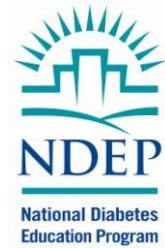


Overview of Diabetes in Children and Adolescents

From the [National Diabetes Education Program \(NDEP\)](#)



Diabetes mellitus is a group of diseases characterized by high levels of glucose in the blood resulting from defects in insulin production, insulin action, or both. Diabetes is associated with serious complications and premature death, but timely diagnosis and treatment of diabetes can prevent or delay the onset of long-term complications (damage to the cardiovascular system, kidneys, eyes, nerves, blood vessels, skin, gums, and teeth). New management strategies are helping children with diabetes live long and healthy lives.

Type 1 diabetes in U.S. children and adolescents is increasing (1) and more new cases of type 2 diabetes are being reported in young people. The American Diabetes Association provides helpful guidance in consensus statements for managing children with type 1 diabetes (2) and type 2 diabetes (3). To update primary care providers and their staff about this evolving area of diabetes care, the NDEP has developed this overview of current statistics and care recommendations.

Statistics

Diabetes is one of the most common diseases in school-aged children. According to the 2011 National Diabetes Fact Sheet, about 215,000 young people in the US under age 20 had diabetes in 2010. This represents 0.26 percent of all people in this age group. (4)

Based on data from 2002 to 2005, the SEARCH for Diabetes in Youth study reported that approximately 15,600 US youth less than 20 years of age were diagnosed annually with type 1 diabetes, while 3,600 were newly diagnosed with type 2 diabetes. (5) Type 2 diabetes was rare in children younger than 10 years of age, regardless of race or ethnicity. In youth aged 10 to 19 years, type 2 diabetes became increasingly common, especially in minority populations such as American Indians, African Americans, Hispanic/Latinos, Asians and Pacific Islanders. Among non-Hispanic white youth aged 10 to 19 years, the rate of new cases was higher for type 1 than for type 2 diabetes. For Asian/Pacific Islander and American Indian youth aged 10–19 years, the opposite was true—the rate of new cases was greater for type 2 than for type 1 diabetes. Among non-Hispanic black and Hispanic youth aged 10 to 19 years, the rates of new cases of type 1 and type 2 diabetes were similar. (5)

Type 1 Diabetes

Type 1 diabetes accounts for 5 to 10 percent of all diagnosed cases of diabetes, but is the leading cause of diabetes in children of all ages. Type 1 diabetes accounts for almost all diabetes in children less than 10 years of age. Type 1 diabetes is an autoimmune disease in which the immune system destroys the insulin-producing beta cells of the pancreas that help regulate blood glucose levels.

Onset. Type 1 diabetes mostly has an acute onset, with children and adolescents usually able to pinpoint when symptoms began. Onset can occur at any age, but it most often occurs in children and young adults. Children and adolescents may present with ketoacidosis as the first indication of type 1 diabetes. Others may have post-meal hyperglycemia, or modest fasting

hyperglycemia that rapidly progresses to severe hyperglycemia and/or ketoacidosis in the presence of infection or other stress.

Symptoms. The immunologic process that leads to type 1 diabetes can begin years before the symptoms of type 1 diabetes develop. Symptoms become apparent when most of the beta-cell population is destroyed and usually develop over a short period of time. Early symptoms, which are mainly due to hyperglycemia, include increased thirst and urination, constant hunger, weight loss, and blurred vision. Children also may feel very tired.

As insulin deficiency worsens, ketoacids, formed from the breakdown of fat, build up in the blood and are excreted in the urine and breath. Ketoacids cause shortness of breath and abdominal pain, vomiting, and worsening dehydration. Elevation of blood glucose, acidosis, and dehydration comprise the condition known as diabetic ketoacidosis or DKA. If diabetes is not diagnosed and treated with insulin at this point, the individual can lapse into a life-threatening coma. Often, children with vomiting are mistakenly diagnosed as having gastroenteritis. New-onset diabetes can be differentiated from gastroenteritis by the frequent urination that accompanies continued vomiting, as opposed to decreased urination due to dehydration if the vomiting is caused by gastroenteritis.

Risk Factors. A combination of genetic and environmental factors put people at increased risk for type 1 diabetes. Researchers are working to identify these factors so that targeted treatments can be designed to stop the autoimmune process that destroys the pancreatic beta-cells.

Predicting Type 1 Diabetes

As type 1 diabetes is caused by immune destruction of the insulin-producing beta cells, antibodies against proteins in the islets are found in children and adolescents months to years before the onset of diabetes. The presence of these antibodies, GAD-65, ICA, IAA and IA-2, have formed the basis for trials predicting who will develop diabetes and for recruiting high risk youth and adults for prevention trials. Individuals with high titer antibodies and those with more than one antibody are more likely to develop type 1 diabetes. In addition, young age and being a first degree relative of someone with type 1 diabetes place children at high risk. In general, 70 percent of people with new-onset diabetes will have a positive antibody if only one antibody is measured, whereas 90 percent will have at least one antibody when all four are measured. (6)

Co-morbidities. Children with type 1 diabetes are at risk for the long-term complications of diabetes. Autoimmune diseases such as celiac disease and autoimmune thyroiditis are also associated with type 1 diabetes.

