Continuous Glucose Monitors

J. Lacie Bradford, PharmD, BCPS
Family Medicine Clinical Pharmacist
Erlanger Pharmacy Department
UT Family Medicine Department

Objectives

- Understand the basics of continuous glucose monitors (CGMs)
- Describe the benefits of using CGMs
- Explain how to implement using these devices in a clinic setting
- Review examples of CGM data

Abbreviations

- CGM- continuous glucose monitor
- rtCGM- real-time continuous glucose monitor
- isCGM- intermittently scanned continuous glucose monitor
- MDI- multiple daily injections
- CSII- continuous subcutaneous insulin infusion
- MARD- mean absolute relative difference
- RCT- randomized controlled trial
- %TIR- percent time in range
- %TBR- percent time below range
- %TAR- percent time above range
- DSME- diabetes self-management education

In your practice…

Are you using CGMs?

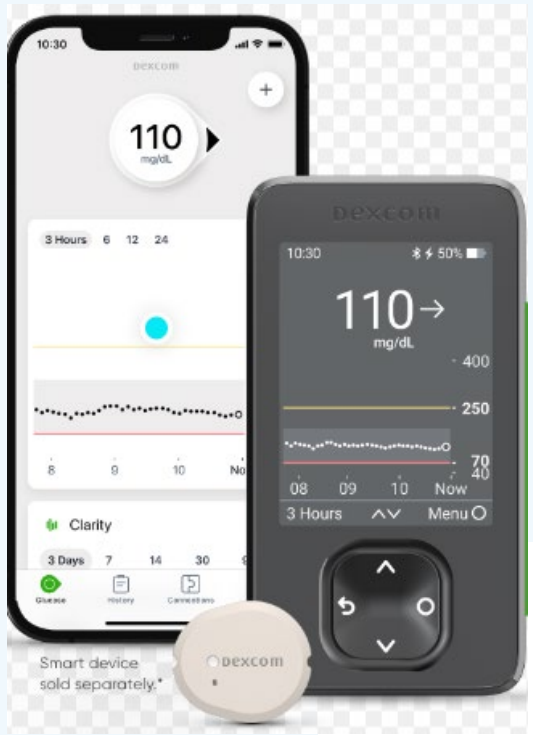
1. Every diabetic patient that can get them
2. Only if a patient asks for them
3. Not at all, defer to Endocrinology

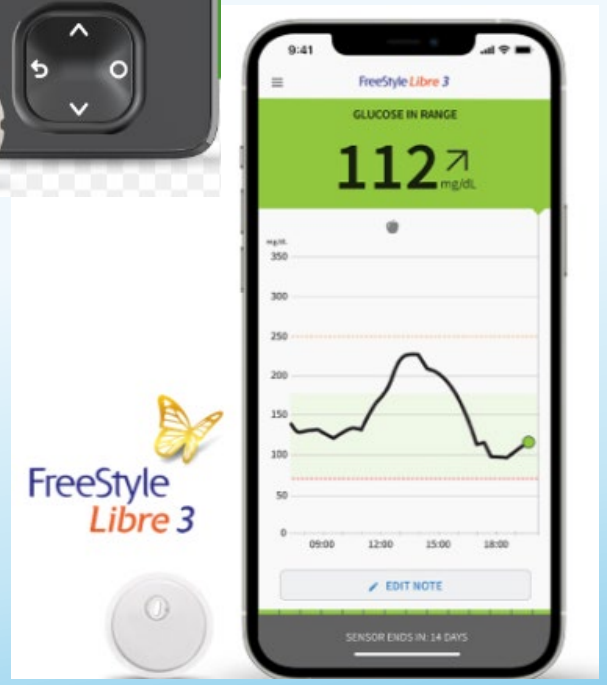
What systems are you using?

- Professional systems
  - Dexcom Pro
  - Libre Pro
- Personal systems
  - Freestyle Libre
  - Dexcom
  - Guardian
  - Eversense

CGM Basics

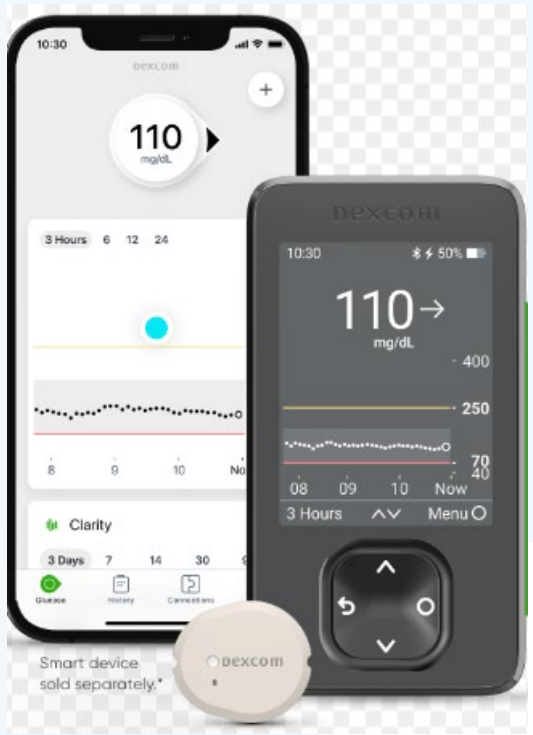
- Measures interstitial glucose
- Uses Bluetooth technology
- Displays current glucose readings
- Displays projected trends in glucose
- Integration with insulin pumps
- Ability to share data with friends and family





