

Overview of Diabetes in Children and Adolescents

A Fact Sheet from the National Diabetes Education Program

Type 1 diabetes in U.S. children and adolescents may be increasing[1] and many more new cases of type 2 diabetes are being reported in young people. Standards of care for managing children with diabetes issued by the American Diabetes Association in January 2005 provide helpful guidance. To update primary care providers and their staff members about this rapidly changing area of diabetes care, the National Diabetes Education Program (NDEP) has developed this overview of the current literature.

What Is Diabetes?

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 can be associated with serious complications and premature death, but people with diabetes can take steps to control the disease and lower the risk of complications.

Type 1 Diabetes

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. 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.

Since the pancreas can no longer produce insulin, people with type 1 diabetes are required to take insulin daily, either by injection or via an insulin pump. Other methods to deliver insulin are being investigated. Children with type 1 diabetes are at risk for long-term complications (damage to the cardiovascular system, kidneys, eyes, nerves, blood vessels, skin, gums, and teeth).

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, and in those less than 10 years of age, type 1 accounts for almost all diabetes. A diabetes management plan for young people includes insulin therapy, self-monitoring of blood glucose, healthy eating, and physical activity. The plan is designed to ensure proper growth and prevention of hypoglycemia. New management strategies are helping children with type 1 diabetes live long and healthy lives.

- **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 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. They cause the feeling of 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 diabetic coma. Often, children with vomiting are mistakenly diagnosed as having gastroenteritis. New-onset diabetes can be differentiated from a GI infection by the frequent urination that accompanies continued vomiting, as opposed to decreased urination due to dehydration if the vomiting is caused by a GI "bug."

- **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.

- **Co-morbidities.** Autoimmune diseases such as celiac disease and autoimmune thyroiditis are associated with type 1 diabetes.

Type 2 Diabetes

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 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, obese and inactive, type 2 diabetes is occurring more often in young people. 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. 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.[2] Overweight and obese children are at increased risk for developing type 2 diabetes during childhood, adolescence, and later in life.

- **Symptoms.** Type 2 diabetes usually develops slowly and insidiously in children. Symptoms may be similar to those of type 1 diabetes. A child or teen can 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 children or adolescents with type 2 diabetes may show no symptoms at all when they are diagnosed, and others may present with vaginal yeast infection or burning on urination due to yeast infection. Some children may have extreme elevation of the blood glucose level associated with severe dehydration and coma. Therefore, it is important for health care providers to identify and test children or teens 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. High blood pressure and dyslipidemia also are associated with insulin resistance. Girls can have polycystic ovary syndrome with infrequent or absent periods, and excess hair and acne.
- **Risk Factors.** Being overweight, having a family member who has type 2 diabetes, being a member of a high risk racial or ethnic group, having signs of insulin resistance, being older than 10 years of age, and experiencing puberty are risk factors for the disease.
- **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).

Timely diagnosis and treatment of type 2 diabetes can prevent or delay the onset of diabetes complications. The cornerstone of diabetes management for children with type 2 diabetes is healthy eating, with portion control, and increased physical activity. To control their diabetes, children with type 2 diabetes also may need to take glucose-lowering medications. However, few of the available medications have been approved for use in children and youth. (See treatment strategies below.) Ongoing efforts to prevent and treat type 2 diabetes in children will require collaborative involvement of health care providers, school personnel, community institutions, and government agencies working together.

Gestational Diabetes

Gestational diabetes mellitus (GDM) is a form of diabetes that is diagnosed in about 7 percent of *all* pregnancies, at a rate of about 200,000 per year. It 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 and avoid complications in the infant.

GDM imparts a lifetime risk for type 2 diabetes, although the risk is highest 5 to 10 years after delivery. In women with a history of GDM, even 10 years postpartum, the risk of developing diabetes

is 70 percent higher than in a comparable group of women without GDM. The children of women with a history of GDM also are at increased risk for obesity and diabetes compared to other children.

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. The children born to a pregnancy complicated by diabetes are at increased risk for obesity and diabetes themselves, and should have the fact they were an infant of a diabetic mother as part of their permanent medical record.

(See "[Resources](#)" for information on gestational diabetes.)

