CONTINUOUS GLUCOSE MONITORING AND INSULIN DELIVERY FOR MANAGING DIABETES

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Related Policies:

- DME, Orthotics, Ostomy Supplies, Medical Supplies, and Repairs/Replacement
- Intermittent Intravenous Insulin Therapy

INSTRUCTIONS FOR USE

This Medical Policy provides assistance in interpreting UnitedHealthcare benefit plans. When deciding coverage, the enrollee specific document must be referenced. The terms of an enrollee's document (e.g., Certificate of Coverage (COC) or Summary Plan Description (SPD) and Medicaid State Contracts) may differ greatly from the standard benefit plans upon which this Medical Policy is based. In the event of a conflict, the enrollee's specific benefit document supersedes this Medical Policy. All reviewers must first identify enrollee eligibility, any federal or state regulatory requirements and the enrollee specific plan benefit coverage prior to use of this Medical Policy. Other Policies and Coverage Determination Guidelines may apply. UnitedHealthcare reserves the right, in its sole discretion, to modify its Policies and Guidelines as necessary. This Medical Policy is provided for informational purposes. It does not constitute medical advice.

UnitedHealthcare may also use tools developed by third parties, such as the MCG™ Care Guidelines, to assist us in administering health benefits. The MCG™ Care Guidelines are intended to be used in connection with the independent professional medical judgment of a qualified health care provider and do not constitute the practice of medicine or medical advice.

BENEFIT CONSIDERATIONS

Essential Health Benefits for Individual and Small Group:
For plan years beginning on or after January 1, 2014, the Affordable Care Act of 2010 (ACA) requires fully insured non-grandfathered individual and small group plans (inside and outside of Exchanges) to provide coverage for ten categories of Essential Health Benefits ("EHBs"). Large group plans (both self-funded and fully insured), and small group ASO plans, are not subject to the requirement to offer coverage for EHBs. However, if such plans choose to provide coverage for benefits which are deemed EHBs (such as maternity benefits), the ACA requires all dollar limits on those benefits to be removed on all Grandfathered and Non-Grandfathered plans. The determination of which benefits constitute EHBs is made on a state by state basis. As such, when using this guideline, it is important to refer to the enrollee's specific plan document to determine benefit coverage.

Many states require benefit coverage of services that diagnose or treat diabetes mellitus, including glucose monitors, test strips, syringes, medications and related supplies. Specific required coverage varies from state to state.

The enrollee-specific benefit document, either a Certificate of Coverage (COC) or Summary Plan Description (SPD), includes information regarding repair and replacement of Durable Medical Equipment. Many benefit documents also include language governing the coverage of Durable Medical Equipment that meets the enrollee's basic need. Further information can be found in the Coverage Determination Guideline titled Durable Medical Equipment, Orthotics, Ostomy Supplies, Medical Supplies, and Repairs/Replacements. In all cases, the enrollee-specific benefit document must be used to determine coverage.

COVERAGE RATIONALE

Insulin Delivery

External insulin pumps that deliver insulin by continuous subcutaneous infusion are proven and medically necessary for treating patients with diabetes. Programmable disposable external insulin pumps are considered equivalent to standard insulin pumps.
For information regarding medical necessity review, when applicable, see MCG™ Care Guidelines, 18th edition, 2014, Insulin Infusion Pump ACG:A-0339 (AC).

Nonprogrammable transdermal insulin delivery systems are unproven and not medically necessary for treating patients with diabetes.
There is insufficient evidence in the clinical literature demonstrating the safety and efficacy of transdermal insulin delivery in the management of patients with diabetes.

Implantable insulin pumps are investigational, unproven and not medically necessary.
No implantable insulin pumps have received U.S. Food and Drug Administration (FDA) approval at this time. While some preliminary studies reported improved glycemic control and fewer episodes of hypoglycemia in carefully selected patients, complications such as catheter blockage and infection were observed. Larger, randomized controlled trials are needed to determine the long-term impact of implantable insulin pumps on diabetes management.

Insulin infuser ports are unproven and not medically necessary for insulin delivery in patients with diabetes.
There is insufficient evidence demonstrating that the use of insulin infuser ports results in improved glycemic control beyond what can be achieved by using standard insulin delivery methods. In addition, an increase in complications, such as infection at the port site, has been reported when using these devices. Further well-designed, large-scale randomized controlled trials are needed to establish the safety and efficacy of this device.

See the Description of Services section below for further details on the various types of insulin delivery systems.

Continuous Glucose Monitors with or without Combined Insulin Pumps

Long-term continuous glucose monitoring (greater than 72 hours), alone or in combination with an external insulin pump, is proven and medically necessary as a supplement to self-monitoring of blood glucose (SMBG) for patients with type 1 diabetes who meet EITHER of the following criteria AND have demonstrated adherence to a physician ordered diabetic treatment plan:

- Have been unable to achieve optimum glycemic control as defined by the most current version of the American Diabetes Association (ADA) *Standards of Medical Care in Diabetes*; or
- Have experienced hypoglycemia unawareness and/or frequent episodes of hypoglycemia

For information regarding medical necessity review, when applicable, see MCG™ Care Guidelines, 18th edition, 2014, Continuous Glucose Monitoring ACG:A-0126 (AC).

Long-term continuous glucose monitoring is unproven and not medically necessary for patients with type 2 diabetes or gestational diabetes.
There is insufficient evidence that the use of long-term continuous glucose monitoring leads to improvement of glycemic control in patients with type 2 or gestational diabetes.

Remote Glucose Monitoring

Remote glucose monitoring is unproven and not medically necessary for managing patients with diabetes.
There is insufficient evidence in the clinical literature to conclude that remote glucose monitoring demonstrates improvement in clinical outcomes.

Artificial Pancreas Device Systems (APDS)

Devices classified by the U.S. Food and Drug Administration (FDA) as an artificial pancreas are unproven and not medically necessary.
Study results fail to provide conclusive evidence that artificial pancreas devices lead to improved health outcomes, such as improved glycemic control or delay in diabetes-related complications, in patients with diabetes. Larger, randomized controlled trials are needed to determine the long-term impact of these devices on diabetes management.

Additional Information

As part of the ongoing effort to improve diabetes care, the National Diabetes Education Program, the American Association of Clinical Endocrinology and others have recommended the term "A1c" be used for GHB or hemoglobin A1c (HbA1c) measurement in health care practice to avoid confusion.

APPLICABLE CODES

The Current Procedural Terminology (CPT®) codes and Healthcare Common Procedure Coding System (HCPCS) codes listed in this policy are for reference purposes only. Listing of a service code in this policy does not imply that the service described by this code is a covered or non-covered health service. Coverage is determined by the enrollee specific benefit document and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claims payment. Other policies and coverage determination guidelines may apply. This list of codes may not be all inclusive.

CPT® Code	Description
95250	Ambulatory continuous glucose monitoring of interstitial tissue fluid via a subcutaneous sensor for a minimum of 72 hours; sensor placement, hook-up, calibration of monitor, patient training, removal of sensor, and printout of recording
95251	Ambulatory continuous glucose monitoring of interstitial tissue fluid via a subcutaneous sensor for a minimum of 72 hours; interpretation and report

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HCPCS Code	Description
A9274	External ambulatory insulin delivery system, disposable, each, includes all supplies and accessories
A9275	Home glucose disposable monitor, includes test strips

HCPCS Code	Description
A9276	Sensor; invasive (e.g., subcutaneous), disposable, for use with interstitial continuous glucose monitoring system, 1 unit = 1 day supply
A9277	Transmitter; external, for use with interstitial continuous glucose monitoring system
A9278	Receiver (monitor); external, for use with interstitial continuous glucose monitoring system
E0607	Home blood glucose monitor
E0784	External ambulatory infusion pump, insulin
E1399	Durable medical equipment, miscellaneous NOTE: The i-port device is not durable medical equipment (DME) nor does it have a listed code
S1030	Continuous noninvasive glucose monitoring device, purchase (for physician interpretation of data, use CPT code)
S1031	Continuous noninvasive glucose monitoring device, rental, including sensor, sensor replacement, and download to monitor (for physician interpretation of data, use CPT code)
S1034	Artificial Pancreas Device System (eg, Low Glucose Suspend [LGS] Feature) Including Continuous Glucose Monitor, Blood Glucose Device, Insulin Pump And Computer Algorithm That Communicates With All Of The Devices
S1035	Sensor; Invasive (eg, Subcutaneous), Disposable, For Use With Artificial Pancreas Device System
S1036	Transmitter; External, For Use With Artificial Pancreas Device System
S1037	Receiver (Monitor); External, For Use With Artificial Pancreas Device System

Coding Clarification
E1399 is often misused when reporting the i-port device; however, the i-port device is not durable medical equipment (DME) nor does it have a listed code. E1399 can apply to other unspecified DME devices.

DESCRIPTION OF SERVICES

Diabetes mellitus is one of the leading causes of death in the United States. If poorly controlled, diabetes can lead to complications such as heart disease, stroke, peripheral vascular disease, retinal damage, kidney disease, nerve damage and impotence. In gestational diabetes, fetal and maternal health can be compromised.

Improved glycemic control has been shown to slow the onset or progression of major complications. Management of diabetes involves efforts to maintain blood glucose levels near the normal range. Currently, self-monitoring of blood glucose (SMBG) and laboratory testing of glycosylated hemoglobin (A1C) to measure longer term glycemic control are the standard methods for glucose testing (AACE, 2011; ADA, 2014).

