DIABETES MELLITIS: TYPE 1 AND TYPE 2

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SIGNIFICANCE

Diabetes mellitus is a group of metabolic diseases characterized by elevated blood glucose levels (hyperglycemia) resulting from defects in insulin secretion, insulin action or both. Insulin is a hormone manufactured by the beta cells of the pancreas, which is required to utilize glucose from digested food as an energy source. Chronic hyperglycemia is associated with microvascular and macrovascular complications that can lead to visual impairment, blindness, kidney disease, nerve damage, amputations, heart disease, and stroke. In 1997 an estimated 4.5% of the US population had diabetes. Direct and indirect health care expenses were estimated at $98 billion.[1]

The type of diabetes is based on the presumed etiology. This chapter provides information about the two most common types of diabetes: type 1 and type 2 diabetes (see Table 1).

TABLE 1
Characteristics of the Common Types of Diabetes

	Type 1	Type 2
Age	Childhood	Pubertal
Onset	Acute; severe	Mild-severe; often insidious
Insulin secretion	Very low	Variable
Insulin sensitivity	Normal	Decreased
Insulin dependence	Permanent	Temporary; may occur later
Racial/ethnic groups at increased risk	All (low in Asians)	African Americans, Hispanics, Native Americans, Asian/Pacific Islanders
Genetics	Polygenic	Polygenic
Proportion of those with diabetes	80%	10%-20%
Association: obesity	No	Strong
Acanthosis nigricans	No	Yes
Autoimmune etiology	Yes	No

Source: Adapted from Orr, DP. Contemporary management of adolescents with diabetes mellitus. Part 1: Type 1 diabetes. Adolescent Health Update 2000;12(2), Table 2, p 3.

In type 1 diabetes, the body does not produce insulin, and daily insulin injections are required. Over 700,000 people in the United States have type 1 diabetes; this is 5-10% of all cases of diabetes mellitus. Type 1 diabetes is usually diagnosed during childhood or early adolescence and it affects about 1 in every 600 children.

Type 2 diabetes is the result of failure to produce sufficient insulin and insulin resistance. Elevated blood glucose levels are managed with reduced food intake, increased physical activity, and eventually oral medications or insulin. Type 2 diabetes is believed to affect more than 15 million adult Americans, 50% of whom are undiagnosed. It is typically diagnosed during adulthood. However with the increasing incidence of childhood obesity and concurrent insulin resistance, the number of children diagnosed with type 2 diabetes has also increased worldwide.[2]

For example, from 1982 to 1994 in one mid-western city, the proportion of children with type 2 diabetes increased from approximately 4% to 16%.[3] This increase is greatest among individuals from certain ethnic/racial groups (African Americans, Native Americans, Hispanics and Asians/Pacific Islanders) and for those with a family history of type 2 diabetes.

ETIOLOGY/CONTRIBUTING FACTORS

Type 1 Diabetes

- Caused by the immune destruction of the beta cells of the pancreas.
- Antibodies to islet cells and insulin are present at diagnosis.
- Insulin secretion gradually diminishes.
- May present at any age, but most common in childhood and adolescence.
- Insulin by injection is necessary for survival.
- Contributing factors:
  - Genetic predisposition
  - Environmental triggers (infection or other stress)

Type 2 Diabetes

- Caused by insulin resistance in the liver and skeletal muscle, increased glucose production in the liver, over production of free fatty acids by fat cells and relative insulin deficiency.
- Insulin secretion decreases with gradual beta cell failure.
- Reductions in blood glucose levels often can be achieved with changes in food intake and physical activity patterns. Oral medication and/or insulin injections are eventually required.
- Contributing factors:
  - Obesity
  - Age (onset of puberty is associated with increased insulin resistance)
  - Lack of physical activity
  - Genetic predisposition
  - Racial/ethnic background (African American, Native American, Hispanic and Asian/Pacific Islander)
  - Conditions associated with insulin resistance, (e.g., polycystic ovary syndrome)

CONSEQUENCES

Type 1 Diabetes

Before diagnosis with type 1 diabetes, a teen with elevated blood glucose levels will develop symptoms of increased urination, thirst, and appetite in addition to weight loss or failure to grow normally. If not diagnosed soon enough, life-threatening ketoacidosis may result.

After diagnosis with type 1 diabetes, the teen must follow a daily management regimen that includes regularly scheduled insulin injections, blood glucose monitoring, and attention to food intake (especially carbohydrates) that adds stress to many families. Families must receive comprehensive education, diabetes self-management training, frequent follow-up, and social support on an on-going basis. The burden of living with a chronic illness is a consequence that is often overlooked.

