Continuous Glucose Monitoring

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This *Clinical Resource* consists of three charts. The first chart is a comparison of the features of personal **prescription** continuous glucose monitors (CGMs) for patients **with diabetes**. The second chart compares **nonprescription** CGMs. The third chart answers frequently asked questions about prescription CGMs, including professional CGMs.

Comparison of Personal Continuous Glucose Monitors (Prescription)

See the FAQ chart below for information on **professional** CGM.

FEATURE	Dexcom G6, Dexcom G7	Freestyle (Libre 2, Libre 3 [US only])	Guardian Connect with Guardian Sensor 3	Eversense 3 (US)
Patient population	≥2 years of age with diabetes.[1,2,43,44]	≥4 years of age with diabetes (≥2 years of age with Libre 2 Plus sensor or Libre 3 Plus sensor).[4,7,45]	14 to 75 years of age with diabetes (US).[10] Note performance limitations in pediatric patients.[62]	≥18 years of age with diabetes[14]
Sensor Placement	**G6**: Abdomen or upper buttocks (2 to 17 years of age only).[1,43] **G7**: Back of upper arm, upper buttocks (2 to 6 years of age only), abdomen (Canada [nonpregnant]).[2,44]	Back of upper arm.[4,7,22,45]	Back of upper arm, abdomen.[10,62]	Inserted SC in upper arm provider who has completed the training program.[14]
Sensor Life	**G6**: 10 days[1,43] **G7**: 10.5 days[2,44]	Up to 14 days (Up to 15 days with *Libre 2 Plus* sensor or *Libre 3 Plus* sensor)[4,7,45]	7 days[10,62]	6 months[14]
Sensor Adhesion Management	See tips at: https://www.dexcom.com/en-us/faqs/adhesive-tips (**US**) **or** https://s3-us-west-2.amazonaws.com/dexcompdf/OUS+Specific+PDFs/Canada+2.0/LBL017361+Adhesive+Supplements_EN.pdf (**Canada**)	See tips at: https://www.freestyle.abbott/content/dam/adc/freestyle/countries/us-en/documents/freestyle-libre-sensor-adhesion-guide.pdf (**US**) **or** https://www.freestyle.abbott/content/dam/adc/freestyle/countries/ca-en/files/ADC-34254v3.0-AdhesionGuide-FSL2_EN.pdf.coredownload.pdf (**Canada**)	See tips at: https://www.medtronicdiabetes.com/sites/default/files/library/download-library/workbooks/Tape%20Tips%20and%20Site%20Management.pdf	Not applicable (sensor is inserted SC).[14]

FEATURE	Dexcom G6, Dexcom G7	Freestyle (Libre 2, Libre 3 [US only])	Guardian Connect with Guardian Sensor 3	Eversense 3 (US)
Calibration Required?	Optional[1,2,43,44]	No[4,7,51]	Yes, every 12 h after initial calibration.[10]	Yes, once or twice daily.[14]
Frequency of readings	**G6**: Every 5 min (after initial 2 h warmup).[1,43] **G7**: Every 5 min (after initial 30 min warmup).[2,44]	***Libre 2***: Every minute **when scanned** with reader or mobile device (after initial 60 min warmup).[8,22,46] Stored every 15 min.[4,46] Scan every 8 h to avoid data loss.[4,47] ***Libre 3***: Every minute (sent to smartphone, or scanned with reader) after initial 60 warmup)[7-9] Sensor stores glucose readings every 5 min for up to 14 days (15 days for Libre 3 Plus sensor).[7]	Every 5 min, after initial warmup of up to 2 h[10,11,62]	Every 5 min (after initial 24 h warmup).[14,15]
Display device/Max distance from transmitter	Receiver or smart device[1,2,43,44,a] **G6**: 20 ft (6 m)[1,43] **G7**: 20 ft (6 m from smartwatch), 33 ft (10 m) from other devices, including *Siri*[2,44]	Reader[f] or smart device.[4,7,45,b,c] To **scan**: 1.5 inch (4 cm)[22,23,47] ***Libre 2***: 20 ft (6 m) from reader or smart device to receive alarms[4] ***Libre 3***: 33 ft (10 m) from smart device[7]	Smart device[10,62,d]/ 20 ft (6.1 m)[10,62]	Smart device[14,e] 24.9 ft (7.6 m)[14]
Alarms	Customizable.[1,2,43,44] "Low soon" alert.[1,2,43,44]	Customizable.[4,7,22,52]	Customizable, predictive alerts.[10,62]	Customizable, predictive alerts.[14]
Shareable data	Yes (using phone app)[1,2,43,44]	Can send a screenshot of a report,[4,7] or share data with *LibreView* (healthcare team)[48,49] or *LibreLinkUp* (caregivers)[50]	Yes (automatically sends data to personal website)[11,62]	Yes[14]
Compatible insulin pump or smart pen	*iLet Bionic Pancreas*, *Omnipod 5*, *Tandem Mobi*, *Tandem t:slim X2 with Control-IQ*, *InPen*, *Tempo* (G7), *Tidepool Loop*.[6]	*Libre 2 Plus* sensor is compatible with *Tandem t:slim X2* with *Control-IQ*.[5]	*MiniMed 630G* (US), *MiniMed 670G* (Canada), *MiniMed 770G* (US), *InPen* (US)[12,18,19,63]	None