Insulin Delivery
An external insulin pump is an insulin delivery device that can be worn on a belt or kept in a pocket. Standard insulin pumps connect to flexible plastic tubing that ends with a needle inserted through the skin into the fatty tissue. Another type of insulin pump (OmniPod®) combines an insulin reservoir placed on the skin with a wireless device to manage dosing and perform SMBG. Both types of devices can be programmed to release small doses of insulin continuously (basal), or a bolus dose close to mealtime to control the rise in blood glucose after a meal. Newer patch devices (e.g., V-Go®) deliver preset dosages of insulin transdermally and lack programmability.

Implantable insulin pumps, with programmable infusion rates, provide continuous intraperitoneal insulin delivery. A blood glucose monitor is not an integral part of this type of system (ADA website).

An insulin infuser port is a device used to reduce the number of needle injections for patients with insulin-dependent diabetes. An insertion needle guides a soft cannula into the subcutaneous tissue. Once applied, the insertion needle is removed, leaving the soft cannula under the skin to act as a direct channel into the subcutaneous tissue. Insulin is then injected through the cannula using a standard needle and syringe or insulin pen. Devices remain in place for up to 72 hours to accommodate multiple drug injections without additional needle sticks.

Continuous Glucose Monitors (CGM)
Continuous glucose monitoring (CGM) devices continuously monitor and record interstitial fluid glucose levels and have three components - a disposable subcutaneous sensor, transmitter and monitor. Some CGM systems are designed for short-term diagnostic or professional use. These devices store retrospective information for review at a later time. Other CGM systems are designed for long-term patient use and display information in real-time allowing the patient to take action based on the data (AMA, 2009). Glucose measurements provided during continuous monitoring are not intended to replace standard self-monitoring of blood glucose (SMBG) obtained using fingerstick blood samples, but can alert patients of the need to perform SMBG. These long-term devices are available with or without an integrated external insulin pump.

Remote glucose monitors provide real-time nocturnal glucose information. These devices transmit/receive information wirelessly by radiofrequency (RF) transmission.

Artificial Pancreas Devices Systems (APDS)
The FDA defines an APDS as a combined continuous glucose monitor and insulin infusion pump with a computer-controlled algorithm that allows continuous communication between the two devices. These devices can be programmed to automatically adjust insulin dosing. There are currently three main categories of APDS: threshold suspend, control-to-range and control-to-target systems. They differ in how the insulin pump acts on readings from the continuous glucose monitor (FDA website, 2013). The threshold suspend feature of sensor-augmented insulin pumps is designed to minimize the risk of hypoglycemia by interrupting insulin delivery at a preset glucose value.

CLINICAL EVIDENCE

The Agency for Healthcare Research and Quality (AHRQ) published a comparative effectiveness review of insulin delivery and glucose monitoring methods for diabetes. The report concluded that both continuous subcutaneous insulin infusion (CSII) and multiple daily injections (MDI) had similar effects on glycemic control and rates of severe hypoglycemia in children and adolescents with type 1 diabetes and adults with type 2 diabetes. In contrast, some studies suggested that CSII was superior to MDI for glycemic control in adults with type 1 diabetes with no difference in hypoglycemia and weight gain. Limited evidence suggested that measures of quality of life or treatment satisfaction improved in patients with type 1 diabetes. The approach to intensive insulin therapy can therefore be individualized to the preferences of appropriate patients that will maximize their quality of life. Studies suggested that real-time continuous glucose monitoring (rt-CGM) was superior to self-monitoring of blood glucose (SMBG) in lowering HbA1c in nonpregnant individuals with type 1 diabetes, particularly when compliance was high, without affecting the risk of severe hypoglycemia. rt-CGM/CSII in the form of sensor-augmented pumps was superior to MDI/SMBG in lowering HbA1c in the research studies analyzed in this review; however, other combinations of these insulin delivery and glucose monitoring modalities were not evaluated (Golden et al., 2012).

Insulin Delivery

In a meta-analysis, Fatourechi et al. (2009) summarized the evidence on the effect of continuous insulin infusion (CSII) and multiple daily injections (MDIs) on glycemic control and hypoglycemia. Patients with type 1 diabetes using CSII had slightly lower HbA1c, with no significant difference in severe or nocturnal hypoglycemia. Adolescents and adults with type 1 diabetes enrolled in crossover trials had nonsignificantly fewer minor hypoglycemia episodes per patient per week with CSII than MDI; children enrolled in parallel trials had significantly more episodes. Outcomes were not different in patients with type 2 diabetes. Contemporary evidence indicates that compared to MDI, CSII slightly reduced HbA1c in adults with type 1 diabetes, with unclear impact on hypoglycemia. In type 2 diabetes, CSII and MDI had similar outcomes. The authors stated that the effect in patients with hypoglycemia unawareness or recurrent severe hypoglycemia remains unclear because of lack of data.

Pickup and Sutton (2008) conducted a meta-analysis of 22 studies comparing severe hypoglycemia and glycemic control during continuous subcutaneous insulin infusion (CSII) and multiple daily insulin injections (MDI). The severe hypoglycemia rate in type 1 diabetes was markedly less during CSII than MDI, with the greatest reduction in those with most severe hypoglycemia on MDI and those with the longest duration of diabetes. The biggest improvement in HbA1c was in those with the highest HbA1c on MDI.

In a meta-analysis, Jeitler et al. (2008) compared the effects of continuous subcutaneous insulin infusion (CSII) with those of multiple daily insulin (MDI) injections on glycemic control, risk of hypoglycemic episodes, insulin requirements and adverse events in type 1 and type 2 diabetes mellitus. Twenty-two studies were included (17 on type 1 diabetes mellitus, two on type 2 diabetes mellitus, three on children). CSII therapy in adults and adolescents with type 1 diabetes resulted in a greater reduction of glycated hemoglobin. Total daily insulin requirements were lower with CSII than with MDI therapy. No beneficial effect of CSII therapy could be detected for patients with type 2 diabetes mellitus. No overall conclusions were possible for severe hypoglycemia and adverse events for any of the different patient groups due to rareness of such events, different definitions and insufficient reporting.

In a Cochrane review, Farrar et al. (2007) compared continuous subcutaneous insulin infusion (CSII) with multiple daily injections (MDI) of insulin for pregnant women with diabetes. The review found a lack of robust evidence to support the use of one particular form of insulin administration over another for pregnant women with diabetes. The data are limited because of the small number of trials appropriate for meta-analysis, small study sample size and questionable generalizability of the trial population. Conclusions cannot be made from the data available and therefore a robust randomized trial is needed. Assessed as up-to-date September 2011.

The Diabetes Control and Complications Trial (DCCT) demonstrated that tight glycemic control achieved with intensive insulin regimens significantly delayed the onset and slowed the progression of retinopathy, nephropathy or neuropathy in patients with type I or II diabetes. Elements of intensive therapy included testing blood glucose levels four or more times a day, injecting insulin at least three times daily or using an insulin pump, adjusting insulin doses according to food intake and exercise, following a diet and exercise plan and making monthly visits to a health care team (DCCT, 1993).

Clinical evidence evaluating the V-Go insulin delivery system is limited. Rosenfeld et al. (2012) performed an analysis of glycemic control in twenty-three patients who used the V-Go device. Clinical data was retrospectively collected before V-Go initiation, after 12 weeks of use, at the end of treatment and 12 weeks after discontinuation. Patient perceptions of device use were obtained through telephone surveys. The authors reported that glycemic control improved when patients were switched to the V-Go for insulin delivery and deteriorated when the V-Go was discontinued. No differences in hypoglycemic events were noted. Study limitations include its retrospective design, small sample size and short-term follow-up. Further well-designed, prospective studies are needed to establish the safety and efficacy of this device in managing patients with diabetes.]

Implantable Insulin Pumps
Implantable insulin pumps (IIP) are a promising new technology for the treatment of insulin-dependent diabetes but at this time are only available in a clinical trial setting (Hayes, 2011; updated 2013).

Insulin Infuser Ports
Blevins et al. (2008) conducted a prospective, randomized controlled cross-over trial comparing the outcomes of insulin-dependent diabetics (n=74) who used the i-port compared to standard multi-injection insulin therapy. Type 1 (n=56) and type 2 (n=18) diabetics were randomly assigned to one of four cohort groups. Cohort 1 (n=18) compared standard injections (SI) to single i-port, cohort 2 (n=20) compared single i-port to SI, cohort 3 (n=18) compared dual i-ports to single i-port and cohort 4 (n=18) compared single i-port to dual i-ports. At the end of the first three weeks, each group switched to the alternative method for an additional three weeks. Ten participants were lost to follow-up, six of which were due to device related issues (adhesive failure, discomfort, hyperglycemia, cannula bends and adverse events). Participant's glycosylated albumin was not significantly different between SI, single i-port and dual i-port treatment regiments. A1c levels were similar among all cohorts at the initiation and completion of the study. Adverse events included erythema, suppuration, skin irritation, itching, and bruising at the i-port insertion site. Three events of severe hyperglycemia were also reported.

Continuous Glucose Monitors
A meta-analysis of fourteen randomized controlled trials (n=1188) evaluated the use of continuous glucose monitoring (CGM) in patients with type 1 diabetes. Compared to self-monitoring of blood glucose (SMBG), the use of CGM was associated with a greater reduction in HbA1c. The number of hypoglycemic events was not significantly different between the two groups, but duration of hypoglycemia was shorter for the CGM group, with an incremental reduction of hypoglycemia duration. Continuous glucose monitoring also resulted in a shorter duration of hyperglycemia than SMBG (Floyd et al., 2012).

