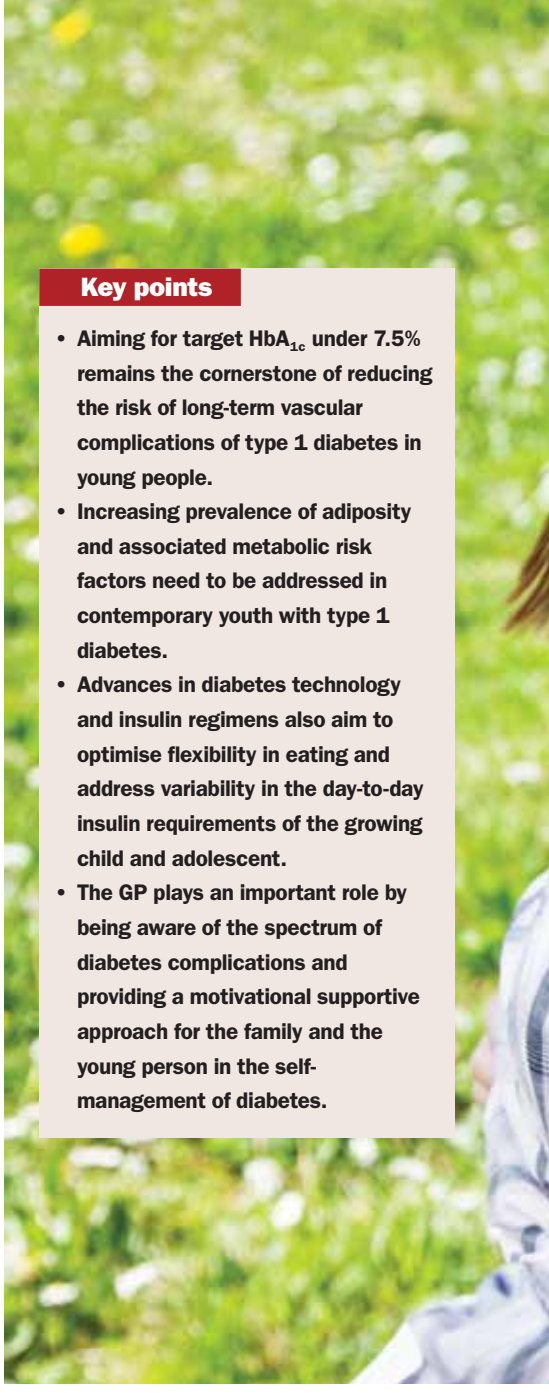
Type 1 diabetes in young people

How can we minimise complications?

YOON HI CHO BSc(Med), MB BS, MIPH, FRACP
KIM C. DONAGHUE MB BS, PhD, FRACP

This article highlights the spectrum of diabetes complications and potential strategies to help young people achieve optimal glycaemic control and meet metabolic targets to reduce the risk of complications.



Key points

- **Aiming for target HbA_{1c} under 7.5% remains the cornerstone of reducing the risk of long-term vascular complications of type 1 diabetes in young people.**
- **Increasing prevalence of adiposity and associated metabolic risk factors need to be addressed in contemporary youth with type 1 diabetes.**
- **Advances in diabetes technology and insulin regimens also aim to optimise flexibility in eating and address variability in the day-to-day insulin requirements of the growing child and adolescent.**
- **The GP plays an important role by being aware of the spectrum of diabetes complications and providing a motivational supportive approach for the family and the young person in the self-management of diabetes.**

Although overt vascular complications (such as sight-threatening retinopathy, nephropathy, symptomatic neuropathy) are rarely seen in adolescents with type 1 diabetes, early markers of microvascular complications can be detected as early as two to five years after diagnosis.[1] The aim of routine screening for microvascular complications is to detect early markers at a reversible stage and promptly address through greater attention to glycaemic control and instituting other intervention where appropriate. There is ongoing research in the area of early pharmacological intervention at these subclinical phases.[2] Type 1 diabetes may also be complicated by other autoimmune conditions such as thyroid and coeliac disease. Recommended consensus screening guidelines for children and adolescents with type 1 diabetes are outlined in Table 1.[3-5]

Psychological complications are not uncommon and, in addition to the challenges of normal childhood and adolescence, may also impact on ability to adhere to the demands of diabetes management. These should be recognised and addressed appropriately.

