

Continuous glucose monitors in diabetes mellitus – the Continuous Glucose Monitoring System (CGMS)

Issues for health service planners and practitioners

1 Use of continuous glucose monitoring systems

- 1.1 In Scotland, it is estimated that 153,000 people have diabetes (3% of population) and this figure is expected to double over the next 10–15 years.¹
- 1.2 It is well established that maintaining strict glycaemic control reduces the risk of long-term complications associated with diabetes.^{2,3} Intensive self monitoring of blood glucose by frequent fingerstick testing and periodic testing of glycated haemoglobin (HbA1c) has a key function in managing glycaemic levels in people with diabetes. However, glycaemic oscillations, particularly nocturnal episodes of hypoglycaemia, can often go undetected by current self-monitoring methods.⁴
- 1.3 Continuous glucose monitors profile variations in glucose levels over an evaluation period. A variety of glucose monitoring devices are available for both clinical and experimental use, with some devices more invasive than others. Three minimally-invasive enzymatic glucose sensor devices exist: the Continuous Glucose Monitoring System[®] (CGMS) (Medtronic-MiniMed), GlucoWatch Biographer[®] (Cygnus) (although this device was recently withdrawn from the UK market) and GlucoDay[®] (Menarini Diagnostics). This evidence note focuses on the CGMS, for which most clinical evidence was available.
- 1.4 The CGMS consists of a disposable glucose sensor that is inserted subcutaneously into the abdomen and wired to a monitor worn externally. A chemical reaction at the site of the sensor generates measurable current, which is proportional to the concentration of interstitial fluid glucose in skin cells. Readings from 2.2 to 22 mmol/L (40 to 400 mg/dL), measured every 10 seconds and averaged over 5 minutes, and programmed events such as insulin injections, meals, hypoglycaemic episodes and exercise are stored in the monitor's memory. The data collected over the recommended 72-hour period are downloaded to a computer and reviewed retrospectively by a healthcare professional. Therefore, the patient has no access to real-time glucose recordings.^{4,5} The CGMS requires rigorous calibration with blood glucose measurements obtained by fingerstick testing, at least four times per day⁶, and as such, necessitates a trained user.
- 1.5 A CGMS has a life expectancy of 3–5 years and can be used by several patients in a diabetes department.^{6,7} A Committee for Evaluation and Diffusion of Innovative Technologies (CEDIT) report estimated that 5–8 monitors would allow follow up of 220 diabetes patients in one year.⁷
- 1.6 The cost of the CGMS covers the monitor, a communications station, software, a senserter (to facilitate sensor insertion), a shower pack and a box of sensors.⁸ In addition, there are ongoing costs for disposable sensors (worn for up to 72 hours but limited to once-only use) and batteries for the monitor.
- 1.7 There are several limitations of the CGMS, such as the measurement of glucose in subcutaneous interstitial fluid rather than in capillary blood and a lack of real-time glucose measurement. Furthermore, sudden temperature changes, excess perspiration and strong electromagnetic forces may affect the CGMS function.⁵

2 Issues for service development or review

- 2.1 The manufacturer recommends that the CGMS is intended for occasional rather than everyday use and the information provided by the CGMS is to supplement – and not replace – blood glucose information from conventional home monitoring methods.⁴ The information provided by the CGMS is intended to guide future therapeutic management, for example, to alter timing of fingerstick testing and to adjust therapy accordingly in order to reduce frequency of hypo- and hyperglycaemic episodes. CGMS use is contraindicated in people with auditory or visual limitations.⁶

Further information

- 1 See Scottish Diabetes Survey 2002, www.scotland.gov.uk/library5/health/sds02-00.asp
- 2 See UKPDS Group (1998), Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with Type 2 diabetes (UKPDS 33). *Lancet* **352**: 837-53.
- 3 See DCCT Group (1993), The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Eng J Med* **329**: 977-86.
- 4 See Blue Cross and Blue Shield Association, Use of intermittent or continuous interstitial fluid glucose monitoring in patients with diabetes mellitus, www.bcbs.com/tec/Vol18/18_16.pdf
- 5 See CCOHTA, Continuous glucose monitoring in the management of diabetes mellitus, Issues in Emerging Technologies, May 2002, Issue 32.
- 6 See ECRI, Continuous subcutaneous glucose monitoring system for diabetes patients, 2001 (Target report no 519).
- 7 See CEDIT, Glycemic Holter, 2002, <http://cedit.ap-hop-paris.fr>
- 8 See Medtronic MiniMed UK Insulin Pump Therapy and Continuous Glucose Monitoring Price List, 1 May 2004.