In a randomized, controlled multicenter study, Battelino et al. (2011) assessed the impact of continuous glucose monitoring on hypoglycemia in patients with type 1 diabetes. A total of 120 children and adults on intensive therapy for type 1 diabetes and an A1c <7.5 were randomly assigned to a control group performing self-monitoring of blood glucose (SMBG) and wearing a masked continuous glucose monitor every second week for five days or to a group with real-time continuous glucose monitoring. Continuous glucose monitoring was associated with reduced time spent in hypoglycemia and a concomitant decrease in HbA1c in children and adults with type 1 diabetes.

The Juvenile Diabetes Research Foundation sponsored a multicenter, randomized controlled trial evaluating the use of continuous glucose monitoring in the management of type I diabetes mellitus. The investigators randomly assigned 322 adults and children who were already receiving intensive therapy for type 1 diabetes to a group with continuous glucose monitoring or to a control group performing home monitoring with a blood glucose meter. All the patients were stratified into three groups according to age and had a glycated hemoglobin level of 7.0 to 10.0%. The primary outcome was the change in the glycated hemoglobin level at 26 weeks. The changes in glycated hemoglobin levels in the two study groups varied markedly according to age group (P=0.003), with a significant difference among patients 25 years of age or older that favored the continuous-monitoring group (mean difference in change, -0.53%; 95% confidence interval [CI], -0.71 to -0.35; P<0.001). The between-group difference was not significant among those who were 15 to 24 years of age (mean difference, 0.08; 95% CI, -0.17 to 0.33; P=0.52) or among those who were 8 to 14 years of age (mean difference, -0.13; 95% CI, -0.38 to 0.11; P=0.29). Secondary glycated hemoglobin outcomes were better in the continuous-monitoring group than in the control group among the oldest and youngest patients but not among those who were 15 to 24 years of age. The investigators concluded that continuous glucose monitoring can be associated with improved glycemic control in adults with type 1 diabetes; however, further work is

needed to identify barriers to effectiveness of continuous monitoring in children and adolescents (Juvenile Diabetes Research Foundation (JDRF) Continuous Glucose Monitoring Study Group, 2008).

The same JDRF study group also evaluated factors associated with successful use of continuous glucose monitoring (CGM) among participants with intensively treated type 1 diabetes. 232 participants randomly assigned to the CGM group (165 with baseline A1C >or=7.0% and 67 with A1C <7.0%) were asked to use CGM on a daily basis. The associations of baseline factors and early CGM use with CGM use >or=6 days/week in the 6th month and with change in A1C from baseline to 6 months were evaluated. The only baseline factors found to be associated with greater CGM use in month 6 were age >or=25 years ($P < 0.001$) and more frequent self-reported prestudy blood glucose meter measurements per day ($P < 0.001$). CGM use and the percentage of CGM glucose values between 71 and 180 mg/dl during the 1st month were predictive of CGM use in month 6 ($P < 0.001$ and $P = 0.002$, respectively). More frequent CGM use was associated with a greater reduction in A1C from baseline to 6 months ($P < 0.001$), a finding present in all age-groups. After 6 months, near-daily CGM use is more frequent in intensively treated adults with type 1 diabetes than in children and adolescents, although in all age-groups near-daily CGM use is associated with a similar reduction in A1C. Frequency of blood glucose meter monitoring and initial CGM use may help predict the likelihood of long-term CGM benefit in intensively treated patients with type 1 diabetes of all ages (JDRF, 2009a).

In a parallel study of 129 adults and children with intensively treated type 1 diabetes (age range 8-69 years), the JDRF study group reported that the evidence suggests that CGM is beneficial for individuals with type 1 diabetes who have already achieved excellent control with A1C <7.0% (JDRF, 2009b).

In a 6-month extension to the JDRF trial, the study group evaluated the long-term effects of continuous glucose monitoring (CGM) in 83 intensively treated adults (≥ 25 years of age) with type 1 diabetes. The group found that most adults continued to use CGM on a daily or near daily basis and had sustained benefits for improved glucose control noted by A1c levels and the amount of time sensor glucose values were in the target range. These benefits persisted despite less intensive follow-up, designed to approximate usual clinical practice, than during the 6-month randomized phase of the study (JDRF, 2009c).

In a Cochrane review, Langendam et al. (2012) assessed the effects of continuous glucose monitoring (CGM) systems compared to conventional self-monitoring of blood glucose (SMBG) in patients with Type 1 diabetes. Twenty-two randomized controlled trials (RCTs) comparing retrospective or real-time CGM with conventional self-monitoring of blood glucose levels or with another type of CGM system in patients with type 1 diabetes mellitus were included. The studies randomized 2883 patients with type 1 diabetes to receive a form of CGM or to use SMBG using fingerprick. The duration of follow-up varied between 3 and 18 months; most studies reported results for six months of CGM use. This review shows that CGM helps in lowering the HbA1c. In most studies the HbA1c value decreased in both the CGM and the SMBG users, but more in the CGM group. The difference in change in HbA1c levels between the groups was on average 0.7% for patients starting on an insulin pump with integrated CGM and 0.2% for patients starting with CGM alone. The most important adverse events, severe hypoglycemia and ketoacidosis did not occur frequently in the studies, and absolute numbers were low (9% of the patients, measured over six months). Diabetes complications, death from any cause and costs were not measured. There are no data on pregnant women with Type 1 diabetes and patients with diabetes who are not aware of hypoglycemia.

Chase et al. (2010) reported on the 12-month follow-up of 80 patients age 8–17 years who participated in the 6-month randomized JDRF study and the subsequent 6-month extension study. Outcomes included frequency of CGM use, HbA1c levels, rate of severe hypoglycemia and a CGM satisfaction scale. Seventy-six (95%) of 80 subjects were using CGM after 6 months (median use = 5.5 days/week) compared with 67 (84%) after 12 months (median use = 4.0

days/week). The 17 subjects using CGM >or=6 days/week in month 12 had substantially greater improvement from baseline in HbA1c than did the 63 subjects using CGM <6 days/week in month 12 (mean change - 0.8 +/- 0.6% vs. +0.1 +/- 0.7%). They also reported greater satisfaction with use of CGM. The incidence of severe hypoglycemic events was low during the 12 months of the study irrespective of the amount of CGM use. The study concluded that individuals who use CGM on a near-daily basis can have substantial improvement in glycemic control.

Chetty et al. (2008) performed a meta-analysis of randomized controlled trials comparing CGMS and SBGM in Type 1 diabetic patients. Seven studies with a total of 335 patients were included. Five studies were confined to the pediatric population (age<18 years). The authors concluded that while there was some indication of improved detection of asymptomatic nocturnal hypoglycemia in the CGMS group, there was insufficient evidence to support the notion that CGMS provides a superior benefit over SBGM in terms of HBA1c reduction.

Adult Patients

Szypowska et al. (2012) conducted a systematic review and meta-analysis to explore the potential beneficial effects of real-time continuous glucose monitoring (RT-CGM) on diabetes management compared with self blood glucose measurement (SBGM) in patients with type 1 diabetes (T1DM). Seven randomized controlled trials (n=948) were included. Combined data from all studies showed better HbA1c reduction in subjects using RT-CGM compared with those using SBGM. Patients treated with insulin pump and RT-CGM had a lower HbA1c level compared with subjects managed with insulin pump and SBGM (four RCTs, n=497) The benefits of applying RT-CGM were not associated with an increase in rate of major hypoglycemic episodes. The use of RT-CGM for over 60-70% of time was associated with a significant lowering of HbA1c. The authors concluded that RT-CGM is more beneficial than SBGM in reducing HbA1c in patients with type 1 diabetes. Further studies are needed to evaluate the efficacy of this system in the pediatric population, especially in very young children.

Vigersky et al. (2012) conducted a randomized controlled trial of 100 adults with type 2 diabetes, who were not on prandial insulin, to determine whether short-time, real-time continuous glucose monitoring (RT-CGM) had long-term glycemic effects. Intermittent RT-CGM over 12 weeks significantly improved glycemic control both during and for up to 1 year following the intervention. The authors concluded that additional studies are needed to confirm these results as well as determine the mechanism by which the improvement occurred, the minimum time for RT-CGM to be effective and the effect/timing of refresher courses of this intervention.

Hoeks et al. (2011) performed a systematic review of seven randomized controlled trials evaluating the effect of real-time continuous glucose monitoring systems in diabetes management. The analysis concluded that real-time continuous glucose monitoring has a beneficial effect on glycemic control in adult patients with diabetes, without an increase in the incidence of hypoglycemia. Studies in well-selected patient groups (pregnancy, history of severe hypoglycemia, type 2 diabetes) are lacking.

Cooke et al. (2009) presented the results of the Minimally Invasive Technology Role and Evaluation (MITRE) study in a randomized controlled trial (RCT) comparing the efficacy of two CGM devices in adult patients with insulin-dependent diabetes. The primary endpoint was long-term glucose control, as indicated by changes in A1C levels at 18 months. The patients were randomized to the MiniMed CGMS (n=102), the GlucoWatch G2 Biographer (n=100), standard control (n=102) or attention control (n=100). By month 18, the percentage of patients who had a relative reduction of A1C of at least 12.5% was 15% in the Biographer group, 27% in the CGMS group, 24% in the standard control, and 27% in the attention control group. The investigators found that CGMS has a small benefit but it does not last and the Biographer had a smaller effect on A1C than the MiniMed CGMS or standard treatments.

