CHAPTER 20

Diabetes Mellitus

KEY CONCEPTS

- Diabetes mellitus is a metabolic disorder of glucose metabolism that has many causes and forms.
- A consistent and sound diet is a major keystone of diabetes care and control.
- Daily self-care skills enable a person with diabetes to remain healthy and reduce risks for complications.
- Blood glucose monitoring is a critical practice for effective blood glucose control.
- A personalized care plan that balances food intake, exercise, and insulin regulation is essential to successful diabetes management.

The National Center for Health Statistics reported that 11% of the American adult population older than the age of 20 years has diabetes. Diabetes is currently the seventh leading cause of death in the United States.[1] Historically, diabetes mellitus claimed the lives of its victims at a young age. Greater knowledge of the disease and proper self-care practices have enabled people with diabetes to live long and fulfilling lives. However, diabetes has no cure, and individuals without health care and access to proper medication continue to die early in life. With professional guidance and support, individuals with diabetes can remain in a state of good health and reduce the risk of long-term complications by consistently practicing good self-care skills.

This chapter examines the nature of diabetes and explains why daily self-care is essential for the health of those with the condition.

THE NATURE OF DIABETES

Defining Factor

Glucose is the primary and preferred source of energy for the body. As discussed in Chapter 2, carbohydrate foods break down during digestion in the gastrointestinal tract, and they are absorbed into the bloodstream mainly as glucose. Glucose is then circulated throughout the body. For glucose to be used as energy by the cells in the body, it first has to be taken out of the blood and transported into the cells. For this process to happen in most cells, the hormone **insulin** must be present. Insulin is produced by the β cells of the pancreas (see the For Further Focus box, "The History and Discovery of Insulin"). Individuals with diabetes either do not produce insulin or cannot effectively use the insulin produced. Without insulin, glucose accumulates in the bloodstream. The American Diabetes Association defines diabetes as a group of metabolic diseases that are characterized by **hyperglycemia** that results from defects in insulin secretion, insulin action, or both.[2]

Classification of Diabetes Mellitus and Glucose Intolerance

Various types of diabetes mellitus are classified according to the pathogenic process of the disease.

from the Dietary Approaches to Stop Hypertension (DASH) trial. *Circ Cardiovasc Qual Outcomes*. 2010;3(5):484-489.
35. Blumenthal JA, Babyak MA, Sherwood A, et al. Effects of the dietary approaches to stop hypertension diet alone and in combination with exercise and caloric restriction on insulin sensitivity and lipids. *Hypertension*. 2010;55(5): 1199-1205.
36. Levitan EB, Wolk A, Mittleman MA. Consistency with the DASH diet and incidence of heart failure. *Arch Intern Med*. 2009;169(9):851-857.
37. Al-Solaiman Y, Jesri A, Mountford WK, et al. DASH lowers blood pressure in obese hypertensives beyond potassium, magnesium and fibre. *J Hum Hypertens*. 2010;24(4): 237-246.
38. Hall WL. Dietary saturated and unsaturated fats as determinants of blood pressure and vascular function. *Nutr Res Rev*. 2009;22(1):18-38.
39. U.S. Department of Agriculture, U.S. Department of Health and Human Services. *Dietary guidelines for Americans, 2010*. Washington, DC: U.S. Government Printing Office; 2010.

FURTHER READING AND RESOURCES

American Heart Association. www.americanheart.org

National Center for Chronic Disease Prevention and Health Promotion. Heart disease prevention: what you can do. www.cdc.gov/HeartDisease/prevention.htm

National Cholesterol Education Program. www.nhlbi.nih.gov/about/ncep/

National Cholesterol Education Program. Risk assessment tool for estimating 10-year risk of developing coronary heart disease. hp2010.nhlbihin.net/atpiii/calculator.asp?usertype=prof

These organizations are valuable sources of information regarding the most current recommendations for healthy lifestyles to prevent and treat heart disease. The Web sites also provide educational materials for both health care professionals and the public.

Huang CL, Sumpio BE. Olive oil, the Mediterranean diet, and cardiovascular health. *J Am Coll Surg*. 2008;207(3):407-416.

Walker C, Reamy BV. Diets for cardiovascular disease prevention: what is the evidence? *Am Fam Physician*. 2009;79(7):571-578.

