Management of Type 2 Diabetes in Youth: An Update

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Although type 1 diabetes historically has been more common in patients eight to 19 years of age, type 2 diabetes is emerging as an important disease in this group. Type 2 diabetes accounts for 8 to 45 percent of new childhood diabetes. This article is an update from the National Diabetes Education Program on the management of type 2 diabetes in youth. High-risk youths older than 10 years have a body mass index greater than the 85th percentile for age and sex plus two additional risk factors (i.e., family history, high-risk ethnicity, acanthosis nigricans, polycystic ovary syndrome, hypertension, or dyslipidemia). Reducing overweight and impaired glucose tolerance with increased physical activity and healthier eating habits may help prevent or delay the development of type 2 diabetes in high-risk youths. The American Academy of Pediatrics does not recommend population-based screening of high-risk youths; however, physicians should closely monitor these patients because early diagnosis may be beneficial. The American Diabetes Association recommends screening high-risk youths every two years with a fasting plasma glucose test. Patients diagnosed with diabetes should receive self-management education, behavior interventions to promote healthy eating and physical activity, appropriate therapy for hyperglycemia (usually metformin and insulin), and treatment of comorbidities. (Am Fam Physician 2007;76:658-64, 665-6. Copyright © 2007 American Academy of Family Physicians.)

ILLUSTRATION BY JOHN KARAPELOU

See related editorial on page 634.

Patient information: A handout on type 2 diabetes in youth, written by the authors of this article, is provided on page 665.

AFP This article exemplifies the AAFP 2007 Annual Clinical Focus on management of chronic illness.

More than 13,000 youths are diagnosed with diabetes every year, making it one of the most common chronic childhood diseases in the United States.[1-3] The prevalence of childhood type 2 diabetes has increased by 33 percent in the past 15 years,[3] mirroring the increasing rates of overweight in this population.[4] In response to this emerging problem, the American Diabetes Association (ADA) developed a consensus statement in 2000 to guide primary care physicians on the prevention, screening, and treatment of type 2 diabetes in youth.[5] In 2003, the ADA developed an additional consensus guideline for the management of dyslipidemia,[6] and the American Heart Association developed a guideline on the primary prevention of atherosclerotic cardiovascular disease in youth.[7]

Diagnosis

Glucose intolerance is part of a continuum that ranges from normal blood glucose levels to clinically evident type 2 diabetes. Children at risk of type 2 diabetes often are overweight and insulin resistant. Together, these metabolic risk factors substantially increase the risk of atherosclerosis.[8,9]

The U.S. Preventive Services Task Force (USPSTF) concludes that there is insufficient evidence to recommend for or against routine screening for overweight in youth to prevent adverse health outcomes[10]; however, American Academy of Family Physicians policy states that "optimal weight management in children and adolescents is desirable. The effectiveness of screening and counseling for overweight is uncertain."[11] The American Academy of Pediatrics endorses universal screening using body mass index (BMI) and

SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	*Evidence rating*	*References*
Fasting plasma glucose levels should be checked every two years in high-risk children and adolescents, beginning at 10 years of age.	C	5
All aspects of the diabetes management regimen should be individualized to the patient.	C	13
The blood glucose level should be maintained as close to the normal range as possible without hypoglycemia.	C	5
Primary prevention of cardiovascular disease should begin in childhood.	C	7
Youths with type 2 diabetes and those with a body mass index greater than the 85th percentile for age should be counseled to increase physical activity and reduce body weight gain.	C	21
Comorbidities such as hypertension and hyperlipidemia should be controlled.	C	5

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, see page 612 or http://www.aafp.org/afpsort.xml.

growth curves to identify overweight children (i.e., those with a BMI greater than the 95th percentile for sex and age).[12] Clinical growth charts are available at http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/clinical_charts.htm.

Table 1 presents ADA recommendations for diabetes screening in youth.[5,13] The USPSTF has not addressed screening youths for diabetes.[5,14]

Distinguishing between type 1 and 2 diabetes can be difficult in a child or adolescent with new-onset diabetes. Youths with type 1 diabetes often have antibodies against islet cell antigens (i.e., glutamic acid decarboxylase or insulin autoantibodies), whereas children with type 2 diabetes are overweight and usually do not have autoantibodies. The clinical distinction between the types of diabetes can be blurred because ketosis may be present in patients with type 2 diabetes, and patients with type 1 diabetes may be overweight and have acanthosis nigricans.[13,15]

Insulin and C-peptide levels are usually low at diagnosis in patients with either type of diabetes; furthermore, some patients have elements of both types. Youths with insulin resistance, overweight, and type 2 diabetes may have the pancreatic islet cell antibodies that are typically associated with type 1 diabetes; this is sometimes called "hybrid," "mixed," or "double" diabetes. If

