Utilization of Continuous Glucose Monitors in Pharmacy Practice

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Disclosure Statement

I have no relevant financial relationship(s) with ineligible companies to disclose

Learning Objectives

At the completion of this activity, the participant will be able to:

- Compare continuous glucose monitors (CGMs) currently available to patients with diabetes
- Identify emerging continuous glucose monitor technology
- Apply continuous glucose monitor data and its use in treatment decisions

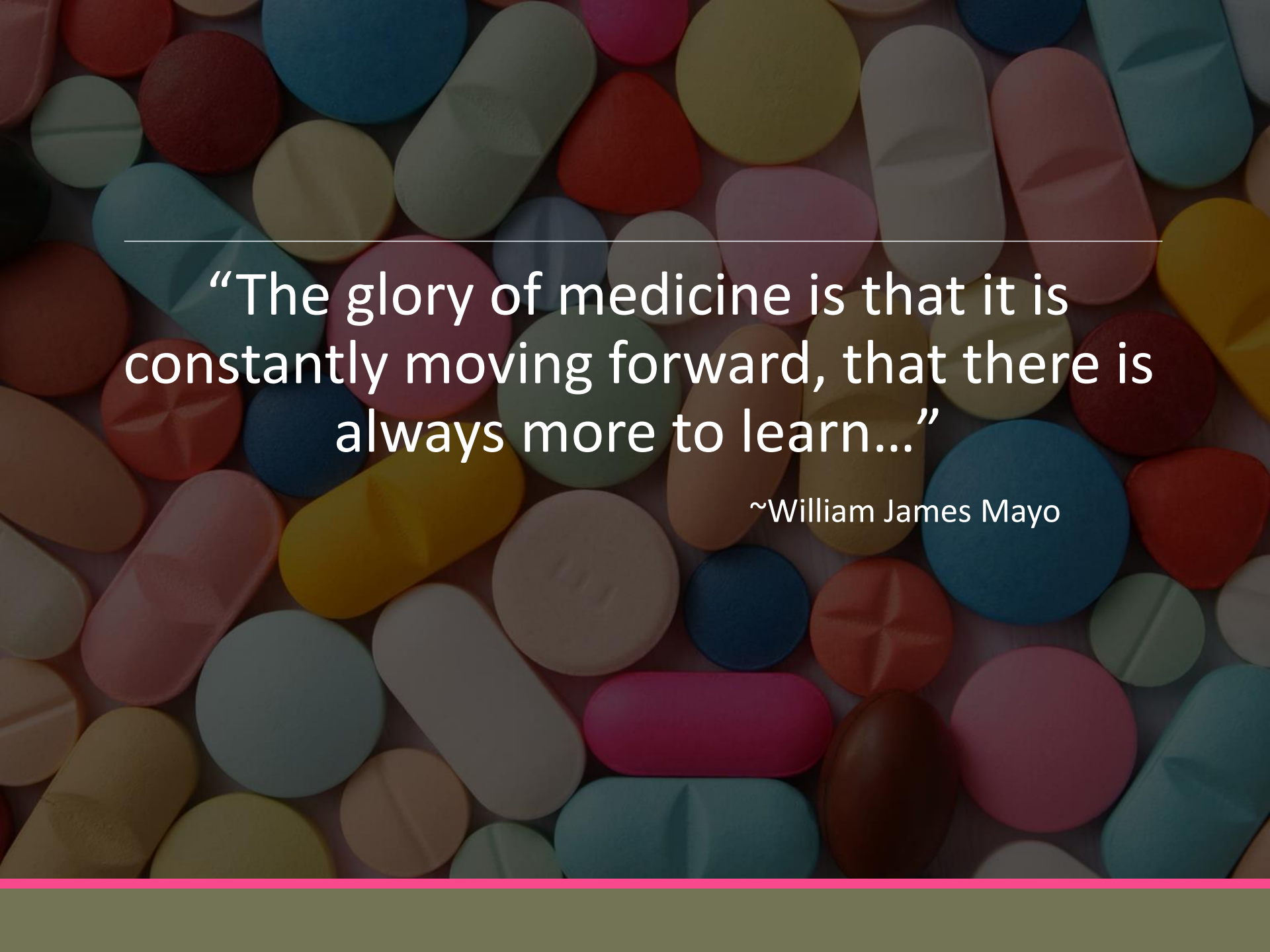
Patient Case

- A 47 YO female patient with type 2 diabetes
- Current meds
  - Glargine 18 units once daily at bedtime
  - Metformin 1000 mg twice daily

