KAISER PERMANENTE®

Kaiser Foundation Health Plan of Washington

Clinical Review Criteria
Continuous Glucose Monitor (CGM)

The Libre Free Style is not on the formulary for continuous glucose monitors for KPWA commercial members and will not be covered at this time.

Criteria

For Medicare Members

Source	Policy
CMS Coverage Manuals	None
National Coverage Determinations (NCD)	NCD for Closed-Loop Blood Glucose Control Device (CBGCD) NCD 40.3.
Local Coverage Determinations (LCD)	LCD for Glucose Monitors (L33822)
Local Coverage Article	Coding and Coverage - Therapeutic Continuous Glucose Monitors (CGM)

For Commercial Members

Kaiser Permanente has elected to use the Continuous Glucose Monitor (KP-0126) MCG* for medical necessity determinations.

> **MCG* are proprietary and cannot be published and/or distributed**. However, on an individual member basis, Kaiser Permanente can share a copy of the specific criteria document used to make a utilization management decision. If one of your patients is being reviewed for heart transplant eligibility, you may request a copy of the criteria by calling the Kaiser Permanente Clinical Review staff at 1-800-289-1363.

If requesting this service, please send the following documentation to support medical necessity:

- Last 6 months of clinical notes from requesting provider &/or specialist (endocrinology, primary care)
- Last 6 months of lab work
- Last 3 months of home monitoring logs

ORDER FORM

Request for Approval of Patient-Use Continuous Glucose Monitoring System (CGMS)

> The following information was used in the development of this document and is provided as background only. It is provided for historical purposes and does not necessarily reflect the most current published literature. When significant new articles are published that impact treatment option, KPWA will review as needed. This information is not to be used as coverage criteria. Please only refer to the criteria listed above for coverage determinations.

Background

Diabetes mellitus is one of the leading causes of death in the United States. If poorly controlled, it causes accelerated both large and small artery diseases that predispose patients to a number of late secondary complications including heart disease, stroke, renal, disease, peripheral vascular disease, retinal damage, peripheral nerve damage, and others. Management of diabetes involves maintaining blood glucose levels close to the normal range. Currently, self-monitoring of capillary blood glucose (SMBG), and laboratory testing of HbA1c, to measure longer term glycemic control, are the standard methods for glucose testing. Blood glucose values are influenced by a number of changing variables, including food choices and portions, stress, insulin doses, physical

Back to Top

activity, and rate of nutrient absorption. SMBG is important for monitoring and treating fluctuations in blood glucose level, but it provides only a snapshot of glucose status at a given moment, and even compliant diabetics do not do perform it frequently enough to identify all the fluctuations in the blood glucose level, especially those that occur at night (Evert 2009).

In hopes of gaining a more complete picture of blood glucose level, researches have thus developed technologies for monitoring blood glucose concentrations on a continuous basis. Among these are the continuous glucose monitoring systems (CGMS) which are capable of monitoring interstitial glucose levels every 1-5 minutes. These systems consist of a small needle which is inserted in the abdominal subcutaneous fat. On the tip of the needle there is a glucose sensor that measures the glucose levels in the fluid surrounding the fatty tissue. There are two types of CGMS: retrospective systems and real-time systems. Both systems measure glucose concentration during a certain time span; however, these systems differ with regards to when the information is accessed. With the retrospective system data is stored in a monitor to be downloaded for later use while the real-time system continuously provides the actual glucose concentration on a display. It is thought that CGMS may help diabetic patients reach a near normal blood glucose pattern, assist in preventing hypoglycemic events, reduce emergency room visits, and decrease long-term complications by improving glycemic control (Cemeroglu 2010, Chetty 2008, De Block 2008, Girardin 2009, Langendam 2012).

Early generations of CGMS e.g. the GlucoWatch Biographer, and the physician use device MiniMed Continuous Glucose Monitoring System were uncomfortable and difficult to use. In addition, their results could only be determined in a physician's office and when graphed provided useful, but retrospective information about within- and between-day blood glucose variations and the frequency of unrecognized hypoglycemia. When compared with venous plasma glucose values, the interstitial fluid glucose sensor yielded lower values when blood glucose concentrations were rapidly rising. More recent devices were developed to overcome some of the earlier limitations, and several products that provide real-time information on glucose levels to patients rather than requiring data download in a providers' office are now available. These newer systems, however, still measure glucose in the interstitial space, and it takes time for interstitial glucose to achieve equilibrium with blood glucose (Reach, 2008, Cox 2009).