These two articles discuss the following: (1) How olive oil in the traditional Mediterranean diet helps to improve cardiovascular health; and (2) how the Mediterranean diet compares with other common diets (e.g., Atkins, Zone, South Beach) in the area of overall cardiovascular health.

FOR FURTHER FOCUS

THE HISTORY AND DISCOVERY OF INSULIN

Early History and Name

The symptoms of diabetes were first described on an Egyptian papyrus, the Ebers Papyrus, which dates to approximately 1500 BC. During the first century, the Greek physician Areatus wrote of a malady in which the body "ate its own flesh" and gave off large quantities of urine. He named it *diabetes,* from the Greek word meaning "to siphon" or "to pass through." During the seventeenth century, the word *mellitus* from the Latin word meaning "honey" was added because of the sweetness of the urine. The addition of *mellitus* distinguished the disorder from another disorder, *diabetes insipidus,* in which large urine output also was observed. However, diabetes insipidus is a much more rare and quite different disease that is caused by a lack of the pituitary antidiuretic hormone. Today, the term *diabetes* is almost always in reference to diabetes mellitus.

Diabetic Dark Ages

Throughout the Middle Ages and the dawning of the scientific era, many early scientists and physicians continued to puzzle over the mystery of diabetes, but the cause remained obscure. For physicians and their patients, these years could be called the "Diabetic Dark Ages." Patients had short life spans and were maintained on a variety of semistarvation and high-fat diets.

Discovery of Insulin

The first breakthrough came from a clue that pointed to the involvement of the pancreas in the disease process. This clue was provided by a young German medical student, Paul Langerhans (1847-1888), who found special clusters of cells scattered throughout the pancreas forming little islands of cells. Although he did not yet understand their function, Langerhans could see that these cells were different from the rest of the tissue and assumed that they must be important. When his suspicions later proved true, these clusters of cells were named the *islets of Langerhans* for their young discoverer. In 1922, with the use of this important clue, two Canadian scientists—Frederick Banting and his assistant, Charles Best, together with two other research team members, physiologists J.B. Collip and J.J.R. Macleod—extracted the first insulin from animals. It proved to be a hormone that regulates the oxidation of blood glucose and that helps to convert it to heat and energy. They called the hormone *insulin* from the Latin word *insula,* meaning "island." Insulin did prove to be the effective agent for the treatment of diabetes. Leonard Thompson was the first child to be treated with insulin, in January 1922. He lived to adulthood, but he died at the age of 27 years—not from his diabetes but from coronary heart disease caused by the diabetic diet of the day, which obtained 70% of its total kilocalories from fat. Unsurprisingly, his autopsy showed marked atherosclerosis.

Successful Use of Diet and Insulin

The insulin discovery team was more successful on their third try with a young girl who was diagnosed with diabetes at the age of 11 years. She initially had been put on a starvation diet, and her weight fell from 75 to 45 pounds (34 to 21 kg) over a 3-year period. However, the medical research team fortunately had learned the importance of a well-balanced diet for normal growth and health. Thus, with a good diet and the new insulin therapy, this child, Elizabeth Hughes, gained weight and vigor and lived a normal life. She married, had three children, took insulin for 58 years, and died of heart failure at the age of 73 years.

Type 1 Diabetes Mellitus

Type 1 diabetes mellitus accounts for 5% to 10% of all cases of diabetes. It develops rapidly, and it tends to be more severe and unstable than other forms of diabetes. Type 1 diabetes is caused by the autoimmune destruction of the β cells in the pancreas. At least four autoantibodies have been identified as the causes of this destruction: islet cell autoantibodies, autoantibodies to insulin, autoantibodies to glutamic acid decarboxylase, and autoantibodies to the tyrosine phosphatases IA-2 and IA-2β.[2] The rate of destruction determines the onset of diabetes. The initial onset of type 1 diabetes occurs rapidly among children and adolescents (hence its former name *juvenile-onset diabetes*), but it can occur at any age. For some individuals, the rate of destruction is slower, and symptoms may not appear until adulthood. Individuals with this type of diabetes rely on **exogenous** insulin for survival (hence its other former name *insulin-dependent diabetes*). At the time of diagnosis, individuals with type 1 diabetes are often underweight and at higher risk for acidosis.