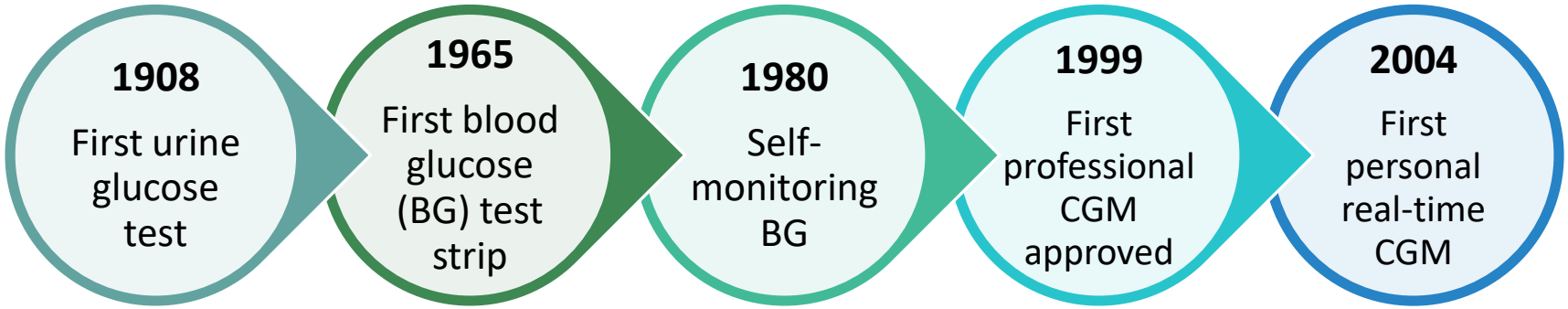
3/1/2023	**A1C**	**9.2%**

Blood Glucose Monitoring

What type of blood glucose monitoring would you recommend for this patient?


“The glory of medicine is that it is constantly moving forward, that there is always more to learn…”
~William James Mayo