CGM Basics

- Receiver and sensor devices
- Applications and software
- Skin reactions
- Alerts and alarms
- Calibration
- Insulin administration



ADA Recommendations for Who should use Continuous Glucose Monitors (CGMs)

rtCGM A or isCGM B should be offered for diabetes management in the following patient populations:

- 7.14 Adults with diabetes on MDI or CSII
- 7.15 Adults with diabetes on basal insulin
- 7.16Youth with type 1 diabetes on MDI or CSII
- 7.17 Youth with type 2 diabetes on MDI or CSII
- 7.19 Pregnancy
- 7.20 Periodic use can be helpful for diabetes management in circumstances where consistent use of CGM is not desirable or available

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Types of CGMs

Personal CGM (user owned)

- rtCGM
  - Measure and display glucose levels continuously
- isCGM
  - Measures glucose levels continuously but requires scanning for visualization and storage of glucose values
    - Must be scanned every 8 hours to capture all data

Professional CGM (clinic owned)

- Office owned and purchased devices
- Date can be blinded or visible to patients
- Worn for 10-14 days
- Ideal for patients who
  - Want to try before they buy
  - Insurance does not cover personal CGM
  - A1C does not match reported glucose data

Professional CGMs

Features	Abbott Libre Pro	Dexcom G6 Pro
Blinded or Unblinded	Blinded	Blinded and Unblinded
Wear time	14 days	10 days
Components	Sensor	Sensor and transmitter
Wear site	Back of upper arm	Abdomen
Software	LibreView	CLARITY

Personal CGMs

Feature	Freestyle Libre 14 day	Freestyle Libre 2	Freestyle Libre 3	Dexcom G6	Dexcom G7	Guardian Connect/ Guardian 3	Eversense
CGM type	isCGM	isCGM	rtCGM	rtCGM	rtCGM	rtCGM	rtCGM
Real time alarms	No	Yes	Yes	Yes	Yes	Yes	Yes
Calibrations	None	None	None	None	None	BID	BID x 3 weeks the daily
Sensor wear	14 days	14 days	14 days	10 days	10 days	7 days	180 days
Sensor sites	Upper arm	Upper arm	Upper arm	Abdomen, buttocks (2-17 years)	Upper arm, buttocks (2-6 years)	Abdomen or arm	Implanted in upper arm

Personal CGMs (continued)

Feature	Freestyle Libre 14 day	Freestyle Libre 2	Freestyle Libre 3	Dexcom G6	Dexcom G7	Guardian Connect/ Guardian 3	Eversense
Integration with insulin pump	No	No	No	Yes	Yes	Yes	No
Display device	Reader, smartphone	Reader, smartphone	Smartphone	Reader, smartphone	Reader, smartphone	Smartphone	Smartphone
Age (years)	≥ 18	≥ 4	≥ 4	≥ 2	≥ 2	Guardian Connect: 14-75 Guardian 3: ≥ 2	≥ 18
Mean absolute relative difference	9.4%	9.2%	7.9%	9%	8.2%	8.7-10.6% lower with more calibrations and arm site	8.5%

Drug Interactions with CGM

7.13 Health care professionals should be aware of medications and other factors that can interfere with glucose meter accuracy and provide clinical management as indicated

Table 7.4—Continuous glucose monitoring devices interfering substances

Medication	Systems affected	Effect
Acetaminophen		
>4 g/day	Dexcom G6, Dexcom G7	Higher sensor readings than actual glucose
Any dose	Medtronic Guardian	Higher sensor readings than actual glucose
Ascorbic acid (vitamin C), >500 mg/day	FreeStyle Libre 14 day, FreeStyle Libre 2, FreeStyle Libre 3	Higher sensor readings than actual glucose
Hydroxyurea	Dexcom G6, Dexcom G7, Medtronic Guardian	Higher sensor readings than actual glucose
Mannitol (intravenously or as peritoneal dialysis solution)	Senseonics Eversense	Higher sensor readings than actual glucose
Sorbitol (intravenously or as peritoneal dialysis solution)	Senseonics Eversense	Higher sensor readings than actual glucose

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Standardized CGM Metrics for Clinical Care

Table 6.2—Standardized CGM metrics for clinical care in nonpregnant individuals with type 1 or type 2 diabetes

