

Detecting diabetes complications in children

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Abstract

Clinical symptoms of diabetes-related complications are very rare in children and adolescents with type 1 diabetes (T1D). Screening for complications aims to detect their presence shortly after development but before they cause clinically significant symptoms. Early detection of complications, alongside efforts to improve glycaemic control, can slow the progression of microvascular complications with consequently improved quality of life and life expectancy. An ideal screening programme should be evidence based and should include the majority of clinically important complications and associated diseases. Such programmes have been formulated by multidisciplinary bodies representing a number of specialist diabetes societies worldwide.

The purpose of this review is to highlight the importance of screening for diabetes complications and comorbidities in T1D in childhood and to review and compare the latest guidelines of the International Society for Pediatric and Adolescent Diabetes, American Diabetes Association, Canadian Diabetes Association, Australian Government National Health and Medical Research Council, and the UK National Institute for Health and Clinical Excellence. Copyright © 2011 John Wiley & Sons.

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Key words

childhood; diabetes; screening; complications

Introduction

Although type 1 diabetes (T1D) frequently begins in childhood, most complications appear later in adult life causing life-long disability. Complications of T1D involve microvascular (including retinopathy, nephropathy and neuropathy) and macrovascular disease. T1D can also cause other conditions such as lipodystrophy, necrobiosis lipoidica diabetorum, oedema and limited joint mobility. It is also associated with autoimmune disorders such as Hashimoto's disease, Graves' disease, coeliac disease and Addison's disease. Growth and development may be adversely influenced too.

Glycaemic control is closely linked to the development of diabetes complications, and screening for these complications is therefore important given the failure of most young people to achieve such optimal glycaemic control. Regular clinical examination can identify early signs of complications and associated diseases even before they cause clinical symptoms. Prompt and appropriate treatment of complications in time can improve quality of life as well as life expectancy.

Screening protocols for these complications and associated conditions have been published by a number of specialist groups.^{1–5} The guidelines

are broadly similar though vary in their detail from country to country. An ideal screening programme should include the majority of clinically important complications and associated diseases and should be evidence based. In practice, these programmes are often formulated by a multidisciplinary writing committee. An ideal screening programme in paediatric diabetes should also be deliverable within routine clinical practice, cost effective and relevant to both children and adolescents.

The purpose of this review is to emphasise the importance of screening for diabetes complications and comorbidities, and to review and compare the latest guidelines of the International Society for Pediatric and Adolescent Diabetes (ISPAD), American Diabetes Association (ADA), Canadian Diabetes Association (CDA), Australian Government National Health and Medical Research Council (NHMRC) and the UK National Institute for Health and Clinical Excellence (NICE).

Microvascular complications
Retinopathy

Diabetic retinopathy is a specific retinal vascular disease which has been reported to affect 36% of Australian teenagers after a mean duration of

diabetes of 4.9 years.⁶ Chronic exposure to hyperglycaemia and other risk factors are thought to initiate complex biochemical and physiological changes.^{7–10} According to the International Clinical Diabetic Retinopathy Disease Severity Scale, diabetic retinopathy can be characterised by different stages based on the findings observed by ophthalmoscopy through dilated pupils. Mild non-proliferative diabetic retinopathy is characterised by microaneurysms only. Moderate non-proliferative diabetic retinopathy is established when more than microaneurysms are present but appearances are less than severe non-proliferative diabetic retinopathy (NPDR). In NPDR any of the following can be found: >20 intraretinal haemorrhages in each of four quadrants, definite venous beading in two or more quadrants, prominent intraretinal microvascular abnormalities in one or more quadrants but no signs of proliferative retinopathy. Proliferative diabetic retinopathy is present when neovascularisation and/or vitreous or preretinal haemorrhages are present. Clinically significant macular oedema can develop at any stage of ophthalmopathy.¹¹