"Hybrid" or "Mixed" Diabetes

While for the most part it is easy to determine if a child or teenager has type 1 or type 2 diabetes, some teens have elements of both kinds of diabetes. This phenomenon may be called "hybrid" or "mixed" diabetes. It is not surprising that some youth have elements of both type 1 and type 2 diabetes, given the fact that more children are becoming overweight and obese. Youth with "hybrid" 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.

Maturity-onset Diabetes of the Young

Maturity-onset diabetes of the young (MODY), due to one of six gene defects, is a rare form of diabetes in children that is caused by a single gene defect that results in faulty insulin secretion. MODY is defined by its early onset (usually before age 25), absence of ketosis, and autosomal dominant inheritance.[3] Thus, each child of a parent with MODY has a 50 percent chance of inheriting the same type of diabetes. MODY is thought to account for 2 to 5 percent of all cases of diabetes and often goes unrecognized.[3] Treatment of MODY varies. Some children respond to diet therapy, exercise, and/or oral anti-diabetes medications that enhance insulin release. 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.

Statistics

Diabetes is one of the most common diseases in school-aged children. According to the National Diabetes Fact Sheet, about 186,300 young people in the US under age 20 had diabetes in 2007. This represents 0.2% of all people in this age group.

Based on data from 2002-2003, the SEARCH for Diabetes in Youth study reported that approximately 15,000 US youth under 20 years of age are diagnosed annually with type 1 diabetes, while 3,700 are newly diagnosed with type 2 diabetes. Type 2 diabetes is rare in children younger than 10 years of age, regardless of race or ethnicity. After 10 years of age, type 2 diabetes becomes increasingly common, especially in minority populations, representing 14.9% of newly diagnosed cases of diabetes in non-Hispanic whites, 46.1% in Hispanic youth, 57.8% in African Americans, 69.7 % in Asian/Pacific Islanders, and 86.2% in American Indian youth.[4]

Results from the 2005-2006 National Health and Nutrition Examination Survey (NHANES), using measured heights and weights, indicate that an estimated 16-17 percent of children and adolescents ages 2-19 years had a BMI greater than or equal to 95th percentile of the age- and sex-specific BMI—about double the number of two decades ago.[5] Overweight in youth contributes to the increasing numbers of young people who have type 2 diabetes. The Centers for Disease Control and Prevention (CDC) BMI and growth curves calculate body fatness in children:
<http://www.cdc.gov/nccdphp/dnpa/bmi/index.htm>.

Identifying Children with Diabetes

Type 1 diabetes

The rate of beta cell destruction in type 1 diabetes is quite variable -- rapid in some individuals (mainly infants and children) and slow in others (mainly older adolescents and 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.[6]

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 children 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 tested, whereas 90 percent will have at least one antibody when all four are measured.

Type 2 diabetes

Most children and adolescents diagnosed with type 2 diabetes are overweight or obese, insulin resistant, and have a family history of type 2 diabetes. They also may have physical signs of insulin resistance such as acanthosis nigricans. Diabetes complications such as microalbuminuria and the presence of cardiovascular risk factors such as abnormal cholesterol and high blood pressure have been observed among teenage Pima Indians[7] and in other pediatric populations in the United States[8-10] and are often present at disease onset.

Undiagnosed type 2 diabetes in children and adolescents may place these young people at early risk for cardiovascular disease; however, no data are available to define the scope of this problem. In adults, up to 25% of individuals who have type 2 diabetes are undiagnosed and at risk for microvascular and macrovascular complications of diabetes.[11] It is important, therefore, for health care providers to consider testing for diabetes in high risk or symptomatic children. Note that adult screening programs identify more people with diabetes than do equivalent screening programs in youth.

Current testing criteria and diabetes risk factors to help identify type 2 diabetes in children before the onset of complications were developed in 2000 by the American Academy of Pediatrics and the American Diabetes Association.[12]

Testing Criteria

1. Overweight (BMI 85th to 94th percentile) or obese (BMI \geq 95th percentile) for age and gender; weight for height >85th percentile; or weight >120 percent of ideal for height
PLUS
2. Any two of the following risk factors:
 - Family history of type 2 diabetes in first- or second-degree relative
 - American Indian, African American, Hispanic/Latino, Asian American, or Pacific Islander heritage
 - Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovarian syndrome)

Age to begin testing--10 years old or at onset of puberty if puberty occurs earlier
Frequency of testing--every 2 years
Test to use--fasting plasma glucose

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

Treatment Strategies

The basic elements of type 1 diabetes management are insulin administration, nutrition management, physical activity, blood glucose testing, and the avoidance of hypoglycemia. Algorithms are used for insulin dosing based on blood glucose level and food intake.