Consequences occur with administration of too much or not enough insulin. Too much insulin or inadequate food intake may lead to low blood glucose levels (hypoglycemia) and potentially, loss of consciousness and seizures. Chronic hyperglycemia, a reflection of insufficient insulin, results in eye disease, kidney disease, nerve damage, and an increased risk of cardiovascular disease that may appear 10-15 years after diagnosis.

Type 2 Diabetes

Before diagnosis with type 2 diabetes, a teen with elevated blood glucose levels may present with no symptoms or have mild glucosuria and/or ketosis with or without weight loss.

After diagnosis with type 2 diabetes, the teen must follow a daily management regimen that includes attention to food intake (carbohydrates, as well as fats and total energy intake), exercise, and blood glucose monitoring. Administration of medication (insulin or oral medications) may also be required. This new regimen may add stress to families. Families must receive comprehensive education, diabetes self-management training, frequent follow-up, and social support on an on-going basis. The burden of living with a chronic illness is a consequence that is often overlooked.

Acute consequences will depend on the medication prescribed. Those teens treated with insulin or sulfonylureas are at risk for low blood glucose levels.

Long term consequences are similar to those resulting from poor control of type 1 diabetes– eye disease, kidney disease, nerve damage and an increased risk of cardiovascular disease.

SCREENING

Early Warning Signs for Type 1 and Type 2 Diabetes

A blood glucose level should be checked if one or more of these symptoms is present:

- Increased urination
- Increased thirst
- Increased appetite
- Unexplained weight loss

Screening for Type 1 Diabetes

- No screening recommendations for the diagnosis of type 1 diabetes in adolescents have been established.

Screening for Type 2 Diabetes

The screening recommendations listed in Table 2 are from the American Diabetes Association.[4]

TABLE 2
Testing for Type 2 Diabetes in Children and Adolescents

Criteria*

Overweight (BMI ≥ 85th percentile for age and gender, weight for height ≥ 85th percentile or weight ≥ 120% 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, Asian/Pacific Islander)
- Signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovary syndrome)

Age of initiation: age 10 years or at onset of puberty if puberty occurs at a younger age.

Frequency: every 2 years.

Test: fasting plasma glucose is the preferred method for screening.

*Clinical judgment should be used to test for diabetes in high-risk patients who do not meet these criteria.

Source: © 2002 American Diabetes Association. From Standards of medical care for patients with diabetes mellitus. Diabetes Care 2002;25(1):213-229; Table 4, p. 215. Reprinted with permission from The American Diabetes Association.

ASSESSMENT

A nutrition assessment should be done at diagnosis and at least once a year thereafter by a registered dietitian experienced with diabetes and adolescent nutrition. The assessment includes an evaluation of typical food intake and eating habits in addition to identifying the many factors that influence food intake (Table 3). A 24-hour dietary recall and an age appropriate nutrition questionnaire are useful tools to obtain this information (see Chapter 4). Then an initial meal plan can be determined and adjustments in total energy intake may be made to allow for stage of growth and activity level. Information about family support and barriers to learning will help the dietitian individualize the educational experience.

TABLE 3
Factors that Influence Adolescent Food Intake

School schedule	Family culture	Financial resources
Work schedule	Family traditions	Family and/or peer support
Social activities	Food likes/dislikes	
Weekday vs. weekend routines	Places where meals are eaten	

- Use body mass index to assess physical growth (see Chapter 4). A teen with weight loss prior to diagnosis often needs additional calories for catch-up growth. Once healthy weight gain has occurred, it is important to check the meal plan 3-4 weeks after diagnosis and decrease total food intake, if necessary, to prevent excess caloric intake and unwanted weight gain.
- Total energy and protein requirements can be estimated by a combination of typical food intake and the Recommended Dietary Allowances. Adolescent energy and protein intake is often calculated by height to allow for changes in energy requirements related to growth during puberty rather than chronological age.

INTERVENTION AND COUNSELING STRATEGIES

Treatment for both types of diabetes is aimed at maintaining blood glucose values near normal levels. Additional goals are:

- Promote normal growth and development and achievement of a healthy weight.
- Normalize blood glucose levels and minimize hyperglycemia and hypoglycemia.
- Achieve normal lipid levels.
- Prevent and delay complications.
- Promote optimal health and well-being.

Achieving these goals requires insulin or glucose-lowering medications that depend on the type of diabetes, medical nutrition therapy, frequent blood glucose monitoring to identify and evaluate blood glucose patterns, and comprehensive education in diabetes, self-management and decision-making skills at diagnosis and follow-up visits. Target blood glucose goals for teens are listed in Table 4.