Type 2 Diabetes Mellitus

Approximately 90% to 95% of individuals with diabetes have type 2 diabetes. This form has a strong genetic link, and it is more prevalent among obese individuals.[2-4] Box 20-1 lists additional risk factors for the development of type 2 diabetes. Unlike type 1 diabetes, type 2 diabetes is not caused by an autoimmune response. This form of diabetes results from an insulin resistance or insulin defect: either the body is not producing enough insulin or the insulin that it is producing cannot be used. These individuals usually do not need exogenous insulin for survival; rather, they rely on diet, exercise, and oral

CULTURAL CONSIDERATIONS

PREVALENCE OF TYPE 2 DIABETES

Type 2 diabetes was known for years as *adult-onset diabetes,* because it rarely affected anyone who was younger than 40 years old. However, this form of diabetes has rapidly become a health care concern among children and adolescents. As with the occurrence of type 2 diabetes in adults, it has been reported in all races and ethnic populations, with a disproportionate burden on minority groups. Diabetes, impaired glucose tolerance, obesity, and even cardiovascular disease are beginning to plague the children of America in a similar fashion as they do adults.

Children

In an effort to define the contributing factors responsible for the increased prevalence of type 2 diabetes in children, researchers have investigated fetal exposure to maternal diabetes and obesity and found such exposures to be strong contributing factors among diverse ethnic groups.[1] Ethnic groups with pronounced risks are African Americans, Hispanic and Latino Americans, Native Americans, and some Asian Americans, Native Hawaiians, and other Pacific Islanders. The estimated prevalence of type 2 diabetes in children younger than 20 years old is 24.3 cases per 100,000 youth,[2] of which 10.4% were overweight and 79% were obese at the time of study.[3]

Adults

The Centers for Disease Control and Prevention reported the number of people diagnosed with diabetes from 2007 to 2009 who were 20 years old or older to have the following prevalence by race and ethnicity[4]:

- 7.1% of non-Hispanic whites
- 8.4% of Asian Americans
- 11.8% of Hispanics
- 12.6% of non-Hispanic blacks

1. Dabelea D, Mayer-Davis EJ, Lamichhane AP, et al. Association of intrauterine exposure to maternal diabetes and obesity with type 2 diabetes in youth: the SEARCH Case-Control Study. *Diabetes Care.* 2008;31(7):1422-1426.
2. Writing Group for the SEARCH for Diabetes in Youth Study Group; Dabelea D, Bell RA, D'Agostino Jr RB, et al. Incidence of diabetes in youth in the United States. *JAMA.* 2007;297(24):2716-2724.
3. Liu LL, Lawrence JM, Davis C, et al. Prevalence of overweight and obesity in youth with diabetes in USA: the SEARCH for Diabetes in Youth study. *Pediatr Diabetes.* 2010;11(1):4-11.
4. Centers for Disease Control and Prevention. *National diabetes fact sheet: national estimates and general information on diabetes and prediabetes in the United States, 2011.* Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2011.

BOX 20-1 RISK FACTORS FOR TYPE 2 DIABETES MELLITUS

- A family history of diabetes
- Age of 45 years or more
- Overweight (i.e., a body mass index of 25 kg/m^2 or more)
- Not physically active on a regular basis
- Race/ethnicity (non-Hispanic African American, Hispanic American, Native American, Alaska Native, Asian American, and Pacific Islander)
- Women with a history of gestational diabetes or who have delivered an infant who weighed more than 9 pounds
- Previously identified as having impaired glucose tolerance
- Low high-density lipoprotein cholesterol level or high triglyceride level; high blood pressure

medications for disease management. This form of diabetes, which was previously called *adult-onset diabetes* or *non–insulin-dependent diabetes,* has an onset primarily in adults who are older than 40 years old. However, as children get heavier, the prevalence of type 2 diabetes among young people is on the rise (i.e., 8.1 cases per 100,000 youth between the ages of 10 and 14 years and 11.8 cases per 100,000 youth between the ages of 15 and 19 years).[5] The Cultural Considerations box entitled "Prevalence of Type 2 Diabetes" discusses this issue in more depth. Many adults and children with type 2 diabetes can improve or reduce their symptoms with weight loss and thus require only diet therapy and balanced exercise programs.

Table 20-1 summarizes the differences between type 1 and type 2 diabetes mellitus.