Glucose testing throughout history

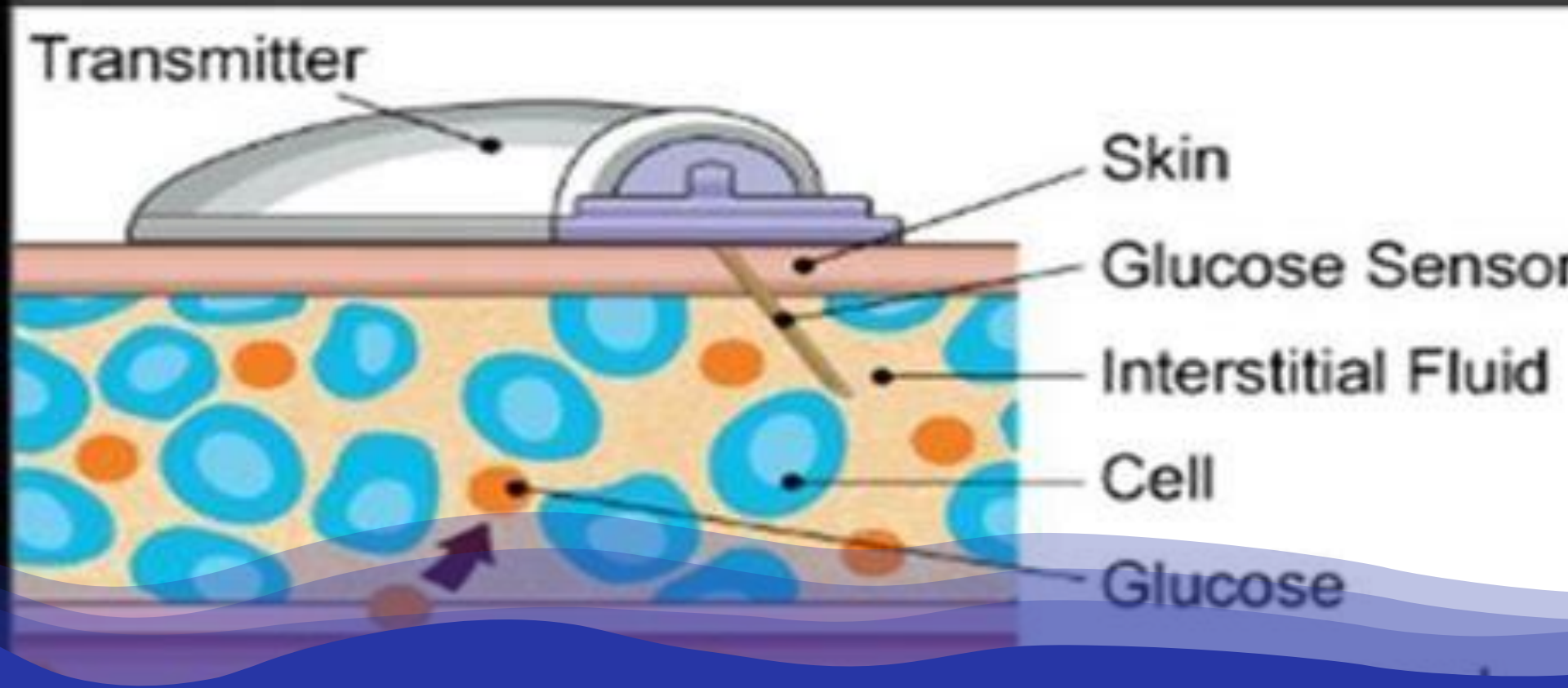


Clarke SF, Foster JR. A history of blood glucose meters and their role in self-monitoring of diabetes mellitus. Br J Biomed Sci 2012;69:83–93

What is a CGM?

- Minimally invasive device that tracks glucose levels continuously
- Consists of
  - Sensor
    - Measures glucose levels
  - Transmitter
    - Separate or built in
    - Allows glucose readings to be sent to another device
  - Reader (receiver)
    - Receives data from transmitter and displays data
- Measures glucose through interstitial fluid through filament coated in glucose sensing enzymes

Klonoff DC, Ahn D, Drincic A. Continuous glucose monitoring: A review of the technology and clinical use. Diabetes Research and Clinical Practice. 2017;133:178-192. doi:10.1016/j.diabres.2017.08.005



Glucometer measures glucose in blood while CGM measures interstitial fluid

- Glucose travels from blood vessels to fluid
- Often will not match
  - Larger differences when glucose rising or falling rapidly
    - After meals
    - With insulin use
    - exercise

Continuous Glucose Monitoring: A Review of Available Systems. www.ncbi.nlm.nih.gov/pmc/articles/PMC6705487/. Accessed March 1, 2023

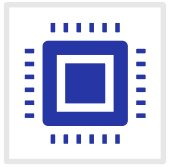
Types of CGMs

Real-time (rtCGM)

Intermittently scanned (isCGM)

Professional

Types of CGMs



Real-time (rtCGM)

Measure and display glucose continuously

Intermittently scanned (isCGM)

Requires a scan for visualization of glucose data

Overview of Continuous Glucose Monitors on the Market

Overview of CGMs

Frequency of readings	• How often CGM sends glucose readings
Calibration	• Requirement of fingerstick BG to generate accurate sensor readings
Labeling	• FDA approved use
Warm-up	• Time for sensor calibration after placement
Wear length	• Sensor wear time
Sensor placement	• Anatomical location of sensor
Interfering substances	• May influence measurements from CGM