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Dr Cho is a Paediatric Endocrinologist, Institute of Endocrinology and Diabetes at The Children's Hospital at Westmead; and Clinical Lecturer at The University of Sydney. Professor Donaghue is a Paediatric Endocrinologist, Head of Diabetes Services and Co-Head of Department, Institute of Endocrinology and Diabetes at The Children's Hospital at Westmead; and Professor at The University of Sydney, Sydney, NSW.

Diabetes complications

Microvascular and macrovascular complications

The landmark Diabetes Control and Complications Trial (DCCT) published in 1993 provided definitive evidence that intensive management of diabetes reduces long-term microvascular complications.[6] Prior to these findings, the prevalence of any degree of detectable retinopathy in Australian adolescents was approximately 53% in 1990 to 1994, with a progressive reduction in the past 15 years to 12% in 2005 to 2009. HbA_{1c}, as a measure of glycaemic control, has shown only a modest reduction over this period. Interestingly, other forms of microvascular complications, such as microalbuminuria and abnormal albumin excretion, have also declined since the pre-DCCT era, but not to the same extent.[7] This therefore suggests that other factors besides HbA_{1c} contribute to vascular complications in adolescents. Since the early 1990s, we have also seen an increase in the body mass index (BMI) of adolescents with type 1 diabetes, followed by a recent plateau, which mirrors the

prevalence of overweight/obesity in the general paediatric population in Australia. There is emerging evidence that overweight and obesity in childhood may indeed contribute to the long-term vascular health (including macrovascular complications) in young people with type 1 diabetes.

Having diabetes during the pubertal years confers a greater risk of complications than onset after puberty or even in earlier childhood, as indicated by longitudinal type 1 diabetes cohorts.[8] Pubertal years may therefore be a crucial window of opportunity to influence the long-term vascular health of individuals with type 1 diabetes. It also represents a period when various adolescent psychosocial factors and changes in the family environment may pose greater challenges in adhering to the demands of diabetes management.

Acute complications

Diabetes ketoacidosis (DKA) is a potentially life-threatening complication, often related to insulin omission, inappropriate insulin pump management, precipitating intercurrent illness or delayed diagnosis of new-onset diabetes.[3,9] Appropriate sick-day management, using blood ketone testing at home and timely provision of extra insulin, can reduce the need for hospitalisation. Recurrent DKA presentations may be a red flag indicating chronic poor glycaemic control, psychological difficulties or family dysfunction. Clinicians also need to look for poor diabetes management as a cause of school absenteeism. This can be manifest as abdominal pain and nausea, thought to be infection related but is actually due to ketosis caused by forgotten insulin doses.

Severe hypoglycaemia in children is usually defined as a hypoglycaemic event resulting in a coma or seizure,[10] and is often a prominent concern in families of young children with type 1 diabetes. Hypoglycaemic unawareness results from a reduced counter-regulatory response to hypoglycaemia and may increase the risk of severe hypoglycaemia.[11,12] Avoiding

Table 1. Screening for complications in children and adolescents with type 1 diabetes[3-5]

Complication	When to start screening	How often
Autoimmune conditions: coeliac and thyroid disease	At diagnosis	Every one to two years
Dyslipidaemia	At diagnosis in all children from age 10 years; or age 2 years if family history	Every five years until puberty, then every year
Retinopathy	From age 10 years (or at onset of puberty if this is earlier), after two to five years' duration	Every one to two years Annually in those who have a high risk, long diabetes duration, high HbA_{1c} or nonproliferative retinopathy
Nephropathy	From age 10 years (or at onset of puberty if this is earlier), after two to five years' duration	Annually
Neuropathy	From age 10 years (or at onset of puberty if this is earlier), after two to five years' duration	Annually

recurrent hypoglycaemia helps to maintain awareness of hypoglycaemic symptoms.[12]

Psychological and psychiatric complications

Both high and low blood glucose levels may acutely impair cognitive performance.[3] Chronic hyperglycaemia, history of severe hypoglycaemia and diabetes from a young age have been associated with difficulties in learning.[3] Low mood, anxiety and need to conform to peers are common experiences of adolescents, and may contribute to non-adherence to the routines of diabetes management.

Clinical depression, anxiety disorders and eating disorders are higher in young people with type 1 diabetes compared with the general population;[13,14] although the differences have been less marked in more recent studies.[13] Disordered eating behaviour may coexist with intentional insulin omission for weight loss.

