* Published online October 16, 2025. doi:10.1177/19322968251377008





# Medicare Coverage

- Type 1 or Type 2 diabetes with any insulin use and/or "problematic hypoglycemia"
  - Documentation of 2 or more episodes of level 2 hypoglycemia (glucose <54 mg/dL) despite multiple efforts to adjust medications/treatment plan or 1 episode of level 3 hypoglycemia (glucose <54 mg/dL and altered mental and/or physical state that requires third-party assistance for treatment)
- Patient or caregiver trained in use of CGM (prescription for CGM serves as evidence)
- Needs to be seen in person or telehealth within past 6 months
- Considered DME, Part B coverage
  - Co-pay, deductible may apply

# Insurance Medicaid Coverage

- Oregon Health Plan
  - Short or intermediate acting Insulin use for Type 1, Type 2 or gestational diabetes with A1c  $\geq 8\%$  in the past 3 months (or prior to CGM use), frequent or severe hypoglycemia or diabetes related complications (peripheral neuropathy, CVD, end-organ damage, etc)
- Washington Medicaid
  - Type 1 Diabetes
  - Type 2 diabetes on insulin AND unable to achieve 'target' A1c OR severe hypoglycemia  $< 50$  or symptomatic OR have hypoglycemia unawareness
  - Pregnant individuals with Type 1, 2 or gestational diabetes

*-Health Technology Clinical Committee FINAL Findings and Decision Topic: Continuous Glucose Monitoring. Accessed January 3, 2026.*

<https://www.hca.wa.gov/assets/program/cgm-final-findings-and-decision-2025.pdf>

*-Continuous Glucose Monitoring (CGM). [https://www.orpd.org/durm/PA\\_Docs/continuousglucosemonitoring.pdf](https://www.orpd.org/durm/PA_Docs/continuousglucosemonitoring.pdf)*





Thank You