In screening for diabetic retinopathy, various methods are used to detect treatable disease. The most sensitive detection methods for retinopathy are stereoscopic fundal photography and fluorescein angiography. Fundal photography can detect structural abnormalities, whereas fluorescein angiography reveals structural and functional abnormalities such as vascular permeability but requires intravenous injection of fluorescein. Both examinations can be recorded and can be compared to the result of subsequent assessments. These images can also be shown to patients and their implications discussed with them. By contrast, minimal assessment may involve ophthalmoscopy through dilated pupils by an observer with special expertise in diabetic retinopathy.^{12,13} Recent recommendations suggest that, in childhood, baseline examinations could be delayed to five years after diagnosis of T1D or at the start of puberty, whichever occurs earliest.⁶

Table 1 shows the different screening recommendations for retinopathy. As can be seen, a range of methods for conducting screening are

	Method	When to start after diagnosis	Frequency
ADA	Dilated pupil ophthalmic exam or retinal photo (B)	3–5 years or ≥10 years old (D)	Annual (D)
NHMRC	Stereoscopic fundal photo (C)	2 years if pubertal	Biennial (C)
CDA	Stereoscopic or digital fundal photo or direct ophthalmoscopy/indirect slit lamp	5 years (B) if ≥15 years old (D)	Annual/ biennial (D)
ISPAD	Fundal photo or pupil-dilated ophthalmoscopy (D)	2 years if ≥11 years 5 years if ≤9 years old (D)	Annual (D)
NICE	Digital retinal photo	If 12 years old (C)	Annual (C)

Letters in brackets demonstrate the level of evidence as defined in Table 7. ADA = American Diabetes Association; NHMRC = Australian Government National Health and Medical Research Council; CDA = Canadian Diabetes Association; ISPAD = International Society for Pediatric and Adolescent Diabetes; NICE = UK National Institute for Health and Clinical Excellence.

Table 1. Screening recommendations for retinopathy

recommended. Also, the time to start screening is not agreed. Annual assessments are suggested from puberty, with the exception of the NHMRC and CDA guidelines which suggest biennial examination in the case of those with good glycaemic control and diabetes duration <10 years. According to the ADA, less frequent examinations (two to three yearly) may be considered following one or more normal eye examinations. The tables show the level of evidence for the recommendations for screening.⁵

Therapy will depend on the severity of retinopathy and ranges from correction of vision by glasses, to laser photocoagulation therapy, surgery (vitrectomy) or pharmacological interventions (intraocular steroid injection or anti-vascular endothelial growth-factor agents). Besides eye-specific therapy, additional measures such as optimisation of glycaemic control, blood pressure and lipid levels have significant roles in the prevention and treatment of diabetic retinopathy.

Nephropathy

Diabetic nephropathy is clinically defined as persistent proteinuria >500mg/24 hours or albuminuria >300mg/24 hours in the absence of other renal disease.¹⁴ A cumulative prevalence of microalbuminuria of 25.7% has been reported in a large cohort of children followed up for nearly 10 years in a prospective observational study from Cambridge.¹⁵

In T1D, thickening of the glomerular basement membrane is an early sign of diabetic nephropathy. With progression, capillary wall thickening and mesangial widening lead to capillary narrowing and reduced glomerular capillary filtration surface area. Additionally, hyaline which consists of plasma proteins and lipids appears in arterioles, capillary walls and Bowman's capsules. Progression of glomerular and arteriolar changes ends in complete sclerosis.^{16–18}

As diabetic nephropathy develops, five stages can be distinguished, associated with increasing proteinuria and deteriorating glomerular filtration rate (GFR). The first stage is characterised by glomerular hyperfiltration and renal enlargement. In the second stage, early glomerular lesions, including glomerular basement membrane thickening and mesangial matrix expansion, can be observed but albumin excretion remains normal.^{19,20} The third stage, known as incipient diabetic nephropathy, is defined by persistent and usually increasing microalbuminuria. This microalbuminuric stage is usually accompanied by hypertension.^{14,21} The fourth stage is typified by albuminuria >300mg/24 hours, decline in renal function and hypertension. The fifth stage is end-stage renal disease.^{14,22}