Associated autoimmune conditions

Coeliac disease is more common in children with diabetes, with a widely variable reported prevalence from 1 to 16% around the world,[8] and 2 to 8% in Australia.[15] Gastrointestinal symptoms, unexplained poor growth, weight loss, anaemia or recurrent hypoglycaemia in a child with diabetes should prompt coeliac screening.[11] Long standing untreated coeliac disease may be associated with increased risk of microvascular complications, osteoporosis and gastrointestinal malignancy.

Thyroid autoimmunity occurs in 10 to 22% of children with diabetes compared with 1 to 4% in the general paediatric population, and may lead to thyroid dysfunction with clinical features of hypo or hyperthyroidism.[16] Regular antibody screening for coeliac disease and autoimmune thyroiditis should be performed, even in the absence of symptoms.[3]

Addison's disease, vitiligo and other autoimmune conditions are less common than thyroid and coeliac disease but are all slightly more common in patients with type 1 diabetes compared with the general population. These conditions should be investigated for in the presence of clinical suspicion.[3]

Management strategies

Education and technology

The standard of care in children and adolescents with type 1 diabetes is intensive insulin therapy, with either continuous subcutaneous insulin infusion (CSII) pump or multiple daily injections (MDI) using basal insulin (insulin analogues such as glargine or determir) and bolus short-acting insulin before main meals.

CSII shows a small but significant reduction in HbA_{1c}, compared with MDI, and consistent improvement in quality of life.[1] Current insulin pumps require the operator to activate boluses before food and enter regular blood glucose levels for corrections. Technology is not at the stage where the pump can be used as 'set and forget'. Development of hyperglycaemia with ketones while using a pump indicates a problem with insulin delivery. Immediate action is required, with extra doses of subcutaneous short-acting insulin and a complete pump set change.

Newer meters are available for patients using MDI to assist in variable dosing of short-acting insulin according to carbohydrate intake and glucose levels. Intensive management using CSII or MDI is associated with a lower risk of microvascular complications compared with older regimens, independent of HbA_{1c}.[7] Intensive regimens are also better able to target the food intake during the day and potentially reduce glucose variability. Twice-daily regimens and premixed insulins are therefore no longer favoured in young people, and reserved for those who cannot adhere to the MDI regimen.

Children with diabetes require age-appropriate levels of support in attending to daily diabetes routines. Adolescence is a period of transition from dependence to independence in diabetes management. This may involve adolescent-focused re-education, and management of family conflict arising from the struggle between desire for independence versus poor adherence.

Monitoring glucose levels

At least four to six finger pricks per day and occasional overnight checks are required for routine diabetes monitoring. Higher

frequency of monitoring per day is associated with better glycaemic control in children and adolescents with diabetes.[17] Continuous glucose monitoring systems (CGMS) may be useful as an adjunct to CSII.

Achieving glycaemic targets

Target HbA_{1c} levels are under 7.5% for children and adolescents, without severe hypoglycaemia.[3] Lower HbA_{1c} may be desirable but can be associated with greater hypoglycaemic events.[6] Target glucose levels are 4 to 7 mmol/L before meals and 5 to 10 mmol/L at postprandial times, and set at 6 mmol/L for those on insulin pumps (Table 2).[3,4]

Although there have been advances in diabetes technologies, a significant management burden remains on young people and their families. Supporting parents of young children with diabetes, particularly after diagnosis, and identifying parental anxiety or depression has been associated with improved diabetes management.[19] Encouraging families to share responsibilities can also be helpful in achieving glycaemic targets.

To reduce complications, adolescents may respond to discussions on short-term goals, rather than long-term goals, including discussions of:

- short-term benefits on well-being, cognition and sporting performance[20]
- reward systems
- driver's license and government authority requirements for medical safety for driving.

Underlying barriers to adherence to insulin regimens need to be explored. These barriers include:

- relationship with peers and family members, and school routines
- psychological factors
- anxiety regarding past experience of severe hypoglycaemia and fear of overnight hypoglycaemia
- external events: school and family.

The Home and Environment, Education and Employment, Activities, Drugs, Sexuality, Suicide/Depression (HEADSS) screening tool can be useful for psychosocial assessment in adolescents.[21] In adolescents, it is also important to address the impact of alcohol consumption on glucose levels and risk of DKA with recreational substance use.