All continuous glucose monitoring devices consist of the same basic components: 1. A disposable short-term glucose sensor (a fine wire about the diameter of two hairs) which is placed under the skin and is worn for 3-7 days depending on the system (3 days for Guardian RT, 5 days for FreeStyle Navigator, or 7 days for DexCom Seven), 2. A reusable transmitter that is wirelessly attached to the sensor and conveys data to a receiver within a 5-10 foot range of the sensor, and 3. A pager-size receiver that displays current glucose values and recent trends. The receiver can be worn on the belt or carried in a pocket or purse. The process is very fast with measurements made every 10 seconds and then aggregated to give a value on the glucose monitor every 1-5 minute. High and low glucose value thresholds can be customized for individual patients and fed into the system. When these thresholds are exceeded, an alarm will sound. The receiver displays directional arrows to show the rate of change in glucose levels, allowing the patient to predict and possibly prevent hypoglycemic episodes. CGMS can be used continuously, as long as the sensors are replaced according to manufacturer recommendations. Continuous readings over a 24-hour period for up to seven days allow the user to detect variations and identify trends. Patients must initialize and calibrate the system whenever a new glucose sensor is inserted. They also need to calibrate it every 8-12 hours and before adjusting insulin therapy (Peters 2009).

Continuous glucose monitors are intended to be used as an adjunct, not a replacement, for self-monitoring of blood glucose. They should not be used to make therapeutic decisions; any readings that indicate hypo-or hyperglycemia events must be verified by SMBG before taking action. CGM systems have several limitations including:

1. They are not suitable for use by all patients and those who are likely to benefit from them are the motivated patients who know the importance of strict metabolic control, participate in the care of their diabetes, and are able to use the technology. Those who have poor control because of reluctance to perform SMBG would not comply with CGMS and will not benefit from its use.
2. Patients need to learn how to use the large amount of data generated by the real-time CGMS.
3. The patients also need to be aware of the limitations of the systems as regards the lag time and calibration issues, and check with a standard blood glucose meter before making medication adjustments. They also need to understand the time of onset and peak of their insulin so that they make appropriate adjustments.
4. The insertion of the sensor under the skin is at times painful, and if it fails to calibrate another one has to be placed. Moreover, it needs to be firmly attached to the skin using tape, which may cause skin irritation or infection, and may become loose especially with sweating and exercise.
5. The functional operability of CGMS is limited to 2-7 days which might not be sufficient to detect recurrent glycemic patterns throughout the day or night.

 Back to Top

6. Providers will have to find ways to incorporate the technology into their already busy clinical practice (De Block 2008, Hrabchak 2010, Ives 2010).

As of the current review the FDA-approved CGM real-time systems include:

- Medtronic Guardian Real Time Glucose Monitoring System that records glucose values for up to 3 days.
- Medtronic MiniMed Paradigm Real-Time System which integrates real-time CGM with an insulin delivery device and records glucose values for up to 3 days.
- DexCom SEVEN PLUS records glucose values for up to 7 days.
- Abbott FreeStyle Navigator provides continuous measurement for up to 5 days.
- The iPro Continuous Glucose Monitor (Medtronic, Inc) used only by the health provider and provides an average blood sugar measurement every 5 minutes for 3 days at a time.

The SEVEN PLUS and the FreeStyle Navigator are FDA approved for adults only. Pediatric versions of MiniMed Paradigm and Guardian systems are approved for use in patients 7-17 years. All systems require a prescription.

Medical Technology Assessment Committee (MTAC)

Continuous Glucose Monitoring

06/07/2001: MTAC REVIEW

Evidence Conclusion: The published evidence is insufficient to draw conclusions about the effect of continuous glucose monitoring on health outcomes. According to MiniMed, a multicenter outcome study is underway.
Articles: The literature search yielded 20 articles. Excluding review articles and opinion pieces, articles on other types of glucose monitoring or other aspects of diabetes control, there were two empirical articles, both of which were case series. One article had a sample size of 11 children and the other had a sample size of 9 adults. Due to the small sample sizes, evidence tables were not created.