Metric	Interpretation	Goals
1. Number of days CGM device is worn		14-day wear for pattern management
2. Percentage of time CGM device is active		70% of data from 14 days
3. Mean glucose	Simple average of glucose values	*
4. Glucose management indicator	Calculated value approximating A1C (not always equivalent)	*
5. Glycemic variability (%CV) target	Spread of glucose values	≤36%†
6. TAR: % of readings and time >250 mg/dL (>13.9 mmol/L)	Level 2 hyperglycemia	<5% (most adults); <10% (older adults)
7. TAR: % of readings and time 181–250 mg/dL (10.1–13.9 mmol/L)	Level 1 hyperglycemia	<25% (most adults); <50% (older adults)‡
8. TIR: % of readings and time 70–180 mg/dL (3.9–10.0 mmol/L)	In range	>70% (most adults); >50% (older adults)
9. TBR: % of readings and time 54–69 mg/dL (3.0–3.8 mmol/L)	Level 1 hypoglycemia	<4% (most adults); <1% (older adults)§
10. TBR: % of readings and time <54 mg/dL (<3.0 mmol/L)	Level 2 hypoglycemia	<1%

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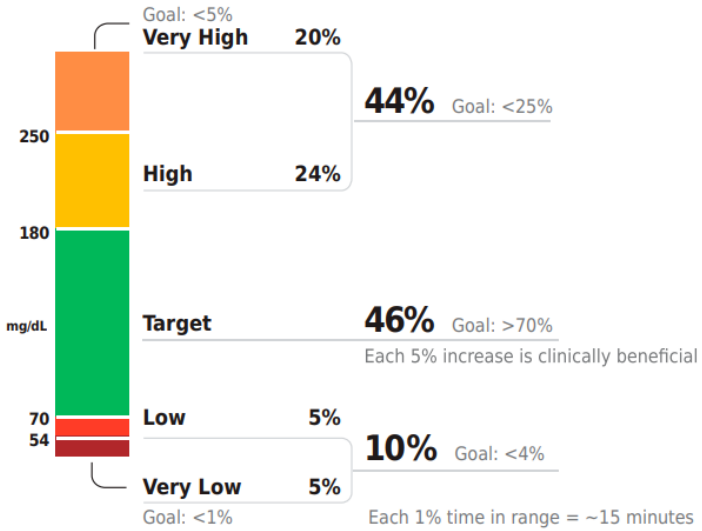
AGP Report: Continuous Glucose Monitoring

Time in Ranges

Goals for Type 1 and Type 2 Diabetes



Test Patient DOB: Jan 1, 1970

14 Days: August 8–August 21, 2021

Time CGM Active: 100%

Glucose Metrics

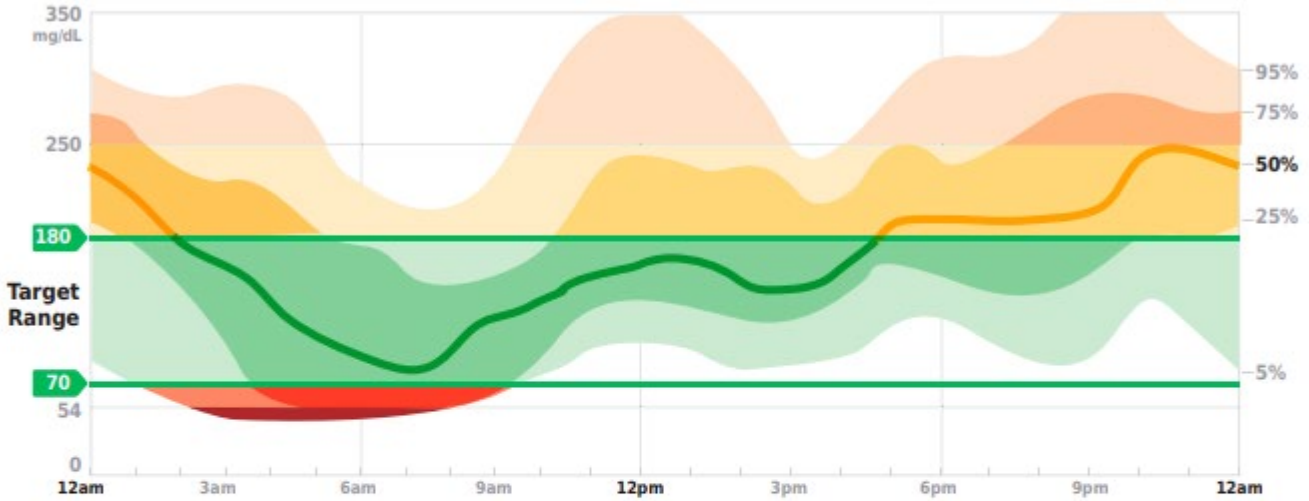
Average Glucose ..... **175 mg/dL**
Goal: <154 mg/dL

