

Experiences with flexible insulin regimens for children

Frances Robson, Carole Gelder

More than 10 years after the main findings of the Diabetes Control and Complications Trial (DCCT) were published (DCCT Research Group, 1993), recommended levels of HbA_{1c} are not being achieved: recent audit data showed that 80 % of children with type 1 diabetes in the UK were not achieving an HbA_{1c} target of 7.5 % (National Clinical Audit Support Programme, 2005). Furthermore, the National Service Framework for diabetes (Department of Health, 2001) reported a significantly reduced lifespan and a high risk of complications in people with type 1 diabetes. With these points in mind, since the launch of insulin glargine in 2002, and the subsequent launch of insulin detemir in 2004, the Leeds Paediatric Diabetes team has actively encouraged the use of flexible insulin regimens throughout their caseload. Of a caseload of 270 children under 17 years of age, 75 % are on flexible insulin administration, including continuous subcutaneous insulin infusion. Flexible methods of insulin administration have been beneficial among all age groups, both in those with established diabetes and, more recently, from diagnosis. Frances Robson and Carole Gelder report on their experiences with flexible insulin regimens for children.

Multiple daily injections (MDI) of insulin for diabetes are possible in children of all ages, from diagnosis, in a variety of families with a range of abilities. Mealtimes flexibility and spontaneity in family lifestyle can remain; changes to these can often be hard to instigate with traditional regimens and can affect the whole family. In our experience, people with established diabetes can feel liberated from their rigid lifestyles when converted to MDI.

Essential elements of MDI treatment

Carbohydrate counting

Carbohydrate counting is a very useful tool in maximising the potential benefits of MDI treatment. This has become easier because of the introduction of extensive food labelling, something that did not exist in the previous incarnation of carbohydrate counting (in the 1970s and 1980s, restricting carbohydrate intake was a major part of blood glucose control).

In terms of teaching carbohydrate counting, and dietetic education in general, a lack of

Article points

1. Multiple daily injections (MDI) of insulin for diabetes are possible in children of all ages, from diagnosis.
2. Carbohydrate counting is a very useful tool in maximising the potential benefits of MDI treatment.
3. MDI can comprise three or four injections and children can swap between the two.
4. Flexible insulin regimens have also been introduced for children who have diabetes secondary to other conditions.
5. The benefits of eating flexibly relative to the inconvenience of four injections each day should not be underestimated, even if HbA_{1c} does not improve significantly.

Key words

- Flexible insulin regimens
- Multiple daily injections
- Education
- Self-management

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Table 1. Components of the dietetic teaching sessions.

- Identification of carbohydrate foods
- Carbohydrate counting within the context of healthy eating
- Interpreting food labels
- Making use of food tables and commercially available books
- Calculating carbohydrate values of food eaten during the previous day
- Understanding insulin-to-carbohydrate ratios
- Knowing how much insulin to use

designated dietetic time can pose problems. This was the case in our service in 2002. In the service, group education was seen as the most time-effective way to see large numbers of children wishing to change to MDI.

A teaching programme was established and the aim was to be able to deliver it within 1 hour. This was taken out of clinic time as there was no additional dietetic funding available. Consultant paediatricians supported this agreement as a way of supporting new treatment options to improve glycaemic control. The components of the teaching sessions are shown in *Table 1*.

Children and families who were commenced on MDI at diagnosis received the same teaching programme during their inpatient stay, but delivered on a one-to-one basis. Ward staff were trained in carbohydrate counting, which has enabled them to teach about it and increased opportunities for children and families to practise after diagnosis in a supported environment.

We feel very strongly that the basic messages of healthy eating should not be ignored when addressing carbohydrate counting. Children are not told 'Eat what you like.' And treats are allowed at the discretion of parents, allowing them to make the decision of frequency, while informing them of how to add sufficient insulin. In addition, the wider health messages regarding fats, vitamins and minerals are just as important as quantifying carbohydrate, we believe.

Rapid-acting insulin can be given before or after the meal. Before the meal is ideal, but if an individual's appetite is variable then

insulin can be given after the food has been consumed (Danne et al, 2003a). Insulin-to-carbohydrate ratios are checked by preprandial and postprandial blood glucose monitoring of a meal with a high or medium glycaemic index (one that is bread or potato based). It has been recommended that preprandial blood glucose levels should be 4–8 mmol/l, while postprandial levels should be under 10 mmol/l (NICE, 2004).