FEATURE	Dexcom G6, Dexcom G7	Freestyle (Libre 2, Libre 3 [US only])	Guardian Connect with Guardian Sensor 3	Eversense 3 (US)
Drug Interactions	Acetaminophen >1 g q6h, hydroxyurea (reads higher)[1,2,43,44]	Ascorbic acid >500 mg/d (>1000 mg/d for *Libre 2 Plus* sensor)(reads higher)[4,7]	Acetaminophen (reads higher; dose-dependent)[10,62]	Tetracyclines (reads lower).[14] Mannitol 9IV) or sorbitol (IV)(reads higher).[14]
Water Exposure	Sensor and transmitter are waterproof to 8 ft (2.4 m) for 24 h. Data might not transmit during this time.[1,2,43,44]	Waterproof to 3 ft (1 m) for 30 min.[4,7,45]	Sensor and transmitter are waterproof to 8 ft (2.4 m) for 30 min.[10,62]	Transmitter waterproof to 3.2 ft (1 m) for 30 min. Data might not transmit during this time.[14]
Security and Air Travel Compatibility	Compatible with hand-wanding and walk-through metal detectors (**G6**, **G7**).[1,2,43,44] Avoid x-rays (e.g., baggage scanner) and AIT (**G6**).[1,43]	Compatible with hand-wanding and walk-through metal detectors.[4,7] Avoid x-rays (e.g., baggage scanner) and AIT.[4,7]	Compatible with hand-wanding and walk-through metal detectors. Avoid x-rays (e.g., baggage scanner) and AIT.[13,62]	Compatible[14]
Medical Imaging Compatibility	**G6: NOT** compatible with MRI, CT, or x-ray.[1,43] **G7**: CT or x-ray: keep sensor out of scanned area and cover it with a lead apron.[2,44] **NOT** compatible with MRI.[2,44]	**NOT** compatible with MRI, CT, or x-ray.[4,7]	Remove sensor and transmitter before entering a room that has x-ray, MRI, or CT equipment.[10,62]	Transmitter must be removed.[14] Sensor is safe with x-ray and CT. MRI is safe under certain conditions.[14]
Health Plan Coverage	**US** (Medicare, private insurance, veteran coverage, financial assistance): https://www.dexcom.com/faqs/g6/coverage **Canada:** https://www.dexcom.com/en-ca/coverage/provincial-plans	**US** (Medicare, private insurance, veteran coverage): https://www.freestyleprovider.abbott/us-en/cost-access.html **Canada:** https://assistatfreestylelibre.ca/	**Medicare**: https://www.medtronicdiabetes.com/medicare **Financial assistance**: https://www.medtronicdiabetes.com/financial-support-programs **Canada**: call 800-284-4416	**US** (Medicare, private insurance, financial assistance): https://www.eversensecgm.com/cost-and-insurance/