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

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

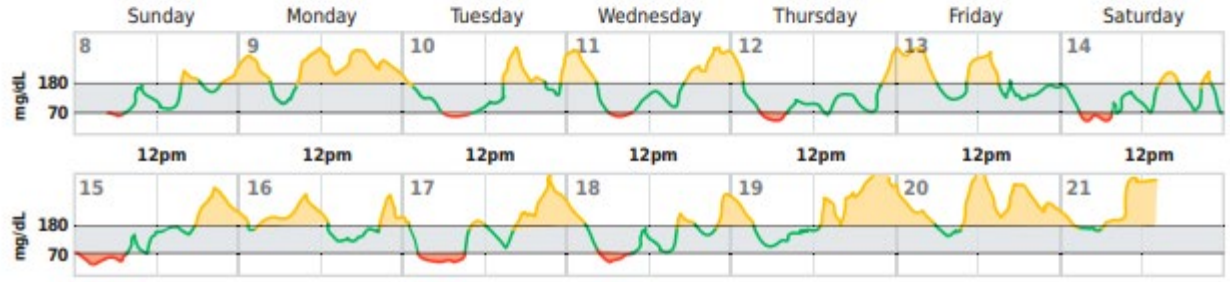
Ambulatory Glucose Profile (AGP)

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.



Daily Glucose Profiles

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



Glycemic Assessment by CGM

- 6.4 TIR is associated with the risk of microvascular complications and can be used for assessment of glycemic status. C
  - Level of chronic hyperglycemia has the best evidence for correlation as being highest risk factor for microvascular complications
  - Strong correlation between TIR and A1C
    - TIR of 70% correlates with an A1C ~7%
  - Lowering A1C from 7% to 6%, without hypoglycemia, is associated with lower risk of microvascular complications

rtCGM RCT Data in Type 2 Diabetes

Study	Patient Population	Insulin therapy	Outcomes	Results
Beck, et al	rtCGM vs usual care Mean A1C 8.5%	MDI of insulin	A1C reduction at 24 weeks	A1C decrease of -0.3% in CGM group No hypoglycemic differences
Martens, et al	rtCGM vs usual care Baseline A1C 9.1% in CGM vs 9%	Basal or intermediate acting insulin, no prandial	A1C level at 8 months, TIR	A1C decrease from 9.1% to 8% in CGM group vs 9% to 8.4% in usual care; TIR 59% for CGM vs 43% in usual care
Grace, et al	rtCGM single arm Baseline A1C (mean±SD) 10.1%±1.8%	Basal insulin only or noninsulin therapies	Changes in A1C, average glucose, glycemic variability, %TIR, %TBR, %TAR	A1C reduction -3 ±1.3% Average glucose reduction of -23.6 ± 38.8 mg/dL No change in glycemic variability %TIR increased 15.2±22.3 %TBR all patients at goal <4% at 70 mg/dL and <1% at <54 mg/dL %TAR (>180 mg/dL) -14.9±22.9 %TAR (>250 mg/dL) -8.4±16.7

Beck RW, Riddlesworth TD, Ruedy K, et al.; DIAMOND Study Group. Continuous glucose monitoring versus usual care in patients with type 2 diabetes receiving multiple daily insulin injections: a randomized trial. Ann Intern Med 2017;167:365–374
Ehrhardt NM, Chellappa M, Walker MS, Fonda SJ, Vigersky RA. The effect of real-time continuous glucose monitoring on glycemic control in patients with type 2 diabetes mellitus. J Diabetes Sci Technol 2011;5:668–675
Grace T, Salyer J. Use of real-time continuous glucose monitoring improves glycemic control and other clinical outcomes in type 2 diabetes patients treated with less intensive therapy. Diabetes Technol Ther 2022;24:26–31

isCGM RCT Data in Type 2 Diabetes

Study	Patient Population	Insulin Therapy	Outcomes	Results
Yaron, et al	isCGM vs usual care Baseline mean A1C 8.7% vs 8.3% in isCGM vs usual care	MDI of insulin	Satisfaction and QOL with isCGM, A1C difference, rate of hypoglycemia at 10 weeks	87.5% highly satisfied;12.5% moderately satisfied; none moderately unsatisfied or unsatisfied A1C reductions of -0.82% vs -0.33% in isCGM vs usual care No difference in QOL or hypoglycemia
Aronson, et al	isCGM + DSME vs DSME alone Baseline A1C (mean±SD) 8.5±1% vs 8.7±1.2% in isCGM + DSME vs DSME alone	Non-insulin therapies	%TIR in final 2 weeks of 16-week study	%TIR 76.3±17.4 in isCGM + DSME vs 65.6±22.6 in DSME alone (mean difference of -9.9 in isCGM +DSME) %TAR 21.2±18.1 vs 30.7±24.5 in isCGM + DSME vs DSME alone A1C reduction to 7.6%±0.9% and 8.1%±1.2% in isCGM + DSME and DSME alone (mean difference of -0.3% in isCGM + DSME) Higher satisfaction in isCGM +DSME No difference in %TBR or hypoglycemia

