11. Children and Adolescents

American Diabetes Association

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POSITION STATEMENT

TYPE 1 DIABETES

Three-quarters of all cases of type 1 diabetes are diagnosed in individuals <18 years of age. The provider must consider the unique aspects of care and management of children and adolescents with type 1 diabetes, such as changes in insulin sensitivity related to sexual maturity and physical growth, ability to provide self-care, supervision in child care and school, and unique neurological vulnerability to hypoglycemia and possibly hyperglycemia as well as diabetic ketoacidosis. Attention to family dynamics, developmental stages, and physiological differences related to sexual maturity are all essential in developing and implementing an optimal diabetes regimen. Due to the paucity of clinical research in children, the recommendations for children and adolescents are less likely to be based on clinical trial evidence. However, expert opinion and a review of available and relevant experimental data are summarized in the American Diabetes Association (ADA) position statement "Care of Children and Adolescents With Type 1 Diabetes" (1) and have been updated in the recently published ADA position statement "Type 1 Diabetes Through the Life Span" (2).

A multidisciplinary team of specialists trained in pediatric diabetes management and sensitive to the challenges of children and adolescents with type 1 diabetes should provide care for this population. It is essential that diabetes self-management education (DSME) and support (DSMS), medical nutrition therapy (MNT), and psychosocial support be provided at diagnosis and regularly thereafter by individuals experienced with the educational, nutritional, behavioral, and emotional needs of the growing child and family. The balance between adult supervision and self-care should be defined at the first interaction and reevaluated at each clinic visit. This relationship will evolve as the child reaches physical, psychological, and emotional maturity.

Glycemic Control

Recommendation

- An A1C goal of <7.5% is recommended across all pediatric age-groups. **E**

Current standards for diabetes management reflect the need to lower glucose as safely as possible. This should be done with stepwise goals. Special consideration should be given to the unique risks of hypoglycemia in young children (aged <6 years), as they are often unable to recognize, articulate, and/or manage their hypoglycemic symptoms. This "hypoglycemia unawareness" should be considered when establishing individualized glycemic targets.

Although it was previously thought that young children were at risk for cognitive impairment after episodes of severe hypoglycemia, current data have not confirmed this (3–5). Furthermore, new therapeutic modalities, such as rapid- and long-acting insulin analogs, technological advances (e.g., continuous glucose monitors, low glucose suspend insulin pumps), and education, may mitigate the incidence of severe hypoglycemia (6). The Diabetes Control and Complications Trial (DCCT) demonstrated that near-normalization of blood glucose levels was more difficult to achieve in adolescents than in adults. Nevertheless, the increased use of basal–bolus regimens and insulin pumps in youth from infancy through adolescence has been associated with more children reaching the blood glucose targets set by the ADA (7–9) in those families in which both parents and the child with diabetes participate jointly to perform the required diabetes-related tasks. Furthermore, studies documenting neurocognitive imaging differences related to hyperglycemia in children provide another compelling motivation for lowering glycemic targets (10).

In selecting glycemic goals, the long-term health benefits of achieving a lower A1C should be balanced against the risks of hypoglycemia and the developmental burdens

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of intensive regimens in children and youth. In addition, achieving lower A1C levels is more likely to be related to setting lower A1C targets (11). A1C goals are presented in **Table 11.1**.

Autoimmune Conditions

Recommendation

- Assess for the presence of additional autoimmune conditions at diagnosis and if symptoms develop. **E**

Because of the increased frequency of other autoimmune diseases in type 1 diabetes, screening for thyroid dysfunction, vitamin B_{12} deficiency (due to autoimmune gastritis), and celiac disease should be considered based on signs and symptoms. Periodic screening in asymptomatic individuals has been recommended, but the effectiveness and optimal frequency are unclear.

Although less common than celiac disease and thyroid dysfunction, there are other autoimmune conditions that occur more commonly in type 1 diabetes, such as Addison's disease (primary adrenal insufficiency), autoimmune hepatitis, dermatomyositis, myasthenia gravis, etc., which should be assessed and monitored as clinically indicated.