Two small studies evaluated poorly controlled patients with type 2 diabetes. Yoo et al. (2008) (n=65) reported significantly greater improvement in glycemic control in CGM patients compared

with SMBG patients. Cosson et al. (2009) (n=48) evaluated both type 1 and 2 patients. Type 2 diabetic patients, but not type 1 patients, achieved significantly greater glycemic control following CGM intervention relative to controls.

In a small nonrandomized comparison study Garg et al. (2007) evaluated real-time CGM with DexCom STS (n=24). At 12 weeks a modest but significant improvement in A1C (0.4%) was observed in the CGM group compared to nonsignificant increase in A1C (0.3%) in the comparison group (n=23). Also, at 12 weeks there was a difference in A1C values between groups despite the fact that there was no change in insulin dose. The number of subjects achieving A1C values <7.5% was higher in the CMG group at 12 weeks. Improvements in metabolic control with CMG were not associated with increased hypoglycemia.

Similar results were reported by Bailey et al. (2007) who conducted an observational trial evaluating the DexCom STS in a heterogeneous patient population (n=139) including type 1 and type 2 diabetics. Overall, at the end of the 12-week study, the A1C was reduced by 0.4%. Decrease in A1C was more pronounced in patients with higher baseline levels. Patients did not report an increase in the time spent in hypoglycemia. Patients in the top quartile of CGM attention experienced a greater A1C reduction compared to those in the bottom quartile.

Zick et al. (2007) compared CGM with conventional measurements of hypoglycemia in a nonrandomized controlled trial. The proportion of patients who experienced hypoglycemia was significantly higher in those assessed with SMBG than with CGM, which may indicate an underreporting by SMBG. Mean daytime glucose values were similar between the two groups, but mean nocturnal glucose values were significantly lower in patients measured with CGM than in patients measured with SMBG.

One randomized controlled trial (Garg 2006a) evaluated the diagnostic performance and clinical effectiveness of the DexCom STS CGMS in 91 adult patients with either type 1 (n=75) or type 2 (n=16) insulin-requiring diabetes. Each subject participated in three, 72-hour cycles of monitoring. Results indicate that patients who were provided unblinded access to continuous glucose data and alerts/alarms were more effectively able to managing hypoglycemic and hyperglycemic events.

A similar study was conducted by Garg and Jovanovic (2006b) to evaluate the safety and efficacy of seven-day abdominal, transcutaneous, real-time CGM (DexCom STS) in a heterogeneous study group including type 1 (n=69) and type 2 (n=17) insulin-requiring diabetics. Study results showed that presenting real-time glucose values to patients was associated with a decrease in the time spent in the hyper- and hypoglycemic ranges while increasing the time spent in the euglycemic range. The greatest improvements were observed in patients with higher A1C baseline values.

Deiss et al. (2006b) reported on a 3-month study of 81 children and 81 adults with stable type 1 diabetes who had A1C levels of 8.1% or greater. Patients were randomized to continuous real-time monitoring with the Guardian RT, continuous monitoring for 3 days every 2 weeks, or SMBG. At 3 months, 50% of patients with continuous real-time monitoring had a decrease in A1C of at least 1% compared to 37% of those with intermittent continuous monitoring, and 15% of controls. An A1C reduction of at least 2% was seen in 26% of group 1 patients, 9% of group 2 patients and 4% of control group patients. The investigators reported that the patients did not record specific information regarding daily self-management activities but reported that changes were made. Therefore, delineation between the link between CGM and improvement in glycemic control could not be made.

Bode et al. (2004) evaluated the effectiveness of alarms based on real-time sensor glucose values provided by the MiniMed Guardian CGMS in 71 adult diabetics. Patient responses to the hypoglycemia alerts resulted in a significantly reduced duration of hypoglycemic events compared with controls, although overtreatment of hypoglycemia may have caused a small increase in the

frequency of hyperglycemic events.

The National Institute for Health and Care Excellence (NICE) states that continuous glucose monitoring systems have a role in the assessment of glucose profiles in adult Type I diabetes patients with consistent glucose control problems on insulin therapy, such as repeated hyper- or hypoglycemia at the same time of day or hypoglycemia unawareness unresponsive to conventional insulin dose adjustment (NICE, 2004; updated 2011).

Pediatric Patients

Mauras et al. (2012) assessed the benefit of continuous glucose monitoring (CGM) in young children aged 4 to 9 years with type 1 diabetes. A total of 146 children with type 1 diabetes (mean age 7.5 ± 1.7 years) were randomly assigned to CGM or to usual care. The primary outcome was reduction in HbA1c at 26 weeks by ≥0.5% without the occurrence of severe hypoglycemia. The primary outcome was achieved by 19% in the CGM group and 28% in the control group. Mean change in HbA1c was -0.1% in each group. Severe hypoglycemia rates were similarly low in both groups. CGM wear decreased over time, with only 41% averaging at least 6 days/week at 26 weeks. There was no correlation between CGM use and change in HbA1c. The authors concluded that CGM in 4- to 9-year-olds did not improve glycemic control despite a high degree of parental satisfaction with CGM. This finding may be related in part to limited use of the CGM glucose data in day-to-day management and to an unremitting fear of hypoglycemia.

The Diabetes Research in Children Network (DirecNet) Study Group examined the feasibility of daily use of a continuous glucose monitor, the FreeStyle Navigator CGMS in children with type 1 diabetes using insulin pumps. Mean A1C improved from 7.1% at baseline to 6.8% at 13 weeks of unblinded sensor use, and the percentage of glucose values in the target range increased from 52% to 60%. There was a modest increase in the percentage of sensor values that were <70 mg/dL. (Buckingham 2007) The DirecNet Study Group also conducted a similar study in 27 children with type 1 diabetes using multiple daily injections of insulin. Mean A1C level fell from 7.9 at baseline to 7.3 at 13 weeks (Weinzimer, 2008).

Golicki et al. (2008) performed a systematic review and meta-analysis of the evidence comparing the effects of continuous glucose monitoring with self-monitoring of blood glucose on glycemic control in children with type 1 diabetes. Combined data from five trials involving 131 patients showed that CGM did not significantly reduce HbA1c levels compared with control groups. The authors concluded that CGM was not better than self-monitoring of blood glucose with regard to improvement of metabolic control among type 1 diabetic children. They also stated that, due to the small number of participants and methodological limitations of the studies included, findings of this meta-analysis should be interpreted with caution.

NICE recommends that continuous glucose monitoring systems be available to children and young people with type 1 diabetes who have persistent problems with hypoglycemia unawareness or repeated hypoglycemia and hyperglycemia (NICE, 2004; updated 2011).

Deiss et al. (2006a) reported results of a small double-blinded, cross-over randomized trial in children with type 1 diabetes. During the first 12 weeks, group A (n=15) had access to the MiniMed CGMS data while group B (n=15) was blinded to the CGMS data. At the end of three months, the groups crossed over. The authors found that visual interpretation of CGMS data resulted in frequent changes in insulin therapy, but had no effect on metabolic control (no significant decrease in A1C levels) and duration of hyperglycemia.

The GuardControl study (Deiss 2006b) that included poorly controlled adults (n=81) and children (n=81) despite intensive insulin therapy showed that, within three months, real-time continuous glucose monitoring with the Guardian RT led to significantly improved A1C values. The study did not report age-specific outcomes. (Also see the Adult Patients section.)

Lagarde et al. (2006) conducted a small (n=27) randomized trial and reported that CGMS may

improve metabolic control in children with type 1 diabetes since A1C levels decreased in the treatment group compared with the control group after 6 months. This decrease, however, was small.

Gestational Diabetes
In a prospective, open label randomized controlled trial, Murphy et al. (2008) evaluated the effectiveness of continuous glucose monitoring during pregnancy on maternal glycemic control, infant birth weight and risk of macrosomia in women with type 1 and type 2 diabetes. 71 women with type 1 diabetes (n=46) or type 2 diabetes (n=25) were allocated to antenatal care plus continuous glucose monitoring (n=38) or to standard antenatal care (n=33). The primary outcome was maternal glycemic control during the second and third trimesters from measurements of HbA1c levels every four weeks. Secondary outcomes were birth weight and risk of macrosomia. Women randomized to continuous glucose monitoring had lower mean HbA1c levels from 32 to 36 weeks' gestation compared with women randomized to standard antenatal care. Compared with infants of mothers in the control arm those of mothers in the intervention arm had decreased mean birthweight, decreased median customized birthweight and a reduced risk of macrosomia. The authors acknowledged that, due to lack of blinding, they could not exclude the possibility of bias in clinical management. They also stated that because the number of women studied was small, larger multicentre trials are required to assess the impact of CGM during pregnancy.

Kestila et al. (2007) conducted a randomized controlled trial to compare CGMS (n=36) to SMBG (n=37) in detecting patients with gestational diabetes mellitus (GDM) who needed antidiabetic drug treatment. In 11 out of 36 patients (31%) monitored with CGMS antihyperglycemic drug therapy was introduced whereas only 3/37 (8%) in the SMBG group were drug-treated. The authors concluded that further large-scale studies are needed to evaluate whether CGMS guided initiation of antihyperglycemic therapy results in less macrosomia and perinatal complications related to GDM.

Buhling et al. (2005) reported that CGMS detected more frequent and longer periods of hyperglycemia. Compared with SMBG, CGMS also offered more differentiation between nondiabetic pregnant women, patients with gestational diabetes and patients with impaired glucose tolerance.

A second small study found that when CGMS was used to adjust insulin treatment, there was a reduction in undetected hyperglycemia and nocturnal hypoglycemic events. However, the study did not indicate a clinical difference in perinatal outcomes between CGMS and SMBG (Yogev, 2003).