Management. The basic elements of type 1 diabetes management are insulin administration (either by injection or insulin pump), nutrition management, physical activity, blood glucose testing, the avoidance of severe hypoglycemia, and the avoidance of prolonged hyperglycemia or DKA. Algorithms are used for insulin dosing based on blood glucose level and food intake.

All people with diabetes are advised to avoid “liquid carbs (carbohydrates)” such as sugar-containing soda and juices (including 100 percent fruit juice) and regular pancake syrup. The liquid carbs raise blood glucose rapidly, contain large amounts of carbs in small volumes, are hard to balance with insulin, and provide little or no nutrition.

Children receiving fixed insulin doses of intermediate- and rapid-acting insulins must have food given at the time of peak action of the insulin. They need a consistent carb meal plan that aims for a set amount of carb grams at each meal (e.g., 60 grams of carbs at lunch) and snack since they do not adjust their mealtime insulin for the amount of carb intake.

Children receiving a long-acting insulin analogue or using an insulin pump receive a rapid-acting insulin analogue just before meals, with the amount of pre-meal insulin based on carb content of the meal using an insulin to carb ratio and a correction scale for hyperglycemia. Carb counting involves calculating the number of grams of carbohydrate, or choices of carbohydrate, the youth eats. One carb choice equals 15 grams of carbohydrate. Sources of carbs include starches (breads, crackers, cereal, pasta, rice), fruits and vegetables, dried beans and peas, milk, yogurt and sweets. In addition to the amount of insulin needed to cover the carbs (called the carb dosage), extra insulin might be needed if the youth’s blood glucose is above the target range before a meal or snack. Further adjustment of insulin or food intake may be made based on anticipation of special circumstances such as increased exercise and intercurrent illness. Children on these regimens are expected to check their blood glucose levels routinely before meals and at bedtime.

Physical activity is a critical element of effective diabetes management. In addition to maintaining cardiovascular fitness and controlling weight, physical activity can help to lower blood glucose levels. To maintain blood glucose levels within the target range during extra physical activity, students will need to adjust their insulin and food intake. They also may need to check their blood glucose levels more frequently to prevent hypoglycemia while engaging in physical activity.

To control diabetes and prevent complications, blood glucose levels in children with type 1 diabetes should be managed as indicated in Table 1. Families need to work with their health care team to set target blood glucose levels appropriate for the child. For more information see NDEP’s Helping the Student with Diabetes Succeed: A Guide for School Personnel at <http://ndep.nih.gov/publications/PublicationDetail.aspx?PubId=97>.

Table 1. Plasma blood glucose and A1C goals for type 1 diabetes by age-group (6)

	Plasma blood glucose goal range (mg/dl)		A1C (%)	Rationale
	Before meals	Bedtime/overnight		
Toddlers and preschoolers (0–6 years)	100–180	110–200	<8.5	<ul style="list-style-type: none"> • Vulnerability to hypoglycemia • Insulin sensitivity • Unpredictability in dietary intake and physical activity • A lower goal (<8.0%) is reasonable if it can be achieved without excessive hypoglycemia
School age (6–12 years)	90–180	100–180	<8	<ul style="list-style-type: none"> • Vulnerability to hypoglycemia • A lower goal (<7.5%) is reasonable if it can be achieved without excessive hypoglycemia
Adolescents and young adults (13–19 years)	90–130	90–150	<7.5	<ul style="list-style-type: none"> • 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 pre-prandial blood glucose values and A1C levels and to help assess glycemia in those on basal/bolus regimens.

Type 2 Diabetes

Type 2 diabetes used to occur mainly in adults who were overweight and older than 40 years. Now, as more children and adolescents in the United States become overweight or obese and inactive, type 2 diabetes is occurring more often in young people aged 10 or older. Most children and adolescents diagnosed with type 2 diabetes are also insulin resistant, and have a family history of type 2 diabetes. Type 2 diabetes is more common in certain racial and ethnic groups such as African Americans, American Indians, Hispanic/Latino Americans, and some Asian and Pacific Islander Americans. (4)

The increased incidence of type 2 diabetes in youth is a “first consequence” of the obesity epidemic among young people, and is a significant and growing public health problem. (7) Results from the 2007-2008 National Health and Nutrition Examination Survey (NHANES), using measured heights and weights, indicate that an estimated 16 to 17 percent of children and adolescents ages 2 to 19 years had a BMI greater than or equal to the 95th percentile of the age- and sex-specific BMI— about double the number of two decades ago. (8) The Centers for

Disease Control and Prevention (CDC) BMI and growth curves calculate body fatness in children. www.cdc.gov/nccdphp/dnpa/bmi/index.htm

Onset. The first stage in the development of type 2 diabetes is often insulin resistance, requiring increasing amounts of insulin to be produced by the pancreas to control blood glucose levels. Initially, the pancreas responds by producing more insulin, but after several years, insulin production may decrease and diabetes develops. Type 2 diabetes usually develops slowly and insidiously in children.