Table 1. ADA Guidelines for Screening Youths for Type 2 Diabetes

Criteria to begin screening

The patient is overweight (i.e., body mass index greater than the 85th percentile for age and sex; weight is greater than the 85th percentile for height; or weight is greater than 120 percent of ideal for height) or at risk of becoming overweight

Plus

Any two of the following risk factors:

- Family history of type 2 diabetes in a first- or second-degree relative or maternal history of gestational diabetes
- Ethnicity: American Indian, black, Hispanic/Latino, Asian American, Pacific islander
- Signs of insulin resistance or conditions associated with insulin resistance; acanthosis nigricans; hypertension; dyslipidemia (hypertriglyceridemia, low high-density lipoprotein cholesterol, and elevated total or low-density lipoprotein cholesterol); or polycystic ovary syndrome

Screening recommendations

Screening should be performed every two years beginning at 10 years of age or at onset of puberty, if puberty occurs earlier

Fasting plasma glucose measurement (no caloric intake for at least eight hours) is the preferred diagnostic testing method

- Diabetes diagnosis: fasting plasma glucose level of 126 mg per dL (7.0 mmol per L) or greater; test should be repeated on a subsequent day to confirm
- Prediabetes diagnosis: fasting plasma glucose level of 100 to 125 mg per dL (5.6 to 6.9 mmol per L)

ADA = American Diabetes Association.

Adapted with permission from American Diabetes Association. Type 2 diabetes in children and adolescents. Diabetes Care 2000;23:386, with additional information from reference 13.

the diagnosis is unclear, it may be helpful to measure islet cell antibodies and C-peptide levels one year or more after the diagnosis.

Treatment

The treatment of children and adolescents with type 2 diabetes differs from that of adults because treatment in youths is focused on decreased insulin sensitivity with advancing sexual maturity, physical growth, ability to provide self-management, and neurologic vulnerability to hypoglycemia (in children younger than five years).[13] The diabetes management regimen should be individualized to the patient.[13] *Table 2* includes resources for more information about the treatment of youths with type 2 diabetes.

Diabetes care is best provided by a team that includes the patient and family and should address medical, educational, nutritional, and behavioral issues. Education about healthy eating, daily physical activity, insulin and medication administration, and self-monitoring of blood glucose levels is essential. Families should be encouraged to share with team members their concerns about day-to-day management tasks.

METABOLIC CONTROL

Diet and exercise alone are effective for metabolic control in less than 10 percent of youths with type 2 diabetes, and an oral medication or insulin is usually required.[3] Metformin (Glucophage) is an oral medication approved for use in some children. Because metformin's onset of action is delayed about four weeks, patients with substantial ketosis, ketoacidosis, or markedly elevated blood glucose levels initially should be treated with insulin. Metformin may be added after blood glucose levels are controlled and symptoms subside.[16] The insulin may be tapered to discontinuation if metabolic control is maintained.

Basal-bolus therapy using a combination of long- or intermediate-acting and short-acting insulin provides flexibility and can improve A1C levels. Insulin pumps can provide even greater flexibility, but they cost more and require more education for accurate use. Fixed-dose regimens provide little flexibility and may not fit the lifestyle of adolescents. A preprandial insulin bolus is based on an insulin:carbohydrate ratio, and an insulin-correction dose should be administered for hyperglycemia. Further adjustment of insulin or food intake may be needed in anticipation of special circumstances such as increased exercise. Patients should self-monitor their blood glucose level before meals and at bedtime.

Treatment regimens (e.g., blood glucose goals, frequency of self-monitoring, type

Table 2. Resources for More Information About Managing Diabetes in Youth

American Association of Diabetes Educators Web site: http://www.aadenet.org Telephone: 800-338-3633	CDC growth charts Web site: http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/clinical_charts.htm
American Diabetes Association Web site: http://www.diabetes.org Telephone: 800-342-2383	Juvenile Diabetes Research Foundation International Web site: http://www.jdrf.org Telephone: 800-533-2873
American Dietetic Association Web site: http://www.eatright.org Telephone: 800-877-1600	National Diabetes Education Program Web site: http://www.ndep.nih.gov/diabetes/youth/youth.htm Telephone: 800-438-5383
American Heart Association Web site: http://www.americanheart.org Telephone: 800-242-8721	National Institute of Diabetes and Digestive and Kidney Diseases Web site: http://diabetes.niddk.nih.gov/ Telephone: 800-860-8747
CDC Division of Diabetes Translation Web site: http://www.cdc.gov/diabetes/ Telephone: 800-232-4636	

CDC = Centers for Disease Control and Prevention.

