Integrating technology into routine clinical care

Type 1 diabetes is one of the most common chronic childhood diseases and its incidence appears to be rising (Cizza et al, 2012). The intensive treatment regimen for type 1 diabetes is complex. Modern management demands that multiple daily doses of insulin are administered (either by subcutaneous injections or by an insulin pump), blood glucose levels are monitored frequently, carbohydrate intake is accounted for, and that insulin doses are adjusted based on blood glucose levels, daily changes in diet and levels of activity. Metabolic control often deteriorates during adolescence, making management even more challenging. This deterioration is due to the insulin resistance (Amiel et al, 1986) and hormonal changes we see in association with puberty. These physiological changes are coupled with increasing self-management autonomy that often leads to lower adherence to the treatment regimen (Rausch et al, 2012).

Moreover, there is now substantial evidence demonstrating the relationship between glucose control and the development of diabetic complications (The Diabetes Control and Complications Trial Research Group [DCCT], 1993; The DCCT/Epidemiology of Diabetes Interventions and Complications [EDIC] Research Group, 2003). As a result, current standards of diabetes management reflect the need to "normalise" blood glucose levels as safely as possible. Clinically, this can increase the risk of the patient developing hypoglycaemia. This is the most feared complication of type 1 diabetes by both the patient and their family. Night-time is of considerable concern because of the risks of developing nocturnal hypoglycaemia (Barnard et al, 2014). It has been reported that the most severe hypoglycaemic episodes in children occur overnight, accounting for 75% of all hypoglycaemic seizures (Davis et al, 1997).

It is well recognised in clinical practice just how difficult it is for those in our care to achieve blood glucose levels that are near "normal" without experiencing significant hypoglycaemic episodes. It is hoped that the development of modern medical technologies and their introduction into routine clinical care may help children and teenagers with type 1 diabetes and their families cope with the intensive management regimens without the daily fear of hypoglycaemia.

Recently, there have been paediatric studies that have evaluated the implications and advantages of using real-time continuous glucose monitoring (CGM) that provides 24-hour glucose monitoring alone as both a diagnostic and therapeutic tool, or as part of pump therapy with or without sensor augmentation.

The use of insulin pump therapy is gradually increasing in clinical practice in the UK. A national audit carried out in our paediatric population revealed this to be 19% (Diabetes UK, 2013). Furthermore, a recent exercise benchmarking the National Paediatric Diabetes Audit (Royal College of Paediatrics and Child Health and Healthcare Quality Improvement Partnership, 2013), the DPV Register in Germany and Austria, and the T1D Exchange in the USA, shows that the use of insulin pumps in England and Wales is more than 50% lower than in these other countries (Maahs et al, 2014).

The use of sensor-augmented pumps in clinical care, both in paediatric and adult practice, is also increasing as it is recognised that, if used safely and effectively, they can lead to improved HbA_{1c} values without increasing the risks of hypoglycaemia (Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group et al, 2008; Bergenstal et al, 2010).

There is now a huge interest in the development of the closed-loop insulin delivery system, or "artificial pancreas" as it is often referred to (Hovorka et al, 2011). This involves the individual wearing

Fiona Campbell
National Clinical Lead for the Children and Young People's Diabetes Network and Peer Review Quality Assurance Programme, NHS England

Sheridan Waldron
Education Lead for Children and Young People, hosted by West Midlands Strategic Clinical Network

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an insulin pump and a sensor that communicate with each other to adjust insulin requirements in real time. It is hoped that these systems could take over the decision-making process and, by applying sophisticated computer algorithms, determine how much insulin is needed at any given time, thereby potentially solving the problems of hyperglycaemia and hypoglycaemia that we currently see in clinical practice. Recently published data suggest that we may indeed be close to a product that can be introduced into clinical practice outside of the research setting (O'Grady et al, 2012). It is clear, however, that, despite the proven clinical benefits of continuous subcutaneous insulin infusion and CGM, psychological and behavioural barriers are still very likely to limit their benefits. It will be vital that children, young people and their families receive ongoing support and education from trained multidisciplinary diabetes teams when these new advances in technology enter routine clinical practice. ■

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