a. Dexcom 6 and Dexcom 7 list of compatible smart devices and operating systems: https://www.dexcom.com/compatibility (**US**), https://www.dexcom.com/en-CA/compatibility (**Canada**). Medicare requires use of a receiver.[3]
b. *Freestyle Libre 2* list of compatible smart devices and operating systems: https://freestyleserver.com/Payloads/IFU/2024/q3/ART41556-202_rev-V-pub.pdf.
c. *Freestyle Libre 3* list of compatible smart devices and operating systems: https://freestyleserver.com/Payloads/IFU/2024/q3/ART44628-004_rev-S-web.pdf
d. *Guardian Connect* with *Guardian Sensor 3* list of compatible smart devices and operating systems: https://www.medtronicdiabetes.com/customer-support/app-support/device-compatibility (**US**); https://www.medtronic.com/ca-en/diabetes/home/support/product-support/guardian-connect-support.html#compatible (**Canada**)
e. *Eversense 3* list of compatible smart devices and operating systems: https://www.eversensecgm.com/compatibility/.
f. Reader has a built-in glucose meter compatible with *FreeStyle Precision Neo* strips.[4,7]
g. User may be prompted to confirm with fingersticks in the first 12 hours.[4,7]

Comparison of NONprescription Continuous Glucose Monitors

FEATURE	Stelo (by Dexcom)	Lingo (by Abbott)
Patient population	≥18 years of age not using insulin (with or without diabetes).[53] NOT for patients with problematic hypoglycemia because it lacks alarms.[53] Helps inform patients of impact of diet, exercise, sleep, and stress on glucose levels.[56]	≥18 years of age not using insulin.[57] Not for patients with problematic hypoglycemia because it lacks alarms.[59,66] Helps inform patient of impact of diet, exercise, sleep, and stress on glucose levels.[65]
Sensor placement	Back of upper arm.[56]	Back of upper arm[58]
Sensor life	15.5 days[56]	14 days[57]
Sensor Adhesion Management	See tips at: https://www.stelo.com/en-us/faqs/troubleshooting/how-can-keep-stelo-biosensor-adhered-full-15-days	If the sensor becomes loose or falls off, a new sensor should be placed.[60,61] Take care to avoid getting the sensor caught on clothing, or bumping into things.[61] Sweating, lotions, oils, moles, scars, and stretch marks can reduce adhesion.[61]
Calibration required?	No[55]	No. It is factor-calibrated, and there may be some sensor-to-sensor variability.[67]
Frequency of readings	Every 5 min (after initial 30 min warmup)[56]	Not available
Display device/Max distance from transmitter	Compatible smart device (see https://www.stelo.com/compatibility)/ 20 feet (6 m)[56]	iPhone 11 or higher (compatibility with additional operating systems will be available in the future)/20 feet (6 m).[57,64]
Alarms	No[53]	No[66]
Shareable data	No	Via Apple Health[57]
Drug interactions	Acetaminophen >1 g q6h, hydroxyurea (reads higher)[56]	Not available

FEATURE	Stelo (by Dexcom)	Lingo (by Abbott)
Water exposure	Sensor and transmitter are waterproof to 8 ft (2.4 m) for 24 h. Data might not transmit during this time.[56]	Waterproof to 3 ft (1 m) for 30 min.[57]
Security and Air Travel Compatibility	Compatible, but may be inaccurate in security area.[56]	Compatible with hand-wanding and walk-through metal detectors. Avoid x-rays (e.g., baggage scanner) and AIT.[68]
Medical Imaging Compatibility	CT or x-ray: keep sensor out of scanned area and cover it with a lead apron.[56] **NOT** compatible with MRI.[56]	**NOT** compatible with MRI, CT, or x-ray.[69]
Health Plan Coverage	HSA/FSA eligible[54]	HAS/FSA eligible[57]