Table 2. Targets for modifiable cardiovascular risk factors

Modifiable cardiovascular risk factors	International Society Pediatric and Adolescent Diabetes (2014)[4]	National Health and Medical Research Council Guidelines (2011)[3]
Preprandial glucose readings	4 to 8 mmol/L	4 to 7 mmol/L
Bed-time glucose readings	6.7 to 10 mmol/L	6 to 10 mmol/L
LDL-cholesterol	<2.6 mmol/L	<2.6 mmol/L
HDL-cholesterol	>1.1 mmol/L	>1.1 mmol/L
Triglycerides	<1.7 mmol/L	<1.7 mmol/L
Blood pressure	<90th percentile by age, sex and height	<90th percentile by age, sex and height (<130/80 mmHg for adolescents)
Waist: height ratio	–	<0.5[18]

Diet recommendations

Dietary recommendations for young people with type 1 diabetes are based on healthy eating recommendations suitable for the whole family while meeting energy and nutritional requirements for growth.[22] Matching insulin to carbohydrate intake through flexible insulin adjustment (for those on MDI) or use of formal insulin-carbohydrate ratios (for those either on CSII or MDI), rather than eating carbohydrates to meet the requirements of predetermined insulin doses, may improve postprandial hyperglycaemia, overall glycaemic control, quality of life and potential weight gain.[3] Inappropriate and overtreatment for hypoglycaemia should be avoided. Low glycaemic index carbohydrates have been shown to have a beneficial effect on glycaemic control.[22]

Weight management

Adolescents who are overweight/obese or have central adiposity should be identified. BMI should be determined according to age and gender standards, with overweight defined as a BMI greater than the 85th percentile. Waist circumference should be less than half of an individual's height (waist: height ratio <0.5) because central adiposity has been associated with metabolic risk factors from childhood.[18] Acanthosis nigricans at the base of neck, axillary regions and skin creases may indicate coexisting insulin resistance.

Meeting targets for modifiable cardiovascular risk factors, such as central adiposity, obesity, hypertension and dyslipidaemia, are important in the overall management of patients with type 1 diabetes (Table 2).

Strategies for weight loss designed for adult patients may not be appropriate in the paediatric population. In overweight children who have not yet completed linear growth, it may be more appropriate to aim to maintain weight with growth.

Simple lifestyle strategies for weight management in children and adolescents include:

- eating breakfast
- no soft drinks or cordial, limiting juice intake, encouraging water as the best drink
- reducing screen time (TV, computer, smartphones and tablets) to less than two hours per day
- eating dinner as a family where possible (and not in front of TV)
- decreasing intake after dinner and overnight
- avoiding the use of food as a reward.

Growth measurements

Regular measurements of height and weight are important in routine diabetes assessment. Normal growth and puberty is associated with physiological insulin resistance, which is more marked in children with type 1 diabetes.[8] Insulin doses greater than 1 units/kg/day are usually required during the pubertal period in type 1 diabetes. Apparently high total daily dose of insulin (>1.5 units/kg/day) in the presence of poor glycaemic control may indicate insulin omission. Impaired linear growth and pubertal delay associated with poor glycaemic control, known as 'Mauriac syndrome', is rarely seen in the modern era of insulin access and improved delivery.[3] Reduced linear growth should therefore also prompt screening for underlying coeliac or autoimmune thyroid disease.

Exercise

Regular physical activity is encouraged in type 1 diabetes, as in all young people as a part of a healthy lifestyle, with specific benefits on cardiovascular health and weight management.[3,20] Exercise-induced hypoglycaemia may be immediate or delayed up to 24 hours after activity, and may require extra consumption of carbohydrates, adjustment of short-acting insulin doses or use of temporary basal rates on the insulin pump, tailored for the individual. Nocturnal hypoglycaemia after prolonged intense exercise may be prevented by reduction of the overnight basal insulin delivery. For school camps and all-day sporting events, where a sustained period of intense activity is anticipated, ready access to extra carbohydrates and planned reduction of long-acting insulin or use of temporary basal rates (e.g. up to 50% usual rate) may be required.[20]

Conclusion

Adolescence may be a crucial time to influence long-term outcomes of type 1 diabetes. Intensive glucose control remains the cornerstone of reducing complications. This needs to be balanced against the risk of hypoglycaemia and maintaining quality of life during a period marked by significant physiological and psychosocial changes. Increased adiposity and the metabolic syndrome are important factors to address to reduce the additional vascular risk in young people with type 1 diabetes. **ET**

Further reading

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