



Does high blood glucose mean more insulin?

Type 1 diabetes management in children and adolescents

Kwang C Yee, BMedSci (Hons), MBBS (Hons), is basic physician trainee, Royal Hobart Hospital, and Tutor in Pharmacology, University of Tasmania.

Keith N Edwards, DCH, FRCP (Edin), FRCPC, FRACP, is Community Physician, Centre for Disease Control, Royal Darwin Hospital, Northern Territory, and Senior Lecturer in Child Health, Northern Territory Clinical School, Flinders University.

BACKGROUND The growth and development occurring in children and adolescents with type 1 diabetes contributes to many medical and nonmedical factors that may affect diabetic control.

OBJECTIVE This article discusses the assessment of high blood sugar levels in children and adolescents with type 1 diabetes.

DISCUSSION Traditionally, diet, exercise and insulin dose are seen as the determinants of blood glucose levels in type 1 diabetic patients. While these factors are important, other practical, medical and psychosocial factors need to be considered. Appropriate management requires more than just alteration of insulin dose. Insulin injection technique, adherence to insulin and management regimens in general, psychosocial issues, the role of intercurrent infections and the development of other medical problems need to be considered. Children and adolescents may only be seen by specialist physicians at three monthly intervals. Exploring these issues with patients during routine general practitioner consultations is likely to allow early identification of treatable problems and improve long term glucose control.



Diabetes mellitus in childhood represents one of the most costly and distressing diseases in the paediatric population in Australia. Type 1 diabetes mellitus, caused by the total destruction of beta cells in the Islet of Langerhans, constitutes approximately 98% of all childhood cases.¹ The body therefore is able to produce less insulin and eventually there is a total absence of endogenous insulin. Patients (often children and adolescents) have to rely on insulin injections to survive. These patients undergo the most significant and arguably the most crucial physical and mental development during the transition from childhood to adolescence and then into adulthood. This

growth period contributes multiple non-medical and medical factors that may affect the control of type 1 diabetes.

The prevalence of type 1 diabetes mellitus in the 0–19 years age group is estimated to be 0.80 cases per 1000 population.¹ Researchers have shown the incidence in Australia is increasing.^{2,3} This group of children and adolescents require frequent general practitioner consultations for their disease management. One of the common presenting complaints is poor control of blood glucose levels. The following four cases of high glucose levels presented to the North West Regional Hospital (Tasmania) highlight the heterogeneity of the causes of poor blood

glucose control. This is followed by a discussion on the important role that a GP should play in the control of diabetes mellitus in children and adolescents.

Identifying the cause of poor diabetic control

There are a wide variety of reasons why patients with type 1 diabetes mellitus might experience poor control over a period of a few months. Traditionally, paediatric textbooks often indicate diet, exercise and insulin as the factors that influence blood glucose levels.³ While these three factors are important, there are other medical and/or psychosocial factors that should be taken into account.

Case 1 – Samantha B

Samantha, 15 year of age, was admitted to hospital for investigation of poor blood sugar control. She was on a four injections per day regimen with a total dose of 114 units of insulin per day. Her blood glucose levels were often in the 15–25 mmol/L range. Her weight at that time was 56 kg. Her psychosocial history revealed recent grief of a close relative, family financial problems and an unwillingness to attend an important future social function due to her body image perception. Intravenous insulin infusion was commenced with hourly blood glucose level monitoring. Over a 24 hour period, it was found that Samantha required a total of 48 units of insulin to keep her blood glucose levels in the target range of 5–9 mmol/L. The large difference between the self administered insulin and intravenous insulin infusion indicated a technical problem with her injections. Samantha was closely observed over the next few days for her insulin injection technique and injection site lipohypertrophy. Although her injection technique was found to be adequate (injection site lipohypertrophy was not identified), her blood glucose measurements remained high. When Samantha was discharged, her blood glucose levels required further increase in her insulin dose. However, very good control was achieved when her father gave the injections in a new site, her gluteal area.