TABLE 4
Blood Glucose Goals for Adolescents[1]

Biochemical Index	Normal	Goal	Action Indicated[2]
Average premeal BG (mg/dl)[3]	<110	80-120	<80 or >140
Average 2 hour postmeal BG (mg/dl)[3] for rapid-acting insulin only	<120	150-180	>180
Average bedtime BG (mg/dl)[3]	<120	100-140	<100 or >160
Average 3:00 am BG (mg/dl)	<110	80-100	<80 or >120
HbA_{1c} (%)	<6	<7	>8

[1] These values are generally not indicated for preadolescents. The values shown in this table are by necessity generalized to the entire population of individuals with diabetes. Patients with comorbid diseases, the very young and older adults, and others with unusual conditions or circumstances may warrant different treatment goals. These values are for nonpregnant adults.

[2] "Action indicated" depends on individual patient circumstances. Such actions may include enhanced diabetes self-management education, comanagement with a diabetes team, referral to an endocrinologist, change in pharmacological therapy, initiation of or increase in SMBG, or more frequent contact with the patient. HbA_{1c} is referenced to a nondiabetic range of 4.0-6.0% (mean, 5.0%, SD 0.5%).

[3] Measurement of capillary blood glucose.

Adapted from: Orr, DP. Contemporary management of adolescents with diabetes mellitus. Part 1: Type 1 diabetes. Adolescent Health Update 2000;12(2), Table 1, p 2.

Successful education programs will include the following components:

- Involvement of the teen, family, key teachers, school nurses and/or coaches.
- An individualized approach to treatment plans.
- Culturally appropriate information, educational materials, and treatment plans.
- Frequent follow-up to evaluate and adjust as needed.

Treatment for Type 1 Diabetes

Insulin Therapy

Insulin is the only medication that is effective in lowering blood glucose levels in type 1 diabetes. The use of insulin requires daily management of those factors that affect the insulin dose (food, physical activity, illness, stress). See Table 5 for common insulin preparations. Rapid-acting insulin may be given before, during, or immediately after a meal. Administration after a meal may help reduce the postprandial hyperglycemia associated with high fat meals. The number of insulin injections/day will vary; insulin may be delivered with insulin syringes, insulin pens or external insulin pumps.

- *Conventional therapy*– 2 daily injections of mixed insulin (rapid- or short-acting and intermediate-acting) before breakfast and the evening meal.
- *Conventional therapy with a split night-time dose*– 1 injection of mixed insulin (rapid- or short-acting and intermediate-acting) before breakfast, 1 injection of rapid- or short-acting insulin before the evening meal and 1 injection of intermediate-acting insulin before the bedtime snack. This regimen is used to help reduce fasting hyperglycemia associated with the long interval between the evening meal and breakfast and the duration of action of the intermediate-acting insulin and to facilitate management of the dawn phenomenon.
- *Multiple daily injections (MDI) of rapid- or short-acting insulin before every meal (and sometimes large snacks) with intermediate- or long-acting insulin once or twice a day*. The addition of rapid- or short-acting insulin before lunch helps reduce pre-supper hyperglycemia with less risk of hypoglycemia associated with very large pre-breakfast doses of intermediate-acting insulin. With the exception of a bedtime snack to prevent hypoglycemia during the night, snacks usually are not required with MDI– an advantage for busy teens and those who wish to maintain a target weight. This may be called intensive therapy depending on the level of glycemic control that is targeted.
- *Intensive therapy with a continuous subcutaneous insulin infusion (CSII or insulin pump)*– Rapid-acting insulin is delivered constantly to meet the body's basal need to suppress hepatic glucose production. A bolus dose of insulin is given before meals and snacks based on the amount of carbohydrate eaten and the measured level of blood glucose. This regimen is for motivated teens who are willing to test frequently (>4 times/day), monitor carbohydrate intake accurately, adjust insulin doses and commit to frequent contact with the diabetes team.

TABLE 5
Description of Commonly Used Insulin Preparations

Common Description	Name	Onset (hrs)	Peak (hrs)	Effective Duration (hrs)
Rapid-acting	Lispro	0.25	1-2	2-3
Short-acting	Regular	0.5-1	2-3	3-6
Intermediate-acting	NPH	2-4	4-10	10-16
Intermediate-acting	Lente	3-4	4-12	12-18
Long-acting	Ultralente	6-10	12-18	18-20
Long-acting	Glargine	1	None	24

Adapted From: Orr, DP. Contemporary management of adolescents with diabetes mellitus. Part 1: Type 1 diabetes. Adolescent Health Update 2000;12(2), Table 3, p 7.

The insulin dose depends on basal needs, food intake (especially the total amount of carbohydrate) and amount of physical activity. Changes in the dose of rapid- or short-acting insulin can be made according to a sliding scale that increases the dose for higher blood glucose levels and decreases the dose when blood glucose levels are lower. In addition, average blood glucose levels at various times of day can be calculated to further adjust the insulin recommended (rapid, short, intermediate and/or long-acting preparations).