Celiac Disease

Recommendations

- Consider screening children with type 1 diabetes for celiac disease by measuring tissue transglutaminase or deamidated gliadin antibodies, with documentation of normal total serum IgA levels, soon after the diagnosis of diabetes. **E**
- Consider screening in children with a positive family history of celiac disease, growth failure, failure to gain weight, weight loss, diarrhea, flatulence, abdominal pain, or signs of malabsorption or in children with frequent unexplained hypoglycemia or deterioration in glycemic control. **E**
- Children with biopsy-confirmed celiac disease should be placed on a gluten-free diet and have consultation with a dietitian experienced in managing both diabetes and celiac disease. **B**

Celiac disease is an immune-mediated disorder that occurs with increased frequency in patients with type 1 diabetes (1–16% of individuals compared with 0.3–1% in the general population) (12,13).

Testing for celiac disease includes measuring serum levels of IgA antitissue transglutaminase antibodies or, with IgA deficiency, screening can include measuring IgG tissue transglutaminase antibodies or IgG deamidated gliadin peptide antibodies. A small-bowel biopsy in antibody-positive children is recommended to confirm the diagnosis (14). European guidelines on screening for celiac disease in children (not specific to children with type 1 diabetes) suggested that biopsy may not be necessary in symptomatic children with high-positive antibody titers as long as further testing such as genetic or HLA testing was supportive, but that asymptomatic at-risk children should have biopsies (15).

In symptomatic children with type 1 diabetes and confirmed celiac disease, gluten-free diets reduce symptoms and rates of hypoglycemia (16). The challenging dietary restrictions associated with having both type 1 diabetes and celiac disease place a significant burden on individuals. Therefore, we recommend a biopsy confirming the diagnosis of celiac disease before endorsing significant dietary changes, especially in asymptomatic children.

Thyroid Disease

Recommendations

- Consider testing children with type 1 diabetes for antithyroid peroxidase and antithyroglobulin antibodies soon after diagnosis. **E**
- Measuring thyroid-stimulating hormone concentrations soon after diagnosis of type 1 diabetes is reasonable. If normal, consider rechecking every 1–2 years or sooner if the patient develops symptoms of thyroid dysfunction, thyromegaly, an abnormal growth rate, or unusual glycemic variation. **E**

Autoimmune thyroid disease is the most common autoimmune disorder associated with diabetes, occurring in 17–30% of patients with type 1 diabetes (17). About one-quarter of children with type 1 diabetes have thyroid autoantibodies at the time of diagnosis (18), and the presence of thyroid autoantibodies is predictive of thyroid dysfunction—most commonly hypothyroidism, although hyperthyroidism may occur (19). Subclinical hypothyroidism may be associated with increased risk of symptomatic hypoglycemia (20) and reduced linear growth. Hyperthyroidism alters glucose metabolism, potentially resulting in deterioration of metabolic control.

Management of Cardiovascular Risk Factors

Hypertension

Recommendations

Screening

- Blood pressure should be measured at each routine visit. Children found to have high-normal blood pressure (systolic blood pressure [SBP] or diastolic blood pressure [DBP] ≥90th percentile for age, sex, and height) or hypertension (SBP or DBP ≥95th percentile for age, sex, and height) should have blood pressure confirmed on three separate days. **B**

Table 11.1—Plasma blood glucose and A1C goals for type 1 diabetes across all pediatric age-groups

Plasma blood glucose goal range			
Before meals	Bedtime/overnight	A1C	Rationale
90–130 mg/dL (5.0–7.2 mmol/L)	90–150 mg/dL (5.0–8.3 mmol/L)	<7.5%	A lower goal (<7.0%) is reasonable if it can be achieved without excessive hypoglycemia

Key concepts in setting glycemic goals:

- Goals should be *individualized*, and lower goals may be reasonable based on benefit-risk assessment.
- Blood glucose goals should be modified in children with frequent hypoglycemia or hypoglycemia unawareness.
- Postprandial blood glucose values should be measured when there is a discrepancy between preprandial blood glucose values and A1C levels and to help assess glycemia in those on basal–bolus regimens.