Symptoms. Some children or adolescents with type 2 diabetes may show no symptoms at all. In others, symptoms may be similar to those of type 1 diabetes. A youth may feel very tired, thirsty, or nauseated and have to urinate often. Other symptoms may include weight loss, blurred vision, frequent infections, and slow healing of wounds or sores. Some youth may present with vaginal yeast infection or burning on urination due to yeast infection. Some may have extreme elevation of the blood glucose level associated with severe dehydration and coma. Because symptoms are varied, it is important for health care providers to identify and test youth who are at high risk for the disease.

Signs of Diabetes. Physical signs of insulin resistance include acanthosis nigricans, where the skin around the neck or in the armpits appears dark and thick, and feels velvety. Girls can have polycystic ovary syndrome with infrequent or absent periods, and excess hair and acne. Microalbuminuria and cardiovascular risk factors such as abnormal cholesterol and high blood pressure may be present at the time of diagnosis. (8)

Diabetes Risk Factors and Testing Criteria. Current diabetes risk factors and testing criteria in Table 2 help identify type 2 diabetes in children before the onset of complications. (6)

Co-morbidities. Children with type 2 diabetes also are at risk for the long-term complications of diabetes and the co-morbidities associated with insulin resistance (lipid abnormalities and hypertension).

Management. Although there are no national recommendations for blood glucose levels in children with type 2 diabetes, it may be reasonable to use the values in Table 1 (for children with type 1) as a guide. All aspects of the regimen need to be individualized.

The cornerstone of diabetes management for children with type 2 diabetes is healthy eating with portion control, and increased physical activity. If this is not sufficient to normalize blood glucose levels, glucose-lowering medication and/or insulin therapy are used as well. There are a variety of different diabetes medications, some that are taken orally, and some taken by injection (or via a subcutaneous pump), such as insulin. Youth with type 2 diabetes may take one or more different glucose-lowering medications of which metformin is the most frequently used in this population.

Prevention Strategies for Type 2 Diabetes. For children and teens at risk, health care professionals can encourage, support, and educate the entire family to make lifestyle changes that may delay – or lower the risk for – the onset of type 2 diabetes. Such lifestyle changes include keeping at a healthy weight and staying active. New research findings will help determine effective ways to lower risk factors in high risk children. See NDEP's Tips for Teens: Lower Your Risk for Type 2 Diabetes at <http://ndep.nih.gov/teens/LowerYourRisk.aspx> and NDEP's Diabetes HealthSense searchable database of tools, programs, and research that

helps people make lifestyle and behavior changes at <http://ndep.nih.gov/resources/diabetes-healthsense> and select “I am a teacher or school health professional.”

Table 2. Type 2 Diabetes Risk Factors and Testing Criteria. (6)

Overweight (BMI >85th percentile for age and gender; weight for height >85th percentile; or weight >120 percent of ideal for height

PLUS

Any two of the following risk factors

- family history of type 2 diabetes in first- or second-degree relative
- race/ethnicity – American Indian, African American, Hispanic/Latino, Asian American, or Pacific Islander
- signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovarian syndrome, or small-for-gestational-age birth weight)
- maternal history of diabetes of GDM during the child’s gestation

Age to begin testing – 10 years old or at onset of puberty if puberty occurs earlier

Frequency of testing – every 3 years

Tests to use – fasting plasma glucose, A1C, 2-h oral glucose tolerance test

Clinical judgment should be used to perform testing in children and adolescents who do not meet the above criteria.

Other Forms of Diabetes

Gestational Diabetes

Gestational diabetes mellitus (GDM) is a form of diabetes that is diagnosed during pregnancy. Reported rates of GDM range from 2 percent to 10 percent of pregnancies. GDM is more common among obese women, women with a family history of diabetes, and among African American, Hispanic/Latino American, and American Indian women. During pregnancy, GDM must be treated to normalize maternal blood glucose levels to lower risk of adverse maternal, fetal, and neonatal outcomes. GDM imparts a lifetime risk for diabetes. Immediately after pregnancy, 5 percent to 10 percent of women with gestational diabetes are found to have diabetes, usually type 2. Women who have had gestational diabetes have a 35 percent to 60 percent chance of developing diabetes in the next 10 to 20 years.(4) At 10 years postpartum, the risk of developing diabetes is 70 percent higher than in a comparable group of women without GDM. Overweight women with a history of GDM can take steps to reduce their risk for diabetes by losing at least 5 to 7 percent of their body weight and increasing their physical activity.