Continuous Glucose Monitoring for the management of unstable diabetes is approved by the FDA, but does not meet the *Kaiser Permanente Medical Technology Assessment Criteria.*

02/11/2004: MTAC REVIEW

Continuous Glucose Monitoring

Evidence Conclusion: *Pediatric population* - Three studies with the pediatric population were reviewed. The DirecNet study, a relatively large study with nearly 100 patients, evaluated the accuracy of the CGMS in children during a 24-hour hospital stay. It did not specifically include children with diabetes management problems. The authors found a relatively low accuracy. According to Clarke error grid, 61% of the decisions using the CGMS would lead to clinically correct treatment decisions (Zone A). Newer modified sensors appeared to be more accurate (78% of measurements were in Zone A compared to 58% with older original sensors). The newer sensors were also more reliable than the original sensors, but measurement taken by two new sensors differed from one another by more than 20% about one-fourth of the time. The Ludviggson study, a randomized cross-over design, focused on changes in HbA1c during three months with the benefit of data from the CGMS and three months without CGMS data. Eligibility included an initial HbA1c ³6.8%. When each time period was examined separately, there was not a statistically significant benefit from having CGMS data available. When data from both periods were combined, there was a significant decrease in mean HbA1c in the study arm using CGMS data, but not the other arm. The authors did not compare the change in HbA1c in the arm using CGMS data versus the other arm and had several threats to validity including lack of a wash-out period. The Kaufman study included patients with glucose management problems. The study found that data from the CGMS leads to changes in the recommendation for patient management. However, the authors did not discuss the impact of these changes on health outcomes. In summary, the limited evidence suggests that the accuracy of the CGMS in children may not be sufficiently high. The evidence is insufficient to determine the effect of continuous glucose monitoring on improving health outcomes. *Adult population* - There is less published empirical evidence in the adult population and no high-quality studies on accuracy. The best available study (Yogev) was on pregnant women with type 1 diabetes (not on patients with uncontrolled diabetes). In this sample, continuous glucose monitoring detected hyperglycemia that was not detected by self-blood glucose monitoring in all 34 patients and nocturnal hypoglycemia in 26 (76%) patients. Recommendations to change insulin treatment were made for 24 out of the 34 (70%) patients. However, the authors did not present data on how the change in recommendations affected maternal or neonatal outcomes.
Articles: The Medline search yielded 52 articles, some of which were reviews or opinion pieces, were on technical aspects of glucose monitoring or had outcomes unrelated to the accuracy of the glucose monitor e.g. changes in blood glucose with a low glycemic diet. *Pediatric population* - The search yielded 5 empirical articles. One had a sample size of only 9 patients (Caplin, 2003). Another was a case series with 28 patients and appeared to be relatively weak methodologically (e.g. only included 28 out of the 44 children who used the monitor in the analysis,

 Back to Top

did not discuss management changes following use of the monitor) (Salardi, 2002). The remaining 3 studies, one of which was a randomized cross-over trial, were critically appraised: Diabetes Research in Children Network (DirecNet) Study Group. The accuracy of the CGMS in children with type 1 diabetes: Results of the diabetes research in children network (DirecNet) accuracy study. Diabetes Technol Ther 2003; 5: 781-789. See Evidence Table. Kaufman FR, Gibson LC, Halvorson M. A pilot study of the continuous glucose monitoring system. Diabetes Care 2001; 24: 2030-2034. See Evidence Table. Ludvigsson J, Hanas R. Continuous subcutaneous glucose monitoring improved metabolic control in pediatric patients with type 1 diabetes; A controlled crossover study. Pediatrics 2003; 111: 933-938. See Evidence Table. *Adult population* - The search yielded 4 empirical articles. One was specifically on diabetic patients needing dialysis and included only 8 patients. Two other studies each included only 18 patients. The remaining study, which studied pregnant women with type 1 diabetes, was critically appraised: Yogev Y, Chen R, Ben-Haroush A. Continuous glucose monitoring for the evaluation of gravid women with type 1 diabetes mellitus. Obstet Gynecol 2003; 101: 633-638. See Evidence Table.

The use of continuous glucose monitoring in the management of diabetes does not meet the *Kaiser Permanente Medical Technology Assessment Criteria.*

08/30/2005: MTAC REVIEW
Continuous Glucose Monitoring
Evidence Conclusion: The new studies published after our last review of 2/11/2004 were evaluated. There was only one RCT with just over 100 patients (Tanenberg 2004), that compared the hemoglobin A1c values between patients who used the CGMS to those who underwent self-monitoring. The difference between the two groups in the HBA1c was not statistically significant.
Articles: Tanenberg R, Bode B, Lane W et al. Use of the continuous glucose monitoring system to guide therapy in patients with insulin-treated diabetes: A randomized controlled trial. Mayo Clin Proc 2004; 79: 1521-1526. See Evidence Table.