Treatment

- Initial treatment of high-normal blood pressure (SBP or DBP consistently ≥90th percentile for age, sex, and height) includes dietary intervention and exercise, aimed at weight control and increased physical activity, if appropriate. If target blood pressure is not reached with 3–6 months of lifestyle intervention, pharmacological treatment should be considered. **E**
- Pharmacological treatment of hypertension (SBP or DBP consistently ≥95th percentile for age, sex, and height) should be considered as soon as hypertension is confirmed. **E**
- ACE inhibitors or angiotensin receptor blockers (ARBs) should be considered for the initial pharmacological treatment of hypertension, following appropriate reproductive counseling due to its potential teratogenic effects. **E**
- The goal of treatment is blood pressure consistently <90th percentile for age, sex, and height. **E**

Blood pressure measurements should be determined correctly, using the appropriate size cuff, and with the child seated and relaxed. Hypertension should be confirmed on at least three separate days. Evaluation should proceed as clinically indicated. Treatment is generally initiated with an ACE inhibitor, but an ARB can be used if the ACE inhibitor is not tolerated (e.g., due to cough). Normal blood pressure levels for age, sex, and height and appropriate methods for measurement are available online at www.nhlbi.nih.gov/health/prof/heart/hbp/hbp_ped.pdf.

Dyslipidemia

Recommendations

Testing

- Obtain a fasting lipid profile on children ≥2 years of age soon after the diagnosis (after glucose control has been established). **E**
- If lipids are abnormal, annual monitoring is reasonable. If LDL cholesterol values are within the accepted risk levels (<100 mg/dL [2.6 mmol/L]), a lipid profile repeated every 5 years is reasonable. **E**

Treatment

- Initial therapy may consist of optimization of glucose control and MNT using a Step 2 American Heart Association (AHA) diet aimed at a decrease in the amount of saturated fat in the diet. **B**
- After the age of 10 years, the addition of a statin in patients who, after MNT and lifestyle changes, have LDL cholesterol >160 mg/dL (4.1 mmol/L) or LDL cholesterol >130 mg/dL (3.4 mmol/L) and one or more cardiovascular disease (CVD) risk factors is reasonable. **E**
- The goal of therapy is an LDL cholesterol value <100 mg/dL (2.6 mmol/L). **E**

Children diagnosed with type 1 diabetes have a high risk of early subclinical (21,22) and clinical (23) CVD. Although intervention data are lacking, the AHA categorizes children with type 1 diabetes in the highest tier for cardiovascular risk and recommends both lifestyle and pharmacological treatment for those with elevated LDL cholesterol levels (24,25). Initial therapy should be with a Step 2 AHA diet, which restricts saturated fat to 7% of total calories and restricts dietary cholesterol to 200 mg/day. Data from randomized clinical trials in children as young as 7 months of age indicate that this diet is safe and does not interfere with normal growth and development (26).

For children with significant family history of CVD, the National Heart, Lung, and Blood Institute recommends a fasting lipid panel beginning at 2 years of age (27). Abnormal results from a random lipid panel should be confirmed with a fasting lipid panel. Evidence has shown that improved glucose control correlates with a more favorable lipid profile. However, improved glycemic control alone will not reverse significant dyslipidemia (28).

Neither long-term safety nor cardiovascular outcome efficacy of statin therapy has been established for children. However, studies have shown short-term safety equivalent to that seen in adults and efficacy in lowering LDL cholesterol levels, improving endothelial function, and causing regression of carotid intimal thickening (29,30). Statins are not approved for use in patients under the age of 10 years, and statin treatment should generally not be used in children with type 1 diabetes prior to this age. For postpubertal girls, issues of pregnancy prevention are paramount, as statins are category X in pregnancy (see Section 12. Management of Diabetes in Pregnancy for more information).

Smoking

Recommendation

- Elicit smoking history at initial and follow-up diabetes visits and discourage smoking in nonsmoking youth and encourage smoking cessation in those who smoke. **B**

The adverse health effects of smoking are well recognized with respect to future cancer and CVD risk. In youth with diabetes, it remains important to avoid additional CVD risk factors; thus, discouraging cigarette smoking, including e-cigarettes, is important as part of routine diabetes care. In younger children, it is important to assess exposure to cigarette smoke in the home due to the adverse effects of secondhand smoke and to discourage youth from adopting smoking behaviors if exposed to them in childhood. In addition, smoking has been associated with onset of albuminuria; therefore, avoiding smoking is important to prevent both microvascular and macrovascular complications (31,32).