Children born to pregnancies complicated by diabetes may be at increased risk for obesity and diabetes. Pediatricians need to

- note mother’s history of GDM in child’s medical record
- note baby’s birth weight in child’s medical record
- encourage breastfeeding for six or more months

- encourage a healthy family lifestyle – healthy food choices, physical activity, and a healthy body weight
- counsel children to be active and eat healthy foods
- counsel mothers to seek blood glucose screening before next pregnancy and to reduce risk factors for GDM
- monitor children for CVD risk factors and counsel mother about the increased risk and need for particular attention to healthy eating and activity

"Hybrid" or "Mixed" Diabetes

For the most part it is easy to distinguish whether a youth has type 1 or type 2 diabetes. However, it is not surprising that some youth may have elements of both kinds of diabetes, given that that more children are becoming overweight and obese. Youth with “hybrid” or “mixed” diabetes are likely to have both insulin resistance that is associated with obesity and type 2 diabetes, and antibodies against the pancreatic islet cells that are associated with autoimmunity and type 1 diabetes.

Signs and Symptoms. The signs and symptoms are the same as those for type 1 and type 2 diabetes.

Management. At the time of diagnosis, the clinician should attempt to determine which type of diabetes is present. Measuring antibodies against islet cells and assessing insulin production by measuring C-peptide levels help make the distinction. C-peptide levels are best determined about a year after diagnosis. The presence of hybrid diabetes may affect how the child or teen is treated. Insulin injections are likely to be needed (as for type 1), and oral diabetes medications may be used to improve insulin resistance (as for type 2). It is important to counsel the child or teen about healthy eating habits and the need for daily physical activity so he or she can reach a healthy weight. Weight loss and physical activity independently increase the body’s sensitivity to insulin.

Monogenic Diabetes Syndromes

Rare monogenic forms of diabetes (neonatal diabetes or maturity-onset diabetes of the young) that occur in less than 5 percent of children are due to one of six gene defects that results in faulty insulin secretion. (6) It is important to correctly diagnose the monogenic forms of diabetes to ensure optimal treatment and prevent delay in diagnosing other family members. Commercial genetic testing is readily available.

Diagnosis. Diagnosis should be considered

- if diabetes is diagnosed within the first six months of life
- in children with strong family history of diabetes but without typical features of type 2 diabetes (non-obese, low-risk ethnic group)
- in children with mild fasting hyperglycemia (100–150 mg/dl especially if young and non-obese)
- in children with diabetes but with negative auto-antibodies without signs of obesity or insulin resistance. (6)

Treatment. Treatment varies – some children respond to diet therapy, exercise, and/or oral anti-diabetes medications that enhance insulin release while others may require insulin therapy.

Secondary Diabetes

Diabetes can occur in children with other diseases such as cystic fibrosis or those using glucocorticoid drugs. These causes may account for one to five percent of all diagnosed cases of diabetes.

Management Considerations for all Children with Diabetes

There is no single recipe to manage diabetes that fits all children. Blood glucose targets, frequency of blood glucose testing, type, dose and frequency of insulin, use of insulin injections with a syringe or a pen or pump, use of oral glucose-lowering medication and details of nutrition management all may vary among individuals. The family and diabetes care team determine the regimen that best suits each child's individual characteristics and circumstances. (See NDEP tip sheet series for youth with diabetes at <http://ndep.nih.gov/teens/index.aspx>.)

Hypoglycemia

Diabetes treatment can sometimes cause hypoglycemia (low blood glucose levels). Taking too much insulin, missing a meal or snack, or strenuous exercising may cause hypoglycemia. In addition, hypoglycemia can occur with no apparent cause. A child can become irritable, shaky, or confused. When blood glucose levels fall very low, loss of consciousness or seizures may develop.

When hypoglycemia is recognized, the child should drink or eat about 15gms of a concentrated sugar to quickly raise the blood glucose to greater than 70 mg/dl. Examples of 15gms of carbohydrate include 3 or 4 glucose tablets, or 4 ounces of fruit juice (not low-calorie or reduced sugar). Once the blood glucose is over 70 mg/dl, the child can eat food containing protein to maintain blood glucose levels in the normal range. Hypoglycemia occurring during the night should be treated with a concentrated sugar to achieve a BG of 80 to 100 mg/dL before giving a protein-containing food. The concentrated sugar will cause resolution of symptoms quickly, avoiding over-treatment of "lows." If the child is unable to eat or drink, a glucose gel may be administered to the buccal mucosa of the cheek; however, in the face of an altered level of consciousness or if the child cannot cooperate, glucagon or IV glucose should be administered.