Gestational Diabetes

Gestational diabetes mellitus (GDM) is a temporary form of diabetes that occurs during pregnancy, with normal blood glucose control usually recovered after delivery. Women who have type 1 or type 2 diabetes before conception do not fall into this category during pregnancy. GDM

insulin a hormone that is produced by the pancreas, attaches to insulin receptors on cell membranes, and allows the absorption of glucose into the cell.

hyperglycemia an elevated blood glucose level.

exogenous originating from outside the body.

TABLE 20-1 DIFFERENTIATING TYPE 1 AND TYPE 2 DIABETES MELLITUS

Factor	Type 1	Type 2
Ethnicity	Increased rates among persons with Northern European heritage	Increased rates among persons with heritages from equatorial countries; the highest rates are found in those with Native American, Hispanic, African-American, Asian, Pacific Islander, and Mediterranean heritages
Age of onset	Generally younger than 30 years of age, with the peak onset before puberty	Generally older than 40 years of age, although genetic predisposition and obesity may cause onset to occur at younger ages
Weight	Usually normal or underweight; unintentional weight loss often precedes diagnosis	Usually overweight, but may be of normal weight
Treatment	Insulin injections are necessary for life; food and exercise must be balanced with insulin	Weight loss is usually the first goal; a reduction in sugar and fat and an increase in soluble fiber are helpful; oral hypoglycemic agents, insulin, or both may be necessary for good blood glucose management, but they are not necessary to prevent imminent death; exercise is important
β-cell functioning	Totally absent (i.e., no insulin is produced) after the "honeymoon period"; residual insulin is produced for approximately 1 year after diagnosis	Excess insulin production is usually evident (i.e., hyperinsulinemia), but insulin resistance occurs at the cellular level; insulin production may also be normal or below normal

Modified from Peckenpaugh NJ. *Nutrition essentials and diet therapy.* 10th ed. Philadelphia: Saunders; 2007.

BOX 20-2 SCREENING FOR AND DIAGNOSIS OF GESTATIONAL DIABETES MELLITUS

- Perform a 75-g oral glucose tolerance test with a plasma glucose measurement at baseline (fasting) and at 1 and 2 hours at 24 to 28 weeks' gestation in women who were not previously diagnosed with overt diabetes.
- The oral glucose tolerance test should be performed in the morning after an overnight fast of at least 8 hours.
- The diagnosis of gestational diabetes mellitus is made if any of the following plasma glucose values are exceeded:
  - Fasting: 92 mg/dL (5.1 mmol/L)
  - 1 hour: 180 mg/dL (10.0 mmol/L)
  - 2 hour: 153 mg/dL (8.5 mmol/L)

From American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care.* 2011;34(Suppl 1):S62-S69.

can present complications for both the mother and the infant if it is not carefully monitored and controlled. Persistent hyperglycemia is associated with an increased risk of intrauterine fetal death and **macrosomia**.

GDM develops in approximately 7% of all pregnant women.[2] Risk factors for GDM are the same as for type 2 diabetes (see Box 20-1). Pregnant women who are at high risk for developing GDM should be screened with a fasting plasma glucose and glycosylated hemoglobin A1c test during the first prenatal visit. All women who are not otherwise known to have diabetes should be screened with a glucose tolerance test between 24 and 28 weeks' gestation.[2,6] The screening protocol for GDM is provided in Box 20-2.[2]

Women with GDM have their blood glucose levels carefully monitored and are taught to follow a tightly managed program of diet and to self-test blood glucose, blood pressure, and urinary protein. For women who are unable to maintain blood glucose levels within an acceptable range (i.e., 92 mg/dL or less fasting, 180 mg/dL or less 1 hour postprandial, or 153 mg/dL or less 2 hours postprandial), insulin therapy is recommended. Oral hypoglycemic agents were not used for GDM in the past for fear of teratogenic effects. However, recent research indicates that selective oral hypoglycemic agents are as appropriate for use in this population as exogenous insulin.[7,8]

Complications of GDM for mother and baby are greatly reduced (if not eliminated) by the tight control of blood glucose levels. Women with GDM are also advised to maintain a balanced diet, a regular exercise schedule, and a healthy body mass index and to attend all follow-up visits with their physicians. Women with GDM have a 41.5% chance of having subsequent pregnancies that are

macrosomia excessive fetal growth that results in an abnormally large infant; this condition carries a high risk for perinatal death.