Insulin injection technique

Samantha's case shows that insulin injection technique is probably as important, if not more so, than drawing up the exact dose of insulin that a child should be administered. Although during puberty, the insulin requirement may increase due to increase in growth hormone and other hormone production, a dose requirement of more than 2.0 units/kg/24 hours should warrant further investigation. Some children may decide not to draw up proper dose, not to inject all the insulin drawn, or not to inject in an appropriate way. In our experience, leak back is critical if the

patient is on 0.1 mL (10 units) of insulin. These actions may all cause high glucose levels. Although we could not identify specific defects in Samantha's injection technique, it seems likely that the dose she administered herself was not getting into her blood stream. A follow up review with some psychosocial assessment would be recommended to help solve the problem.

Case 2 – Jane G

Jane, 13 years of age, attended our diabetic clinic for review. She was diagnosed with type 1 diabetes two years previously. At that time, she was on a three month trial of a four times per day injection regimen with a total of 51 units of insulin per day. Her diabetic diary showed excellent control within this three month period with her glucose levels written down as being within the 6–10 mmol/L range. However, her HbA1c at the time of review was over 14%. The data within the glucometer meter was analysed and revealed only four entries within the past month. She confessed that she did not perform glucose measurements frequently and had falsified her diabetic diary. Upon further questioning, Jane admitted that she often missed her mid-day injection at school. Although it was very obvious that she had difficulties with her mid-day dose, her mother insisted she stay on a four injections per day regimen. After lengthy discussion, it was agreed that a conventional twice per day regimen might be more suitable until Jane felt more comfortable with a mid-day dose at school.

Psychosocial issues

Jane's case demonstrates the importance of a high index of suspicion when faced with a perfect diabetes diary (eg. neat and tidy, no blood smudges, all the same pen color, etc). The HbA1c measurement will usually be helpful to detect such practices. The advance in technology that has allowed clinicians to directly download and display information through a computer has helped to avoid confrontations

and arguments between patients, guardians and health care providers. This case also demonstrates the difficulties for a child or teenager to be compliant with an intensive insulin regimen. Although it has been shown in diabetes control and complications trials that an intensive regimen is more physiological than a twice per day regimen,⁴ it is often difficult for patients to administer insulin four times per day. In our experience, the dose that is commonly missed is the mid-day dose at school. In these cases, a twice per day regimen often results in better long term control until the child is older.

Table 1. Assessment of high blood sugar levels in children with type 1 diabetes

Medical history

- General wellbeing, including intercurrent infections
- The amount of insulin used per day
- The normal daily diet of the patient
- Exercise and physical activities
- Occurrence of hypoglycaemic episodes

Psychosocial history

- Behavioural problems
- School progress and absenteeism
- General coping, conflicts and psychosocial disturbances

Examination

- Height and weight
- Injection site examination
- Demonstration of technique for injection of insulin

Others

- Examination of the BSL record book
- HbA1c if indicated
- Coeliac disease and thyroid disease screen if indicated

Case 3 – Hashim H

Hashim, 10 years of age, presented to the diabetic clinic for review. It was found on reviewing his diabetic diary that his blood glucose levels had remained high over the past few months. His HbA1c measurement was over 14%. Upon further questioning, Hashim stated that he had experienced chest infections over the past few months. During these illnesses, he had lost his appetite and reduced his food intake. He also reduced his insulin dose in proportion to his reduced food intake. The role of infection on blood glucose levels was then clearly explained to the family and they were advised to increase insulin dosage to previous levels.

Infection and insulin requirement

As in Hashim's case, infection often causes an increase in blood glucose levels although food intake may decrease. This is probably due to the increase in stress related hormones that tend to antagonise the effects of insulin. Often, ketonuria occurs in type 1 diabetes patients during a period of infection. If untreated, diabetic ketoacidosis may develop. It is therefore important to advise patients to monitor blood glucose and urinary ketone regular during infections and increase their insulin dose until stabilisation is achieved. One exception from this general rule is gastroenteritis, which often requires less insulin.