Self-blood glucose testing is recommended before each meal and the bedtime snack to help assess the dose and make changes as needed. Testing at 2:00-3:00 am is useful for evaluating night-time hypoglycemia and fasting hyperglycemia (dawn phenomenon).

A variety of blood glucose testing meters are available. Many contain memory to store the date, times and test results. Some can be downloaded to personal computers that graphically display blood glucose readings. New meters are available that allow the user to obtain blood from other areas beside the fingertips.

Average blood glucose levels over the last 3 months are measured by a blood test called glycated hemoglobin. Different assays are available, each with their own normal (nondiabetic) range; hemoglobin A_{1c} (HbA_{1c}) is the preferred method. It is recommended to use the same laboratory to avoid confusion. The teen should have the test performed before visiting the physician to facilitate early discussion of results and if necessary, strategies to improve control. The 1994 Diabetes Control and Complications Trial (DCCT) that included 195 adolescents (13-18 years old) demonstrated that better blood glucose control significantly reduced the risk for long-term complications.[5] Based upon the DCCT results, the target HbA_{1c} is 7%.

Medical Nutrition Therapy

Food intake influences the amount of insulin required to meet blood glucose target goals. Dietary carbohydrate influences postprandial blood glucose levels the most and is the major determinant of meal-related insulin requirements. The intermediate- or longer-acting insulin usually covers the effects of protein and fat.

At diagnosis, the teen and the family are taught how to monitor food intake with basic carbohydrate-counting guidelines (see Table 6 for teaching ideas). Two types of counting methods are available to monitor carbohydrate intake.

- Counting carbohydrate servings: Standard servings of foods in the starch/bread, fruit and milk groups are considered to be approximately equal in carbohydrate value (1 serving = approximately 15 g carbohydrate). Carbohydrate values are obtained from food lists and nutrition labels. For example, a teen who eats 2 pieces of toast (2 carbs) with margarine and 1 cup of milk (1 carb) for breakfast is eating a 3 carb breakfast. If premeal insulin is calculated on the basis of units of short-acting insulin per carb and the teen's dose is 1 unit/1 carb, the insulin dose would be 3 units to cover the carbohydrate in this breakfast.

- Counting grams of carbohydrate: The specific carbohydrate gram value for all foods eaten is determined, thus increasing the accuracy of the carbohydrate count. For example, the above breakfast is equal to approximately 45 g carbohydrate (3 carbohydrate servings x 15 g/serving = 45 g total carbohydrate). However, if the bread is actually 20 g/slice and the milk is 12 g/cup, the carbohydrate intake is 52 g. If the same teen is taking 1 unit/15 g carbohydrate, the insulin dose would be 3.5 units for this breakfast instead of 3 units.

TABLE 6
Teaching Ideas for Carbohydrate-Counting

Use food models to illustrate portion sizes.	Plan sample menus that incorporate school lunches, snacks from vending machines, and fast food menu items.
Provide opportunities to weigh and measure common foods.	Teach how to work-in sugar-containing foods in moderation.
Teach how to read nutrition labels with labels from actual food items.	

Carbohydrate counting guidelines are provided by a stepped approach (see Table 7). With conventional insulin therapy, a structured meal plan with defined carbohydrate goals is necessary to synchronize the timing of carbohydrate intake with the time-action of the insulin used and to promote a consistent intake of dietary carbohydrate. Once teens are comfortable with the basics and learn how to identify blood glucose patterns, they may choose to begin a more intensive insulin regimen. At this level carbohydrate/insulin ratios and corrective dose adjustments are used to increase flexibility with the timing of meals and snacks and the amount of carbohydrate eaten. Carbohydrate counting as a meal planning approach offers varied food choices and many strategies for achieving target blood glucose levels.[6]

TABLE 7
Carbohydrate Counting Guidelines

Level 1 – Basic Carbohydrate Counting

Objective: To identify usual carbohydrate (CHO) intake and promote consistent CHO at meals and snacks.

- Why CHO relates to blood glucose levels.
- Importance of consistent amounts of CHO at meals and snacks.
- Which foods contain CHO, protein and fat.
- How to identify portion sizes of common foods.
- How to read nutrition labels to determine number of CHO choices.

Level 2 – Advanced Carbohydrate Counting

Objectives

1. To learn how to identify patterns in blood glucose levels that relate to insulin, food intake and/or exercise and make changes to improve blood glucose levels.
    - Importance of monitoring blood glucose levels.
    - How to identify blood glucose patterns.
    - How to adjust insulin, food and/or exercise to reduce high and/or low blood glucose levels.
    - Suggestions to help avoid unwanted weight gain.
    - Suggestions for treating low blood glucose episodes.
2. To learn how to adjust rapid- or short-acting acting insulin when CHO intake and timing of meals and snacks vary.
    - How to calculate the amount of insulin needed to cover the amount of CHO eaten.
    - How to determine the amount of insulin needed to lower your blood glucose level.
    - Importance of accurate CHO counting.
    - How to make insulin adjustments for high fat meals, high fiber foods and unusually large amounts of CHO or protein.