Glycemic goals may need to be modified to take into account the fact that most children younger than 6 or 7 years of age have a form of "hypoglycemic unawareness." They lack the cognitive capacity to recognize and respond to hypoglycemic symptoms and may be at greater risk for hypoglycemia. Children under 5 years of age may be at risk for permanent cognitive impairment after episodes of severe hypoglycemia. (1)

Hyperglycemia

Causes of hyperglycemia include forgetting to take medications on time, eating too much, and getting too little exercise. Some episodes of hyperglycemia may occur without an apparent reason. Being ill also can raise blood glucose levels. Over time, hyperglycemia can cause damage to the eyes, kidneys, nerves, blood vessels, gums, and teeth. Neurocognitive complications of hyperglycemia have also been documented. (6)

Sick-day management rules, including assessment for ketosis with every illness, must be established for children with type 1 diabetes. Families need to be taught what to do for vomiting and for ketosis to prevent severe hyperglycemia and ketoacidosis. (10)

Monitoring Complications and Reducing CVD Risk

The following recommendations are based on the American Diabetes Association's Standards of Medical Care unless noted otherwise.(1)

Retinopathy. Although retinopathy most commonly occurs after the onset of puberty and after 5 to 10 years of diabetes duration, it has been reported in prepubertal children and with diabetes duration of only 1 to 2 years. Referrals should be made to eye care professionals with expertise in diabetic retinopathy, an understanding of the risk for retinopathy in the pediatric population, as well as experience in counseling the pediatric patient and family on the importance of early prevention/intervention. For children with type 1 diabetes, the first ophthalmologic examination should be obtained once the child is 10 years of age or older and has had diabetes for 3 to 5 years. In type 2 diabetes, the initial examination should be shortly after diagnosis. In type 1 and type 2 diabetes, annual routine follow-up is generally recommended. Less frequent examinations may be acceptable on the advice of an eye care professional.

Nephropathy. To reduce the risk and/or slow the progression of nephropathy, optimize glucose and blood pressure control. For children with type 1 diabetes, annual screening for microalbuminuria should be initiated once the child is 10 years of age and has had diabetes for 5 years. In type 2 diabetes, annual screening should be considered at diagnosis. Screening may be done with a random spot urine sample analyzed for microalbumin-to-creatinine ratio. Confirmed, persistently elevated microalbumin levels should be treated with an ACE inhibitor, titrated to normalization of microalbumin excretion if possible.

Neuropathy. Although it is unclear whether foot examinations are important in children and adolescents, annual foot examinations are painless, inexpensive, and provide an opportunity for education about foot care. The risk for foot complications is increased in people who have had diabetes over 10 years.

Lipids. Based on data obtained from studies in adults, having diabetes is equivalent to having had a heart attack, making diabetes a key risk factor for future cardiovascular disease. In children older than 2 years of age with a family history of total cholesterol over 240 mg/dl, or a cardiovascular event before age 55, or if family history is unknown, perform a lipid profile after diagnosis of diabetes and when glucose control has been established. If family history is not a concern, then perform a lipid profile at puberty.

Pubertal children with type 1 diabetes should have a lipid profile at the time of diagnosis after glucose control has been established. If lipids are abnormal, monitor annually. If lipid values fall within the accepted risk levels (LDL-cholesterol less than 100 mg/dl), repeat the lipid profile every 5 years.

Children with type 2 diabetes should have a lipid profile soon after diagnosis when blood glucose control has been achieved and annually thereafter. (11) Experts also recommend lipid testing every two years if the lipid profile is normal.

The goal for LDL-cholesterol in children and adolescents with diabetes is less than 100 mg/dl. If the LDL-cholesterol is greater than 100 mg/dl, the child should be treated with an exercise plan and a Step 2 American Heart Association diet. If, after 6 months of diet and exercise, the LDL-cholesterol level remains above 160 mg/dl, a statin should be given. If, the LDL-cholesterol is between 130 and 160 mg/dl and the patient has one or more cardiovascular disease risk

factors, statin therapy should be considered. Weight loss, increased physical activity, and improvement in glycemic control often result in improvements in lipid levels.

Blood pressure. Careful control of hypertension in children is critical. Hypertension in childhood is defined as an average systolic or diastolic blood pressure >90th percentile for age, sex, and height. Normal blood pressure levels for age, sex, and height, appropriate methods for measurement, and treatment recommendations are available online at www.nhlbi.nih.gov/health/prof/heart/hbp/hbp_ped.pdf. (12)

ACE inhibitors should be considered for the treatment of hypertension in children after counseling about potential negative effects on a developing fetus. ACE inhibitors have beneficial effects on slowing progression or preventing diabetic nephropathy.

Visiting the Health Care Team

Ideally, diabetes care for youth with diabetes should be provided by a team that can deal with the special medical, educational, nutritional, and behavioral issues associated with children and teens. The team usually consists of a physician, diabetes educator, dietitian, social worker or psychologist, along with the patient and family. Children should be seen by the team at diagnosis and in follow-up, as agreed upon by the primary care provider and the diabetes team. The following schedule of care is based on the American Diabetes Association's Standards of Medical Care. (1)

At Diagnosis

- Establish the goals of care and required treatment
- Begin diabetes self-management education about healthy eating habits, daily physical activity, and insulin/medication administration, and self-monitoring of blood glucose levels if appropriate (a solid educational base is needed so that the individual and family can become increasingly independent in self-management of diabetes - diabetes educators play an important role in this aspect of management)
- Provide nutritional therapy by an individual experienced with the nutritional needs of the growing child and the behavioral issues that have an impact on adolescent diets
- Conduct a psychosocial assessment to identify emotional and behavioral disorders
- Check lipids as noted above
- Check for microalbumin in type 2 diabetes
- Provide ophthalmologic examination shortly after diagnosis in type 2 diabetes