complicated by diabetes, and the risk for developing type 2 diabetes later in life is significantly higher among women with a history of GDM.[9]

Other Types of Diabetes

Secondary diabetes may be caused by a number of conditions or agents that affect the pancreas, including the following:

- *Genetic defects:* Defects in the β cells or insulin action may result in several forms of diabetes. These forms are not characteristic of the autoimmune destruction found in patients with type 1 diabetes. Mutations on at least six genetic loci have been identified, and these result in impaired insulin secretion (although not the action of the insulin). Other less common defects in the action of the insulin (but not in the amount secreted) also result in hyperglycemia and diabetes. Two such syndromes that have been identified in the pediatric population are leprechaunism and Rabson-Mendenhall syndrome.[2]
- *Pancreatic conditions or diseases:* Any condition that causes damage to the pancreatic cells can result in diabetes. Such conditions include tumors that affect the islet cells; acute viral infection by a number of agents, such as the mumps virus; acute pancreatitis from biliary disease and gallstones; chronic pancreatic insufficiency, such as that which occurs with cystic fibrosis; pancreatic surgery; and severe traumatic abdominal injury. One of the most common causes of chronic pancreatitis is alcohol abuse. Approximately one third to one half of patients with acute pancreatitis develop disorders such as diabetes and steatorrhea.[10]
- *Endocrinopathies:* Insulin works in conjunction with several other hormones in the body. Hormones such as growth hormone, cortisol, glucagon, and epinephrine are all antagonistic to the functions of insulin. Therefore, for patients with disorders in which excessive amounts of antagonistic hormones are produced, the action of insulin is hindered, and hyperglycemia ensues. **Cushing's syndrome**, glucagonoma, **pheochromocytoma**, hyperthyroidism, and **aldosteronoma** are examples of endocrinopathies that ultimately cause symptoms of diabetes. When the primary disorder (i.e., excessive antagonistic hormone secretion) is removed, the resulting hyperglycemia is usually resolved.
- *Drug- or chemical-induced diabetes:* Certain drugs and toxins can impair insulin secretion or insulin action. The following drugs and toxins have been linked to impaired glucose tolerance (IGT) and diabetes: Vacor (rat poison), pentamidine, nicotinic acid, glucocorticoids, thyroid hormone, thiazides, diazoxide, phenytoin (Dilantin), β-adrenergic agonist, and α-interferon.[2]

Impaired Glucose Tolerance

Individuals whose fasting blood glucose is higher than normal (i.e., 110 mg/dL or more) but less than the level for the clinical diagnosis of diabetes (i.e., 126 mg/dL or more) are given the IGT classification, which is also referred to as *prediabetes.* IGT is a risk factor for the development of type 2 diabetes. Treatment guidelines follow those that are designed for patients with type 2 diabetes, and they can help to prevent or prolong the progression into full-blown diabetes. Individuals with IGT often have a complicated assortment of underlying conditions (e.g., dyslipidemia, obesity, hypertension) that build on one another to create the condition known as *metabolic syndrome.* The prevalence of cardiovascular disease (CVD) with the diagnosis of type 2 diabetes in patients with metabolic syndrome is approximately 20.1%, and metabolic syndrome is thought to be an independent risk factor for CVD and mortality.[11-13] See Table 19-2 for the diagnostic criteria for metabolic syndrome.

Symptoms of Diabetes

Initial Signs

Early signs of diabetes include three primary symptoms: (1) increased thirst (polydipsia); (2) increased urination (polyuria); and (3) increased hunger (polyphagia). Unintentional weight loss occurs with type 1 diabetes. Additional signs include blurred vision, dehydration, skin irritation or infection, and general weakness and loss of

Cushing's syndrome the excess secretion of glucocorticoids from the adrenal cortex; symptoms and complications include protein loss, obesity, fatigue, osteoporosis, edema, excess hair growth, diabetes, and skin discoloration.

pheochromocytoma a tumor of the adrenal medulla or the sympathetic nervous system in which the affected cells secrete excess epinephrine or norepinephrine and cause headache, hypertension, and nausea.

aldosteronoma the excess secretion of aldosterone from the adrenal cortex; symptoms and complications include sodium retention, potassium wasting, alkalosis, weakness, paralysis, polyuria, polydipsia, hypertension, and cardiac arrhythmias.

strength. Older adults also may demonstrate poor wound healing.