Carbohydrate intake is adjusted for other circumstances, such as increased physical activity and lower blood glucose levels before the evening snack to reduce the risk of low blood glucose levels.

- *For increased physical activity beyond the usual routine*: Eat or drink 15 g carbohydrate for every hour of extra activity before the activity. For longer, more strenuous exercise (>1 hour), include protein with the carbohydrate. These guidelines may be individualized depending on the insulin regimen, blood glucose level before exercise, and training intensity (Table 8).
- *For lower blood glucose levels before the evening snack*: If blood glucose levels are 70-100 mg/dl, eat or drink an additional 15 grams of carbohydrate with the regular evening snack. If blood glucose levels are < 70 mg/dl, treat the low blood glucose first with 15 g carbohydrate or glucose; wait 15 minutes and retest; eat or drink another 15 g carbohydrate if the blood glucose level is still < 70 mg/dl. Otherwise, have the regular evening snack with an additional 15 g carbohydrate.

TABLE 8
Guidelines for Exercise

For most people, the safe pre-exercise blood glucose (BG) range is from 100-250 mg/dl.

If BG is less or close to 100 mg/dl, have a snack to raise it before exercising, as shown below.

When BG is 100-150 mg/dl, many people do not require a snack unless exercise is intense. However, test during exercise and be prepared to snack to keep BG up if necessary.

For every hour of exercise, be ready to consume 10-15 grams of carbohydrate.

A BG 151-250 mg/dl is optimal for safe exercise.

Avoid exercise if fasting BG is >350 mg/dl or >250 mg/dl and ketones are present.

Identify usual BG response to exercise to determine if insulin must be reduced

Be prepared to test in the middle of the night if the exercise is intense or of long duration.

Have carbohydrate (CHO) foods available at all times – before, during and after exercise.

Examples of regimens tailored to intensity of exercise

Intensity of Exercise	Examples	Suggested Snack
Mild/moderate (<30 minutes)	Walking, cycling	15g CHO - 1 granola bar or 4 oz juice
Moderate (1 hour)	Tennis, swimming, jogging, golfing, or leisurely cycling	30g CHO* - Large banana or 16 oz sports drink
Intense	Football, hockey, racquetball, basketball, strenuous cycling, swimming, shoveling snow	45g CHO* - Sandwich and 8 oz sports drink

* Some guidelines suggest adding a protein serving with moderate or intense exercise

Adapted From: Orr, DP. Contemporary management of adolescents with diabetes mellitus. Part 1: Type 1 diabetes. Adolescent Health Update 2000;12(2), Table 7, p 10.

Nutritional recommendations for teens are similar to those for other young people. Macronutrient distribution should be approximately 50-60% carbohydrate, 10-20% protein and 30% fat. Saturated fat should be limited to < 10% of total calories and dietary cholesterol to < 300 mg/day to help reduce the risk of cardiovascular disease. Further adjustments in fat intake may be required with elevated lipid levels and/or unhealthy weight gain. Guidelines for dietary fiber and sodium are the same as for the general population.

Scientific evidence no longer supports the need to restrict sucrose and sucrose-containing foods to reduce hyperglycemia. Therefore, teens can continue to eat many common foods, such as sweetened cereal, cookies, brownies, and ice cream, in the context of a healthy eating plan as long as they estimate the amount of carbohydrate eaten and make appropriate adjustments.

Special Considerations

Hypoglycemia (a blood glucose level < 70 mg/dl). (See Table 9.)

- Also called low blood sugar, insulin reaction or insulin shock.
- Usually caused by too little food, too much insulin, extra physical activity or delayed meals and snacks.
- May occur at any time, but is most likely before meals, during peak action time of insulin and during or after exercise.
- Frequent or severe hypoglycemia is unpleasant and many teens will tolerate higher blood glucose levels and not increase insulin doses as recommended in order to avoid these episodes. The diabetes team should be sensitive to this and work with the teen to promote gradual improvements in blood glucose levels.
- Teens with limited cognitive ability, those who skip or delay meals, those lacking awareness of hypoglycemia (increasingly common after having diabetes for 10 years) and those who are starting intensive insulin therapy are at risk for increased hypoglycemia. If this persists, higher blood glucose levels may be acceptable.