The aim of screening for diabetic nephropathy is to recognise early symptoms of renal disease and to prevent further deterioration by

	Method	When to start after diagnosis	Frequency
ADA	Random spot urine for ACR (D)	10 years old or diabetes for 5 years (D)	Annual (D)
NHMRC	Timed overnight AER or spot ACR (C)	2 years if pubertal 5 years if prepuberty (C)	Annual (C)
CDA	Prefer early morning (B) or random ACR (D)	12 years old or diabetes for 5 years	Annual
ISPAD	Prefer random ACR or early morning AC (D)	2 years if ≥ 11 years old 5 years if ≤ 9 years old (D)	Annual (D)
NICE	Prefer timed overnight urine or spot ACR	If 12 years old (C)	Annual (C)

Letters in brackets demonstrate the level of evidence as defined in Table 7. ACR = albumin/creatinine ratio; AER = albumin excretion rate; AC = albumin concentration.

Table 2. Screening recommendations for nephropathy

providing appropriate treatment. The first abnormality that can be detected is microalbuminuria. Several approaches have been suggested to define microalbuminuria:

- Albumin excretion rate (AER)
 - 20–200 μ g/min
 - 30–300mg/24 hours
- Albumin concentration (AC)
 - 30–300mg/L – early morning urine sample
- Albumin/creatinine ratio (ACR)
 - 2.5–25mg/mmol
 - 30–300mg/g
 - 3.5–25mg/mmol in girls because of lower creatinine excretion.

As shown in Table 2, random spot urine analyses for ACR are recommended by all the guidelines as sample collection is straightforward for patients and may be obtained during hospital clinic visits, although the CDA recommends early morning and NICE timed overnight urine samples for measurement of ACR too. ISPAD also recommends collection of an early morning urine sample for measurement of AC. There is no agreed standard for when screening should be started, but all guidelines advise annual screening from puberty.

If random or spot ACR is used, attention must be paid to circumstances when artefactual elevation of urinary albumin excretion can occur, including exercise within the last 24 hours, intercurrent infection or fever, marked hyperglycaemia, hypertension, urinary tract infection, vaginal

discharge, menstrual bleeding, and orthostatic proteinuria. If screening demonstrates microalbuminuria, it should be confirmed in the next three to six months by repeating the above measurements (and excluding other causes of microalbuminuria such as urinary tract infections, glomerulonephritis or artefactual causes). Progression of diabetic renal disease may be slowed by improved blood pressure regulation and appropriate diet with respect to protein intake. In growing children, decreasing protein excretion by lowering nutritional protein intake below normal levels is not recommended, though excessive nutritional protein intake should be avoided (recommended maximum 1.0–1.2g/kg body weight/day).⁴

Neuropathy

In children and adolescents with T1D, clinical symptoms and signs of nerve disease are very rare, but studies have demonstrated the presence of subclinical abnormalities.⁴ Diabetes can affect both the somatic (focal neuropathies and diabetic sensorimotor polyneuropathy) and autonomic nervous systems,¹ and the prevalence of diabetic neuropathy has been reported to range from 7–57%.^{23,24}

According to the San Antonio Convention, the main groups of neurologic disturbance in patients with diabetes mellitus include:²⁵

- Subclinical neuropathy determined by abnormalities in electrodiagnostic and quantitative sensory

testing without concomitant clinical signs and symptoms.

- Diffuse clinical neuropathy which may be proximal or distal and involve large symmetrical sensorimotor or small fibres and autonomic dysfunction.
- Focal neuropathies which include mononeuropathies and entrapment syndromes.