The use of continuous glucose monitoring in the management of diabetes does not meet the *Kaiser Permanente Medical Technology Assessment Criteria.*

08/07/2006: MTAC REVIEW
Continuous Glucose Monitoring
Evidence Conclusion: There are no published studies to date that evaluate the impact of real-time glucose monitor use on diabetic complications. There are also no published studies evaluating the accuracy or effectiveness of the Medtronic Minimed Guardian RT device, or the consistency of measurements of either the Guardian RT or DexCom STS when multiple devices are worn. One published empirical study on the DexCom STS system was identified. The study evaluated both device accuracy compared to self-monitoring of glucose measurements and impact on short-term glycemic control. In 47 patients, 95% of paired sensor-home monitoring data points over nine days were in Clarke error grid regions A (clinically accurate) or B (acceptable). In addition, compared to a control group (n=44) that used devices but did not receive display information, there was a statistically significant improvement in glycemic control (more time in target glucose range, less time in hypoglycemic and hyperglycemic ranges). Conclusions cannot be drawn about the intermediate or long-term impact of the DexCom STS on glycemic control-- patients were only followed during the nine days devices were worn. Another remaining issue is the 15-30-minute lag time between interstitial glucose readings and blood glucose levels when the blood glucose is rising or falling quickly.
Articles: No published empirical studies evaluating the Guardian RT were identified. One published empirical study on the subcutaneous DexCom STS was identified. This was a randomized controlled trial with 91 patients and was critically appraised: Garg S et al. Improvement in glycemic excursions with a transcutaneous, real-time continuous glucose sensor. Diabetes Care 2006; 29: 44-50. See Evidence Table.

The use of continuous glucose monitoring in the management of diabetes does not meet the *Kaiser Permanente Medical Technology Assessment Criteria.*

08/04/2008: MTAC REVIEW
Continuous Glucose Monitoring
Evidence Conclusion: *Accuracy/Reliability* the Garg et al. (2006) study, previously reviewed by MTAC, found that the DexCom STS device was reasonably accurate compared to self-monitoring of blood glucose. >95% of 6,767 paired sensor-SMBG data points were in Clarke error grid regions A or B (clinically accurate or acceptable, respectively). An issue identified was the 15-30-minute lag time between interstitial glucose readings and blood glucose levels when the blood glucose is rising or falling quickly. Weinstein et al. (2007) also found >95% of paired sensor-venous blood sample data points were in Clarke error grid regions A or B when the FreeStyle Navigator

 Back to Top

was tested in an inpatient setting in adults. A smaller study of the FreeStyle Navigator in children (Wilson et al., 2007) identified a lag time, with Navigator readings lagging behind reference values during times of rapid rates of change in glucose levels. Impact: There is insufficient evidence on the impact of real-time continuous glucose monitor use on diabetic complications, hospitalizations and ER visits. There is fair evidence from one RCT (Deiss et al., 2006) that there are greater improvements in HbA1C levels of children and adults when a Guardian RT is worn continuously, but not intermittently, compared to self-monitoring of blood glucose. Limitations of the RCT were that it was sponsored by Medtronic, the device manufacturer, and the process for using glucose monitor data to make changes to patient treatment was not well described. There is insufficient evidence that other commercially available real-time continuous glucose monitors, the DexCom STS or Seven, and the Abbott FreeStyle Navigator, impact glycemic control. Only case series were available. A series of 140 patients (Bailey et al., 2007) found a significant reduction in HbA1c level after 12 weeks of continuous glucose monitoring with the DexCom STS. Significant reductions in HbA1c over 13 weeks were also found in small case series with children who were managed with the FreeStyle Navigator. The available evidence is insufficient to evaluate the impact of real-time continuous glucose monitors on detection of hypoglycemic episodes, larger sample sizes and longer follow-up are required.
Articles: No published empirical studies evaluating the Guardian RT were identified. One published empirical study on the subcutaneous DexCom STS was identified. This was a randomized controlled trial with 91 patients and was critically appraised: Garg S et al. Improvement in glycemic excursions with a transcutaneous, real-time continuous glucose sensor. Diabetes Care 2006; 29: 44-50. See Evidence Table.