See NICE, Type 1 diabetes: diagnosis and management of Type 1 diabetes in children, young people and adults, www.nice.org.uk/pdf/CG015NICEguideline.pdf

- 2.2 The CGMS is likely to be of greatest use in people with Type 1 diabetes, or Type 2 diabetes on insulin. Two health evaluation organisations suggested that continuous glucose monitors may benefit select diabetic populations such as people with nocturnal hypoglycaemia, people with asymptomatic hypoglycaemia, people whose glucose levels are difficult to control regardless of therapeutic adjustment, people with unexplained large fluctuations in pre-prandial glucose levels, people starting or changing insulin regimens and during the initiation or monitoring of insulin pump use.^{5,6}
- 2.3 The National Institute for Clinical Excellence (NICE) guideline on Type 1 diabetes recommends the use of continuous glucose monitoring systems in adults on insulin therapy who have consistent problems with controlling blood glucose level, in particular, “repeated hypo- and hyperglycaemia at the same time each day, and hypoglycaemia unawareness, unresponsive to conventional insulin dose adjustment”. The guidance also recommends that continuous glucose monitoring systems be offered to children and young people with Type 1 diabetes who have persistent problems with impaired awareness of hypoglycaemia or repeated hypo- and hyperglycaemia.⁹
- 2.4 Evidence on safety of the CGMS is limited to Phase 2 trials, with adverse effects of redness, bleeding, bruising and discomfort at the site of sensor insertion reported.⁵
- 2.5 Studies have reported close correlation of glucose levels (correlation coefficient >0.85) as measured by the CGMS compared with conventional fingerstick testing.^{4,5} However, one small study reported only 65% concordance of results from two CGMS sensors worn simultaneously during an evaluation period.⁶
- 2.6 To date, the best available evidence on the effects of using the CGMS on diabetes-related morbidity uses HbA1c as a surrogate outcome. The effect on HbA1c of adding the CGMS to conventional treatments is reported in several randomised controlled trials (RCTs), each with at least one methodological weakness and primarily involving people with Type 1 diabetes. Three of four RCTs, including the largest trial (n=128), did not show statistically significant differences in glycaemic control as measured by HbA1c with CGMS in addition to conventional fingerstick testing compared with fingerstick testing alone. In the RCT reporting positive results, the improvement in HbA1c in the treatment group was small ($\leq 0.5\%$), with an increase in HbA1c in the control group contributing to the statistically significant difference between groups.⁴ However, a health services research organisation suggested that increased scrutiny by a healthcare professional of glycaemic levels recorded by the CGMS may have led to increased patient compliance and thus improved control in these trials.⁶
- 2.7 While there is some evidence that the use of CGMS increased identification of hypo- and hyperglycaemic episodes that would otherwise have remained undetected by intermittent fingerstick testing, no studies have been identified that demonstrate the use of the CGMS altered the frequency or severity of clinically significant, symptomatic glycaemic events.⁴
- 2.8 A small RCT showed no significant improvement in quality of life with the CGMS.⁴
- 2.9 Although the use of the CGMS increases the cost of diabetes care, the long-term economic benefits of continuous glucose monitoring systems are anticipated to be lower costs associated with fewer long-term diabetes complications due to improved glycaemic control.^{6,7} Currently, there is a paucity of evidence on the cost effectiveness of the CGMS.

3 Further research

- 3.1 There is a need for a well-designed and adequately powered RCT to evaluate whether continuous glucose monitoring devices can improve long-term patient outcomes and produce sustained benefit with regards to glycaemic control.
- 3.2 The NICE guidance on Type 1 diabetes in childhood recommends that the effectiveness of invasive compared with non-invasive continuous blood glucose monitoring systems is evaluated in children and young people with Type 1 diabetes.⁹
- 3.3 An economic evaluation to establish the cost effectiveness of the CGMS both in the short and long term is also required.

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**Glasgow Office ~
Delta House
50 West Nile Street
Glasgow G1 2NP
Tel 0141 225 6999
Fax 0141 228 3778**

comments@nhshealthquality.org
www.nhshealthquality.org