Children receiving fixed insulin doses of intermediate- and rapid-acting insulins must have food given at the time of peak action of the insulin. 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 carbohydrate content of the meal using an insulin:carbohydrate ratio and a correction scale for hyperglycemia. 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.

Management of type 2 diabetes involves nutrition management, increased physical activity, and blood glucose testing. 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. Glucose lowering medications differ by their mechanism of actions. Overall, they can enhance endogenous insulin secretion, inhibit excessive hepatic glucose production, enhance insulin sensitivity in muscle and adipose tissue, inhibit gastrointestinal carbohydrate absorption, delay gastric emptying, inhibit glucagon secretion, and enhance satiety. The most frequently used oral glucose-lowering medication in children and adolescents is metformin. Glimiperide is also approved for children eight years of age and older. All aspects of the regimen are individualized. (See [Tip Sheets for Teens with Type 2 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.

Blood Glucose Goals

To control diabetes and prevent complications, blood glucose levels in children with type 1 diabetes should be managed as indicated in Table 1. Families should work with their health care team to set target blood glucose levels appropriate for the child. Although there are no national recommendations for children with type 2 diabetes, it may be reasonable to use the values in Table 1 as a guide.

Table 1. Optimal plasma blood glucose and A1C goals for type 1 diabetes by age group are:[12]

Values by Age (Years)	Plasma Blood Glucose Goal Range (mg/dl)		A1C Percent	Rationale
	Before Meals	Bedtime/Overnight		
Toddlers and preschoolers under age 6	100–180	110–200	≤8.5 but ≥7.5	• High risk and vulnerability to hypoglycemia
School age, ages 6 to 12	90–180	100–180	<8	• Risks of hypoglycemia and relatively low risk of complications prior to puberty
Adolescents and young adults, ages 13 to 19	90–130	90–150	<7.5*	• Risk of hypoglycemia • Developmental and psychological issues
Key concepts in setting glycemic goals:				
<ul style="list-style-type: none"> • Goals should be individualized and lower goals may be reasonable based on benefit: risk assessment. 				
<ul style="list-style-type: none"> • Blood glucose goals should be higher than those listed above in children with frequent hypoglycemia or hypoglycemia unawareness. 				
<ul style="list-style-type: none"> • Postprandial blood glucose values should be measured when there is a disparity between preprandial blood glucose values and A1C levels. 				

* A lower goal (<7.0 percent) is reasonable if it can be achieved without excessive hypoglycemia.

Hypoglycemia

Diabetes treatment can sometimes cause blood glucose levels to drop too low, with resultant **hypoglycemia**. Taking too much insulin, missing a meal or snack, or strenuous exercising may cause hypoglycemia. In addition, hypoglycemia can occur when there has been 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 a concentrated sugar to quickly raise the blood glucose to greater than 70 mg/dl. 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- 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.[12]

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.

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.[13]

Monitoring Complications and Reducing CVD Risk

The following recommendations are based on the American Diabetes Association's Standards of Medical Care.[12]

Retinopathy. Although retinopathy most commonly occurs after the onset of puberty and after 5–10 years of diabetes duration, 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 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 3–5 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 initiated 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. In children older than 2 years of age with a family history of total cholesterol over 240 mg/dl, or a CVD 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. 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.

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

The goal for LDL-cholesterol in children and adolescents with diabetes is less than 100 mg/dl (2.60 mmol/l). 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, pharmacologic agents should be given. If, the

LDL-cholesterol is between 130 and 160 mg/dl, pharmacologic therapy should be considered. Statins are the agents of choice. 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 $\geq 95^{\text{th}}$ 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 online at: www.nhlbi.nih.gov/health/prof/heart/hbp/hbp_ped.pdf. [14]

ACE inhibitors are the agents of choice for the treatment of hypertension in children with co-existing microalbuminuria. They have beneficial effects on slowing progression or preventing diabetic nephropathy.