Insulin Pump and Continuous Glucose Monitoring Combined Systems
Bergenstal et al. (2010) conducted a multicenter, randomized, controlled trial comparing the efficacy of sensor-augmented pump therapy (pump therapy) to that of multiple daily insulin injections (injection therapy) in 329 adults and 156 children (ages 7 through 70 years) with inadequately controlled type 1 diabetes. The primary end point was the change from the baseline glycated hemoglobin level. At one year, the researchers found that the pump-therapy group had glycated hemoglobin levels that were significantly lower than the injection-therapy group. The baseline mean glycated hemoglobin level, which was 8.3% in the two study groups, had decreased to 7.5% in the pump therapy group, compared with 8.1% in the injection therapy group. The proportion of patients who reached the glycated hemoglobin target (<7%) was greater in the pump-therapy group than in the injection-therapy group. The rates of severe hypoglycemia and diabetic ketoacidosis in the pump-therapy group did not differ significantly from the injection-therapy group. The study concluded that sensor-augmented pump therapy resulted in significant improvement in glycated hemoglobin levels, as compared with injection therapy.

The RealTrend study was a 6-month, randomized, parallel-group, two-arm, open-label study of 132 adults and children with uncontrolled type 1 diabetes (A1C >or=8%) being treated with

multiple daily injections. The objective of the study was to compare the improvements in glycemic control associated with transitioning to insulin pump therapy in patients using continuous glucose monitoring versus standard blood glucose self-monitoring. One group was fitted with the Medtronic MiniMed Paradigm REAL-Time system (PRT group), an insulin pump with integrated continuous subcutaneous glucose monitoring (CGM) capability, with instructions to wear CGM sensors at least 70% of the time. Conventional insulin pump therapy was initiated in the other group. Outcome measures included A1C and glycemic variability. 115 patients completed the study. Between baseline and trial end, A1C improved significantly in both groups, with no significant difference between groups. When the 91 patients who were fully protocol-compliant (CGM sensor wear >or=70% of the time) were considered, A1C improvement was significantly greater in the PRT group. Hyperglycemia parameters decreased in line with improvements in A1C with no impact on hypoglycemia. The authors concluded that CGM-enabled insulin pump therapy improves glycemia more than conventional pump therapy during the first 6 months of pump use in patients who wear CGM sensors at least 70% of the time (Raccah, 2009).

In the first multicenter, randomized treat-to-target, Hirsch et al. (2008) evaluated the clinical effectiveness and safety of a device that combines an insulin pump with real-time continuous glucose monitoring (CGM), compared to using an insulin pump with standard blood glucose monitoring systems. The study enrolled 146 patients treated with continuous subcutaneous insulin infusion between the ages of 12 and 72 years with type 1 diabetes and initial A1C levels of >or=7.5%. Subjects were randomized to pump therapy with real-time CGM (sensor group [SG]) or to pump therapy and self-monitoring of blood glucose only (control group [CG]). A1C levels decreased from baseline in both groups; however, between-group differences did not achieve significance. Fourteen severe hypoglycemic events occurred (11 in the SG group and three in the CG group, P=0.04). A1C reduction was no different between the two groups. Subjects in the CG group had increased hypoglycemia area under the curve (AUC) and number of events during blinded CGM use; however, there was no increase in hypoglycemia AUC or number of events in the SG group. Subjects with greater sensor utilization showed a greater improvement in A1C levels.

Remote Glucose Monitoring

No studies were identified in the published clinical literature demonstrating improved clinical outcomes from managing nocturnal hypoglycemia with the use of remote glucose monitoring.

Ahmet et al. (2011) conducted a pilot study to determine the prevalence of nocturnal hypoglycemia (NH) in pediatric type 1 diabetes, to compare the prevalence of NH detected by continuous glucose monitoring (CGM) and self-monitored blood glucose (SMBG), and to compare the prevalence of NH using different thresholds. Twenty-five patients wore a continuous glucose monitor for 3 nights and also conducted SMBG. NH was defined with three thresholds: (1) <3.9 mmol/L; (2) <3.3 mmol/L; and (3) <2.9 mmol/L. The prevalence of NH with CGM was 68%, 52%, and 48% with the different thresholds. Of the 35 episodes of NH detected by CGM, 25 were not symptomatic and therefore not detected by SMBG. The mean difference in blood glucose between CGM and SMBG was -0.18 mmol/L (P = .35). The authors concluded that this study suggests that the prevalence of NH in pediatric patients with type 1 diabetes with conventional treatment may be as high as 68%, although this varied according to the method of detection and threshold used. Patients may benefit from CGM to detect asymptomatic NH. This study is limited by small sample size and a lack of randomization and control.

Artificial Pancreas Device Systems (APDS)

No studies evaluating the MiniMed 530G sensor-augmented insulin pump with a low glucose suspend feature were identified in the clinical literature. The manufacturer claims that the MiniMed 530G uses the same calibration algorithm and threshold suspend software as the Paradigm® Veo™ device marketed in Europe. Studies to date have evaluated the Veo device.

A BlueCross and BlueShield technology assessment concluded that the artificial pancreas device system with low glucose suspend does not meet the Technology Evaluation Center (TEC)

criteria. The literature on this type of artificial pancreas is very limited, and the evidence is insufficient to permit conclusions regarding the impact on health outcomes. A single trial has reported the results of its use in a home setting. Although the trial results are generally favorable, the study has limitations and further studies are needed. Because an improvement has not been established, its generalizability outside investigational settings cannot be assessed (BCBS, 2014 [in press]).

In the Automation to Simulate Pancreatic Insulin Response (ASPIRE) trial, Bergenstal et al. (2013) evaluated the Medtronic Paradigm Veo sensor-augmented insulin-pump therapy with threshold-suspend feature in patients with type 1 diabetes and documented nocturnal hypoglycemia. The primary safety outcome was the change in the glycated hemoglobin level. The primary efficacy outcome was the area under the curve (AUC) for nocturnal hypoglycemic events. A total of 247 patients were randomly assigned to receive sensor-augmented insulin-pump therapy with the threshold-suspend feature (n=121) or standard sensor-augmented insulin-pump therapy (n=126). The changes in glycated hemoglobin values were similar in the two groups. The mean AUC for nocturnal hypoglycemic events was 37.5% lower in the threshold-suspend group than in the control group. Nocturnal hypoglycemic events occurred 31.8% less frequently in the threshold-suspend group than in the control group. Four patients (all in the control group) had a severe hypoglycemic event; no patients had diabetic ketoacidosis. Over a 3-month period, the authors reported that the use of sensor-augmented insulin-pump therapy with the threshold-suspend feature significantly reduced nocturnal hypoglycemia, without increasing glycated hemoglobin values. Author noted limitations include short-term follow-up, lack of validation for glucose sensor values, exclusion of hypoglycemic events less than 20 minutes long and possible limited generalizability because of inclusion of only hypoglycemia-prone patients. Funded by Medtronic. Clinicaltrial.gov #NCT01497938.

In a randomized, controlled trial, Ly et al. (2013) evaluated the incidence of severe and moderate hypoglycemia with a sensor-augmented pump with low-glucose suspension (Medtronic Paradigm Veo) compared with standard insulin pump therapy. A total of 95 patients with type 1 diabetes were randomized to standard insulin pump therapy (n=49) or automated insulin suspension (n=46). The primary outcome was the combined incidence of severe (hypoglycemic seizure or coma) and moderate (an event requiring assistance for treatment) hypoglycemia. After 6 months of treatment, the event rates decreased from 28 to 16 in the pump-only group vs. 175 to 35 in the low-glucose suspension group. There were no episodes of diabetic ketoacidosis or hyperglycemia with ketosis. The authors concluded that the use of sensor-augmented pump therapy with low-glucose suspension reduced the rate of severe and moderate hypoglycemia in patients with type 1 diabetes and impaired hypoglycemia awareness. However, the authors reported that the results were not statistically significant due to the exclusion of some younger participants with the highest rates of moderate hypoglycemia. There was no associated change in glycated hemoglobin.

In a randomized, crossover study in a controlled clinic environment, patients tested a sensor-augmented insulin pump with a low glucose suspend feature (Medtronic Paradigm Veo). Patients fasted overnight and exercised until their plasma glucose value reached ≤85mg/dL. Fifty subjects attempted 134 sessions, 98 of which were successful. The authors reported that automatic suspension of insulin delivery significantly reduced the duration and severity of induced hypoglycemia without causing rebound hyperglycemia. Further controlled studies with larger patient populations and longer follow-up are needed to apply these results outside the clinic setting (Garg et al., 2012).

Results of three available studies (Weinzimer et al., 2008; Steil et al., 2006; Chee et al., 2002) fail to provide conclusive evidence that closed-loop use of the Paradigm REAL-Time System is a safe and effective method for blood glucose management.

Hovorka et al. (2010) conducted a randomized trial to determine if closed-loop insulin delivery could control overnight blood glucose in young people. During 54 nights in the hospital (33 nights

on closed-loop delivery and 21 on standard continuous subcutaneous insulin infusion [CSII]), researchers assessed 17 patients, ages 5 to 18, with type 1 diabetes. Participants were assigned to three different crossover groups: standard versus closed-loop delivery, closed-loop delivery after rapidly or slowly absorbed meals and standard versus closed-loop delivery after exercise. In the closed-loop group, glucose measurements were fed to a control algorithm every 15 minutes, and a nurse adjusted the insulin pump. Results showed the closed-loop delivery system kept patients within the desired range of plasma glucose 60% of the time compared to 40% of the time with CSII delivery. Use of the closed-loop delivery reduced time for which glucose levels fell below the level considered as mild hypoglycemia - compared to CSII (2.1% versus 4.1%). No events defined as significant hypoglycemia were recorded during closed-loop delivery, compared with 9 events during CSII delivery. The authors concluded that the results suggest that closed-loop devices may be able to significantly lower patients' risk of developing complications later in life by reducing the burden of hypoglycemia. Further controlled studies with larger patient populations and longer follow-up are needed to apply these results outside the hospital setting.