Most families are taught to use 1 U insulin per 10 g carbohydrate to make the insulin dose easier to calculate. This is very important within group teaching, where mathematical abilities will differ and difficult concepts may alienate some people. When different ratios are required, assistance is given to individuals based on what they have already learned.

We have found that small snacks (with 10–20 g carbohydrate) can be consumed without the need for extra insulin, but they are not necessarily required for maintaining blood glucose levels in older children; this is in contrast with twice-daily regimens, when they are generally required (International Society for Pediatric and Adolescent Diabetes, 2000). Younger children (those aged between 4 and 6 years) require these snacks to meet their energy requirements, irrespective of having diabetes (British Nutrition Foundation, 2004).

MDI can comprise three or four injections

Some children are too young to inject in school because of their ability to self-manage or their level of manual dexterity, but they can still benefit from flexibility after school for a number of reasons. The evening meal is typically where there is most variation in food, children may participate in after-school activities, and nocturnal hypoglycaemia can be a major cause of concern.

In our experience, by using a mixed insulin pre-breakfast, the need for an injection in school is eliminated. Rapid-acting insulin can be given at the evening meal (including a correction dose if necessary) and tailored to the meal using carbohydrate counting. A long-acting analogue is given at bedtime with a dose that results in a fasting pre-

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2. Making insulin doses easy to calculate is important within group teaching, where mathematical abilities will differ and difficult concepts may alienate some people.
3. Some children are too young to inject in school because of their ability to self-manage or their level of manual dexterity, but they can still benefit from flexibility after school.

breakfast blood glucose level of 5–8 mmol/l. We have found this to be achievable with less nocturnal hypoglycaemia, in children of all ages, than was previously achieved with a mixed insulin. This is supported by Schober et al (2001), Danne et al (2003b) and Robertson et al (2004).

Children aged 11 or older are always encouraged to use a minimum of four injections per day, but the three-injection option could be considered if they are unwilling to inject at school. In children undergoing puberty, we have found this three-injection option to be much less effective and very much a compromise.

Correction doses, added to meal-time boluses, are encouraged for occasional high preprandial blood glucose measurements. If regular correcting is needed, though, the basal analogue dose is reviewed and then the insulin-to-carbohydrate ratio or mixed insulin dose is looked at. To calculate insulin sensitivity, in terms of how much 1 U insulin will lower blood glucose by (in mmol/l), we either divide 100 by the total daily dose (in U; Denker et al, 2005) or use the ratios 1 U:5 mmol/l for those under 11 years old and 1 U:2.5 mmol/l for those who are 11 years or older.

Children can swap between three and four injections

In our experience, children using three injections for school days can successfully swap to four injections at weekends and holidays, when they are with their family. This helps to maintain carbohydrate counting skills, and allows the family greater lifestyle flexibility. Often, parents report better blood glucose results during this time and reconsider the number of injections for school days. As children gain knowledge, skills and confidence, the introduction of a lunch injection with school supervision becomes a logical next step towards independence.

Consider self-injection at school from the age of 7 years, with supervision

It should not be assumed that schools will be unwilling to support and supervise children

in self-management. It is part of the role of the children's diabetes specialist nurse to provide schools with information on why blood glucose monitoring and injecting insulin during the school day are now being suggested. Education can assist staff with informed decision-making and recognition that self-monitoring and self-injection is in the best interest of the child. As a general rule, we have expected schools to support the child's gradual move to independence through school, mirroring the move which is occurring simultaneously out of school.

Consider MDI from diagnosis in children of all ages

Newly diagnosed teenagers in our area have been started on four insulin injections a day since 2003. We feel that if they have never known any different form of diabetes treatment, it would be relatively easy to accept this as part of their diabetes care. This is supported by Diabetes UK consensus guidelines (Diabetes UK, 2003), which identify the period immediately after diagnosis as an optimal time for learning. The National Institute for Health and Clinical Excellence (NICE; formerly the National Institute for Clinical Excellence) has since recommended that all children over 11 years be started on MDI from diagnosis (NICE, 2004).

We believe that it should not be assumed that certain families will be unable to cope with more intensive regimens or that the age of a child should be a barrier to MDI treatment. The majority of families in our area have been offered, and chosen, MDI after diagnosis, as it has meant less disruption to family lifestyle, particularly with meal timings and food choice.