Each Quarterly Visit

Most young people with diabetes are seen by the health care team every 3 months. At each visit, the following should be monitored or examined A1C, an indicator of average blood glucose control

- Growth (height and weight)
- BMI
- Blood pressure
- Injection sites
- Self-testing blood glucose records
- Psychosocial adjustment

Annually

- Evaluate nutrition therapy
- Provide ophthalmologic examination as noted above
- Check for microalbuminuria as noted above
- Perform thyroid function test (for children with type 1 diabetes)
- Administer influenza vaccination
- Examine feet

Helping Children and Adolescents Manage Diabetes

The health care professional team, in partnership with the young person with diabetes and parents or other caregivers, needs to develop a personal diabetes management plan and daily schedule. The plan helps the child or teen to follow a healthy meal plan, get regular physical activity, check blood glucose levels, take insulin or oral medication as prescribed, and manage hyperglycemia and hypoglycemia. See NDEP's Diabetes HealthSense searchable database of tools, programs, and research that helps people make lifestyle and behavior changes at <http://ndep.nih.gov/resources/diabetes-healthsense> and select "I am a teacher or school health professional."

Follow a healthy meal plan

Young people with diabetes need to follow a meal plan developed by a registered dietitian, diabetes educator, or physician. For children with type 1 diabetes, the meal plan must ensure proper nutrition for growth. For children with type 2, the meal plan should outline appropriate changes in eating habits that lead to better energy balance and reduce or prevent obesity. A meal plan also helps keep blood glucose levels in the target range.

Children or adolescents and their families can learn how different types of food – especially carbohydrates such as breads, pasta, and rice – can affect blood glucose levels. Portion sizes, the right amount of calories for the child's age and activity level, and ideas for healthy food choices at meal and snack time also should be discussed, including reduction in soda and juice intake. Family support for following the meal plan and setting up regular meal times are keys to success, especially if the child or teen is taking insulin. See NDEP tip sheet series for youth with diabetes at <http://ndep.nih.gov/teens/index.aspx>.

For information about healthy eating for all children, visit the Weight-control Information Network (WIN) at <http://win.niddk.nih.gov/publications/index.htm> and the American Diabetes Association at www.diabetes.org/food-and-fitness/food/planning-meals/snacks/.

Get regular physical activity

Children with diabetes need regular physical activity, ideally a total of 60 minutes each day. Physical activity helps to lower blood glucose levels and increase insulin sensitivity, especially in children and adolescents with type 2 diabetes. Physical activity is also a good way to help children control their weight. In children with type 1 diabetes, the most common problem encountered during physical activity is hypoglycemia. If possible, a child or a teen should check blood glucose levels before beginning a game or a sport. If blood glucose levels are too low, the child should not be physically active until the low blood glucose level has been treated.

For more information on helping children be physically active, visit the NDEP tip sheet series for youth with diabetes at <http://ndep.nih.gov/teens/index.aspx>, the Weight-Control Information Network (WIN) at <http://win.niddk.nih.gov/publications/index.htm>, and the Centers for Disease Control and Prevention's (CDC) Verb campaign at www.cdc.gov/youthcampaign/ and www.cdc.gov/HealthyYouth/physicalactivity/.

Check blood glucose levels regularly

Young people with diabetes should know the acceptable range for their blood glucose. Children, particularly those using insulin, should check blood glucose values regularly with a blood glucose meter, preferably one with a built-in memory. A health care team member can teach the child or teen how to use a blood glucose meter properly and how often to use it. Children should keep a journal or other records such as downloaded computer files of their glucose meter results to discuss with their health care team. This information helps providers make any needed changes to the child's or teen's personal diabetes plan. Continuous glucose sensing systems are becoming more available (see box.)

Continuous Glucose Sensing Systems

After many years of research, continuous glucose sensing systems are becoming available for young people and adults with type 1 diabetes. All continuous glucose sensing systems have the same basic components: a sensor that is placed underneath the skin to measure interstitial glucose (the glucose found in the fluid between cells), a small transmitter worn on the body that connects to the sensor, and a hand-held cell-phone sized receiver that displays the current glucose levels and trends. Some systems integrate the receiver into an insulin pump, thereby reducing the number of extra components that need to be carried.

By having more glucose values available, users are able to see trends and better understand the effects of different foods, exercise, stress, and illness. Receivers sound an alarm when the person's glucose level drops below or goes above a certain pre-set level and in some systems when the projected glucose level will be high or low in 10 or 20 minutes, giving users a chance to prevent low blood glucose with early treatment. As insurance companies begin to approve coverage for continuous glucose sensors, more and more young people with type 1 diabetes are likely to benefit from them.