Table 3. Optimal Plasma Glucose and A1C Goals for Youths with Type 1 Diabetes

	Blood glucose goals			
Age (years)	*Preprandial**	*Bedtime/overnight*	*A1C goals (%)*	*Comments*
Younger than six	100 to 180 mg per dL (5.6 to 10.0 mmol per L	110 to 200 mg per dL (6.1 to 11.1 mmol per L)	Between 8.5 and 7.5	High risk of complications; vulnerable to hypoglycemia
Six to 12	90 to 180 mg per dL (5.0 to 10.0 mmol per L)	100 to 180 mg per dL	< 8.0	Risk of hypoglycemia; low risk of complications
13 to 19	90 to 130 mg per dL (5.0 to 7.2 mmol per L)	90 to 150 mg per dL (5.0 to 8.3 mmol per L)	< 7.5	Risk of severe hypoglycemia and developmental and psychological issues; a lower A1C goal is reasonable if it can be achieved without severe hypoglycemia

NOTE: *The American Diabetes Association provides blood glucose goals only for youths with type 1 diabetes; however, because vascular damage may be mediated by glycated end products, it appears reasonable to use these goals in the management of type 2 diabetes.*

**—Postprandial plasma blood glucose values should be measured when there is a disparity between preprandial blood glucose values and A1C levels.*

Adapted with permission from American Diabetes Association. Standards of medical care in diabetes—2006. Diabetes Care 2006;29(suppl 1):S27, with additional information from reference 17.

of insulin, dose and frequency of insulin administration, use of injections or a pump, nutritional management, physical activity levels) vary among patients. The diabetes care team should determine the regimen that best suits the patient's individual characteristics and circumstances.

Because a safe lower-than-normal range for blood glucose has not been identified, the ADA recommends that blood glucose levels be maintained as close to the normal range as possible without serious hypoglycemia.[5] The ADA provides blood glucose goals only for young persons with type 1 diabetes (*Table 3*[13,17]*)*; however, because vascular damage may be mediated by glycated end products, it appears reasonable to use these goals in the management of type 2 diabetes.

BODY WEIGHT MANAGEMENT

The increase in overweight in youths has been associated with increased consumption of beverages with a high sugar content,[18] long hours watching television,[19] and reduced physical activity.[20] Children with a BMI greater than the 85th percentile for age and sex should be counseled to increase physical activity and reduce weight gain while allowing for normal growth and development.[21] *Table 4* includes recommendations for managing body weight in youths with or at risk of type 2 diabetes.[22]

Health Maintenance Schedule

Diabetes presents distinctive issues for youths (e.g., emotional and behavioral challenges, self-management and adherence considerations). *Table 5* summarizes a consensus-based management schedule for monitoring diabetes and comorbidities in youths with diabetes.[5,13,17]

Table 4. Recommendations for Managing Body Weight in Youths with or at Risk of Type 2 Diabetes

Food modification (for weight control and blood glucose control)
Individualize calorie and food intake based on age, sex, and physical activity; go to http://www.mypyramid.gov/ for more information
Limit consumption of snacks that have high levels of fat, sugar, or salt (e.g., potato chips, fast food, soda, desserts)
Provide a meal plan developed by a registered dietitian, diabetes educator, or physician that includes low-fat and high-fiber foods, small portion sizes, and fewer beverages with high sugar content (e.g., soda, juice)
Teach the patient and family how carbohydrates (e.g., breads, pasta, rice) can affect blood glucose levels
Physical activity (for weight control and improvement in insulin sensitivity)
Prescribe 30 to 60 minutes of physical activity per day
Limit television and video game time to one or two hours per day
Psychosocial support
Encourage peer support via youth camps and support groups
Involve the patient's family in using the meal plan and in eating at regular mealtimes, especially if the youth is taking insulin

Information from reference 22.

Performing diabetes management tasks can make school-age youths, particularly adolescents, feel different from their classmates. Learning to cope with the disease may lead to depression or an eating disorder. A social worker or psychologist can help patients and their families adjust to lifestyle changes and can provide resources for health education; financial, social, and mental health services; transportation; and home visits.

It is important that parents talk to their children about avoiding tobacco, alcohol, and drug use. Smoking and diabetes independently increase the risk of cardiovascular disease, and persons with diabetes who smoke have a greatly increased risk of heart disease and circulatory problems. Binge drinking can be associated with acute hyperglycemia or severe hypoglycemia. Because intoxication symptoms are similar to those of hypoglycemia, treatment of hypoglycemia may be delayed in patients who are intoxicated.

Youths should self-manage their diabetes to the extent that is appropriate for their age and maturity level. By six or seven years of age, most children can recognize symptoms of hypoglycemia, perform blood glucose measurements, administer insulin injections, and participate in nutritional decisions. However, children should be supervised until they are able to accurately perform diabetes management tasks independently (e.g., measuring an insulin dose).