Continuous Glucose Monitoring (Prescription): FAQs

Question	Answer/Pertinent Information
What are **professional** continuous glucose monitors?	• **A professional CGM** is placed at the prescriber's office, or via telemedicine instruction. It can be provided to patients on a short-term or episodic basis to analyze glucose trends (e.g., seven to 14 days).[16,17] • Professional CGM might be used: o if use of a personal CGM is not accessible, desirable, or feasible (e.g., frailty).[16,17] o if the patient is using noninsulin antidiabetic agents (as an educational tool).[17] o patients contemplating personal CGM.[17] o to identify hypoglycemic unawareness, fasting hyperglycemia, or reasons for poor control.[17] • Examples include the *FreeStyle Libre Pro*, *Dexcom G6 Pro*, and *iPro2 Professional*.[17]
How does continuous glucose monitoring work?	• Most CGM systems consist of a sensor, transmitter, and receiver.[20] o **Sensor** ▪ Inserted under the skin to measure glucose values in interstitial fluid.[20] o Interstitial fluid glucose levels may lag behind blood glucose readings by a few minutes, especially when glucose levels are changing.[20] o **Transmitter** ▪ May be reusable or disposable. Attaches to sensor base and sends glucose levels to the receiver or reader to display results.[20] o **Receiver (Reader) or compatible smart device**: displays current and stored glucose readings.[20] ▪ Most CGMs send data in real-time.[20] *FreeStyle Libre 2* requires scanning.[4] ▪ Most CGM systems send data to a smartphone or dedicated reader. *Dexcom G6* and *Dexcom G7* can also be read using a smartwatch or *Siri*.[1,2,21,43,44]
Which patients are most appropriate for continuous glucose monitoring?	• US experts state that CGM should be offered to patients using insulin (e.g., basal, basal/bolus, continuous subcutaneous), provided they can use the device correctly (by themselves or with a caregiver).[24] o If daily use is not possible, periodic use of professional or personal GCM devices can provide useful information.[24] • Most RCTs supporting use of CGM were done in patients using multiple insulin injections daily and consistently using a device that provides real-time readings.[24] o If an intermittently scanned device is used, scan it at least every eight hours.[24] • CGM improves A1c, but hypoglycemic episodes are not consistently improved in patients with type 2 diabetes.[24]

Question	Answer/Pertinent Information

Is continuous glucose monitoring appropriate in **pregnancy**?	• In pregnancy, CGM can be used as an adjunct to pre- and postprandial blood glucose monitoring to meet A1c targets.[24]
	• In pregnancy, CGM has been studied mostly in patients with type 1 diabetes.[25]
	  o CGM reduces the risk of macrosomia, shoulder dystocia, neonatal hypoglycemia, neonatal intensive care admission, and neonatal length of stay in pregnancies in patients with type 1 diabetes.[25,26]
	• CGM goals for type 1 patients are available.[26]
	  o These goals can be used as an adjunct, but not a replacement, for blood glucose monitoring and "traditional" pre- and postprandial goals.[25]
	• *Dexcom 7*, *Freestyle Libre 2* (US), *Freestyle Libre 3* are approved for use during pregnancy.[24,44]

What are some general points to cover when **educating patients about their glucose sensors**?	• **Sensor placement (ADULTS)**
	  o Apply to correct are (see comparison chart, above).
	  o Avoid tattoos (Dexcom), irritated skin, loose skin, muscles, bones, hardened tissue.[1,2,4,7,10,43,44]
	  o Avoid insulin injection site and navel.[1,2,4,7,10,22,43,44]
	  o To improve adhesion, avoid the waistband/beltline, hair, moles, lumps, scars, stretch marks, areas where there is a lot of movement or bending, where clothing may rub, and where the sensor may get dislodged, or laid on during sleep.[1,2,4,7,10,22,43,44]
	  o Clean the site with a non-moisturizing, fragrance-free soap and water; let dry; then clean with an alcohol wipe and allow the skin to dry again before applying the sensor.[1,2,4,7,10,22,27,30,43,44,45]
	  o For patients who experience dermatitis from the sensor, consider applying fluticasone nasal spray to site before sensor application.[28]
	• **Managing poor adhesion**
	  o *FreeStyle Libre* sensors should not be reused if they fall off.[4,7] If the sensor falls off early, call 1-855-632-8658 (US). In Canada, go to https://www.freestyle.abbott/ca-en/contact-us.html#contact-us-details-tab-section-item-8e5137601c.
	  o To prevent dislodgement, advise care with doorways, car doors, seat belts, furniture edges, dressing, and undressing. Recommend wearing lightweight clothing that fits loosely around the sensor.[27,30]
	  o If patients struggle with adhesion, consider products to help (e.g., a medical-grade adhesive bandage, *Skin Tac*, *Mastisol*, *Tegaderm HP, Skin -Prep* protective barrier wipes, *IV 3000*).[27,29,30] Consult sensor instructions; parts of the sensor may need to remain uncovered.
	  ▪ Don't block the hole in the *FreeStyle Libre* sensor, or tape over or under the *Dexcom* transmitter or its plastic holder.[1,27,30,43]
	  ▪ See comparison chart above for links to more tips.
	• **Delay between application and availability of glucose reading**
	  o See comparison chart above for details.