Freestyle Libre® Systems

Libre 14

Libre 2

Libre 3

Abbott Freestyle Libre 14

Frequency of Readings	Measures every minute and records every 15 minutes
Fingerstick calibration	Not required
Labeling	Intermittently scanned; personal CGM
Warm up	1 hour
Wear length	14 days
Sensor Placement	Back of upper arm
Potential interfering substances	Ascorbic acid > 500 mg, salicylic acid

FreeStyle Libre User's Manual

Abbott Freestyle Libre 2

Frequency of Readings	Measures every minute and records every 15 minutes
Fingerstick calibration	Not required
Labeling	Intermittently scanned; personal CGM
Warm up	1 hour
Wear length	14 days
Sensor placement	Back of upper arm
Potential interfering substances	Ascorbic acid > 500 mg

Abbott Freestyle Libre 3

Frequency of Readings	Every minute
Fingerstick calibration	Not required
Labeling	Real time; personal CGM
Warm up	1 hour
Wear length	14 days
Sensor Placement	Back of upper arm
Potential interfering substances	Ascorbic acid > 500 mg

Freestyle Libre Comparison

- Sensor size
  - Smaller sensor with Libre 3
- Reader
  - No reader available for Libre 14 and Libre 3
  - Libre 2: optional reader or use with smart phone
- Scanning required
  - Libre 14 and Libre 2
- Applicator
  - One piece with Libre 3
- Alarming features
  - Libre 2 and Libre 3

Dexcom

G6

G7

Dexcom G6®

Frequency of Readings	Every 5 minutes
Fingerstick calibration	Not required
Labeling	Real time, personal CGM
Warm up	2 hours
Wear length	10 days
Sensor Placement	Abdomen (2 years and older)*
Potential interfering substances	Hydroxyurea, acetaminophen

*Upper buttocks (ages 2-17)

Dexcom G6 User Guide

Dexcom G7®

Frequency of Readings	Every 5 minutes
Fingerstick calibration	Not required
Labeling	Real time; personal CGM
Warm up	30 minutes
Wear length	10 days
Sensor Placement	Back of upper arm*
Potential interfering substances	Hydroxyurea, acetaminophen

*upper buttocks (ages 2-6)

Dexcom G7 User Guide

Dexcom Comparison

- Sensor size
  - Change in shape
  - G7 ~60% smaller than G6
- Warm up period
  - G6: 2 hours
  - G7: 30 minutes
- Sensor and transmitter
  - Combined into one device for G7

Dexcom G7 User Guide

Sensionics Eversense E3®®

- Implantable sensor for long term wear
  - Placed under skin by a trained healthcare provider
- Wireless transmitter worn over sensor
  - Rechargeable
  - Water resistant

The Insertion Process of Eversense® CGM Sensor | Ascensia Diabetes Care. www.ascensiadiabetes.com. https://www.ascensiadiabetes.com/eversense/eversense-cgm-system/insertion-process/

Senseonics Eversense E3®

Frequency of Readings	Every 5 minutes
Fingerstick calibration	Yes (after initiation and twice daily)
Labeling	Implantable real time; personal CGM
Warm up	24 hours
Wear length	180 days
Sensor Placement	Upper arm
Potential interfering substances	Tetracyclines, mannitol

Eversense User Guides. Eversense CGM System. Accessed March 13, 2023. https://global.eversensediabetes.com/patient-education/eversense-user-guides/

Medtronic Guardian Connect®

Medtronic Guardian Connect: stand-alone CGM

Medtronic Guardian Sensor 3: integrates with Medtronic 670G

GuardianTM Connect CGM System. Medtronic Diabetes. Published May 24, 2018. Accessed March 13, 2023. https://www.medtronicdiabetes.com/download-library/guardian-connect

Medtronic Guardian

Frequency of Readings	Every 5 minutes
Fingerstick calibration	Yes (after initialization and at least every 12 hours)
Labeling	Real time; personal CGM
Warm up	2 hours
Wear length	7 days
Sensor Placement	Abdomen or back of upper arm
Potential interfering substances	Acetaminophen and hydroxyurea