Yaron M, Roitman E, Aharon-Hananel G, et al. Effect of flash glucose monitoring technology on glycemic control and treatment satisfaction in patients with type 2 diabetes. Diabetes Care 2019;42:1178–1184
Aronson R, Brown RE, Chu L, et al. Impact of flash glucose monitoring in people with type 2 diabetes inadequately controlled with non-insulin antihyperglycaemic therapy (IMMEDIATE): a randomized controlled trial. Diabetes Obes Metab 2023;25:1024–1031

isCGM RCT Data in Type 2 Diabetes (cont)

Study	Patient Population	Insulin Therapy	Outcome	Results
Hakk et al	isCGM vs usual care Baseline A1C 8.7% CGM vs 8.9% in control	MDI or CSII	A1C reduction, Hypoglycemia at 6 months	No difference in A1C Time in hypoglycemia <70 mg/dL reduced by 0.47±0.13 hours/day and <54 mg/dL reduced by 0.22±0.07 hours/day; reductions of 43% and 53% in isCGM vs usual care Increased treatment satisfaction in isCGM vs usual care Self monitoring frequency decreased from 3.8±1.4 to 0.3±0.7 tests /day (mean±SD)

Haak T, Hanaire H, Ajjan R, Hermanns N, Riveline JP, Rayman G. Flash glucose-sensing technology as a replacement for blood glucose monitoring for the management of insulintreated type 2 diabetes: a multicenter, openlabel randomized controlled trial. Diabetes Ther 2017;8:55–73

isCGM Data in Type 2 Diabetes

Study	Patient Population	Insulin Therapy	Outcome	Results
Wright et al (Retrospective, observational)	isCGM vs usual care Baseline A1C (mean±SD) 10.1±1.7%	Basal insulin or non-insulin therapies	A1C reduction	A1C reduction of -1.5±2.2% (10.1±1.7% to 8.6±1.8%) Patients with baseline A1C ≥12% had A1C reduction of -3.7% Basal Insulin group: -1.1% Non-insulin group: -1.6%
Elliott et al (Real-world)	isCGM vs usual care Baseline A1C (mean±SD) 8.9±0.9%	Basal insulin	A1C reduction	A1C reduction of -0.8±1.1% Patients with baseline A1C ≥9% had A1C reduction of -1.6±1.3%

Wright EE Jr, Kerr MSD, Reyes IJ, Nabutovsky Y, Miller E. Use of flash continuous glucose monitoring is associated with A1C reduction in people with type 2 diabetes treated with basal insulin or noninsulin therapy. Diabetes Spectr 2021;34:184–189
Elliott T, Beca S, Beharry R, Tsoukas MA, Zarruk A, Abitbol A. The impact of flash glucose monitoring on glycated hemoglobin in type 2 diabetes managed with basal insulin in Canada: a retrospective real-world chart review study. Diab Vasc Dis Res 2021;18:14791641211021374

rtCGM vs isCGM Data in Type 1 Diabetes

Study	Outcomes
Visser et al (Prospective, 6 month)	%TIR 59.6% vs 51.9% in rtCGM vs isCGM A1C reduction to 7.1% vs 7.4% (baseline 7.4%) Hypoglycemia Fear Survey version II score 15.4 vs 18 Severe hypoglycemia occurred in 3 patients in rtCGM vs 13 patients isCGM
Radovnická (Real-world, 12 month)	A1C reduction to 7.1±3.1% vs 7.7±3.3% in rtCTM vs isCGM (baseline 8.1±3.4%) %TIR 67.5±14.8 vs 57.8±17 %TBR (<70 mg/dL) 4.3±2.8 vs 6.4±5.3 %TBR (<54 mg/dL) 0.9±1 vs 2.3±2.5

Visser MM, Charleer S, Fieuws S, et al. Comparing real-time and intermittently scanned continuous glucose monitoring in adults with type 1 diabetes (ALERTT1): a 6-month, prospective, multicentre, randomised controlled trial. Lancet 2021;397:2275–2283
Radovnicka L, Haskova A, Do QD, et al. Lower glycated hemoglobin with real-time continuous glucose monitoring than with intermittently scanned continuous glucose monitoring after 1 year: the CORRIDA LIFE study. Diabetes Technol Ther 2022;24:859–867

In your practice…

- Start small
- Choose a device
- Identify a staff champion and train 2-3 support staff
- Establish workflow
  - Personal vs Pro
    - Prior authorizations
    - Patient selection
- Cost
- Reimbursement