The use of continuous glucose monitoring in the management of diabetes does not meet the *Kaiser Permanente Medical Technology Assessment Criteria.*

06/21/2010: MTAC REVIEW
Continuous Glucose Monitoring
Evidence Conclusion*:* The CGMS technology was previously reviewed by MTAC for several times between 2001 and 2008 and did not pass the diagnostic test evaluation criteria due to the lack of evidence on the impact of any of the commercially available devices on health outcomes as diabetic complications, hospitalization, and ER visits. The 2006 MTAC review on real-time monitors concluded that DexCom system was reasonably accurate. An issue identified was the 15-30-minute lag time between interstitial glucose readings and blood glucose levels when the blood glucose is rising or falling quickly. Impact of CGMS on health outcomes: To date the best available evidence on the effects of CGMS on health outcomes in patients with diabetes uses HbA1c as a surrogate outcome. Several studies also evaluated the level of duration hyperglycemia and hypoglycemic events. The 2006 review concluded, “There is fair evidence from one trial (Garg 2006) that patients managed using the DexCom system, spent more time in target glucose range and less time in hypoglycemic and hyperglycemic ranges over the 9-day study period, when compared to those managed without CGMS. An issue identified was the 15-30-minute lag time between interstitial glucose readings and blood glucose levels when the blood glucose is rising or falling quickly”. The 2008 re-review of real time CGMS conclusion was: “There is fair evidence from one RCT (Deiss et al, 2006) sponsored by Medtronic the device manufacturer, that there are greater improvements in HbA1c levels of children and adults when a Guardian RT is worn continuously, but not intermittently, compared to self-monitoring of blood glucose”. The recent Juvenile Diabetes Research Foundation Continuous Glucose Monitoring (JDRF CGM) study (2008) was a RCT that evaluated the use of CGM in the management of type 1 diabetes. The study randomized 322 adults and children receiving treatment for type 1 diabetes to a group with continuous glucose monitoring (using DexCom Seven, FreeStyle Navigator, or Mini Med Paradigm Real-Time systems) or a control group performing blood glucose self-monitoring. The participants were stratified into three age groups and the primary outcome was change in HbA1c level at 26 weeks. The results of the trial showed that adults with type1 diabetes achieved significantly better HbA1c levels with 6 months of real-time CGM use than with point-in-time self-monitoring of blood glucose. This improved control was associated with fewer episodes of hypoglycemia. The observed change in HbA1c in the two study groups varied markedly according to age group with a statistically significant difference among patients 25 years of age or older favoring CGM use. There was a smaller nonsignificant benefit for patients in the 15-24 years age group, and no benefit for those in the age group 8-14 years. The results of the study however, may have limited generalizability as it included highly selected group of patients who tested their blood sugar levels six times a day, were able to log their data, and the majority were on insulin pumps. In addition, during the trial the participants had access to top diabetic educators and were provided with complex algorithms for adjusting their insulin doses. Adherence to sensor use may be much lower outside the investigational setting. Moreover, the study used three different CGMS which have variable accuracies, performance and reproducibility. *Conclusion:* There is insufficient evidence to determine the accuracy and reliability of the 7-day continuous glucose monitoring systems. There is fair evidence that the use of CGMSs including the 7 day is associated with a significant reduction in HbA1c levels among highly selected motivated 25 years of age or older patients with type 1 diabetes. There is insufficient evidence to determine whether use of the

 Back to Top

7-day real-time continuous glucose monitoring systems leads to better patient-oriented health outcomes (e.g. hospitalizations, ER visits, and microvascular and macro vascular diabetic complications).
Long-term studies are needed to confirm the potential benefits of CGMS in preventing hypo-and hyperglycemic episode, improving the patient's quality of life and potentially reducing the likelihood of complications that may develop.
Articles: Accuracy/Reliability of CGMS: The literature search revealed the STAR 1 trial (2008) evaluating the MiniMed Paradigm Real-Time System which is sensor augmented insulin pump, the Real Trend study (2009) on the Medtronic MiniMed Paradigm Real-Time System, the MITRE trial (2009) that used the MiniMed CGMS and GlucoWatch which is no longer available commercially and a small study (N=14) by Garg and colleagues (2010) that compared the SEVEN and FreeStyle Navigator CGMS, as well as a meta-analysis of studies published up to March 2007. Impact of CGMS on health outcomes:
The ideal study would be a randomized trial comparing health outcomes in patients managed using a real-time CGMS compared to standard self-monitoring. The literature search did not identify any published RCTs that evaluated the impact of CGMS on hospitalizations, ER visits, microvascular or microvascular diabetic complications. There was a relatively large trial by the Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Group (2008) that used change in the HbA1c as a surrogate outcome for diabetes control. This study was selected for critical appraisal. The Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Group. Tamborlane WV, Beck RW, Bode BW, et al. Continuous glucose monitoring and intensive treatment of type 1 diabetes. N Engl J Med 2008;359:1464176 See Evidence Table.