Take all diabetes medication as prescribed

Parents, caregivers, school nurses, and others can help a child or teen learn how to take medications as prescribed. For type 1 diabetes, a child or teen takes insulin at prescribed times each day via multiple injections or an insulin pump. Some young people with type 2 diabetes need oral medication or insulin or both. In any case, it is important to stress that all medication should be balanced with food and activity every day. See NDEP's Helping the Student with Diabetes Succeed: A Guide for School Personnel for more on insulin management and insulin pump therapy at <http://ndep.nih.gov/publications/PublicationDetail.aspx?PubId=97>.

Special Issues

Care of children and teens with diabetes requires integration of diabetes management with the complicated physical and emotional growth needs of children, adolescents, and their families, as well as consideration of teens' emerging autonomy and independence.

Diabetes presents unique issues for young people with the disease. Simple things, such as going to a birthday party, playing sports, or staying overnight with friends, need careful planning. Checking blood glucose, making correct food choices, and taking insulin or oral medication can make school-age children feel "different" from their classmates and this can be particularly bothersome for teens.

For any child or teen with diabetes, learning to cope with the disease is a big task. Dealing with a chronic illness such as diabetes may cause emotional and behavioral challenges, sometimes leading to depression. Talking to a social worker or psychologist may help young people and their families learn to adjust to the lifestyle changes needed to stay healthy.

Family Support

Managing diabetes in children and adolescents is most effective when the entire family gets involved. Diabetes education should involve family members. Families can be encouraged to share concerns with physicians, diabetes educators, dietitians, and other health care team members to get their help in the day-to-day management of diabetes. Extended family members, teachers, school nurses, counselors, coaches, day care providers, and others in the community can provide information, support, guidance, and help with coping skills. These individuals also may be knowledgeable about resources for health education, financial services, social services, mental health counseling, transportation, and home visits.

Diabetes is stressful for both the children and their families. Parents should be alert for signs of depression or eating disorders or insulin omission to lose weight and seek appropriate treatment. While all parents should talk to their children about avoiding tobacco, alcohol, and other drugs, this is particularly important for children with diabetes. Smoking and diabetes each independently increase the risk of cardiovascular disease and people with diabetes who smoke have a greatly increased risk of heart disease and circulatory problems. Binge drinking can cause hyperglycemia acutely, followed by an increased risk of hypoglycemia. The symptoms of intoxication are very similar to the symptoms of hypoglycemia, and thus, may result in delay of treatment of hypoglycemia with potentially disastrous consequences.

Transition to Independence

Children with diabetes—depending on their age and level of maturity—will learn to take over much of their care. Most school-age children can recognize symptoms of hypoglycemia and monitor blood glucose levels. They also participate in nutrition decisions. They often can give their own insulin injections but may not be able to draw up the dose accurately in a syringe until a developmental age of 11 to 12 years.

Adolescents often have the motor and cognitive skills to perform all diabetes-related tasks and determine insulin doses based on blood glucose levels and food intake. This is a time, however, when peer acceptance is important, risk-taking behaviors common, and rebellion against authority is part of teens' search for independence. Thus, adolescents must be supervised in their diabetes tasks and allowed gradual independence with the understanding that the independence will be continued only if they adhere to the diabetes regimen and succeed in maintaining reasonable metabolic control. During mid-adolescence, the family and health care

team should stress to teens the importance of checking blood glucose levels prior to driving a car to avoid hypoglycemia while driving. See NDEP online resources to help teen, young adults, families, and the health care team improve the transition process at <http://ndep.nih.gov/transitions/index.aspx>.

Diabetes at School

NDEP's Guide for School Personnel educates and informs school personnel about diabetes, how it is managed, and how each member of the school staff can help meet the needs of students with the disease. School principals, administrators, nurses, teachers, coaches, bus drivers, health care professionals, counselors, and office and lunchroom staff all play a role in helping students with diabetes succeed.

Several Federal and some state laws provide protections to children with disabilities, including diabetes. These laws help ensure that all students with diabetes are educated in a medically safe environment and have the same access to educational opportunities as their peers – in public and some private schools. Students with diabetes are entitled to accommodations and modifications necessary for them to stay healthy at school. Accommodations may need to be made in the classroom, with physical education, on field trips, and/or for after-school activities.

Written plans outlining each student's diabetes management help students, their families, school staff, and the student's health care providers know what is expected of them. These expectations should be laid out in written documents, such as

- a Diabetes Medical Management Plan, developed by the student's personal health care team and family
- an Individualized Health Care Plan (or nursing care plan), developed by the school nurse presenting how the diabetes medical management plan will be implemented in the school
- Emergency Care Plans, which describe how to recognize hypoglycemia and hyperglycemia and what to do as soon as signs or symptoms of these conditions are observed
- Education plans, such as the Section 504 Plan, other Education Plan, or an Individualized Education Program (IEP) generated by the 504 or IEP teams to address each student's needs for services to manage their diabetes effectively in school

The school nurse is the most appropriate person to coordinate care for students with diabetes. Each student with diabetes should have a written Individualized Health Care Plan, developed by the school nurse, incorporating physician orders, parent requests, and tailored to the specific developmental, physical, cognitive, and skill ability of the child. The nurse will conduct a nursing assessment of the student and develop the plan, taking into consideration the child's cognitive, emotional, and physical status as well as the medical orders contained in the Diabetes Medical Management Plan. A team approach to developing the plan, involving the student, parent, health care provider, key school personnel, and school nurse, is the most effective way to ensure safe and effective diabetes management during the school day.