2024 CGM CPT Coding Reference Chart

CODES AND DESCRIPTIONS	MEDICARE PHYSICIAN OFFICE FEE SCHEDULE[1]	MEDICARE OUTPATIENT DIABETES CENTER[2]	PRIVATE PAYER (2024 AVERAGES)[3]	RELATIVE VALUE UNIT (RVU) NON-FACILITY[1]
CGM Services				
95249 Personal CGM - Startup/Training Ambulatory continuous glucose monitoring of interstitial tissue fluid via a subcutaneous sensor for a minimum of 72 hours; patient-provided equipment, sensor placement, hook-up, calibration of monitor, patient training, and printout of recording. *Bill only once during the time period that the patient owns the device.*	$64.18	$58.28 APC 5733	$130	1.96
95250 Professional CGM Ambulatory continuous glucose monitoring of interstitial tissue fluid via a subcutaneous sensor for a minimum of 72 hours; physician or other qualified health care professional (office) provided equipment, sensor placement, hook-up, calibration of monitor, patient training, removal of sensor, and printout of recording. *Do not bill more than 1x/month.*	$145.06	$125.95 APC 5012	$319	4.43
95251 CGM Interpretation Ambulatory continuous glucose monitoring of interstitial tissue fluid via a subcutaneous sensor for a minimum of 72 hours; analysis, interpretation and report. *Do not bill more than 1x/month.*	$33.73	Paid under physician fee schedule	$98	1.03
Evaluation and Management (E/M)				
99212-99215 For an established patient in non-facility or office setting. Appropriate code to be determined by the office.	$55.67-$177.47	–	$103-$335	1.70-5.42

Insurance Coverage

Commercial/ Self Pay

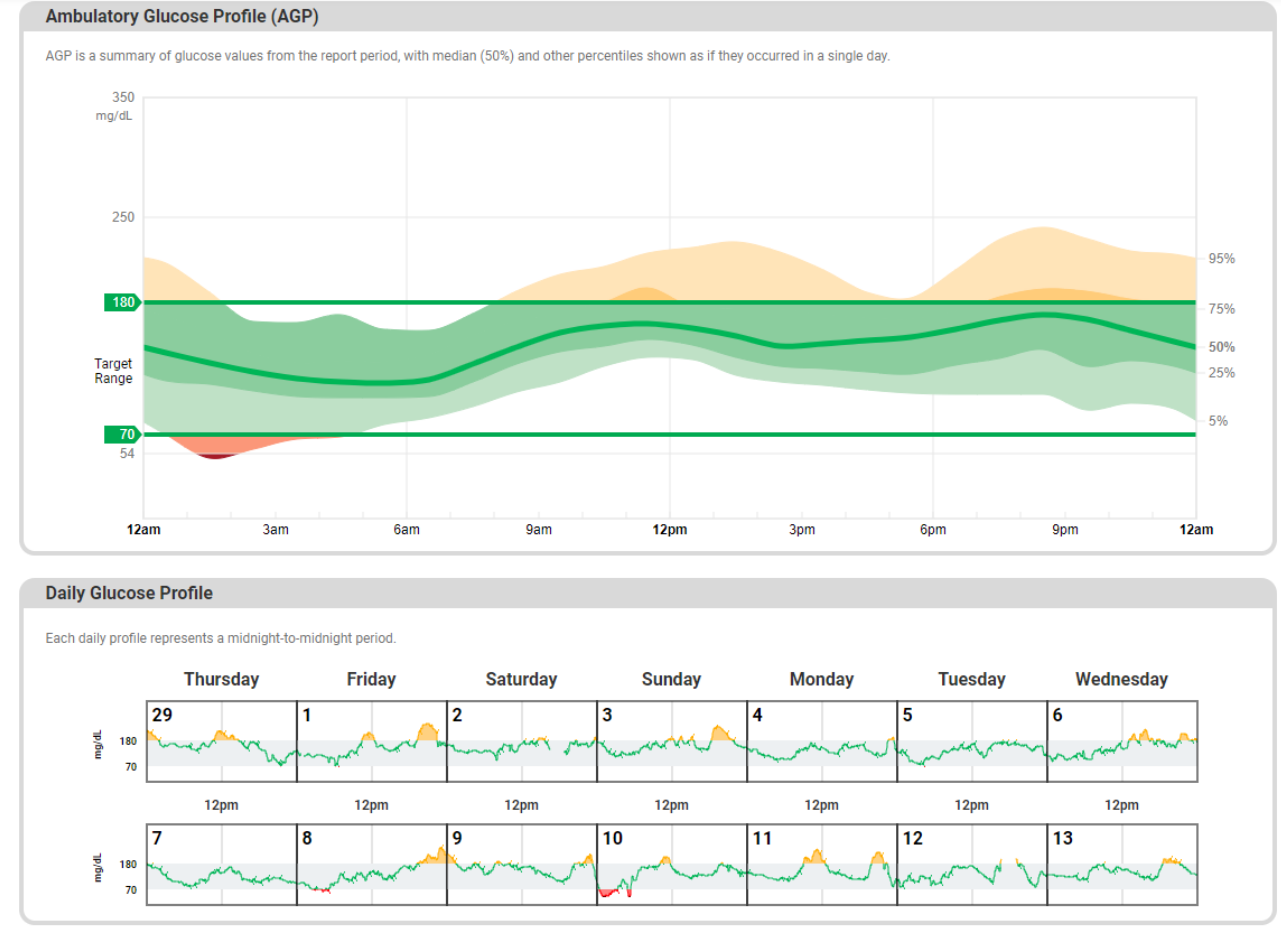
- Most commercial insurances provide coverage
- Prescriptions sent to retail pharmacy
  - May require:
    - Prior authorizations
    - Once daily insulin injection
- Patients can use app vs receiver
- Set cash pay options available