Visiting the Health Care Team

Because most newly diagnosed cases of type 1 diabetes occur in individuals younger than 18 years of age, and more children and teens are now getting type 2 diabetes, care of this group 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 care for children and teens should be provided by a team that can deal with these special medical, educational, nutritional, and behavioral issues. 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. [12]

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 in children with a significant family history*
- Check for microalbumin in type 2 diabetes.
- Provide ophthalmologic examination shortly after diagnosis in type 2 diabetes.

* In children with no significant family history, check lipids at puberty after glucose control has been established and if normal, repeat profile every 5 years (see section on lipids for more information).

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 assessment

Annually:

- Evaluate nutrition therapy
- Provide ophthalmologic examination (less often on the advice of an eye care professional)*
- Check for microalbuminuria (once the child is 10 years old and has had diabetes for 5 years)
- Perform thyroid function test (for children with type 1 diabetes)
- Administer influenza vaccination
- Examine feet.

*The first ophthalmologic examination should be obtained once the child is age 10 or older and has had type 1 diabetes for 3 to 5 years. For children with type 2 diabetes, the first examination should be shortly after diagnosis.

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.

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 consumption. Family support for following the meal plan and setting up regular meal times is a key to success, especially if the child or teen is taking insulin. See NDEP's "[Make Healthy Food Choices](#)" Tip Sheet for Teens with Type 2 Diabetes.

For more information about healthy eating for children, visit the [American Dietetic Association](#), an NDEP partner. Their "Healthy Habits for Healthy Kids" guide for parents is available in [English](#) and [Spanish](#), and includes [tips for a balanced diet](#). The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) also offers [diet tips](#) for people with diabetes.

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. See NDEP's "[Be Active](#)" Tip Sheet for Teens with Type 2 Diabetes.

For more information on helping children be physically active, visit the Weight-Control Information Network (WIN) of the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK). WIN offers a number of [publications](#) that address healthy eating and physical activity. The Centers for Disease Control and Prevention's (CDC) [Verb](#) campaign encourages youth to be physically active. "[Diabetes and Physical Activity at School](#)" provides additional information.

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, 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. ["Managing Insulin Requirements at School"](#) provides additional information, including an update on insulin pump therapy (beginning on page of 11).

Special Issues

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 providers to get their help in the day-to-day management of diabetes. Extended family members, teachers, school nurses, counselors, coaches, day care providers, and other resources 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.

Diabetes at School

NDEP's *School Guide* 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, 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

Quick Reference Emergency Plan, which describes 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 or Individualized Education Program (IEP)

Care Plan or Individual Health Plan generated by the school nurse that provides instructions to faculty and staff.

The school nurse is the most appropriate person to coordinate care for students with diabetes. Each student with diabetes should have a written 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 a nursing care 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 care 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 nursing care plan would also identify school employees assigned 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 [Helping the Student with Diabetes Succeed: A Guide for School Personnel](#).

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.

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. NDEP's "[Lower Your Risk](#)" Tip Sheet provides additional information for teens at risk of developing type 2 diabetes.

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://public.direc.net/>

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 six areas 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, which seeks to identify the best treatment of type 2 diabetes in children and teens, is being conducted in 13 medical centers and affiliated sites around the country.
<http://www.niddk.nih.gov/patient/today/today.htm>

HEALTHY: The HEALTHY study is testing a program to lower risk factors for type 2 diabetes in middle school students at 42 schools in 7 sites across the US. Results from this study are expected in 2009.

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.

1. National Diabetes Education Program (NDEP)

Toll-free: 1-888-693-NDEP (6337)

www.yourdiabetesinfo.org

The goal of this program is to reduce illness and death associated with diabetes and its complications. NDEP offers a number of state-of-the-science resources through its website and publications including a resource directory and a bibliography of recent articles in the pediatric field.

2. National Diabetes Information Clearinghouse

Toll-free: 1-800-860-8747

www.niddk.nih.gov/health/diabetes/diabetes.htm

3. Centers for Disease Control and Prevention

Toll-free: 1-800-311-3435

www.cdc.gov/diabetes

4. American Association of Diabetes Educators

Toll-free: 800-TEAM-UP4 (1-800-832-6874)

www.diabeteseducator.org

5. American Diabetes Association

Toll-free: 1-800-DIABETES (1-800-342-2383)

www.diabetes.org

6. Juvenile Diabetes Research Foundation International

Toll-free: 1-800-223-1138

www.jdf.org

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