Professional Societies

American Diabetes Association (ADA)

Insulin Delivery

In a 2002 position statement the ADA states that both continuous subcutaneous insulin infusion (CSII) and multiple daily insulin injection therapy are effective means of implementing intensive diabetes management with the goal of achieving near normal level of blood glucose and improved lifestyle flexibility. Rapid-acting insulin analogs (such as lispro) are appropriate insulins for insulin infusion pumps. Use of mixtures of insulins in pumps has not been evaluated and therefore is not recommended. Experience with insulin-pump therapy indicates that candidates for CSII must be strongly motivated to improve glucose control and willing to work with their health care provider in assuming substantial responsibility for their day-to-day care. Use of CSII requires care by skilled professionals, careful selection of patients, meticulous patient monitoring and thorough patient education (ADA, 2004a).

In a statement on the care of children and adolescents with type 1 diabetes, the ADA states that there is no best predetermined age to initiate insulin pump therapy. As with all diabetes management issues, individualized treatment plans that consider the needs of the patient as well as those of the family are best. Currently, there are fewer young children than preadolescents and adolescents using insulin pumps. Adult support at both home and school is essential for success with all diabetes management but especially with pump treatment until the child is able to manage the diabetes independently (Silverstein, 2005).

In a statement on gestational diabetes mellitus, the ADA states that insulin is the pharmacologic therapy that has most consistently been shown to reduce fetal morbidities when added to medical nutrition therapy (MNT). Selection of pregnancies for insulin therapy can be based on measures of maternal glycemia with or without assessment of fetal growth characteristics. When maternal glucose levels are used, insulin therapy is recommended when MNT fails to maintain self-monitored glucose at the following levels:

- Fasting plasma glucose less than or equal to 105 mg/dl (5.8 mmol/l); or
- 1-h postprandial plasma glucose less than or equal to 155 mg/dl (8.6 mmol/l); or
- 2-h postprandial plasma glucose less than or equal to 130 mg/dl (7.2 mmol/l)

Human insulin should be used when insulin is prescribed, and self-monitoring of blood glucose should guide the doses and timing of the insulin regimen. The use of insulin analogs has not been adequately tested in gestational diabetes mellitus (ADA, 2004b).

Insulin infusers create "portals'' into which the patient injects insulin. With an infuser, a needle or catheter is inserted into subcutaneous tissue and remains taped in place, usually on the abdomen, for 48–72 hours. The insulin is injected into it, rather than directly through the skin into

the fatty tissue. Some people are prone to infections with this type of product, so precautionary hygiene measures are necessary (ADA, 2008).

Continuous Glucose Monitoring
In the 2014 *Standards of Medical Care in Diabetes*, the ADA states that continuous glucose monitoring (CGM) may be a supplemental tool to SMBG in patients with hypoglycemia unawareness and/or frequent hypoglycemic episodes. CGM in conjunction with intensive insulin regimens can be a useful tool to lower A1C in selected adults (age greater than or equal to 25 years) with type 1 diabetes. Although the evidence for A1C lowering is less strong in children, teens and younger adults, CGM may be helpful in these groups. Success correlates with adherence to ongoing use of the device (ADA, 2014).

American Association of Clinical Endocrinologists (AACE)
Insulin Pumps
Continuous subcutaneous insulin infusion (CSII) is useful in motivated and diabetes-educated patients with type 1 diabetes and in certain insulinopenic patients with type 2 diabetes who are unable to achieve optimal glycemic control with multiple daily injections. Thorough education and periodic reevaluation of CSII users, as well as CSII expertise of the prescribing physician, is necessary to ensure patient safety (Grade D; BEL 4). Sensor-augmented CSII should be considered in patients in whom it is deemed appropriate (Grade B; BEL 2) (Handelsman et al., 2011).

Continuous Glucose Monitoring
Although still early in its development, continuous glucose monitoring (CGM) can be useful for many patients to improve A1C levels and reduce hypoglycemia (Grade D; BEL 4) (Handelsman et al., 2011).

Grade level
Grade B – intermediate evidence
Grade D – lack of conclusive clinical evidence

Best evidence level (BEL)
BEL 2 – intermediate evidence (e.g., nonrandomized prospective or case-controlled trials, prospective cohort study or retrospective case-control study)
BEL 4 – no evidence (theory, opinion, consensus, review or preclinical study)

U.S. FOOD AND DRUG ADMINISTRATION (FDA)

Insulin Delivery
For information on external insulin pumps, see the following web site (use product code LZG). Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm. Accessed March 22, 2014.

No implantable insulin pumps have received FDA approval at this time.

The i-port® Injection Port was approved by the FDA on September 9, 2005 (K052389). The injection port is indicated for use by people requiring multiple daily subcutaneous injections of physician prescribed medications, including insulin. The device is designed for use on adults and children for up to 72 hours. Additional information available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm?ID=K052389. Accessed March 22, 2014.

The i-port Advance® Injection Port was approved by the FDA on February 16, 2012 (K120337). This model has the same indications as the original device but includes an automatic insertion

component. Additional information available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K120337. Accessed March 22, 2014.

The V-Go device (models V-Go20, V-Go30 and V-Go40) received FDA approval (K100504) on December 1, 2010. V-Go is a mechanical (no electronics), self-contained, sterile, patient fillable, single-use disposable insulin infusion device with an integrated stainless steel subcutaneous needle. The device is indicated for continuous subcutaneous infusion of insulin in one 24-hour time period and on-demand bolus dosing in 2-unit increments (up to 36 units per one 24-hour time period) in adult patients requiring insulin. Three models (20, 30 and 40 units/day) are available. The device is intended for use in patients with type 2 diabetes. Additional information available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K100504. A second FDA approval (K103825) came through on February 23, 2011. Additional information is available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?ID=K103825

Continuous Glucose Monitors

The GlucoWatch noninvasive continuous glucose monitor is no longer marketed in the United States.

For information on continuous glucose monitors, see the following website (use product code MDS). Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMA/pma.cfm. Accessed March 22, 2014.

The mySentry remote monitoring system received FDA approval as a supplement (S075) to Premarket Approval P980022. The device is indicated for the remote monitoring of a single Paradigm REAL-Time Revel insulin pump (MMT-523/-723/MMT-523K/-723K). The real-time glucose values provided by the monitor are not intended to be used directly for making therapy adjustments. Rather, they provide an indication that may require a confirmation fingerstick measurement. All therapy adjustments should be based on measurements obtained using a blood glucose meter and not based on the value displayed by the monitor or Paradigm REAL-Time Revel insulin pump. Additional information available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMA/pma.cfm?id=826. Accessed March 22, 2014.

Artificial Pancreas Device Systems (APDS)

The MiniMed 530G artificial pancreas device was approved by the FDA on September 26, 2013 (P120010). The device is intended for continuous delivery of basal insulin (at user selectable rates) and administration of insulin boluses (in user selectable amounts) for the management of diabetes mellitus in persons, sixteen years of age and older, requiring insulin, as well as for the continuous monitoring and trending of glucose levels in the fluid under the skin. The device can be programmed to automatically suspend delivery of insulin when the sensor glucose value falls below a predefined threshold value.

The device is not intended to be used directly for making therapy adjustments, but rather to provide an indication of when a finger stick may be required. All therapy adjustments should be based on measurements obtained using a home glucose monitor and not on values provided by the MiniMed 530G device. The device is also not intended to be used directly for preventing or treating hypoglycemia but to suspend insulin delivery when the user is unable to respond to the threshold suspend alarm to take measures to prevent or treat hypoglycemia himself. Therapy to prevent or treat hypoglycemia should be administered according to recommendations of the patient's health care provider. Additional information available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfTopic/pma/pma.cfm?num=P120010 Accessed March 22, 2014.

CENTERS FOR MEDICARE AND MEDICAID SERVICES (CMS)

Medicare does not have a National Coverage Determination (NCD) for Continuous Glucose Monitoring Systems. Local Coverage Determinations (LCDs) do not exist at this time.

Medicare covers continuous subcutaneous insulin infusion (CSII) and related drugs/supplies for the treatment of diabetic patients when criteria are met. Medicare does not cover implantable infusion pumps for the infusion of insulin to treat diabetes. Refer to the National Coverage Determination (NCD) for Infusion Pumps (280.14). Local Coverage Determinations (LCDs) exist. Refer to the LCDs for External Infusion Pumps and Implantable Infusion Pumps. (Accessed March 7, 2014)

REFERENCES

Ahmet A, Dagenais S, Barrowman NJ, et al. Prevalence of nocturnal hypoglycemia in pediatric type 1 diabetes: a pilot study using continuous glucose monitoring. J Pediatr. 2011 Aug;159(2):297-302.e1.

American Association of Clinical Endocrinologists (AACE). Medical guidelines for clinical practice for the management of diabetes mellitus. Endocr Pract. 2007 May-Jun;13 Suppl 1:1-68. Available at: https://www.aace.com/publications/guidelines . Accessed March 22, 2014.

American Association of Clinical Endocrinologists (AACE). Statement by the AACE Consensus Panel on continuous glucose monitoring. Sep/Oct 2010. Available at: http://www.aace.com/publications/position-statements. Accessed March 22, 2014.