Medicare/Medicaid

- Prescriptions sent to retail pharmacy
- May need to be prescribed through DME
  - Online portal or fax to DME provider
- Medicare
  - Insulin treated OR
  - Hypoglycemic event(s)
- Medicaid
  - Three daily insulin injections

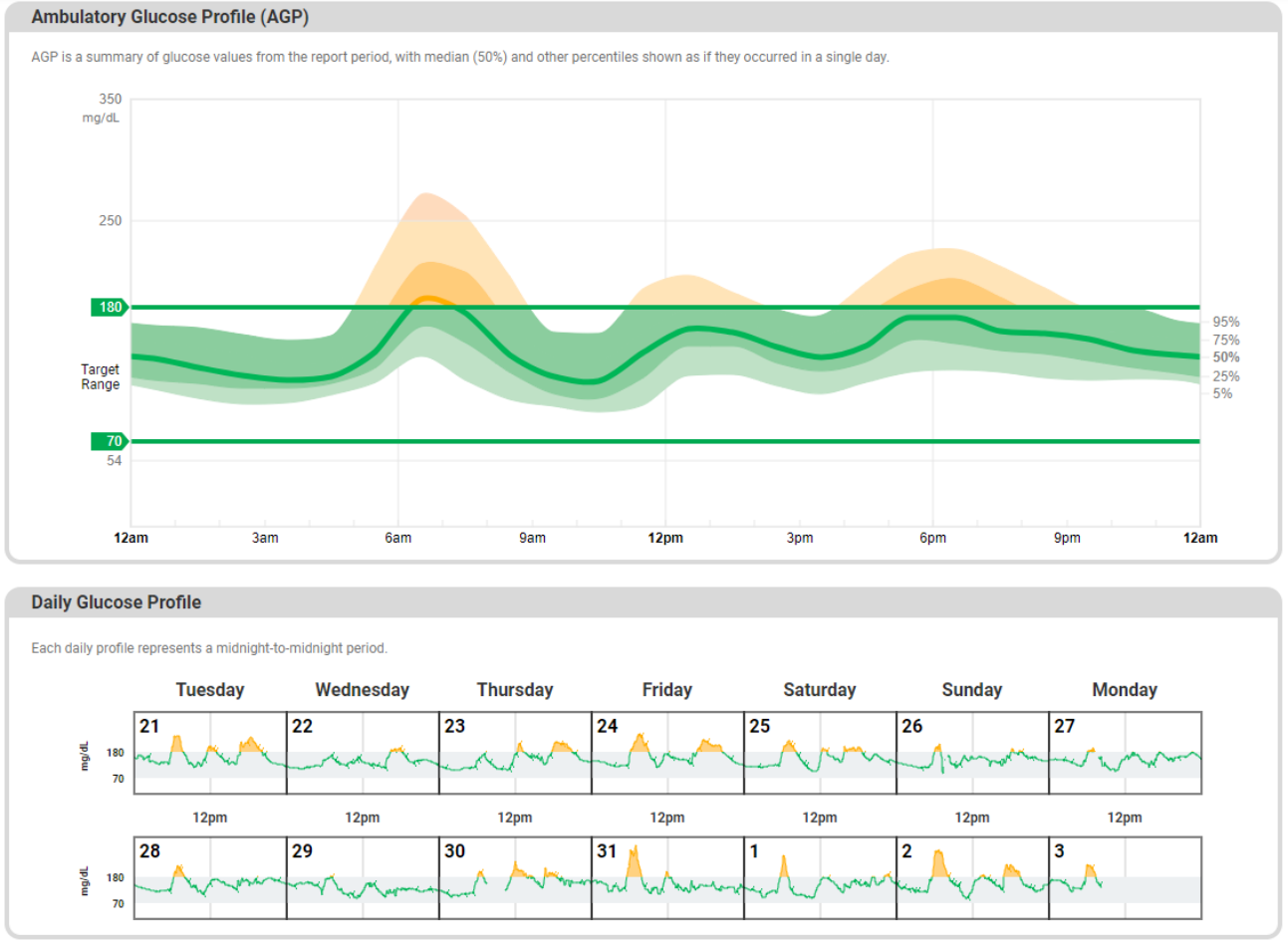
Example 1

- 77 year old female with PMH of T2DM, HTN, OSA, GERD, HLD
- A1C today is 6.9%
- Current medications include
  - Insulin lispro 5 units SQ prior to dinner
  - Insulin glargine 25 units SQ QAM and 10 units QPM
  - Jardiance 25 mg POdaily
  - Ozempic 2 mg SQ once a week on Friday