GuardianTM Connect CGM System. Medtronic Diabetes. Published May 24, 2018. Accessed March 13, 2023. https://www.medtronicdiabetes.com/download-library/guardian-connect

Integrated Continuous Glucose Monitor (iCGM)

- Permitted by FDA as part of an integrated system with other compatible medical devices
- Devices include insulin pumps and blood glucose meters
- One isCGM
  - FreeStyle Libre 2
- Three rtCGMs
  - Libre 3
  - Dexcom G6 and G7

U.S. Food and Drug Administration. Product classification [database]. Accessed 15 March 2023. Available from https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpcd/classification.cfm

CGMS AND DIABETES CARE

Considerations for CGM Use

- Previously recommended for individuals
  - Not meeting glucose targets
  - Experiencing hypoglycemia
  - With hypoglycemia unawareness
- American Diabetes Association (ADA) Standards of Care 2023 recommendations
  - Considered from onset of diagnosis requiring insulin management
  - May be helpful in patients on noninsulin therapies with
    - Altering nutrition plan
    - Physical activity
    - Medications that can cause hypoglycemia

Considerations for CGM Use

- Real time or intermittently scanned recommended for
  - Multiple injection use or insulin infusion
  - Basal insulin alone
- Patient specific factors should be considered
  - Individual's circumstances
  - Preferences
  - Needs

American Association of Clinical Endocrinology (AACE) Recommendations

- Outlines recommendations for use of CGMs in management of Type 1 and Type 2 diabetes
- Use for identification of glucose patterns, hypoglycemia and hyperglycemia
- Goal of maximizing time in range
- Use of metrics may not be appropriate for all patients

Fonseca, V.A. *et al.* (2016) "Continuous Glucose Monitoring: A Consensus Conference of the American Association of Clinical Endocrinologists and American College of Endocrinology," *Endocrine Practice*, 22(8), pp. 1008–1021. Available at: https://doi.org/10.4158/ep161392.cs.

Factors in CGM Selection

- Alarming features
- Wear time
- Placement
- Age restrictions
- Data transmission
- Linking capabilities
- Cost considerations

	Alarm	Wear Time	Age Indications	Data transmission
Abbott Freestyle Libre 14	no	14 days	18 years and older	Reader or smart device
Abbott Freestyle Libre 2 and 3	yes	14 days	4 years and older	Smart device (or reader for Libre 2)
Dexcom G6 and G7	yes	10 days	2 years and older	Receiver or smart device
Medtronic Guardian Connect and Sensor 3	yes	7 days	14-75 years	Smart device
Sensionics Eversense E3	yes	180 days	18 years and older	Smart device

Sensor performance

- Standard measurement for CGM performance
  - Mean absolute relative difference (MARD)

CGM	MARD
Freestyle Libre	9.4%
Freestyle Libre 2	9.2% (adults) 9.7% (peds)
Freestyle Libre 3	7.9%
Dexcom G6	9.0%
Dexcom G7	8.2%
Medtronic Guardian Sensor	8.7%*
Sensionics Eversense E3	8.5%

*3-4 calibrations/day ages 14 and older (9.1% with 2 calibrations per day)

Emerging technologies

Emerging Technology

- Existing models cleared for iCGM use
- New models of iCGMs
- Noninvasive CGM devices

CGM Data and Treatment Decisions

Glycemic Control with CGMs

- Real time measurements of glucose
  - Provide data useful in short term and long-term management
- Facilitates monitoring of time in range over a 24-hour period
- May provide notification of hyperglycemia and hypoglycemia events
- Provides patterns of glycemic excursions and variability

CGM Utilization

- With regular wear, CGMs have shown reduction in a1c
  - Studies in adults and youth with type 1 diabetes on pump therapy
  - Studies in individuals with type 2 diabetes with multiple daily insulin injections, mixed therapies, and basal insulin
- A1c does not provide measure of glycemic variability or hypoglycemia
  - Time in range can be used for assessing glycemic control
  - Time below range and time above range are useful for evaluation for treatment plan