Distal symmetrical polyneuropathy (DSPN) is a heterogeneous disease with widely varying pathology, suggesting differences in pathogenic mechanisms for the different clinical syndromes.^{26,27} There are different theories on the aetiopathogenesis of DSPN which include metabolic, immune, microvascular, neurotrophic and oxidative stress influences. Focal neuropathies are caused by microscopic vasculitis and subsequent ischaemia or infarction of the nerve leading to segmental demyelination.^{28,29} The diagnosis of DSPN can be established from symptom profiles, neurologic examination, quantitative sensory testing, nerve conduction velocity studies or quantitative autonomic function testing.

Diabetic autonomic neuropathy can affect several organs, including the cardiovascular and genitourinary systems, and pupillary reflexes, and may contribute to hypoglycaemia unawareness, though this relationship is complex.²³ Diagnosis requires careful history taking and clinical examination. Autonomic neuropathy affecting the cardiovascular system may be detected by assessing the heart-rate response to the Valsalva manoeuvre or postural changes.¹ In the DCCT and follow-up EDIC studies, monitoring for evidence of autonomic neuropathy included screening for postural hypotension, gastroparesis, diabetic diarrhoea, colonic atony, genitourinary dysfunction, sudomotor abnormality and hypoglycaemia unawareness.³⁰

Methods for diagnosing diabetic neuropathy in childhood are shown in Table 3. The ADA does not have child-specific guidance nor does NICE give recommendations for screening of diabetic neuropathy during childhood. The NHMRC, CDA and ISPAD guidelines suggest detailed history taking, concentrating on specific symptoms and neurological examination

including testing of vibration sense, ankle jerks and fine sensation. NHMRC and ISPAD recommend annual examinations but only in poorly controlled cases. The CDA recommends starting annual screening five years after puberty if diabetes is poorly controlled.

Although the guidelines describe the possibility of examining for diabetic autonomic neuropathy, none of them has clear, children-specific recommendations. If diabetic neuropathy is diagnosed, the goal of the treatment is to prevent progression and to ameliorate symptoms. Prevention of hyperglycaemia and meticulous foot care are the mainstays of successful management.

Macrovascular complications

Cardiovascular disease is the major cause of mortality in adults with T1D. Although increased aortic and carotid intima-media thicknesses have been described in adolescents, clinical macrovascular disease is rare during childhood³¹ despite the presence of risk factors such as hypertension, dyslipidaemia, smoking and obesity.

Hypertension

Hypertension has a greater impact on cardiovascular disease in patients with diabetes than in those without.³² Since blood pressure has a critical role in the evolution of microvascular complications too, it is very important to measure blood pressure regularly to screen for hypertension. Ambulatory blood pressure monitors use either an auscultatory or an oscillometric method for measurement. The blood pressure values should be compared with age- and height-appropriate centile charts. The aim is to maintain values below the 95th percentile.

The ADA does not have child-specific guidance for blood pressure screening (Table 4). The NHMRC suggests blood pressure measurements every visit from the time of diagnosis. The CDA recommends blood pressure measurements twice yearly. NICE and ISPAD recommend annual examinations after age 12.

If hypertension is identified, this needs further investigation by 24-hour ambulatory blood pressure measurement. Angiotensin converting enzyme inhibitor medication is the first-choice treatment for high

	Method	When to start after diagnosis	Frequency
ADA	No child-specific guidance Simple clinical test for DPN (B), DAN (D)	At diagnosis 5 years after the diagnosis (D)	Annual
NHMRC	History, vibration sense, ankle jerks, sensation (C)	If poorly controlled (C)	Annual (C)
CDA	History, vibration sense, ankle jerks, sensation (D)	5 years if post-puberty If poorly controlled (D)	Annual
ISPAD	History, vibration sense, ankle jerks, sensation	Unclear	–
NICE	Not recommended (C)	–	–

Letters in brackets demonstrate the level of evidence as defined in Table 7. DPN = distal polyneuropathy; DAN = diabetic autonomic neuropathy.

