II Strict glycaemic control

The management of children with diabetes mellitus requires more than the control of blood glucose concentrations. We would like to see individual diabetic children achieving their full potential in education, sport, social activities, and employment and hope that our professional advice to them will not adversely affect these goals, their happiness, and that of their families. The track record of conventional management is appalling, however, in failing to prevent the later complications of diabetes, and many¹ now interpret the body of evidence from retrospective and prospective studies in man and animal experimentation as supporting the hypothesis that this failure is in part due to the unphysiological metabolic control achieved.

Home blood glucose monitoring

The use of home blood glucose measurement is well established in most children's diabetic clinics and has been reviewed in this journal.² Undoubtedly, the technique has led to a better understanding of glycaemic control and possibly to subsequent improvement, but its greatest impact in children totally dependent on exogenous insulin may have been to show the frustrating gap between normal and achieved blood glucose concentrations.

There are also many problems inherent in the technique that are of greater importance than whether a machine is used to read the reagent strip or not. Inadequate teaching, poor technique (especially in finger pricking), over enthusiastic schedules, fabrication of results, and failure to use the information gained are practical limitations. The child needs to be prepared to accept the practise and should be taught well, and the clinician should demonstrate the value of these measurements to the child and parents. The child should not be overfaced with the prospect of too many tests in a day (a routine of one test a day at differing times is recommended in our own clinics) and his ability to measure his own blood glucose may be checked by comparing the day's profile with laboratory measurements of the same samples.

The measurement of glycosylated haemoglobins³ can reflect integrated glycaemic control over a two month period (provided correct methodology is used) and thus provides an ideal confirmation⁴ of blood sugars measured at home.

Continuous subcutaneous insulin infusion

Despite home glucose monitoring the degree of glycaemic control in the 'average' diabetic child is poor. If the paediatrician has a small clinic with a high proportion of children in remission he may be misled for a while into thinking that most children are easily and well controlled. A recent publication from a reputable clinic in North America⁵ disclosed that the mean glycosylated haemoglobin concentration over an 18 month period in 477 children was 11.8% (compared with a range in normal children of 4.9% to 7.3%). It is in such a context that the technique of continuous subcutaneous insulin infusion has been explored.

The pattern of physiological insulin secretion is that of a continuous low concentration throughout the day and night with short superimposed peaks after meals. This may be simulated artificially in several ways. A very long acting insulin can be given to provide the low background concentration and the injection of short acting insulin given with each meal—this scheme of multiple subcutaneous injections can achieve better glycaemic control in the short term but is unrealistic and unacceptable in the longer term in children and adolescents. An alternative technique, continuous subcutaneous insulin infusion utilises a small electronic pump which continuously delivers a small volume of short acting insulin through a subcutaneous narrow gauge needle. This basal infusion rate is preset and usually accounts for half of the day's insulin requirement. The remaining insulin is given using the same device in boluses before each meal. The child, however, has to carry the pump attached to a belt or hidden in the clothing and has a subcutaneous needle in the arm, leg, or abdomen present throughout the day and night.

Although reports of continuous subcutaneous insulin infusion in children have appeared since 1979,⁶⁻⁹ there are still relatively few published studies. There are less than 100 children reported, the ages range from 10 to 18 years, and the length of time involved in group studies ranges from 6 weeks to 8 months. Schiffrin *et al*¹⁰ have published the most informative study to date. They conducted a randomised cross over trial in 19 adolescents aged 13 to 18 years of continuous subcutaneous insulin infusion and multiple subcutaneous injections (three

to four injections a day). They showed a significant improvement in glycaemic control in both groups at the end of four months, the degree of improvement being greater during continuous subcutaneous insulin infusion. To achieve this improvement, however, home monitoring of blood glucose was carried out at least four times a day. Furthermore, and characteristic of other studies in adolescence, the mean blood glucose and glycosylated haemoglobin concentrations for the groups were still higher than normal. Most encouraging, however, was the observation that 12 of the 19 patients chose to continue to use an insulin pump after completion of the trial, and this has also been our own experience.

Children and adolescents using an insulin pump enjoy greater flexibility in timing of meals, a considerable advantage in the busy and varied life of an adolescent, but all complain that the pump is too bulky. The second generation pumps are considerably smaller (and more costly) and doubtless they will become even smaller. Certain sports and activities require removal of the pump and sometimes of the subcutaneous needle, a definite demerit. With ingenuity and determination a child can overcome such a problem but he or she may find it a good excuse to avoid an unwelcome sport. The limited amount of information on the psychological impact^{10 11} of continuous subcutaneous insulin infusion has not been discouraging; indeed to give an individual a means of achieving their own expectations in terms of glycaemic control can be very positive and encouraging.

One salient observation, however, is that of those already selected to participate in trials of insulin pumps a proportion do not find the technique acceptable in its present form.^{9 10} There is evidence that certain 'brittle' diabetics¹² may not be helped by continuous subcutaneous insulin infusion and it would be naive to consider such a technique or device a panacea for the psychological and social problems of diabetic children or adults.

One would expect there to be side effects from a new form of treatment and some have already been identified. Problems at the site of infusion include subcutaneous abscesses, rarely seen with routine injections, and inflammatory reactions. More attention to hygiene and rotation of sites (once every two or three days) will reduce or avoid such incidents. Mechanical faults in the pump, insulin reservoir, or cannula could result in over or under delivery of insulin and attempts have been made by pump manufacturers to introduce safety mechanisms into pump design to minimise these accidental dangers. Severe hypoglycaemia has been recorded¹³ and it is questioned whether ketotic episodes may occur more readily. In the USA there was considerable

concern about the number of deaths which had occurred in diabetics using insulin pumps but the conclusion of a careful investigation¹⁴ of these reports was that there is no excess mortality over that expected in conventionally treated patients. The causes of death had not been unusual with the exception of one episode of pump malfunction and another of bacterial endocarditis, the infection originating at the injection site. In summary, there are problems specifically associated with the use of insulin pumps and as might have been predicted these include infection and mechanical failure. Other problems may arise secondary to aggregation of insulin molecules and there is concern that insulin aggregates could provoke amyloid formation.¹⁵

Conclusions

It is now possible to quantify the degree of glycaemic control in diabetic children by a combination of home blood glucose monitoring and laboratory measurements of indices of glycosylation of proteins, and the available information from these measures confirms the clinical impression that glycaemic control is poor. It is unlikely that conventional means of treatment which hitherto have been relatively unsuccessful will begin to succeed and therefore it is not unreasonable to explore new means of management. Under trial conditions, continuous subcutaneous insulin infusion and home monitoring have improved the control of small numbers of selected adolescents over short periods of time, and the techniques have been acceptable to these individuals. A number of complications of insulin pumps have been identified, however, and the amount of information available relating to their use in children is still quite limited.

While the question of whether continuous subcutaneous insulin infusion will provide a long term improvement in management is still unanswered it is disappointing to see ways in which the overall care and support for the diabetic child and his parents can be improved still neglected. The specialised home care diabetic nurse linked to the clinic has been a tremendous help and support to the newly diagnosed diabetic child and his family and those diabetic children with problems, but many health districts do not consider their employment a priority. It is still not possible for the family practitioner to prescribe equipment for blood glucose monitoring, an archaism which discourages his participation in the care of the diabetic child. If we do not have the right basis of care for the diabetic child and adolescent, it will be less productive and more impracticable to introduce any technological improvements.

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D A PRICE

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