Question	Answer/Pertinent Information
	• **Sensor removal** o Gently pull off like an adhesive bandage, starting at the edge (peel the tape from the *Guardian 3* transmitter and sensor, remove the adhesive tab from the transmitter, and remove the transmitter before peeling off the sensor).[4,7,10,31,32] o Remind patients to remove the reusable transmitter from the *Dexcom G6* and *Guardian 3* sensors.[31,33] o Sensors should be disposed of in a container appropriate for sharps and blood exposure.[1,2,4,7,33,43,44] ▪ Abbott has a pilot recycling program for *FreeStyle Libre* sensors (US): https://www.freestyle.abbott/us-en/home/sensor-kit-take-back-pilot.html. o The new sensor should be applied at a different site.[1,2,4,7,10,43,44]
What **supplies** will patients need?	• Patients using a CGM will still need supplies to check fingersticks.[24] • Patients will need alcohol wipes to clean the sensor application site (see above). • For patients with adhesion issues, suggest skin adhesive and/or tape (see above). • Some patients might want to try baby oil or an adhesive remover (e.g., *Uni-Solve*) to remove the adhesive remaining on the skin after the sensor is removed.[34,35]
What **travel** considerations are important with continuous glucose monitors?	• See comparison chart above for compatibility with security technology. • Use fingersticks instead of CGM in the security area to make treatment decisions.[1,2,43,44] • If the mobile device used to receive data must be put in airplane mode, turn *Bluetooth* on to keep receiving data and/or alarms.[1,2,4,7,14,43] • *Eversense* can be exposed to airport security devices, but it may be helpful to inform security that you have an implanted medical device.[14]
When are **fingerstick** blood glucose values needed with continuous glucose monitors?	• Even with CGM, check blood glucose using a fingerstick during the following conditions:[1,2,4,7,10,20,43,44] o during times of rapidly changing glucose, as interstitial fluid glucose levels may not accurately reflect blood glucose levels in some CGMs o if the patient suspects that a CGM reading may be inaccurate. o to calibrate CGMs for which it is required. o during the sensor warmup period. o if prompted by the system. o a LOW or HIGH reading appears. o If the patient experience symptoms that may be due to low or high blood glucose or do not match CGM readings. o before making treatment decisions based on CGM readings (*Guardian Connect Sensor 3*).

Question	Answer/Pertinent Information
What information about glucose values can be obtained from continuous glucose monitors?	Specific terms and available information may vary slightly among the CGMs. Examples of some information that can be found on standardized CGM reports include: • **Average glucose level**: correlates with A1c and measures of hyperglycemia, but not hypoglycemia or glucose variability.[37] • **Glucose variability (GV)**: fluctuation in blood glucose from the mean or median glucose.[37] A glucose variability of <36% suggests "stable" blood glucose values and reduced risk of hypoglycemia.[37,38] • **Glucose management indicator (GMI)**: an approximate A1c based on average glucose levels over shorter period of time (e.g., 14 or 30 days; A1c estimates glucose control over about two to three months).[38,39] For example, a GMI of 7.5% corresponds to a mean glucose of about 175 mg/dL (9.7 mmol/L).[39] o Use an online calculator (https://www.jaeb.org/gmi/) or calculate GMI with a formula: ▪ GMI (%) = 3.31 + 0.02392 x mean glucose (mg/dL).[39] ▪ GMI (mmol/mol) = 12.71 + 4.70587 x mean glucose (mmol/L).[39] o GMI and A1c may differ by at least 0.3% about 50% of the time. For example:[39] ▪ Conditions that affect red blood cell lifespan (e.g., hemolytic anemias) may impact A1c, but not GMI.[39] ▪ **GMI may be higher than the A1c** shortly after periods of hyperglycemia (e.g., illness, ketoacidosis, stress), as A1c reflects glucose control over a two to three-month period not just the last 14 days or so. ▪ **GMI may be lower than the A1c** shortly after periods when glucose readings are lower than normal (e.g., after starting a low-carb diet, periods of intense exercise, starting a new glucose-lowering med). o Avoid using GMI by itself to guide diabetes management decisions.[39] Use GMI as one of the available tools (along with A1c, time in range, etc) to assess treatment and as part of the decision-making process to determine if therapy changes are needed. For example:[39] ▪ GMI will trend downward before an A1c. Use GMI to confirm that dietary or med changes are improving glycemic control. Don't use GMI alone, it is still important to look for hypoglycemia. ▪ GMI may look good, but time in range may indicate adjustments in therapy are needed to prevent significant hypoglycemia. • **Time in range (TIR)**: percent of readings and time measured glucose values fall within the specified target range (e.g., 70 to 180 mg/dL [3.9 to 10 mmol/L]).[36] TIR may be expressed as a percentage of time or in hours per day.[40] o Aim for a TIR of 70% (correlates with an A1c of ~7%) for most patients.[36] o Aim for a TIR of 50% (correlates with an A1c of about 8%) for older or high-risk patients.[36] • **Time above range (TAR)**: percent of readings and time measured glucose values are above 180 mg/dL (10 mmol/L).[36] Aim for less than 25% (six hours) for most patients or <50% for older or high-risk patients.[26] o level one hyperglycemia: TAR with glucose values between 181 and 250 mg/dL (10.1 to 13.9 mmol/L)[36] o level two hyperglycemia: TAR with glucose values above 250 mg/dL (13.9 mmol/L).[36] Aim for less than 5% (72 minutes) for most patients or consider a goal of less than 10% for older or high-risk patients.[26]