TABLE 9
Hypoglycemia Guidelines

	Mild	Moderate	Severe
SYMPTOMS	Hungry, Dizzy Shaky, Sweaty Headache, Weak Pale, Irritable Nervous, Unusual behavior	Confusion Poor coordination Restlessness Double vision Combativeness	Unconsciousness Seizures
TREATMENT	Eat or drink 15 g carbohydrate: – 1/2 c orange juice – 1/2 c regular pop – 5 Lifesavers® – 1 fruit roll-up – 3 glucose tablets Wait 15 minutes and retest. If no better, repeat. If more than 1 hour before the next meal, eat or drink 1 serving of starch/bread item or 1 c milk.	*If alert*: Give 15 g carbohydrate *If confused and unable to swallow*: – Apply glucose gel or Cake Mate® gel to inside of gum. – If no better in 15 minutes, repeat. If more than 1 hour before the next meal, eat or drink 1 serving of starch/bread item or 1 c milk.	Administer glucagon: – Mix according to instructions. – Inject 1 vial. Check blood glucose levels every 15-30 minutes. Upon arousal, encourage small amounts of regular pop and crackers. When tolerating pop well, give 30 g carbohydrate. May sleep if blood glucose >100 mg/dl.

Unwanted weight gain

Teens who improve their blood glucose control may gain unwanted weight unless the meal plan or activity routine is modified. In addition, they may experience more frequent hypoglycemia that requires additional carbohydrate and adds calories. This is especially problematic for young women who may begin to give less insulin or omit doses altogether. Regular attention to the teen's pattern of weight gain or loss is important. The teen needs to work with the diabetes team to decide how to adjust insulin doses or food intake.

Chronic poor control with reported large insulin doses and unexplained weight loss may indicate intentional under-dosing or insulin omission in an attempt to lose weight.

The incidence of eating disorders is no greater in teens with diabetes than those without diabetes. Promotion of healthy eating, regular physical activity, and acceptance of the diversity of body shapes and sizes should be discussed regularly.

Alcohol use

Although many alcoholic drinks contain carbohydrate, alcohol is not converted to glucose. It tends to inhibit gluconeogenesis and interferes with the counter-regulatory response to hypoglycemia. It also impairs judgment. Guidelines to prevent low blood glucose levels with alcohol use include:

- Do not skip meals or snacks when drinking.
- Consume additional carbohydrate if drinking more than the equivalent of two alcoholic beverages.
- Inform someone with you that you have diabetes.
- Do not drive after drinking.
- Do not take extra insulin when drinking.

Driving

Teens should be reminded of the dangers of driving when blood glucose levels are low.

Guidelines to prevent or treat low blood glucose levels immediately include:

- Keep carbohydrate-containing foods (glucose tablets, juice, hard candy, regular soda) in your car at all times.
- Wear an ID bracelet.
- Test before driving at times when the teen may have a greater risk for hypoglycemia (after exercising, after skipped or delayed meals).

Pregnancy

- Young women with diabetes need education about contraception. All commonly used hormonal contraceptives are safe with diabetes and do not influence blood glucose levels.
- The physician should consider early pregnancy in the differential diagnosis of unexplained hypoglycemia.
- Young women with diabetes should be referred to a diabetes program for intensive insulin management as soon as they learn they are pregnant.

Developmental issues

- Adolescence is a time for developing a teen's sense of identity and increasing autonomy and independence. More free time is spent with friends and social activities are loosely structured, unplanned, and often include food. School and work schedules become more challenging and physical activity may be erratic.

- Despite a normal appearance, teens with type 1 diabetes must alter their lifestyle to follow treatment recommendations and minimize serious hypoglycemia and hyperglycemia. They must monitor blood glucose levels, food intake, and exercise as well as inject insulin several times each day. The physical, emotional, and social demands of self-management are often associated with neglect of self-monitoring, dietary recommendations, and insulin injections during adolescence. Depression and avoidance also may contribute to poor blood glucose control. At a time when teens are seeking independence, parents often have to increase their involvement to make sure daily diabetes care is done.
- An interdisciplinary diabetes team can help support the teen and match treatment plans with his/her motivation, ability, and level of functioning. Behavioral interventions, such as coping-skills training to teach problem-solving skills and communication, have been shown to help improve blood glucose control and quality of life in teens starting intensive insulin regimens.[7]
- Teens preparing to live away from home (in college dormitories or apartments) may initiate more intensive insulin regimens in order to increase flexibility and allow for less structured routines. Workshops for juniors and seniors in high school can help them make these transitions.

Strategies to motivate teens (especially those in poor control)

- Identify the reason for poor control and negotiate a plan with the teen.
- Decide on one reasonable and measurable action-oriented goal (number of blood glucose tests, recording carbohydrate at a specific meal, adjusting insulin based on blood glucose or carbohydrate intake).
- Identify short-term benefits relevant to the teen– less hypoglycemia, less frequent nocturia, improved physical performance, more flexibility in timing and content of meal, rewards from parents, greater independence.
- Establish a realistic time for accomplishment based on behavior and goal (e.g., average fasting blood glucose level will be 20% lower over the next 2 weeks).
- Provide frequent feedback. See the teen more often.
- Find out how much supervision or support the parents provide. Request more parental involvement.