Laboratory Test Results

Various laboratory tests show glucosuria (i.e., glucose in the urine), hyperglycemia (i.e., elevated blood glucose), and abnormal glucose tolerance tests. Although the urinary excretion of glucose is correlated with increasing levels of blood glucose, it is not as sensitive in patients with type 2 diabetes.[14] Glycosylated hemoglobin A1c, which is usually abbreviated as *HbA1c* or *A1C*, represents blood glucose levels over a 3-month period. HbA1c levels of 6.5% or more are indicative of diabetes mellitus.[2]

Progressive Results

If the disease is left uncontrolled, chronic hyperglycemia causes progressive deterioration. These results may include water and electrolyte imbalance, **ketoacidosis**, and coma.

THE METABOLIC PATTERN OF DIABETES

Energy Supply and Control of Blood Glucose

Energy Supply

Diabetes has been called a disease of carbohydrate metabolism, but it is a general metabolic disorder that involves all three of the energy-yielding nutrients: carbohydrate, fat, and protein. Diabetes is especially related to the metabolism of the two main fuels, carbohydrate and fat, in the body's overall energy system. The three basic stages of normal glucose metabolism are as follows:

1. Initial interchange with glycogen (glycogenolysis) and reduction to a smaller central compound (glycolysis pathway)
2. Joining with the other two energy-yielding nutrients, fat and protein (pyruvate link)
3. Final common energy production (citric acid cycle and electron transport chain)

Blood Glucose Control

The control of blood glucose within its normal range of 70 to 110 mg/dL is important for general health. Normal control mechanisms ensure sufficient circulating blood glucose to meet the constant energy needs (even the basal metabolic energy needs during sleep), because glucose is the body's preferred fuel. Figure 20-1 shows the balanced sources and uses of blood glucose.

Sources of Blood Glucose. To ensure a constant supply of the body's main fuel, the following two sources provide the body with glucose:

- *Dietary intake:* the energy-yielding nutrients in food (i.e., dietary carbohydrates and the carbon backbones of fat and protein, as needed)
- *Glycogen:* the backup source from the constant turnover of stored glycogen in the liver and muscles (i.e., glycogenolysis)

Uses of Blood Glucose. The body uses glucose as needed in the following actions:

- Burning it during cell oxidation for immediate energy needs (i.e., glycolysis)
- Changing it to glycogen (i.e., glycogenesis), which is briefly stored in the muscles and liver and then withdrawn and changed back to glucose for short-term energy needs
- Converting it to fat, which is stored for longer periods in adipose tissue (i.e., lipogenesis)

Figure 20-2 summarizes the pathways that are involved in glucose metabolism.

Pancreatic Hormonal Control

The specialized cells of the islets of Langerhans in the pancreas provide three hormones that work together to regulate blood glucose levels: insulin, glucagon, and somatostatin. Insulin is produced in the β cells of the islets, which fill its central zone and make up about 60% of each islet gland. The specific arrangement of human islet cells is illustrated in Figure 20-3.

Insulin. Insulin is the major hormone that controls the level of blood glucose. It accomplishes this through the following metabolic actions:

- Helping to transport circulating glucose into cells by binding to insulin receptors and activating glucose transporters
- Stimulating glycogenesis
- Stimulating lipogenesis
- Inhibiting the breakdown of tissue fat (lipolysis) and protein degradation
- Promoting the uptake of amino acids by skeletal muscles, thereby increasing tissue protein synthesis

ketoacidosis the excess production of ketones; a form of metabolic acidosis that occurs with uncontrolled diabetes or starvation from burning body fat for energy fuel; a continuing uncontrolled state can result in coma and death.