Question	Answer/Pertinent Information
	• **Time below range (TBR)**: percent of readings and time measured glucose values fall below 70 mg/dL (3.9 mmol/L).[36] Aim for less than 4% (~1 hour) for most patients or less than 1% for older or high-risk patients.[26] o level one hypoglycemia: TBR with glucose values between 54 and 69 mg/dL (3 to 3.8 mmol/L).[36] o level two hypoglycemia: TBR with glucose values below 54 mg/dL (3 mmol/L).[34] Aim for less than 1% (14 minutes) for most patients and to avoid completely for older or high-risk patients.[26] o **TBR** may be especially useful for patients who are at their goal A1c, but experience frequent low readings.[40] For example, changes in therapy may be needed for a patient who has an A1c of 6.8%, but who has hypoglycemia 10% of the time. However, changes in therapy may NOT be needed for a patient who has an A1c of 6.8%, but who only has hypoglycemia 1% of the time.[39] • You can view an **example of a standardized CGM report** (e.g., Ambulatory Glucose Profile) at https://care.diabetesjournals.org/content/diacare/42/8/1593/F2.large.jpg.
Does continuous glucose monitoring have a role in **hospitalized patients**?	• Patients can continue using CGM in the hospital if the hospital has resources, trained personnel, and policies to support it.[41] o Fingersticks should be used to guide insulin dosing, and to confirm hypoglycemia.[41] • CGM seems superior to periodic fingersticks for identifying hypoglycemia in the hospital.[41] • In patients with COVID-19, CGM can reduce staff exposure and use of personal protective equipment.[41] o For information on Dexcom use in the hospital, see https://www.dexcom.com/hospitalcovid-19.
What **billing codes** should be used with continuous glucose monitors?	• In the US, use the following billing codes when working with CGMs:[20,42] o **Professional CGM: 95250** (e.g., placement, download) ▪ Can be completed by a physician, nurse practitioner or other supervised personnel if it is within their scope of practice. o **Personal CGM: 95249** (e.g., sensor placement, hook-up, calibration, patient training, print-out) ▪ Can be completed by a physician, physician assistant, nurse practitioner, pharmacist, or other personnel if it is within their scope of practice. o **Interpretation of CGM data: 95251** (personal or professional CGM) ▪ Can be completed by a physician, physician assistant, nurse practitioner, or pharmacist with collaborative practice agreement and co-signature. ▪ Can only be used one time/month per patient.

Abbreviations: AIT = advanced imaging technology body scanner; CGM = continuous glucose monitors; CT = computed tomography; d = day; ft = feet; FSA = flexible savings account; h = hour; HAS = health savings account; IV = intravenous; min = minute; MRI = magnetic resonance imaging; RCT = randomized controlled trial; SC = subcutaneously

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