The use of continuous glucose monitoring in the management of diabetes does not meet the *Kaiser Permanente Medical Technology Assessment Criteria.*

08/20/2012: MTAC REVIEW
Continuous Glucose Monitoring
Evidence Conclusion*:* Results from a recent meta-analysis that included 22 RCTs and evaluated the effects of CGMS compared to SMBG found that there was limited evidence on the efficacy of CGMS in children, adolescents, and adults with type 1 diabetes. The mean difference in HbA1c using real-time CGMS compared to SMBG was -0.2% after 6 months of follow-up (Langendam 2012). A recent RCT followed 176 subjects for 12 months to assess the effects of two modes of continuous glucose monitoring (patient led, and physician driven) compared with SMBG in patients with poorly controlled type 1 diabetes. Results from this study suggest that both patient led, and physician delivered CGM resulted in significantly greater reduction in HbA1c compared to SMBG [patient led (-0.50%); physician delivered (-0.45%), SMBG (0.02%)] (Riveline 2012). A recent observational study that included 19 subjects compared the accuracy of multiple glucose sensors worn simultaneously with the accuracy of a single sensor. Results from this study suggest that the use of multiple sensors decreased large (25% above or below the reference blood glucose value) and very large errors (at least 50% above or below the reference blood glucose value) and improve overall accuracy (Castle 2012).

Sensor errors by degree of error and venous blood glucose value (Castle 2012)

			<10%	10 to 24%	25 to 50%	>50%
<70 mg/dL	Single	N=156	26.9%	38.5%	29.5%	5.1%
	Avg of 2	N=58	41.0%	33.3%	21.8%	3.8%
	Avg of 4	N=39	38.5%	38.5%	19.9%	5.1%
70–180 mg/dL	Single	N=2,938	41.9%	38.0%	17.1%	3.1%
	Avg of 2	N=1,478	46.5%	37.9%	14.3%	1.3%
	Avg of 4	N=739	50.6%	37.6%	11.2%	0.5%
>180 mg/dL	Single	N=2,000	46.6%	39.3%	12.6%	1.6%
	Avg of 2	N=1,012	48.3%	42.7%	8.5%	0.5%
	Avg of 4	N=506	54.0%	39.3%	6.5%	0.2%

Children: A recent RCT assessed the benefits of CGM with SMBG compared to SMBG alone in 146 children aged 4 to 9 years with type 1 diabetes. The mean change in HbA1c was -0.1% in both groups. Results from this study suggest that CGM does not reduce HbA1c in children aged 4 to 9 years old (Mauras 2012).
*Conclusion***:** For CGM to be considered a useful technology, it needs to be accurate, reliable, and reproducible for reflecting a patient's plasma glucose values, especially in the lower glucose range to help avoid hypoglycemia and allow patients to achieve lower HbA1c with less hypoglycemia. However, current data do not allow this conclusion. Even when taking the average of four sensors worn simultaneously (an impractical approach for everyday use) results vary from the true plasma glucose value by 25 – 50% almost 20% of the time when patients true blood glucose values were less than 70 mg/dL. Additionally, most studies show no or only trivial improvement in HbA1c, that is not sustained overtime. Results from current data suggest that it is unlikely that everyday use of CGM will result in decreased hypoglycemia or lower HbA1c.

 Back to Top

Articles: No studies were identified that addressed patient-oriented health outcomes. Several meta-analyses and three randomized controlled trials (RCTs) published after the meta-analyses were identified that addressed the effects of CGMS on glycemic control. The most recent meta-analysis, two RCTs, and an observational study published after the meta-analysis were selected for review. The other RCT was not selected for review due to methodological limitations (i.e., not stated if an intent-to-treat analysis was performed, power was not assessed, and baseline characteristic were not similar). The following studies were selected for critical appraisal: Langendam MW, Luijf YM, Hooft L, Devries JH, Mudde AH, Scholten RJ. Continuous glucose monitoring systems for type 1 diabetes mellitus. *Cochrane Database Syst Rev.* 2012;1:CD008101. See Evidence Table Riveline JP, Schaepelynck P, Chaillous L, et al. Assessment of patient-led or physician-driven continuous glucose monitoring in patients with poorly controlled type 1 diabetes using basal-bolus insulin regimens: a 1-year multicenter study. *Diabetes Care.* 2012;35:965-971. See Evidence Table**.** Castle JR, Pitts A, Hanavan K, et al. The accuracy benefit of multiple amperometric glucose sensors in people with type 1 diabetes. *Diabetes Care.* 2012;35:706-710. See Evidence Table. Mauras N, Beck R, Xing D, et al. A randomized clinical trial to assess the efficacy and safety of real-time continuous glucose monitoring in the management of type 1 diabetes in young children aged 4 to <10 years. *Diabetes Care.* 2012;35:204-210. See Evidence Table