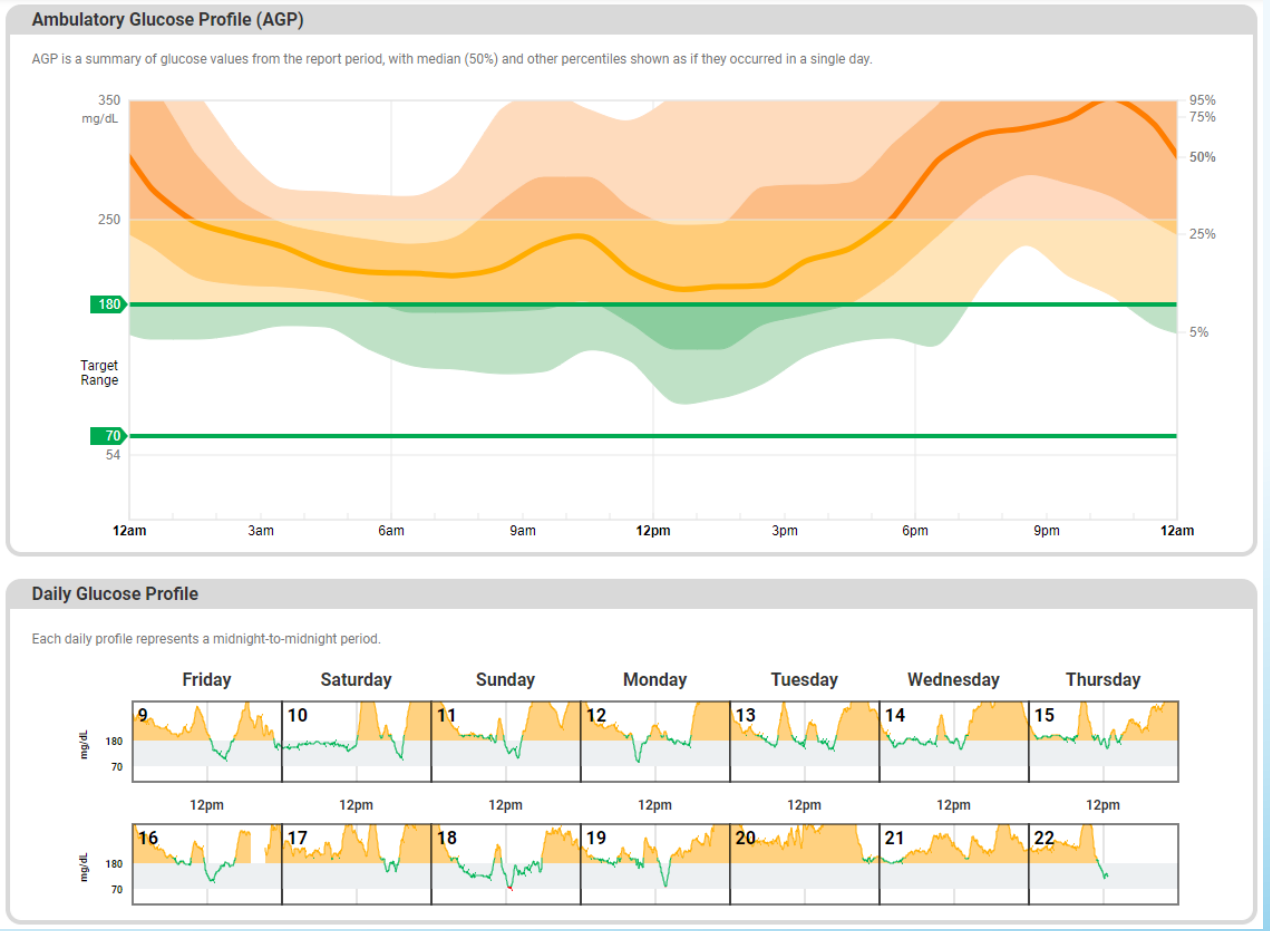
Example 2

- 46 year old female with PMH HTN, T2DM, HLD, schizophrenia, bipolar
- A1C 7%
- Current diabetes medications
  - Semaglutide 0.5 mg SQ weekly
  - Metformin 1000 mg PO BID
  - dapagliflozin 10 mg PO daily



Example 3

- 51 year old female with PMH of HTN, T2DM, HLD, GERD
- A1C 9.9%
- Current diabetes medications
  - Insulin glargine 30 units SQ BID
  - Insulin lispro 10-20 units SQ QID
  - Semaglutide 0.5 mg SQ weekly
  - Empagliflozin 10 mg PO daily
  - Metformin 1000 mg PO BID



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Family Medicine Clinical Pharmacist
Erlanger Pharmacy Department
UT Family Medicine Department
Jennifer.Bradford@erlanger.org