Table 3. Screening recommendations for neuropathy

	When to start after diagnosis	Frequency
ADA	–	Every routine visit (adult guideline)
NHMRC	From diagnosis (C)	Every visit to annual depending on BP (C)
CDA	–	Twice yearly (D)
ISPAD	After age 12 years (D)	At least annual
NICE	After age 12 years (C)	Annual (C)

Letters in brackets demonstrate the level of evidence as defined in Table 7.

Table 4. Screening recommendations for blood pressure (BP) measurements

blood pressure in patients with T1D along with lifestyle interventions.¹

Dyslipidaemia

The DCCT demonstrated the beneficial effect of improving glycaemic control on the long-term risk of late-diabetic complications. Coronary artery calcification, as an index of atherosclerosis, was associated with mean HbA_{1c} levels during the DCCT and EDIC studies. The DCCT and EDIC studies showed that well-controlled T1D is not associated with gross disturbances in blood lipid concentrations, though lipoprotein subclass examination reveals a tendency to atherogenic profiles.³³ In a large multicentre longitudinal study in teenagers with T1D, the mean frequency of high and borderline total cholesterol concentrations has been reported to be 18.6 and 34.8%, respectively.³⁴

Elevated apolipoprotein C-III concentrations are associated with risk factors for cardiovascular disease in normolipidaemic T1D patients.^{32,35,36}

ApoC-III inhibits the receptor-mediated uptake of VLDL, IDL and HDL by the liver and stimulates several processes involved in atherogenesis and vascular inflammation.³⁷ The DCCT/EDIC studies have also shown an independent positive association of apoC-III levels with microvascular complications of T1D.³⁶ The ideal screening method for dyslipidaemia is the measurement of fasting blood lipid concentrations (Table 5). The NHMRC, CDA and ISPAD guidelines suggest lipid screening should start from diagnosis, whereas the ADA suggests early screening only in the case of familial hyperlipidaemia. If serum lipid concentrations are normal, the NHMRC guidelines suggest measurement every second year through puberty and every five years before puberty. By contrast, the ADA and ISPAD guidelines recommend five-yearly measurements if lipid profiles are normal.

The target level for serum LDL cholesterol concentrations should

	When to start after diagnosis	Frequency
ADA	Soon if ≥ 2 years old and FH or ≥ 10 years old if not (D)	Annual if abnormal. Every 5 years if normal (D)
NHMRC	6–12 months from diagnosis (C)	If normal, every 2 years in puberty and every 5 years prepuberty (C)
CDA	Screen post diagnosis and at 12 and 17 years of age. Under 12 years if FH (D)	–
ISPAD	After age 12 years (D)	Every 5 years if normal (D)
NICE	Not recommended (C)	–

Letters in brackets demonstrate the level of evidence as defined in Table 7. FH = familial hyperlipidaemia.

Table 5. Screening recommendations for lipid measurements

	Thyroid function	Coeliac disease
ADA	TPO and Tg Abs at diagnosis and TSH when metabolic established and 1–2 yearly (D)	Anti-tTG, EMA with IgA at diagnosis (D)
NHMRC	TSH 2 yearly	EMA or AGA or anti-tTG with IgA at diagnosis and 2–3 yearly
CDA	TSH and TPO Abs at diagnosis and 2 yearly (D)	IgA and anti-tTG (D)
ISPAD	TSH and Abs at diagnosis and 2 yearly	EMA IgA and anti-tTG IgA at diagnosis and 2 yearly. AGA if < 2 years old
NICE	At diagnosis and yearly (C)	EMA with IgA at diagnosis (C)

Letters in brackets demonstrate the level of evidence as defined in Table 7. TPO = thyroperoxidase; Tg = thyroglobulin; Abs = antibodies; TSH = thyroid stimulating hormone; Anti-tTG = tissue transglutaminase; EMA = anti-endomysium; IgA = immunoglobulin A; AGA = antigliadin antibody.