American Association of Clinical Endocrinologists (AACE). Statement by the AACE Consensus Panel on insulin pump management. Sep/Oct 2010. Available at: http://www.aace.com/publications/position-statements. Accessed March 22, 2014.

American Association of Clinical Endocrinologists (AACE). Comprehensive diabetes management algorithm. 2013 concensus statement. May/June 2013. Available at: https://www.aace.com/publications/position-statements. Accessed March 22, 2014.

American Diabetes Association. Standards of medical care in diabetes - 2014. Available at: http://professional.diabetes.org/ResourcesForProfessionals.aspx?cid=84160. Accessed March 22, 20134

American Diabetes Association. Position Statement. Continuous subcutaneous insulin infusion. Diabetes Care 2004a;27 (suppl 1):S110. Available at: http://care.diabetesjournals.org/cgi/reprint/27/suppl_1/s110. Accessed March 22, 2014.

American Diabetes Association. Gestational diabetes mellitus. Diabetes Care. 2004b Jan;27 Suppl 1:S88-90. Available at: http://care.diabetesjournals.org/content/27/suppl_1/s88.full.pdf+html. Accessed March 22, 2014.

American Diabetes Association. Diabetes Forecast. Insulin Delivery. 2013 Consumer Guide. Available at: http://www.diabetesforecast.org/2014/Jan/. Accessed March 22, 2014.

American Medical Association (AMA). CPT Assistant. December 2009;19(12):6-8. Updated February 2010; 20(2):13.

Bailey TS, Zisser HC, Garg SK. Reduction in hemoglobin A1C with real-time continuous glucose monitoring: results from a 12-week observational study. Diabetes Technol Ther. 2007 Jun;9(3):203-10.

Battelino T, Phillip M, Bratina N, et al. Effect of continuous glucose monitoring on hypoglycemia in type 1 diabetes. Diabetes Care. 2011 Apr;34(4):795-800.

Bergenstal RM, STAR 3 Study Group et al. Effectiveness of sensor-augmented insulin pump therapy in type 1 diabetes. N Engl J Med 2010; 363:311-320.

Bergenstal RM, Klonoff DC, Garg SK, et al.; ASPIRE In-Home Study Group. Threshold-based insulin-pump interruption for reduction of hypoglycemia. N Engl J Med. 2013 Jul 18;369(3):224-32.

BlueCross BlueShield (BCBS). Technology Evaluation Center (TEC). Artificial pancreas device systems. March 2014 [in press]. Available at: http://www.bcbs.com/blueresources/tec/press/artificial-pancreas-device.html. Accessed March 22, 2014.

Bode B, Gross K, Rikalo N, et al. Alarms based on real-time sensor glucose values alert patients to hypo- and hyperglycemia: the guardian continuous monitoring system. Diabetes Technol Ther. 2004 Apr;6(2):105-13.

Buckingham B, Caswell K, Wilson DM. Real-time continuous glucose monitoring. Curr Opin Endocrinol Diabetes Obes. 2007 Aug;14(4):288-95.

Buhling KJ, Winkel T, Wolf C, et al. Optimal timing for postprandial glucose measurement in pregnant women with diabetes and a non-diabetic pregnant population evaluated by the Continuous Glucose Monitoring System (CGMS). J Perinat Med. 2005;33(2):125-31.

Chase HP, Beck RW, Xing D, et al. Continuous glucose monitoring in youth with type 1 diabetes: 12-month follow-up of the Juvenile Diabetes Research Foundation continuous glucose monitoring randomized trial. Diabetes Technol Ther. 2010 Jul;12(7):507-15.

Chase HP, Kim LM, Owen SL, et al. Continuous subcutaneous glucose monitoring in children with type 1 diabetes. Pediatrics 2001 Feb;107(2):222-6.

Chee F, Fernando T, van Heerden PV. Closed-loop control of blood glucose levels in critically ill patients. Anaesth Intensive Care. 2002;30(3):295-307.

Chetty VT, Almulla A, Odueyungbo A, Thabane L. The effect of continuous subcutaneous glucose monitoring (CGMS) versus intermittent whole blood finger-stick glucose monitoring (SBGM) on hemoglobin A1c (HBA1c) levels in Type I diabetic patients: a systematic review. Diabetes Res Clin Pract. 2008 Jul;81(1):79-87.

Chico A, Vida K, Rios P, et al. The continuous glucose monitoring system is useful for detecting unrecognized hypoglycemia inpatients with type 1 and type 2 diabetes but is not better than frequent capillary glucose measurements fir improving metabolic control. Diab Care. 2003 Apr;26(4):1153-7.

Children with diabetes. Continuous glucose sensors. Updated August 10, 2010. Available at: http://www.childrenwithdiabetes.com/continuous.htm. Accessed March 22, 2014.

Cooke D, Hurel SJ, Casbard A, et al. Randomized controlled trial to assess the impact of continuous glucose monitoring on HbA1c in insulin-treated diabetes (MITRE Study). Diabet Med. 2009 May;26(5):540-7.

Cosson E, Hamo-Tchatchouang E, Dufaitre-Patouraux L, et al. Multicentre, randomized, controlled study of the impact of continuous sub-cutaneous glucose monitoring (GlucoDay) on glycaemic control in type 1 and type 2 diabetes patients. Diabetes Metab. 2009;35(4):312-318.

Deiss D, Hartmann R, Schmidt J, Kordonouri O. Results of a randomised controlled cross-over trial on the effect of continuous subcutaneous glucose monitoring (CGMS) on glycaemic control in children and adolescents with type 1 diabetes. Exp Clin Endocrinol Diabetes. 2006a Feb;114(2):63-7.

Deiss D, Bolinder J, Riveline JP, et al. Improved glycemic control in poorly controlled patients with type 1 diabetes using real-time continuous glucose monitoring. Diabetes Care. 2006b Dec;29(12):2730-2.

Diabetes Control and Complications Trial (DCCT) Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin dependent diabetes mellitus. N Engl J Med. 1993;329:977-86.

Diabetes Research in Children Network (DirecNet) Study Group, Buckingham B, Beck RW, Tamborlane WV, Xing D, Kollman C, Fiallo-Scharer R, Mauras N, Ruedy KJ, Tansey M, Weinzimer SA, Wysocki T. Continuous glucose monitoring in children with type 1 diabetes. J Pediatr. 2007 Oct;151(4):388-93, 393.e1-2.

Diabetes Research in Children Network (DirecNet) Study Group. Use of the DirecNet Applied Treatment Algorithm (DATA) for diabetes management with a real-time continuous glucose monitor (the FreeStyle Navigator). Pediatr Diabetes. 2008 Apr;9(2):142-7.

Diabetes Research in Children Network (DirecNet) Study Group. Psychological aspects of continuous glucose monitoring in pediatric type 1 diabetes. Pediatr Diabetes. 2006;7(1):32-38.

ECRI Institute. Health Technology Forecast. Artificial pancreas (closed-loop system) for treating diabetes requiring exogenous insulin. July 2012.

ECRI Institute. Hotline Service. mySentry remote glucose monitor (Medtronic, Inc.) for accessing real-time continuous glucose and insulin pump information. April 2012.

ECRI Institute. Hotline Service. Insulin pump with continuous glucose monitoring system for managing diabetes. March 2012.

ECRI Institute. Evidence Report. Real-time continuous glucose monitoring for type 1 and type 2 diabetes. March 2010.

ECRI Institute. Product Brief. MiniMed 530G Artificial pancreas (Medtronic, Inc.) for treating diabetes. October 2013.

ECRI Institute. Health Technology Forecast. MiniMed 530G artificial pancreas (Medtronic, Inc.) for treating diabetes requiring exogenous insulin. December 2013.

ECRI Institute. Health Technology Forecast. Transermal insulin delivery for treating diabetes. April 2010.

Farrar D, Tuffnell DJ, West J. Continuous subcutaneous insulin infusion versus multiple daily injections of insulin for pregnant women with diabetes. Cochrane Database Syst Rev. 2007 Jul 18;(3):CD005542. Assessed as up-to-date September 2011.

Fatourechi MM, Kudva YC, Murad MH, Elamin MB, et al. Clinical review: Hypoglycemia with intensive insulin therapy: a systematic review and meta-analyses of randomized trials of continuous subcutaneous insulin infusion versus multiple daily injections. J Clin Endocrinol Metab. 2009 Mar;94(3):729-40.

Floyd B, Chandra P, Hall S, et al. Comparative analysis of the efficacy of continuous glucose monitoring and self-monitoring of blood glucose in type 1 diabetes mellitus. J Diabetes Sci Technol. 2012 Sep 1;6(5):1094-102.

Food and Drug Administration (FDA) website. The artificial pancreas device system (APDS). Last updated August 2013. Available at: http://www.fda.gov/MedicalDevices/ProductsandMedicalProcedures/HomeHealthandConsumer/ConsumerProducts/ArtificialPancreas/. Accessed March 18, 2014.

Garg SK, Kelly WC, Voelmle MK, et al.Continuous home monitoring of glucose: improved glycemic control with real-life use of continuous glucose sensors in adult subjects with type 1 diabetes. Diabetes Care. 2007 Dec;30(12):3023-5.

Garg S, Jovanovic L. Relationship of fasting and hourly blood glucose levels to HbA1c values: safety, accuracy, and improvements in glucose profiles obtained using a 7-day continuous glucose sensor. Diabetes Care. 2006b Dec;29(12):2644-9.