Starting an individual on a flexible regimen usually extends his or her inpatient stay by 24 hours to allow sufficient dietary education and practice with insulin adjustment. The ward staff are actively involved in the carbohydrate counting education at meal times to maximise learning opportunities prior to discharge.

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3. The National Institute for Health and Clinical Excellence recommends that all children over 11 years be started on MDI from diagnosis.
4. Starting an individual on a flexible regimen usually extends his or her inpatient stay by 24 hours to allow sufficient dietary education and practice with insulin adjustment.

Administration of variable doses of insulin in the ward environment has led to the development of a new prescription chart, initiated by the ward staff and Paediatric Diabetes team, in collaboration with paediatric pharmacists. The prescription chart includes an insulin-to-carbohydrate ratio, a correction dose factor and a maximum single dose as a safety measure. This has been developed further for insulin pumps. The charts have been approved by the Leeds Teaching Hospital NHS Trust Drugs and Therapeutics Committee and have transformed practice in supporting inpatient management of MDI regimens for paediatric inpatients.

MDI for people with secondary diabetes

Flexible insulin regimens have been introduced for children who have diabetes secondary to other conditions (cystic fibrosis and cancer) and after liver and renal transplants. For those with cystic fibrosis, in particular, flexible regimens have been essential for controlling blood glucose without compromising nutrition. The presence of cystic fibrosis-related diabetes (CFRD) has an impact on the risk of severe lung disease and reduced survival rate (Koch et al, 2001), so it is essential to optimise treatment by attempting to match insulin to food.

Children with CFRD do not face the same dietary restrictions as those with 'true' diabetes, they may be taking nutritional supplements and they are actively encouraged to snack between meals. Soluble insulin is often used at meal times for its longer mode of action, to cover the additional eating periods that would be missed by rapid-acting insulin. This is preferable, we feel, as children may be deterred from snacking if it meant an additional injection of rapid-acting insulin.

MDI and self-management

The philosophy of empowerment is crucial to diabetes self-management and has been recognised as such by the National Service Framework (NSF) for diabetes (DoH, 2001). Standard 6 of the NSF for children, young

people and maternity services (in which 'children' are under 11 years old, while 'young people' are aged 11–17; DoH, 2004) states that:

- children and young people with long-term conditions should be helped to participate fully in life
- children, young people and parents should be involved in decisions about care
- healthcare professionals should be supporting self-care.

Conversations in our clinic about problem solving for MDI regimens are now interactive rather than didactic. They encourage shared responsibility with the family (or interdependence) – rather than early independence – which supports all three of the above points. As children grow and develop, educational needs will change; it is essential that knowledge is reviewed annually in accordance with the NSF for diabetes (DoH, 2001) and Diabetes UK and DoH (2005) guidelines.

Flexible insulin regimens have the potential to improve lifestyle to the benefit of the child and family. For example, MDI facilitates participation in sport at every level with fewer adverse consequences of hypoglycaemia (Gallen, 2003). We therefore should not underestimate the benefits of eating flexibly compared with the inconvenience of four injections each day, even if HbA_{1c} does not improve significantly.

Conclusions

Diabetes is a chronic condition that affects many aspects of a person's life. Consequently, many changes are needed to make diabetes fit in. The child and family require sufficient information to make an informed decision as to which treatment option may be best; it cannot be assumed that certain regimens and behaviours are necessary or are not possible.

MDI regimens will increase demands on the team, child and family initially, but will ultimately become part of usual practice. HbA_{1c} values may improve initially, although this is not always sustainable throughout puberty. Group sessions can be initiated

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with limited dietetic resources if the team is willing to review and make changes to usual practice to release the dietitian from allotted clinic time. Resources may need to be reviewed and ward staff educated. All this will take time, but rewards come from individuals' increased confidence in self-management and their anecdotal evidence of improved lifestyles. Of course, evidence from a robust research study would be preferable to anecdotal evidence.

However, despite the paediatric diabetes centre in Leeds being one of the largest in the country, the sample size has been too small for us to carry out a robust research study. Maybe a multicentre study is thus called for. Based on our experience, any study of this subject area should incorporate a paediatric quality-of-life measurement tool in order to capture some of the aspects of lifestyle that can be more difficult to measure. ■

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