Treatment for Type 2 Diabetes

Glucose Lowering Therapy

It is best to treat type 2 diabetes as vigorously as possible to avoid or delay the long term consequences of elevated blood glucose levels, high blood pressure, and dyslipidemia. Treatment focuses on discovering the most effective method to lower blood glucose levels, whether it is lifestyle modifications, insulin therapy, oral agents, or any combination of these factors. The diabetes team must work with the teen and the family to educate them about the importance of good control and to make the necessary adjustments in treatment every 4-6 weeks until acceptable control is achieved.

- At diagnosis, teens with type 2 diabetes who are acutely ill with significant hyperglycemia (>300 mg/dl) and ketosis require insulin therapy. Insulin regimens are similar to those for teens with type 1 diabetes. In the less ill teen, initial treatment with medical nutrition therapy and exercise or a glucose lowering oral agent may be appropriate. In both circumstances, target blood glucose goals are similar to those with type 1 diabetes and treatment recommendations may change depending on blood glucose control.
- Glucose-lowering oral agents may be effective with type 2 diabetes. See Table 10 for the types currently available in the US.

TABLE 10
Glucose-Lowering Oral Agents Commonly Used for Treatment of Type 2 Diabetes.

Type of Agent	Mechanism of Action	Generic Names
Biguanides	Decrease hepatic glucose production, increase muscle insulin sensitivity	Metformin
Sulfonylureas	Increase insulin secretion	Glyburide Glipizide Glimepiride
Meglitinide	Short-term promotion of glucose-stimulated insulin secretion	Repaglinide
Glucosidase inhibitors	Decrease digestion and absorption of carbohydrate	Acarbose Miglitol
Thiazolidenediones	Increase insulin action in muscle, adipose tissue and probably the liver	Rosiglitazone Pioglitazone

- The biguanide, metformin, is often the first oral agent used with teens. Metformin is effective at reducing blood glucose levels without the risk of hypoglycemia. It does not cause weight gain and it helps reduce total cholesterol, LDL cholesterol, and triglyceride levels. Nausea and abdominal discomfort may occur with initial use. Starting at low doses (500 mg/day) and increasing gradually to a maximum daily dose of 2200 mg may minimize these side effects. Because the kidney metabolizes biguanides, they should not be used if the teen is dehydrated. In young women with diabetes and polycystic ovary syndrome, metformin may normalize ovulatory abnormalities, thereby increasing the risk for pregnancy in those who are sexually active and necessitating preconception counseling.
- The other oral agents are used infrequently with teens due to concerns with hypoglycemia and weight gain (sulfonylureas), more severe gastrointestinal symptoms (glucosidase inhibitors) and safety (thiazolidinediones).
- Combination regimens that include insulin with an oral agent may be used to help lower blood glucose levels. Combination therapy usually requires less insulin, however blood glucose monitoring is still essential.

Blood glucose monitoring is recommended to evaluate treatment. Teens whose diabetes is controlled with life style changes or oral agents are encouraged to perform blood glucose testing before breakfast and one other time during the day. Teens on insulin therapy need to test 2-4 times/day depending on the insulin regimen. In addition, blood glucose monitoring 2 hours after a meal provides information about the effectiveness of lifestyle changes. If 2 hour post-meal blood glucose levels are >180 mg/dl, the teen needs to decrease carbohydrate goals, increase activity or adjust medications. HbA_{1c} are monitored quarterly. As in type 1 diabetes, a large clinical study, the United Kingdom Prospective Diabetes Study, has shown that better glycemic control ($HbA_{1c} < 7.0\%$) results in reduced cardiovascular and microvascular complications.[8]

Medical Nutrition Therapy

At diagnosis**,** dietary recommendations should emphasize blood glucose control, not weight loss. Even though many teens with type 2 diabetes are overweight at diagnosis, it is preferable to educate

the teen about carbohydrate counting, the effects of food on blood glucose levels, and the health benefits of physical activity as opposed to putting them on a "diet." A meal plan with regular meals and snacks and carbohydrate goals that are moderately less than their usual intake will often help lower blood glucose levels. Once the teen learns to identify carbohydrate-containing foods and monitor carbohydrate intake, cessation of weight gain, and even weight loss, may occur. (See Tables 11 and 12 for nutrition tips.)

TABLE 11
General Guidelines for Food Intake

Eat 3 meals and 1 snack on a regular schedule. Try not to skip meals.

Follow carbohydrate goals for meal planning from the dietitian. Try to eat about the same amount of carbohydrate at the same time each day.