Garg S, Zisser H, Schwartz S, et al. Improvement in glycemic excursions with a transcutaneous, real-time continuous glucose sensor: a randomized controlled trial. Diabetes Care. 2006a Jan;29(1):44-50.

Golden SH, Brown T, Yeh HC, et al. Methods for Insulin Delivery and Glucose Monitoring: Comparative Effectiveness. Comparative Effectiveness Review No. 57. (Prepared by Johns Hopkins University Evidence-based Practice Center under Contract No. 290-2007-10061-I.) AHRQ Publication No. 12-EHC036-EF. Rockville, MD: Agency for Healthcare Research and Quality. July 2012. Available at: http://www.effectivehealthcare.ahrq.gov/reports/final.cfm Accessed March 22, 2014.

Golicki DT, Golicka D, Groele L, Pankowska E. Continuous Glucose Monitoring System in children with type 1 diabetes mellitus: a systematic review and meta-analysis. Diabetologia. 2008 Feb;51(2):233-40.

Halvorson M, Carpenter S, Kaiserman K, Kaufman FR. A pilot trial in pediatrics with the sensor-augmented pump: combining real-time continuous glucose monitoring with the insulin pump. J Pediatr. 2007 Jan;150(1):103-105.e1.

Handelsman Y, Mechanick JI, Blonde L, et al; AACE Task Force for Developing Diabetes Comprehensive Care Plan. American Association of Clinical Endocrinologists Medical Guidelines for Clinical Practice for developing a diabetes mellitus comprehensive care plan. Endocr Pract. 2011 Mar-Apr;17 Suppl 2:1-53. Available at: http://www.aace.com/files/dm-guidelines-ccp.pdf. Accessed March 22, 2014.

Hayes, Inc. Hayes Directory. *Implantable insulin pumps.* Lansdale PA: Hayes, Inc; June 2011. Updated July 2013.

Hayes, Inc. Hayes Directory. *Continuous glucose monitoring systems.* Lansdale, PA: Hayes, Inc; December 2010; updated December 2013.

Hirsch IB, Abelseth J, Bode BW, et al. Sensor-augmented insulin pump therapy: results of the first randomized treat-to-target study. Diabetes Technol Ther. 2008 Oct;10(5):377-83.

Hoeks LB, Greven WL, de Valk HW. Real-time continuous glucose monitoring system for treatment of diabetes: a systematic review. Diabet Med. 2011 Apr;28(4):386-94.

Hovorka R, Allen JM, Elleri D, et al. Manual closed-loop insulin delivery in children and adolescents with type 1 diabetes: a phase 2 randomised crossover trial. Lancet. 2010 Feb

27;375(9716):743-51.

Jeitler K, Horvath K, Berghold A, et al. Continuous subcutaneous insulin infusion versus multiple daily insulin injections in patients with diabetes mellitus: systematic review and meta-analysis. Diabetologia. 2008 Jun;51(6):941-51.

Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, et al. Continuous glucose monitoring and intensive treatment of type 1 diabetes. N Engl J Med. 2008 Oct 2;359(14):1464-76.

Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, Beck RW, Buckingham B, et al. Factors predictive of use and of benefit from continuous glucose monitoring in type 1 diabetes. Diabetes Care. 2009a Nov;32(11):1947-53.

Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group. The effect of continuous glucose monitoring in well-controlled type 1 diabetes. Diabetes Care. 2009b Aug;32(8):1378-83.

Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group, Bode B, Beck RW, et al. Sustained benefit of continuous glucose monitoring on A1C, glucose profiles, and hypoglycemia in adults with type 1 diabetes. Diabetes Care. 2009c Nov;32(11):2047-9.

Kestila KK, Ekblad UU, Ronnemaa T. Continuous glucose monitoring versus self-monitoring of blood glucose in the treatment of gestational diabetes mellitus. Diabetes Res Clin Pract. 2007 Aug;77(2):174-9.

Lagarde WH, Barrows FP, Davenport ML, et al. Continuous subcutaneous glucose monitoring in children with type 1 diabetes mellitus: a single-blind, randomized, controlled trial. Pediatr Diabetes. 2006 Jun;7(3):159-64.

Langendam M, Luijf YM, Hooft L, et al. Continuous glucose monitoring systems for type 1 diabetes mellitus.Cochrane Database Syst Rev. 2012 Jan 18;1:CD008101.

Larsen J, Ford T, Lyden E, et al. What is hypoglycemia in patients with well-controlled type 1 diabetes treated by subcutaneous insulin pump with use of the continuous glucose monitoring system? Endocr Pract. 2004 Jul-Aug;10(4):324-9.

Ludvigsson J, Hanas R. Continuous subcutaneous glucose monitoring improved metabolic control in pediatric patients with type 1 diabetes: a controlled crossover study. Pediatrics. 2003 May;111(5 Pt 1):933-8.

Ly TT, Nicholas JA, Retterath A, et al. Effect of sensor-augmented insulin pump therapy and automated insulin suspension vs. standard insulin pump therapy on hypoglycemia in patients with type 1 diabetes: a randomized clinical trial. JAMA. 2013 Sep 25;310(12):1240-7.

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 Feb;35(2):204-10.

Murphy HR, Rayman G, Lewis K, et al. Effectiveness of continuous glucose monitoring in pregnant women with diabetes: randomised clinical trial. BMJ. 2008 Sep 25;337:a1680.

National Institute for Health and Care Excellence (NICE). CG15. Type 1 diabetes: diagnosis and management of type 1 diabetes in children, young people and adults. July 2004. Updated May

2012. Available at: http://guidance.nice.org.uk/CG15/NICEGuidance/pdf/English. Accessed March 22, 2014.

Patton Medical Devices website. http://www.i-port.com/ Accessed March 22, 2014.

Pickup JC, Sutton AJ. Severe hypoglycaemia and glycaemic control in Type 1 diabetes: meta-analysis of multiple daily insulin injections compared with continuous subcutaneous insulin infusion. Diabet Med. 2008 Jul;25(7):765-74.

Pickup J, Mattock M, Kerry S. Glycaemic control with continuous subcutaneous insulin infusion compared with intensive insulin injections in patients with type 1 diabetes: meta-analysis of randomised controlled trials. BMJ. 2002;324:705.

Pohar SL. Subcutaneous open-loop insulin delivery for type 1 diabetes: Paradigm Real-Time System. Issues Emerg Health Technol. 2007 Oct;(105):1-6.

Raccah D, Sulmont V, Reznik Y, et al. Incremental value of continuous glucose monitoring when starting pump therapy in patients with poorly controlled type 1 diabetes: the RealTrend study. Diabetes Care. 2009 Dec;32(12):2245-50.

Sachedina N, Pickup JC. Performance assessment of the Medtronic-MiniMed continuous glucose monitoring system and its use for measurement of glycaemic control in type 1 diabetic patients. Diabet. Med. 2003; 20(12):1012-1015.

Silverstein J, Klingensmith G, Copeland K, et al. Care of children and adolescents with type 1 diabetes: a statement of the American Diabetes Association. Diabetes Care. 2005 Jan;28(1):186-212.

Steil GM, Rebrin K, Darwin C, et al. Feasibility of automating insulin delivery for the treatment of type 1 diabetes. Diabetes. 2006;55(12):3344-3350.

Szypowska A, Ramotowska A, Dzygalo K, Golicki D. Beneficial effect of real-time continuous glucose monitoring system on glycemic control in type 1 diabetic patients: systematic review and meta-analysis of randomized trials. Eur J Endocrinol. 2012 Apr;166(4):567-74.

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(12):1521-1526.

Valeritas, Inc. website. https://www.go-vgo.com/. Accessed March 22, 2014.

Vigersky RA, Fonda SJ, Chellappa M, et al. Short- and long-term effects of real-time continuous glucose monitoring in patients with type 2 diabetes. Diabetes Care. 2012 Jan;35(1):32-8.

Weinzimer SA, Steil GM, Swan KL, et al. Fully automated closed-loop insulin delivery versus semiautomated hybrid control in pediatric patients with type 1 diabetes using an artificial pancreas. Diabetes Care. 2008;31(5):934-939.

Weinzimer S, Xing D, Tansey M, Fiallo-Scharer R, et al.; Diabetes Research in Children Network (DirecNet) Study Group. FreeStyle navigator continuous glucose monitoring system use in children with type 1 diabetes using glargine-based multiple daily dose regimens: results of a pilot trial Diabetes Research in Children Network (DirecNet) Study Group. Diabetes Care. 2008 Mar;31(3):525-7.

Yates K, Milton AH, Dear K, Ambler G. Continuous glucose monitoring-guided insulin adjustment in children and adolescents on near-physiological insulin regimens. Diabetes Care.

2006;29:1512-1517.

Yogev Y, Chen R, Ben-Haroush A, et al. Continuous glucose monitoring for the evaluation of gravid women with type 1 diabetes mellitus. Obstet Gynecol. 2003;101(4):633-638.

Yoo HJ, An HG, Park SY, et al. Use of a real time continuous glucose monitoring system as a motivational device for poorly controlled type 2 diabetes. Diabetes Res Clin Pract. 2008;82:73-79.

Zick R, Petersen B, Richter M, Haug C. Comparison of continuous blood glucose measurement with conventional documentation of hypoglycemia in patients with Type 2 diabetes on multiple daily insulin injection therapy. Diabetes Technol Ther. 2007;9(6):483-492.

POLICY HISTORY/REVISION INFORMATION

Date	Action/Description
07/01/2014	• Updated list of applicable HCPCS codes to reflect quarterly code edits (effective 07/01/2014); added S1034 – S1037 • Archived previous policy version 2014T0347O