The Individualized Health Care Plan should also identify school personnel needed to provide care to an individual student, under the direction of the school nurse, when allowed by state nurse practice acts. The school nurse is responsible for training, monitoring, and supervising these school personnel. The school nurse will promote and encourage independence and self-care consistent with the student's ability, skill, maturity, and developmental level.

For more information on managing diabetes in the school setting, see NDEP's Helping the Student with Diabetes Succeed: A Guide for School Personnel at <http://ndep.nih.gov/publications/PublicationDetail.aspx?PubId=97>

Camps and Support Groups

Local peer groups and camps for children and teens with diabetes can provide positive role models and group activities. Peer encouragement often helps children perform diabetes-related tasks that they had been afraid to do previously and encourages independence in diabetes management. Talking with other children who have diabetes helps young people feel less isolated and less alone in having to deal with the demands of diabetes. They have the opportunity to discuss issues they share in common that others in their peer group can't understand, and they can share solutions to problems that they have encountered. Often, these programs challenge children physically and teach them how to deal with increased exercise, reinforcing the fact that diabetes should not limit them in their ability to perform strenuous physical activity.

Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) conducts and supports a wide range of research aimed at finding ways to prevent and treat diabetes and its health complications. The Centers for Disease Control and Prevention (CDC) compiles diabetes statistics and conducts studies to help prevent and treat diabetes in children.

DirecNet: The Diabetes Research in Children Network (DirecNet) is a network of clinical centers working to determine the potential use of glucose monitoring technology and its impact on the management of type 1 diabetes in children. <http://direcnet.jaeb.org>

TEDDY: The consortium to identify The Environmental Determinants of Diabetes in the Young (TEDDY) is an international effort to identify infectious agents, dietary factors, or other environmental factors that trigger type 1 diabetes in genetically susceptible individuals. <http://teddy.epi.usf.edu/>

TrialNet: Type 1 Diabetes TrialNet is a clinical trials network of 18 sites in the United States, Canada, Europe, and Australia that is testing new ways to prevent type 1 diabetes and to preserve beta cell function in people who already have type 1 diabetes. It is also studying the natural history of the development of type 1 diabetes, and plans to study family members of those with type 1 diabetes. www.DiabetesTrialnet.org

SEARCH: The SEARCH for Diabetes in Youth study is co-funded by CDC and NIDDK to determine the incidence and prevalence of diabetes in children in several of the U.S. and help clarify trends in the development of diabetes in youth. www.searchfordiabetes.org/

TODAY Trial: The TODAY (Treatment Options for type 2 Diabetes in Adolescents and Youth) study seeks to identify the best treatment of type 2 diabetes in children and teens and is being carried out in 13 medical centers and affiliated sites around the country. <http://clinicaltrials.gov/ct2/show/NCT00081328>

The HEALTHY study was an intervention in middle schools to lower obesity rates. Findings reported in 2010 reported lower obesity rate in students at highest risk for type 2 diabetes who started out overweight or obese in sixth grade. However, schools that implemented the program did not differ from comparison schools in the study's primary outcome—the prevalence of overweight and obesity combined—which had declined 4 percent in both groups of schools by the end of the three-year study. (13)

The National Collaboration on Childhood Obesity Research (NCCOR): NCCOR is a public–private initiative launched in 2009 to accelerate research and help reverse the childhood obesity epidemic. Partners include the NIH, CDC, Robert Wood Johnson Foundation, and the U.S. Department of Agriculture. NCCOR accelerates progress to reduce childhood obesity in the United States by

- maximizing outcomes from research
- building the capacity for research and surveillance
- creating and supporting the mechanisms and infrastructure needed for research translation and dissemination
- supporting evaluations

www.nccor.org/index.html

Resources

For more information about diabetes, target goals for blood glucose levels, educational materials, and support programs for people with diabetes and their families and friends, contact the following organizations.

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| 1. National Diabetes Education Program (NDEP)
1-888-693-NDEP (1-888-693-6337)
www.YourDiabetesInfo.org | 4. American Association of Diabetes Educators
1-800-TEAM-UP4 (1-800-832-6874)
www.diabeteseducator.org |
| 2. National Diabetes Information Clearinghouse
1-800-860-8747
http://diabetes.niddk.nih.gov/ | 5. American Diabetes Association
1-800-DIABETES or 800-342-2383
www.diabetes.org |
| 3. Centers for Disease Control and Prevention
1-800-311-3435
www.cdc.gov/diabetes | 6. Juvenile Diabetes Research Foundation International
1-800-223-1138
www.jdf.org |

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