Eat smaller portions at meals.

Decrease saturated fat intake.

Work towards a healthy weight.

TABLE 12
Ways to Limit Carbohydrate Intake

Drink calorie-free beverages (e.g., water, tea, diet soda).

Limit fruit juice to 1 cup/day.

Limit carbohydrate servings to 3-4/meal. If necessary decrease to 1-2 at breakfast.

Check blood glucose level 2 hours after eating. (If >180 mg/dl, you ate more carbohydrate than your body could handle).

- Modest weight loss (5-10% of body weight) may improve blood glucose control but treatment should focus more on modifying the factors that contribute to excess weight gain–poor eating habits and sedentary lifestyle–than on low calorie diet plans. For more information on healthy weight loss strategies, see Chapter 6.
- Exercise is another factor that may improve insulin sensitivity independent of weight loss (see Table 13). It is important to find out what activities teens enjoy and to identify easy ways to incorporate more physical activity into their daily routines. Forty-five to sixty minutes of aerobic exercise at least 3 times/week is recommended.
- Hyperlipidemia may improve as blood glucose levels normalize. If cholesterol and triglyceride levels do not improve, weight loss, a decreased intake in saturated fat or treatment with a lipid-lowering medication may be indicated. See Chapter 10 for dietary strategies to reduce lipid levels.

TABLE 13
Benefits of Exercise

Helps you feel better and increases your energy

Reduces HbA_{1c}

Improves insulin sensitivity

Helps in reaching a healthy weight

Increases strength and flexibility

Decreases risk factors for heart disease

Reduces body fat and increases muscle mass

PREVENTION

Type 1 Diabetes

Presently there is no way to prevent type 1 diabetes.

- Current research with relatives of people with type 1 diabetes is studying how to prevent or delay the autoimmune destruction of the beta cells. If a simple blood test detects the presence of islet cell antibodies, the person is eligible to enter. Participants in the Type 1 Diabetes TrialNet studies are randomly assigned to either a Natural History or Prevention Study and followed by a medical team (see Internet Resources in RESOURCES section).

Type 2 Diabetes

Prevention requires identifying those children and teens at risk and providing them appropriate knowledge, resources, and support to help reduce risk factors.

- Since 40-80% of teens diagnosed with type 2 diabetes are overweight and the incidence of overweight is increasing, primary prevention of type 2 diabetes in young people should include a public health approach that targets the general population. Health professionals need to be involved in developing and implementing community programs in schools, churches, and health centers that promote positive lifestyle modifications (healthy food choices, increased physical activity, and achievement/maintenance of a healthy weight) for children and their families.

- The Diabetes Prevention Program conclusively showed that people can prevent the development of type 2 diabetes by making changes in food intake and increasing physical activity. A 5-10% decrease in body weight and 30 minutes/day of moderate physical activity produced a 58% reduction in diabetes.[9]

REFERRAL

Teens with newly diagnosed type 1 or type 2 diabetes should be referred for initial education and treatment to an interdisciplinary diabetes program. Their care should be coordinated by a physician experienced in the care of children and adolescents with diabetes, a nurse, a registered dietitian, and a social worker who have expertise in diabetes management as well as the physical and emotional needs of teens and their families. Once a firm educational base is established, the well-informed physician who has access to a certified diabetes educator (a nurse or dietitian) can follow the teen with diabetes. Other circumstances that require referral to the diabetes specialist are the following:

- Recurrent diabetic ketoacidosis.

- Severe or frequent hypoglycemia.

- Multiple psychosocial problems that contribute to poor glycemic control.

- Pregnancy.

- Initiation of intensive insulin therapy with multiple injections or an insulin pump.

RESOURCES

Books

Betschart J, Thom S. In control – A guide for teens with diabetes. Minneapolis, MN: Chronimed Publishing, 1995.

Boland, E. Teens pumping it up! 2nd ed. Sylmar, CA: Minimed Inc., 1998.

Monk A, Pearson J, Hollander P, Bergenstal RM. Managing type II diabetes: your invitation to a healthier lifestyle. Minneapolis, MN: IDC Publishing, 1996.

Booklets

Basic Carbohydrate Counting; Advanced Carbohydrate Counting. Alexandria, VA: American Diabetes Association, 2003.

Nutrition in the fast lane: The fast food dining guide. Indianapolis, IN: Franklin Publishing Incorporated,2004. http://www.fastfoodfacts.com/

Internet Resources

American Diabetes Association
http://www.diabetes.org

Juvenile Diabetes Association
http://www.jdf.org

Type 1 Diabetes Research Studies
http://www.diabetestrialnet.org

National Diabetes Education Program
http://www.ndep.nih.gov/

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9. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, Nathan DM. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346(6):393-403.