Table 6. Screening recommendations for thyroid and coeliac diseases

be < 2.6 mmol/L according to the ISPAD and ADA recommendations.^{1,2} Treatment of hyperlipidaemia includes dietary and lifestyle changes, with medication considered in more severe cases.

Autoimmune diseases associated with diabetes

Children with T1D and their family members are more likely to have positive autoantibodies and manifestations of different autoimmune diseases than the general population, the two most common diseases being thyroiditis and coeliac disease (CD).^{38–40} Vitiligo, an acquired form of depigmentation, is also more common in those with T1D. Addison's disease can occur as a part of autoimmune polyglandular syndrome type I

or type II. A total of 21.6% of young people with T1D have been reported to have significantly elevated titres of at least one thyroid antibody on at least one occasion in a multicentre survey in Germany and Austria; 16% of patients with thyroid autoimmunity had abnormal thyroid stimulating hormone (TSH) levels.⁴¹

To establish the diagnosis of autoimmune thyroid disease, antibodies against thyroperoxidase (a-TPO) and thyroglobulin (a-Tg) and serum concentrations of TSH, free thyroxine, HbA_{1c} and ultrasound examination of thyroid glands should be assessed.^{38–41}

An Italian multicentre study has shown 6.8% of children and adolescents with T1D to have biopsy-confirmed coeliac disease.⁴² Based

on the NASPGHAN (North American Society for Pediatric Gastroenterology, Hepatology and Nutrition) recommendations, measurement of IgA antibody to human recombinant tissue transglutaminase (TTG) is recommended for initial testing for CD. Although as accurate as TTG, measurement of IgA antibody to endomysium (EMA) is observer dependent and more subject to interpretation error and added cost. The use of antigliadin antibody tests (AGA), IgA and AGA IgG tests are no longer recommended for detecting CD.⁴³ ADA, NHMRC, CDA, ISPAD and NICE guidelines recommend different laboratory tests for screening of thyroid and coeliac diseases (Table 6). All guidelines suggest screening for thyroid disease at the time of the diagnosis and one to two yearly thereafter. All guidelines, except CDA, suggest screening for CD at the time of the diagnosis. Regular examination for CD is also suggested by NHMRC and ISPAD, although coeliac disease can occur many years into diabetes.

Other conditions associated with diabetes

There are several other conditions which can affect people with diabetes and can make their lives more difficult. Some of these are seen in childhood whereas others develop only in adulthood. Conditions which may be found on clinical examination of children with T1D include lipodystrophy, necrobiosis lipoidica diabetorum, limited joint mobility, oedema, growth and development disturbances, juvenile cataracts and diabetic foot complications. The above mentioned guidelines have no agreement on screening for these conditions.

Discussion

The treatment goal for children with T1D is to achieve individually adapted optimal blood glucose control that reduces to a minimum the future risk of complications. Although diabetes complications are rare during childhood, clinicians, parents, older children and adolescents need to be aware of their significance, and regular examinations may be helpful in demonstrating this to children and their families. Several prospective studies have shown the

Grade	Basis for recommendations
A	Based directly on evidence from randomised controlled trials (level I evidence)
B	Based directly on evidence from well-designed, controlled or quasi-experimental studies (level II evidence) or extrapolated from level I evidence
C	Based directly on evidence from well-designed, non-experimental descriptive studies (level III evidence), or extrapolated from level I or level II evidence
D	Based directly on reports of expert committees or other authorities (level IV evidence) or extrapolated from level I, II or III evidence