The use of continuous glucose monitoring in the diagnosis of diabetes does not meet the *Kaiser Permanente Medical Technology Assessment Criteria.*

03/20/2017: MTAC REVIEW
Continuous Glucose Monitoring
Evidence Conclusion:

CGM with the use of multiple daily insulin injection A randomized controlled trial (Beck et al., 2017) (evidence table 1) assessed the effect of CGM on HbA1c. 105 patients using multiple injection of insulin daily were randomized to CGM and 53 patients were randomized to control (home based blood glucose monitoring). Patients' age ranged from 26 to 73 years with HbA1c between 7 to 9.9%. Follow-up was 6 months. The authors reported a greater improvement in HbA1c with the use of CGM with high satisfaction on the short-term.

An open-label crossover randomized controlled trial (Lind et al., 2017) (evidence table 2) evaluated the effects of CGM in adults with type 1 diabetes with multiple daily insulin injections. 142 patients were randomized to either CGM or conventional therapy (self-monitoring of blood glucose). The mean age was 44.6 years; the sample was predominantly male (56.3%) with a mean HbA1c of 8.7% and diabetes lasted 22.2 years in average. Follow-up was 26 weeks. The authors reported that the use of CGM led to a reduction of HbA1c, glycemic variation, and severe hypoglycemia compared to conventional therapy. Similarly, improvements in satisfaction and well-being favored CGM over conventional therapy.

CGM with the use of insulin pumps A meta-analysis (Benkhadra et al., 2016) (evidence table 3) of 11 RCTs found that CGM reduced HbA1c in patients with T1DM especially in patients >15 years old. The authors found no statistically significant difference in time spent in hypoglycemia.

HbA1c - Strength of evidence (SOE)

Study	Precision	Directness	Consistency	Risk of bias	SOE
Beck et al., 2017	precise	direct	N/A	Moderate	Moderate
Lind et al., 2017)	precise	direct	N/A	Low	High
Benkhadra et al., 2016)	precise	direct	unknown	Moderate	Moderate

Other studies

	Characteristics	Outcomes	Risk of bias
(Gu et al., 2017) RCT, open label	Hospitalized Adults 18-65 years; 40 CGM (pump) vs. 41 MDI with blinded CGM in T2DM patients requiring insulin Follow-up: 2 weeks HbA1c>8%	**Time to target glucose:** 3.7 ± 1.1 vs 6.3 ± 3.1 days **P<0.001**; **CGM group reached target glucose 2.6 days quicker than the MDI group** 53% vs. 15% reached target within 3 days; Within 14 days, 7% in the MDI group did not reach target	**High risk of bias** No ITT, Blinding of patients: no Blinding of assessors: no Allocation concealment: not specified

 Back to Top

	Glycemic targets: Three pre-prandial measurements between 80 and 130mg/dL (4.4 and 7.2mmol/L) and three 2-h postprandial measurements between 80 and 180mg/dL (4.4 and 10.0mmol/L) within the same day.	**Glycemic variability:** hypoglycemia (<50mg/dL): 0.04% vs 0.32%, **P<0.05** Hyperglycemia (glucose>180mg/dL): 21.56% vs 35.03%, **P<0.05.**	Sequence generation: not specified Missing data: not specified Power Analysis: not specified Completeness of follow up:70%
(van Beers et al., 2016) RCT, open label, crossover trial	52 patients, high risk population, T1DM, age 18-75 years, treated with insulin pump or MDI and controlling glucose with SMBG ≥3 times a day 26 CGM-SMBG sequence vs. 26 SMBG-CGM sequence; intervention provided for 16 weeks	Time spent in normoglycemia (4-10 mmol/L): mean difference 9·6%, 95% CI 8·0-11·2; p<0·0001 **(time spent in noromoglycemia was higher during CGM)** time spent in hypoglycemia (≤3·9 mmol/L): mean difference 4·7%, 3·4-5·9; p<0·0001 **(time in hypoglycemia was reduced during CGM)** time spent in hyperglycemia (>10 mmol/L): mean difference 5·0%, 3·1-6·9; p<0·0001 **(reduction in time spent in hyperglycemia during CGM)** number of severe hypoglycemic events: 14 events during CGM vs 34 events, p=0·033 **(lower number of severe hypoglycemic events)** Adverse events: not related to interventions	Moderate Risk of bias ITT: was done Blinding of patients: no Blinding of assessors: no Allocation concealment & Sequence generation: computer generated, block size of four Missing data: controlled for Power Analysis: power of 80% Completeness of follow up: high