Microvascular Complications

Nephropathy

Recommendations

Screening

- At least an annual screening for albuminuria, with a random spot urine sample for albumin-to-creatinine ratio (UACR), should be considered once the child has had diabetes for 5 years. **B**
- Measure creatinine clearance/estimated glomerular filtration rate at initial evaluation and then based on age, diabetes duration, and treatment. **E**

Treatment

- Treatment with an ACE inhibitor, titrated to normalization of albumin excretion, should be considered when elevated UACR (>30 mg/g) is documented with at least two of three urine samples. This should be obtained over a 6-month interval following efforts to improve glycemic control and normalize blood pressure for age. **B**

Recent research demonstrates the importance of tight glycemic and blood pressure control, especially as diabetes duration increases (33). A creatinine clearance using an estimated glomerular filtration rate can be obtained with the serum creatinine, height, age, and sex of the patient (34) and should be obtained at baseline and repeated as indicated based on clinical status, age, diabetes duration, and therapies. There are ongoing clinical trials assessing the efficacy of early treatment with ACE inhibitors for persistent albuminuria (35).

Retinopathy

Recommendations

- An initial dilated and comprehensive eye examination should be considered for the child at the start of puberty or at age ≥10 years, whichever is earlier, once the youth has had diabetes for 3–5 years. **B**
- After the initial examination, annual routine follow-up is generally recommended. Less frequent examinations, every 2 years, may be acceptable on the advice of an eye care professional. **E**

Although retinopathy (like albuminuria) most commonly occurs after the onset of puberty and after 5–10 years of diabetes duration (36), it has been reported in prepubertal children and with diabetes duration of only 1–2 years. Referrals should be made to eye care professionals with expertise in diabetic retinopathy, an understanding of retinopathy risk in the pediatric population, and experience in counseling the pediatric patient and family on the importance of early prevention/intervention.

Neuropathy

Recommendation

- Consider an annual comprehensive foot exam for the child at the start of puberty or at age ≥10 years, whichever is earlier, once the youth has had type 1 diabetes for 5 years. **E**

Neuropathy rarely occurs in prepubertal children or in youth with 1–2 years of duration of diabetes (36). A comprehensive foot exam, including inspection, palpation of dorsalis pedis and posterior tibial pulses, assessment of the presence or absence of patellar and Achilles reflexes, and determination of proprioception, vibration, and monofilament sensation, should be performed annually along with assessment of symptoms of neuropathic pain. Foot inspection can be performed at each visit as education for youth regarding the importance of foot care.

Diabetes Self-management Education and Support

Recommendation

- Youth with type 1 diabetes and parents/caregivers (for patients aged <18 years) should receive culturally sensitive and developmentally appropriate individualized DSME and DSMS according to national standards when their diabetes is diagnosed and routinely thereafter. **B**

No matter how sound the medical regimen, it can only be as good as the ability of the family and/or individual to implement it. Family involvement remains an important component of optimal diabetes management throughout childhood and adolescence. Health care providers who care for children and adolescents, therefore, must be capable of evaluating the educational, behavioral, emotional, and psychosocial factors that impact implementation of a treatment plan and must work with the individual and family to overcome barriers or redefine goals as appropriate. DSME and DSMS are activities that require ongoing reassessment, especially as the youth grows, develops, and acquires need for greater self-care skills. In addition, it may be necessary to assess the educational needs and skills of day care providers, school nurses, or school personnel who may participate in the care of the young child with diabetes (37).

School and Child Care

As a large portion of a child's day is spent in school, close communication with and cooperation of school or day care personnel is essential for optimal diabetes management, safety, and maximal academic opportunities. Please refer to the ADA position statements "Diabetes Care in the School and Day Care Setting" (38) and "Care of Young Children With Diabetes in the Child Care Setting" (39) for additional details.

Transition From Pediatric to Adult Care

Recommendations

- As teens transition into emerging adulthood, health care providers and families must recognize their many vulnerabilities **B** and prepare the developing teen, beginning in early to mid-adolescence and at least 1 year prior to the transition. **E**
- Both pediatricians and adult health care providers should assist in providing support and links to resources for the teen and emerging adult. **B**

Care and close supervision of diabetes management are increasingly shifted from parents and other adults to the youth with diabetes throughout childhood and adolescence. However, the shift from pediatrics to adult health care providers often occurs very abruptly as the older teen enters the next developmental stage referred to as emerging adulthood (40), which is a critical period for young people who have diabetes. During this period of major life transitions, youth begin to move out of their parents' home and must become fully responsible for their diabetes care. Their new responsibilities include the many aspects of managing self-care, making medical appointments, and financing health care, once they are no longer covered under their parents' health insurance (although ongoing coverage until age 26 years is possible with recent U.S. health care reform). In addition to lapses in health care, this is also a period of deterioration in glycemic control; increased occurrence of acute complications and psychosocial, emotional, and behavioral issues; and emergence of chronic complications (41–44).