Table 7. Grading of recommendations. (Sourced from The National Collaborating Centre for Women's and Children's Health. Type 1 diabetes: diagnosis and management of type 1 diabetes in children and young people. Clinical Guideline, September 2004. RCOG Press, 2004)⁵

importance of optimised blood glucose control to prevent diabetic complications.^{44–46} The risk of developing complications varies. The prevalence of severe nephropathy was very low in patients with long-term HbA_{1c} values below 9.6% (81mmol/mol), whereas the risk of severe retinopathy increases when HbA_{1c} concentrations exceed 8.6% (70mmol/mol).⁴⁷

In every child with HbA_{1c} values which exceed 10.0% (86mmol/mol), it is important to identify and address confounding factors such as depression and eating disorders in efforts to improve glycaemic control.³ Smoking is also an additional risk factor for developing persistent micro- or macroalbuminuria, and may also interact to produce excess cardiovascular morbidity and mortality, though the effects on retinopathy are less clear.¹ Puberty seems to be a further risk factor for complications. During puberty, insulin sensitivity is decreased, but the risk of complications is only partially attributed directly to deteriorating poor glycaemic control. It is hypothesised that puberty itself represents an independent risk factor through rapid renal growth and associated hormonal and metabolic changes.⁴⁸

Regular (usually annual) clinical examination and investigations are necessary to screen for early symptoms of complications and associated diseases before they cause overt problems. Several studies have shown that, with appropriate screening, early intervention can delay the progression of complications in a cost-effective way.⁴⁹

All of the main guidelines reviewed here emphasise the importance of screening for complications. However, despite efforts to make them well considered and evidence based, recommendations differ, reflecting the poor evidence base

that underpins this important area of clinical practice. Screening for retinopathy is recommended by all guidelines using fundal photography, though other examination methods are suggested too. The time to start screening is not agreed. All of the guidelines use the classification of the grading of recommendations (Table 7). According to this classification, the grade of evidence for recommendations for screening for retinopathy is between B and D.

Likewise, screening for nephropathy is agreed using random spot urine analyses for ACR measurement. Other more accurate methods such as timed overnight AER or early morning AC are recommended too, but there is no agreed standard for when screening should be started though all guidelines advise annual screening from puberty. The grade of recommendations for screening for nephropathy is between B and D.

There is less consistency about screening for neuropathy. The ADA does not have child-specific guidance nor does NICE give recommendations for screening of diabetic neuropathy during childhood. The NHMRC, CDA and ISPAD guidelines suggest detailed history taking, concentrating on specific symptoms and neurological examination including testing of vibration sense, ankle jerks and fine sensation, and suggest regular examinations only if diabetes is poorly controlled. The grade of evidence for these recommendations is between B and D. No guidelines recommend examination for autonomic neuropathy and, consistent with this, there is no agreement about when to start blood pressure screening or frequency of the follow up. The grade is between C and D. The agreed screening method for dyslipidaemia is the measurement of

Key points

- Children with T1D should undergo regular assessment for complications and diseases associated with diabetes
- Early detection of complications allows interventions designed to reduce their progression and severity
- Recommendations for screening programmes have been published by several specialist societies, but variations in recommendations for screening reflect the limited evidence base in childhood diabetes

fasting blood lipid concentrations but, again, there is no agreement on when to start or the frequency of screening (grade of evidence is between C and D). All guidelines (except CDA) recommend laboratory tests to screen for thyroid and coeliac diseases at the time of the diagnosis, but there is no agreement about follow-up testing (grade of evidence is between C and D).

There is general agreement that optimal management of diabetes is important to prevent or delay the development of complications which will impair the quality of life in older age and that screening for retinopathy, nephropathy and associated diseases should occur, particularly in children who are in puberty; however, there is much less agreement about screening for complications during earlier childhood or for neuropathy given its rarity.

These findings suggest that there is an important need for large-scale cohort observational studies to measure the impact of screening in younger children, its sensitivity, specificity, cost effectiveness and the effect on quality of life. The global increase in the incidence, prevalence and costs to health care systems of T1D emphasises the need to clarify these uncertainties about the value of screening for complications.

Declaration of interests

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