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

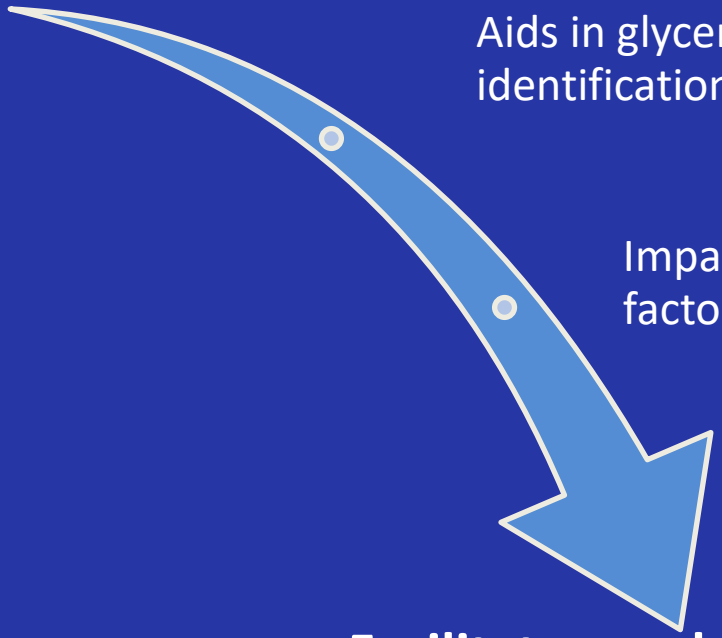
CGM Data Tools

Time in range metrics

Ambulatory Glucose Profile

Overlay reports

Daily views



Aids in glycemic pattern identification

Impact on lifestyle factors on these patterns

Facilitates goal setting and improved glycemic management

Ambulatory Glucose Profile (AGP)

- Developed by the International Diabetes Center (IDC)
- Incorporates core CGM metrics and targets along with a 14-day composite glucose profile
- Referenced as an example in ADA “Standards of Medical Care in Diabetes” and AACE “Consensus Statement on Use of CGM” as integral component of clinical decision making
- Used by each of the FDA approved CGMs on the market and available within their reporting features