Conclusion:

- Moderate evidence shows that the Continuous Glucose Monitoring system with the use of multiple daily insulin injection may be more effective in HbA1c and glycemic variability in adults with type 1 Diabetes Mellitus than self-monitoring blood glucose on the short term; no major adverse events were reported
- Moderate evidence shows that continuous Glucose Monitoring with the use of insulin pump may be more effective on HbA1c in adults with T1DM than self-monitoring blood glucose on the short term; no statistically significant difference in time spent in hypoglycemia was found
- In patients with T2DM, Hayes conclusion can be adopted: there is conflicting evidence concerning efficacy
- The technology is safe. Studies with longer follow-up are warranted.

Articles: Beck, R. W., Riddlesworth, T., Ruedy, K., Ahmann, A., Bergenstal, R., Haller, S., Polonsky, W. (2017). Effect of Continuous Glucose Monitoring on Glycemic Control in Adults with Type 1 Diabetes Using Insulin Injections: The DIAMOND Randomized Clinical Trial. JAMA, 317(4), 371-378. Benkhadra, K., Alahdab, F., Tamhane, S., Wang, Z., Prokop, L. J., Hirsch, I. B., Murad, M. H. (2016). Real Time Continuous Glucose Monitoring in type 1 diabetes: A Systematic review and Individual Patient Data Meta-Analysis. Clinical Endocrinology. Gu, W., Liu, Y., Chen, Y., Deng, W., Ran, X., Chen, L. Mu, Y. (2017). Multicentre randomized controlled trial with sensor-augmented pump vs multiple daily injections in hospitalized patients with type 2 diabetes in China: Time to reach target glucose. Diabetes Metab. doi:10.1016/j.diabet.2016.12.009
Lind, M., Polonsky, W., Hirsch, I. B., Heise, T., Bolinder, J., Dahlqvist, S., Wedel, H. (2017). Continuous Glucose Monitoring vs Conventional Therapy for Glycemic Control in Adults with Type 1 Diabetes Treated with Multiple Daily Insulin Injections: The GOLD Randomized Clinical Trial. JAMA, 317(4), 379-387. van Beers, C. A., DeVries, J. H., Kleijer, S. J., Smits, M. M., Geelhoed-Duijvestijn, P. H., Kramer, M. H., . . . Serne, E. H. (2016). Continuous glucose monitoring for patients with type 1 diabetes and impaired awareness of hypoglycaemia (IN CONTROL): a randomised, open-label, crossover trial. Lancet Diabetes Endocrinol, 4(11), 893-902. doi:10.1016/s2213 8587(16)30193-0.

Date Created	Date Reviewed	Date Last Revised
06/07/2001	07/06/2010[MDCRPC],04/05/2011[MDCRPC],07/05/2011[MDCRPC],05/01/2012[MDCRPC], 09/04/2012[MDCRPC],07/02/2013[MDCRPC],08/06/2013[MPC],12/03/2013[MPC],10/07/2014[MPC],11/07/2014[MPC], 08/04/2015[MPC], 06/07/2016[MPC], , 04/04/2017[MPC], 02/06/2018[MPC], 01/08/2019[MPC]	08/27/2018

[MDCRPC] Medical Director Clinical Review and Policy Committee
[MPC] Medical Policy Committee

Revision History	Description
08/04/2015	• Removal of with a negative C peptide an indication

 Back to Top

	• "Criteria for current users and for annual evaluation" was changed to "For ongoing approvals of supplies and/or replacement of current CGM"
04/03/2018	MPC approved to revise indication to criteria: *Patient is motivated, and has monitored and documented blood glucose 4 or more times per day for 2 months (change to 1 month)*
08/27/2018	Added Free Style Libre non-coverage language
09/13/2018	Removed Medicare from the Free Style Libre language

Codes

CPT: 95250, 95251, 95249
HCPCS: A9276, A9277, A9278, S1030, S1031, 0446T, 0447T, 0448T
Medicare HCPCS: K0553, K0554

Back to Top