Although scientific evidence continues to be limited, it is clear that comprehensive and coordinated planning, beginning early and with ongoing attention, facilitates a seamless transition from pediatric to adult health care (41,42). Transition planning should begin in early adolescence. Even after the transition to adult care is made, support and reinforcement are recommended.

A comprehensive discussion regarding the challenges faced during this period, including specific recommendations, is found in the ADA position statement "Diabetes Care for Emerging Adults: Recommendations for Transition From Pediatric to Adult Diabetes Care Systems" (42).

The National Diabetes Education Program (NDEP) has materials available to facilitate the transition process (http://ndep.nih.gov/transitions), and the Endocrine Society in collaboration with ADA and other organizations has developed transition tools for clinicians and youth and families (http://www.endo-society.org/clinicalpractice/transition_of_care.cfm).

TYPE 2 DIABETES

For information on testing for type 2 diabetes and prediabetes in children and adolescents, please refer to Section 2. Classification and Diagnosis of Diabetes.

The Centers for Disease Control and Prevention recently published projections for type 2 diabetes prevalence using the SEARCH database. Assuming a 2.3% annual increase, the prevalence of type 2 diabetes in those under 20 years of age will quadruple in 40 years (45,46). Given the current obesity epidemic, distinguishing between type 1 and type 2 diabetes in children can be difficult. For example, autoantibodies and ketosis may be present in patients with features of type 2 diabetes (including obesity and acanthosis nigricans). Nevertheless, accurate diagnosis is critical as treatment regimens, educational approaches, dietary counsel, and outcomes will differ markedly between the two diagnoses.

Significant comorbidities may already be present at the time of a type 2 diabetes diagnosis (47). It is recommended that blood pressure measurement, a fasting lipid panel, assessment for albumin excretion, and dilated eye examination be performed at diagnosis. Thereafter, screening guidelines and treatment recommendations for hypertension, dyslipidemia, albumin excretion, and retinopathy in youth with type 2 diabetes are similar to those for youth with type 1 diabetes. Additional problems that may need to be addressed include polycystic ovary disease and the various comorbidities associated with pediatric obesity, such as sleep apnea, hepatic steatosis, orthopedic complications, and psychosocial concerns. The ADA consensus report "Type 2 Diabetes in Children and Adolescents" (48) provides guidance on the prevention, screening, and treatment of type 2 diabetes and its comorbidities in young people.

PSYCHOSOCIAL ISSUES

Recommendations

- At diagnosis and during routine follow-up care, assess psychosocial issues and family stresses that could impact adherence with diabetes management and provide appropriate referrals to trained mental health professionals, preferably experienced in childhood diabetes. **E**
- Encourage developmentally appropriate family involvement in diabetes management tasks for children and adolescents, recognizing that premature transfer of diabetes care to the child can result in nonadherence and deterioration in glycemic control. **B**

Diabetes management throughout childhood and adolescence places substantial burdens on the youth and family, necessitating ongoing assessment of psychosocial issues and distress during routine diabetes visits (49–51). Further, the complexities of diabetes management require ongoing parental involvement in care throughout childhood with developmentally appropriate family teamwork between the growing child/teen and parent in order to maintain adherence and prevent deterioration in glycemic control (52,53). In addition, as diabetes-specific family conflict is related to poorer adherence and glycemic control, it is appropriate to inquire about such conflict during visits and to either help negotiate a plan for resolution or refer to an appropriate mental health specialist (54).

Screening for psychosocial distress and mental health problems is an important component of ongoing care. It is important to consider the impact of diabetes on quality of life as well as the development of mental health problems related to diabetes distress, fear of hypoglycemia (and hyperglycemia), symptoms of anxiety, disordered eating behaviors as well as eating disorders, and symptoms of depression (55). Consider screening for depression and disordered eating behaviors using available screening tools, and, with respect to disordered eating, it is important to recognize the unique and dangerous disordered eating behavior of insulin omission for weight control in type 1 diabetes (49,56). The presence of a mental health professional on pediatric multidisciplinary teams highlights the importance of attending to the psychosocial issues of diabetes. These psychosocial factors are significantly related to nonadherence, suboptimal glycemic control, reduced quality of life, and higher rates of acute and chronic diabetes complications.

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