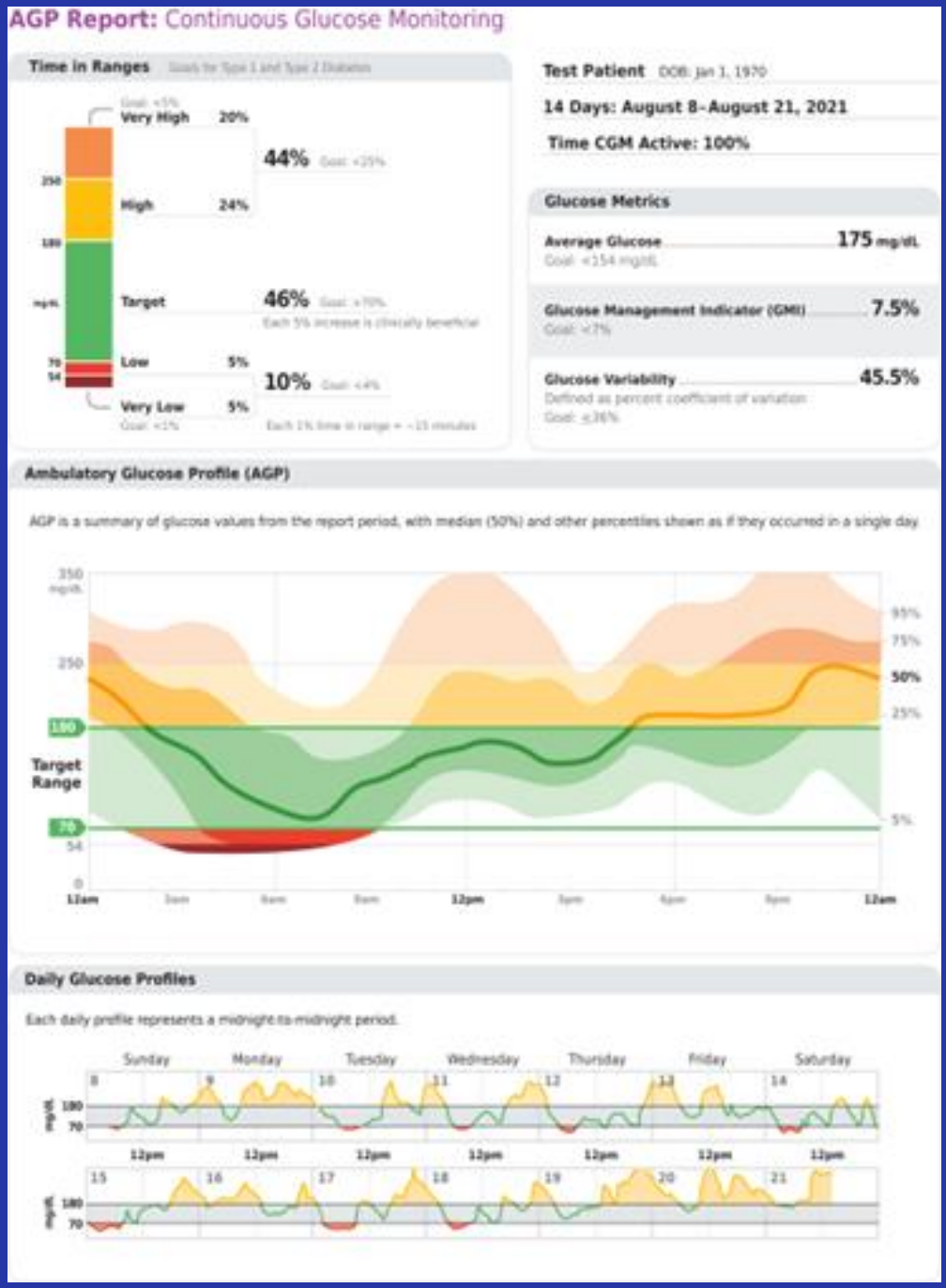
Bergenstal R. Understanding Continuous Glucose Monitoring Data. *Role of Continuous Glucose Monitoring in Diabetes Treatment*. 2018:20-23. doi:10.2337/db20181-8

Metrics from AGP

Metric	Goal
Number of Days CGM is worn	14 continuous days
% time CGM is active	> 70%
Mean glucose	< 143 mg/dL
Glucose management indicator (GMI)	< 7%
Glycemic Variability	≤ 36%

Metrics from AGP

Metric	Goal
% time above range (TAR) Level 2 hyperglycemia (>250 mg/dL)	< 5%
% time above range (TAR) Level 1 hyperglycemia (181-250 mg/dL)	> 25%
% time in range (TIR) (70-180 mg/dL)	> 70%
% time below range (TBR) Level 1 hypoglycemia (54-69 mg/dL)	< 4%
% time below range (TBR) Level 2 hypoglycemia (<54 mg/dL)	< 1 %



Diabetes Care. 2022;46(Supplement_1):S97-S110. doi:10.2337/dc23-S006

Targeting Therapy Adjustments

- If not at target TIR (70%)
  - Patients can be encouraged to work to increase by increments of 5%
- If not at target TBR (<5%)
  - View when during the day or night hypoglycemia most often occurs to optimize therapy and reduce risk
- If variable control throughout the day
  - Utilize trend data to help manage dietary intake and exercise
  - Adjust bolus dosing strategically based on trends

American Diabetes Association. 7. Diabetes Technology: Standards of Medical Care in Diabetes—2020. *Diabetes Care*. 2019;43(Supplement 1):S77-S88. doi:https://doi.org/10.2337/dc20-s007

Special Populations

- Older adults with frailty or high risk of hypoglycemia
  - TIR goal > 50%
  - TBR <1%
- Pregnant patients
  - CONCEPTT trial
  - Demonstrated mild improvement in a1c without increase in hypoglycemia
    - Pregnancy complicated by type 1 diabetes
    - Use of TIR for glycemic control
    - Insufficient data to support CGM use with pregnancy
      - Type 2 diabetes or gestational diabetes

Tundidor D, Meek CL, Yamamoto J, Martínez-Bru C, Gich I, Feig DS, Murphy HR, Corcoy R; CONCEPTT Collaborative Group. Continuous Glucose Monitoring Time-in-Range and HbA(1c) Targets in Pregnant Women with Type 1 Diabetes. Diabetes Technol Ther. 2021 Oct;23(10):710-714. doi: 10.1089/dia.2021.0073. Epub 2021 May 25.