Case 4 – Luke C

Luke, 9 years of age, diagnosed with type 1 diabetes mellitus two years ago, attended the diabetes clinic for review. He had achieved reasonable blood glucose levels until recently with a twice per day regimen. His blood glucose levels were high over the past few months. His mother also complained of worsening behavioural problems over the past few months. Height and weight measurements were obtained during the clinic review, which showed loss of weight as evident by the crossing downward of the weight percentile. However, his height remained on the 50th percentile line. Thyroid function tests and endomysial antibody test were performed which showed high levels of the latter. He was referred to a paediatric gastroenterologist who performed a biopsy of the jejunum, confirming coeliac disease. He was advised to have a gluten free diet and his insulin regimen was adjusted according to his blood sugar levels after he commenced a gluten free diet.

Other medical conditions

In Luke's case the development of another medical condition resulted in poor diabetes control. Type 1 diabetes is an autoimmune disease associated with a higher incidence of other autoimmune disorders, in particular coeliac disease⁵ and autoimmune thyroid disorders.⁶ Both of these conditions may cause difficulties in achieving good blood glucose control. It is therefore worthwhile to perform simple blood tests to identify these conditions especially when growth pattern changes are detected, as demonstrated in this child. Worsening behavioural problems are another clue that coeliac disease may have developed in a diabetic child. It is critical for good diabetic control that associated conditions are diagnosed and treated as early as possible.

Discussion

The four cases presented in this article demonstrate the wide variety of causes for poor blood glucose control in childhood diabetes. The first two cases are due to practical and psychosocial problems while the latter two cases are due to medical problems. A systemic approach to the problem of high blood sugar levels in type 1 diabetes is suggested in Table 1. This list includes commonly asked questions and provides adequate information for the initial assessment of high blood sugar levels. Studies have shown that type 1 diabetes patients with regular follow up did much better over the longer term.⁷ The reliance on quarterly diabetic clinic attendance may not be enough. Enquiring about diabetic control when a diabetic child visits the GP for consultation is a

pivotal component of improving diabetic control and reducing complications. This will, on the one hand, reinforce the message of the importance of good control, and on the other, allow early identification of treatable problems associated or causing poor diabetic control.

Conflict of interest: none declared.

References

1. Sutton D L, Lyle D M, Pierce J P. Incidence and prevalence of insulin dependent diabetes mellitus in the zero-19 years age group in Sydney. *Med J Aust* 1989; 151:140–146.
2. Craig M E, Howard N J, Silink M, Chan A. The rising incidence of childhood type 1 diabetes in New South Wales, Australia. *J Pediatr Endocrinol Metab* 2000; 13:363–372.
3. Kelly H A, Russell M T, Jones T W and Byrne G C. Dramatic increase in incidence of insulin dependent diabetes mellitus in Western Australia. *Med J Aust* 1994; 161:426–429.
4. Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin dependent diabetes mellitus. *N Engl J Med* 1993; 329:977–986.
5. Westman E, Ambler G R, Royle M, Peat J, Chan A. Children with coeliac disease and insulin dependent diabetes mellitus : Growth, diabetes control and dietary intake. *J Pediatr Endocrinol Metab* 1999; 12:433–442.
6. Roldan M B, Alonso M, Barrio R. Thyroid autoimmunity in children and adolescents with type 1 diabetes mellitus. *Diabetes Nutr Metab* 1999; 12:27–31.
7. Kaufman F R, Halvorson M, Carpenter S. Association between diabetes control and visits to a multidisciplinary pediatric diabetes clinic. *Pediatrics* 1999; 103:948–951.

AFP

Correspondence

Email: kcyee@utas.edu.au