Adolescents usually have the motor and cognitive skills to perform all diabetes-related tasks, including determining insulin doses based on blood glucose levels and food intake. Adolescence, however, is a time when peer acceptance is important and risk-taking behaviors and rebellion are common. Thus, diabetes management should be supervised in adolescents, and gradual independence should be allowed based on adherence to the regimen and reasonable metabolic control. During midadolescence, the diabetes care team should stress the importance of checking blood glucose levels before driving to avoid hypoglycemia while driving.

Accommodations may be needed to manage diabetes at school (e.g., in the classroom, during physical education, field trips, and after-school activities). A written plan outlining the student's diabetes management tasks is helpful. A guide for effective diabetes management at school is available at http://www.ndep.nih.gov/diabetes/youth/youth.htm.

Table 5. Schedule for Managing Type 2 Diabetes in Youth

At diagnosis
Assess baseline A1C level; lipid profile (if normal, repeat every three to five years); and ophthalmologic status
Begin diabetes education
Conduct a psychosocial assessment to identify emotional and behavioral disorders
Establish the goals of care and required treatment
Evaluate for microalbuminuria
Provide nutrition therapy to meet growth needs and prevent excess weight gain
Refer for dietary, behavioral, family, or community support as necessary
Quarterly
Assess injection site
Assess psychosocial adjustment/adherence, self-management skills, dietary needs, and physical activity level
Discuss tobacco, drug, and alcohol use
Measure A1C and fasting plasma glucose levels
Review self-managed blood glucose records
Annually
Administer influenza vaccination
Assess physical status (e.g., skin, acanthosis nigricans, signs of polycystic ovary syndrome, liver enlargement)
Evaluate for microalbuminuria
Examine feet
Perform ophthalmologic examination (may be performed less often on the advice of an ophthalmologist)

Information from references 5, 13, and 17.

Reducing Cardiovascular Disease Risk

Diabetes microvascular complications and cardiovascular risk factors, including dyslipidemia and hypertension, have been observed among teenage Pima Indians[2] and in other youths in the United States and may be present at diabetes diagnosis.[23,24] Monitoring for hypertension and early treatment can slow the progression of retinopathy, nephropathy, and possibly neuropathy that can occur in adulthood.[25] Evidence indicates that primary prevention of cardiovascular

Table 6. Recommendations for Monitoring Blood Pressure and Lipid Levels in Youth

Blood pressure[7]
Hypertension is defined as an average systolic or diastolic blood pressure greater than the 95th percentile for age, sex, and height measured on at least three separate days
Normal blood pressure levels for age, sex, and height; appropriate methods for measurement; and treatment recommendations are available at www.nhlbi.nih.gov/health/prof/heart/hbp/hbp_ped.pdf
Angiotensin-converting enzyme inhibitors are preferred in children with microalbuminuria
Lipids[13]
Optimal levels are: LDL cholesterol less than 100 mg per dL (2.60 mmol per L); high-density lipoprotein cholesterol greater than 35 mg per dL (0.90 mmol per L); and triglycerides less than 150 mg per dL (1.70 mmol per L)
A lipid profile should be obtained at diagnosis, after glucose control is established; if lipids are at optimal levels, repeat lipid profile every three to five years
If the LDL cholesterol level is greater than 100 mg per dL, prescribe an exercise plan and healthy diet; if goals are not reached after six months of diet and exercise, consider statin* therapy for patients with an LDL cholesterol level of 130 to 159 mg per dL (3.35 to 4.10 mmol per L), and begin medications for patients with an LDL cholesterol level of 160 mg per dL (4.15 mmol per L) or greater
Weight loss, increased physical activity, and improved glycemic control often lead to improved lipid levels

LDL = low-density lipoprotein.

**—Statins are contraindicated in pregnant women.*

Information from references 7 and 13.

disease should begin in childhood.[7] *Table 6* presents consensus-based recommendations for monitoring lipid levels and blood pressure in youths.[7,13]

Further Study

There are ongoing studies of youths with diabetes. The HEALTHY study (part of STOPP-T2D [Studies to Treat or Prevent Pediatric Type 2 Diabetes]) will help determine effective ways to lower diabetes risk factors in middle school students. The SEARCH for Diabetes in Youth project is tracking the incidence and prevalence of diabetes in the United States and will help clarify trends in childhood and adolescent diabetes. For more information on the project, go to http://www.searchfordiabetes.org/. The TODAY (Treatment Options for Type 2 Diabetes in Adolescents and Youth) study seeks to identify the best treatment for children and adolescents with type 2 diabetes. For more information on the study, go to http://www.niddk.nih.gov/patient/today/today.htm.

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