Use of technology in type 2 diabetes management

Clinical context

Recently there has been an acceleration of uptake of technology for managing diabetes: as an adjunct to conventional therapy, to improve self-management and to provide education. This presents both challenges and opportunities for general practitioners (GPs) and their patients.

The technology available to help manage diabetes falls into three main categories:

- Information technology – such as mobile phone apps, SMS messaging, wearable technology (eg fitness trackers, smartwatches), web-based programs and clinic-based chronic disease care programs
- Technological innovations for monitoring of glycaemia – such as continuous glucose monitoring (CGM) and flash glucose monitoring, which provide greater insights into glycaemic patterns
- Technology for medication delivery – such as evolving insulin pen devices and continuous subcutaneous infusion of insulin (insulin pumps). Although insulin pumps have, traditionally, been used mainly by people with type 1 diabetes, they are increasingly being used in type 2 diabetes

Information technology

A recent meta-analysis found that information technology such as mobile phone apps and web-based applications combined with standard diabetes care resulted in clinically significant reduction in glycated haemoglobin (HbA1c) in people with type 2 diabetes.[1] Additionally, there is emerging evidence that information technology interventions are associated with:

- reduced sedentary behaviour (computer, mobile and wearable technologies)[2]
- increased physical activity (online self-tracking program)[3]
- improvements in diet and exercise, including understanding of nutrition (counselling delivered via mobile phone messaging).[4]

Continuous glucose monitoring

What is it?

CGM involves a small sensor being implanted in the subcutaneous tissue to monitor interstitial glucose. 'Real-time' CGM continuously records and reports glucose levels, with some devices using alarms to alert users to hypoglycaemia or hyperglycaemia. CGM measures interstitial glucose, and therefore is not the same as capillary blood glucose measurement, which remains the standard for confirmation of high and low blood glucose levels and treatment decisions.

Flash glucose monitoring (FGM), also called 'intermittently viewed CGM', uses a disc device, worn on the arm, that can be scanned with a reader to obtain interstitial glucose results instantly.[5] Currently, these devices do not alert the user to either low or high blood glucose levels.

How does it help?

HbA1c is the standard for assessing long-term glycaemic control; however, it does not reflect within-day and day-to-day glycaemic variability that might lead to hypoglycaemia or postprandial hyperglycaemia.[6]

CGM can be a useful clinical tool to detect glycaemic patterns, and evaluate quality of glycaemic control, glycaemic variability and patterns of hypoglycaemia.

Increasingly, standardised reporting that uses the ambulatory glucose profile (AGP) is being adopted. AGP represents the modal distribution of interstitial glucose in a graphic form, which allows identification of issues such as hypoglycaemic risk, glycaemic variability and excessive glycaemic excursions, which informs clinical intervention such as modifying pharmacotherapy or implementing medical nutrition therapy.

The minimum duration of CGM to obtain enough data to effectively characterise and interpret glycaemia patterns has been reported as at least 14 days.[7]

Accuracy of CGM

The accuracy of CGM is often reported as the 'mean absolute relative difference' (MARD) between the CGM system values and matched reference values. A MARD of 10% is considered desirable.[7]

To be accurate, real-time CGM requires calibration with self-monitoring of blood glucose (SMBG). Calibration is best performed when glucose levels are not changing rapidly.[6]

FGM sensors do not require calibration; however, discrepancy with SMBG can occur when glucose levels are changing rapidly or in a lower glucose range. Compression on the sensor (eg when lying on it while asleep) can lead to false reporting of hypoglycaemia, due to restriction of flow of interstitial fluid around the sensor. Glucose levels should be confirmed with a finger-prick test if:[5]

- glucose levels are changing rapidly
- sensors indicate hypoglycaemia or possible hypoglycaemia
- a person displays symptoms inconsistent with reported glucose levels.

Continuous subcutaneous insulin infusion (insulin pumps)

Continuous subcutaneous insulin infusion (CSII) allows for more controlled delivery of insulin compared with injectable insulin, particularly for basal insulin. Pumps deliver basal plus bolus (prandial and correction) doses that can be programmed to change in response to the user's changing needs (eg mealtimes, exercise).

In practice

Mobile apps, web-based programs, text messaging

Many practices already use web- and phone-based messaging for recalls, reminders and appointment scheduling.

More work needs to be done to determine the most effective interventions and the optimal integration of technology with validated models of care for chronic disease management.

CGM and CSII

The decision to implement CSII or CGM is a case-by-case assessment based on cost–benefit analysis, individualising the decisions according to patient's needs, wishes and capacity. These technologies can be costly and resource intensive, and might increase stress and distress to the patient.

The introduction, implementation and ongoing use of any complex technology requires high levels of professional support to instruct users about the appropriate use and interpretation of outcomes.[8,9]

Clinicians who recommend these technologies should be experienced in their use or co-opt experts in the domain (endocrinologists, credentialled diabetes educators). The National Association of Diabetes Centres has developed national standards for diabetes technology.

Individuals who might benefit most from CGM or FGM are those:[7]

- at high risk of hypoglycaemia
- with hypoglycaemic unawareness
- with high glycaemic variability.

Intermittent use of CGM or FGM by the patient can be a useful adjunct to SMBG.

Those likely to benefit from CSII most are those:

- with the poorest glycaemic control
- with recurrent hypoglycaemia
- who are engaged with the additional offerings of the technology beyond insulin delivery.

When paired with CSII, the benefits of CGM are added to those of CSII.

Potential barriers include:

- cost (insulin pumps are covered by most private health insurers, but consumables are not; the National Diabetes Services Scheme subsidises consumables only for type 1 diabetes)
- lack of technical or IT literacy (users need to navigate pump menus, upload pump and/or CGM data, be able to 'troubleshoot')
- level of clinical and technological support that is required from family, healthcare professionals and purveyors of technology
- the dexterity required to apply infusion sets, CGM sensors and transmitters.

Recommended glycaemic targets for users of CGM/FGM with type 1 or type 2 diabetes (not during pregnancy) are as follows.[10]

- Time in range – a target of 3.9 mmol/L to 10 mmol/L should be maintained at least 70% of the time.
- Time below range – blood glucose levels <3.9 mmol/L should occur for less than 4% of the day (approximately one hour); very low levels (<3.0 mmol/L) should occur for no more than 1% of the day (15 minutes).
- Time above range – blood glucose levels >10 mmol/L should occur less than 25% of the time; very high levels (>13.9 mmol/L) should occur less than 5% of the time.

The following targets are recommended for older or high-risk individuals with type 1 or type 2 diabetes.[10]

- Time in range – a target of 3.9 mmol/L to 10 mmol/L should be maintained more than 50% of the time.
- Time below range – avoiding hypoglycaemia is a priority in this population, so blood glucose levels <3.9 mmol/L should occur for less than 1% of the day, or 15 minutes.
- Time above range – very high blood glucose levels of >13.9 mmol/L should be allowed for less than 10% of the time.

Battelino et al[10] have published detailed information about clinical glucose targets for CGM.

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