Additional blood glucose monitoring (BGM) with CGM Use?

- Needed for CGMs requiring calibration
  - Frequency varies by device
- During warm up if symptomatic
- Adjunctive indication
  - CGM cannot be used to make treatment decisions
- Non-adjunctive indication
  - CGMs that can be used for treatment decisions

Aleppo G, Ruedy KJ, Riddlesworth TD, et al.; REPLACE-BG Study Group. REPLACE-BG: a randomized trial comparing continuous glucose monitoring with and without routine blood glucose monitoring in adults with well-controlled type 1 diabetes. Diabetes Care 2017;40:538–545

Sharing Data

- Ability to link CGM data to practice
  - Patient may authorize sharing through invite from practice
    - Via automated email to patient
    - Providing patient with practice ID

Limitations of CGM Use

CGM Limitations

- Accuracy and need for finger stick for treatment decisions
- Sensor malfunction
- Technology/scanning barriers
- Data gaps and scanning
- Inaccurate readings
- Cost/insurance coverage
- Alarm fatigue
- Skin irritation

Factors Effecting CGM Accuracy

Location of sensor	Loose sensor	Exercise
Compression low	Dehydration	Medications

Returning to the Case

Patient Case

PH is a 47 YO female patient with type 2 diabetes

- Current meds
  - Glargine 18 units once daily at bedtime
  - Metformin 1000 mg twice daily

Patient has been BGM with glucometer once daily in the morning with reports of AMFBG “mostly” in range (80-130 mg/dL). She is frustrated that her morning readings have been improving but a1c is still elevated. She would like to avoid blood glucose testing completely if possible: her “fingers are sore!”

3/1/2023	**A1C**	**9.2%**

Assessment Question #1

Would PH benefit from a personal CGM?

Why?

Assessment Question #2

Patient expressed interest in a CGM but does not want to wear a device on her arm. Which of the following CGMs would you recommend for this patient?

a. Dexcom G6
b. Dexcom G7
c. Freestyle Libre 2
d. Freestyle Libre 3

The CGM was placed, and patient was able to connect data with your practice site. Most recent AGP shows average glucose of 179 mg/dL and time in range as 59%. Time below range is 0% and time above range 36% (very high 5%). Glucose trends show a pattern of high post prandial readings in afternoon and evening.

Assessment Question #3

What AGP metric would allow the user to assess if there is enough data to make a treatment recommendation?

a. Time in range
b. Time above range
c. Time below range
d. % time CGM active

Assessment Question #4

What is the most appropriate TIR goal for PH?

a. 60%
b. 70%
c. 80%
d. 90%

Patient returns two weeks later after a GLP1 has been started for this patient. PH was continued on glargine and metformin therapies. She reports several alerts on her CGM for low blood sugar. Patient did not have any symptoms of hypoglycemia at time of alert but drank some orange juice just in case sugar was low.

Assessment Question #5

How should PH be counseled if she receives a low alert on her CGM with no symptoms of hypoglycemia?

a. Report to ED for follow up care immediately
b. Treat the low with a candy bar
c. Confirm the low with glucometer check
d. Do nothing-it is problem a compression low

References

1. Clarke SF, Foster JR. A history of blood glucose meters and their role in self-monitoring of diabetes mellitus. Br J Biomed Sci 2012;69:83–93
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3. Continuous Glucose Monitoring: A Review of Available Systems. www.ncbi.nlm.nih.gov/pmc/articles/PMC6705487/. Accessed March 1, 2023
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Need More Information?

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