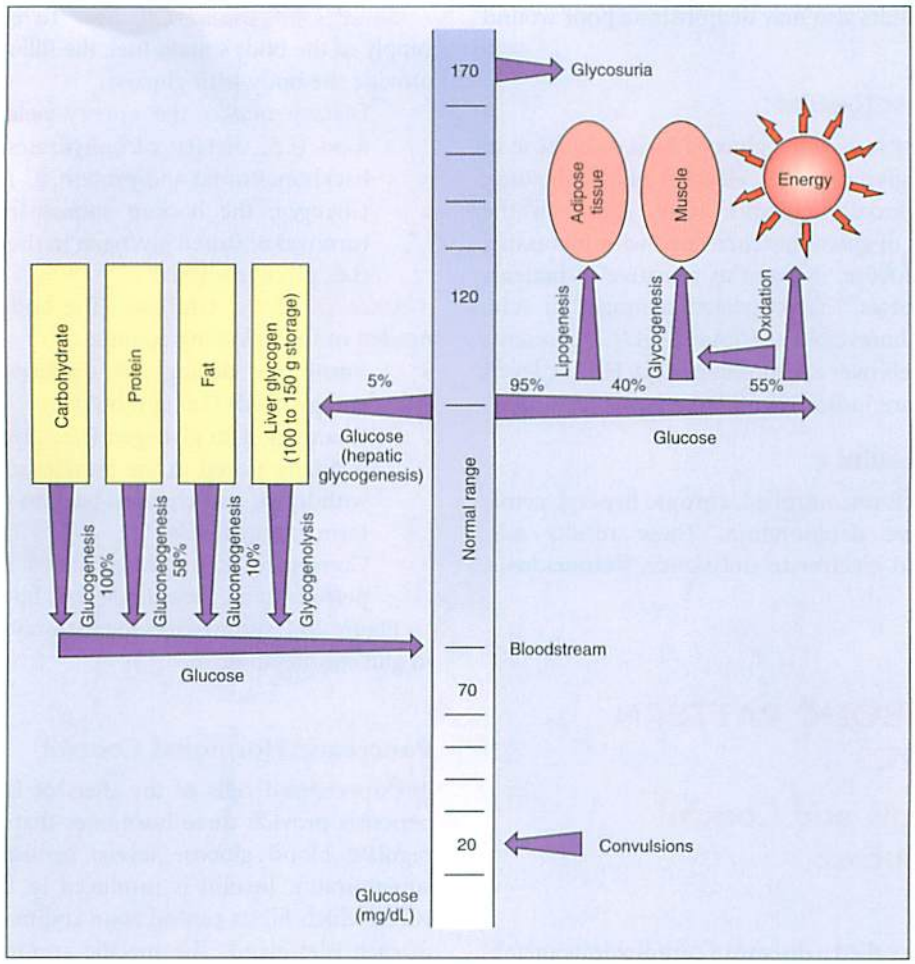


Figure 20-1 Sources of blood glucose (e.g., food, stored glycogen) and normal routes of control.

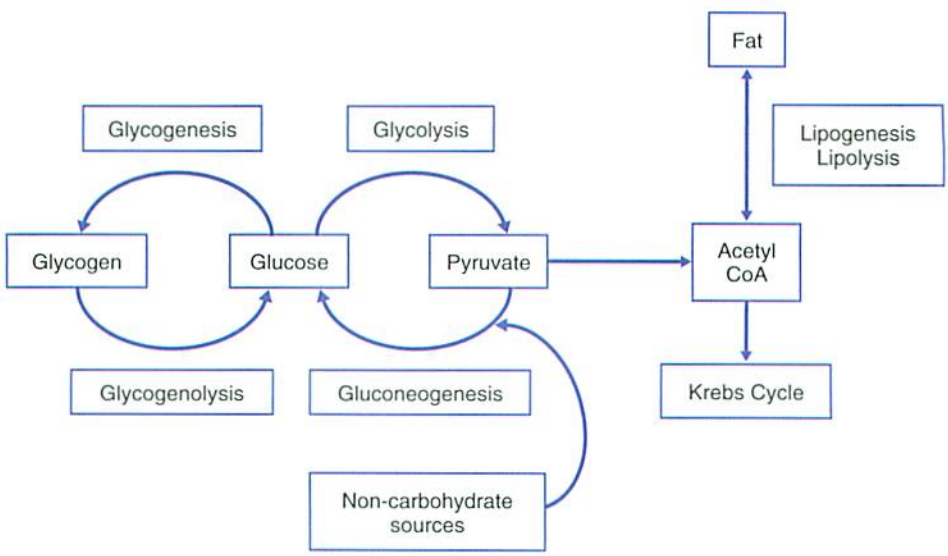


Figure 20-2 Glucose metabolism.

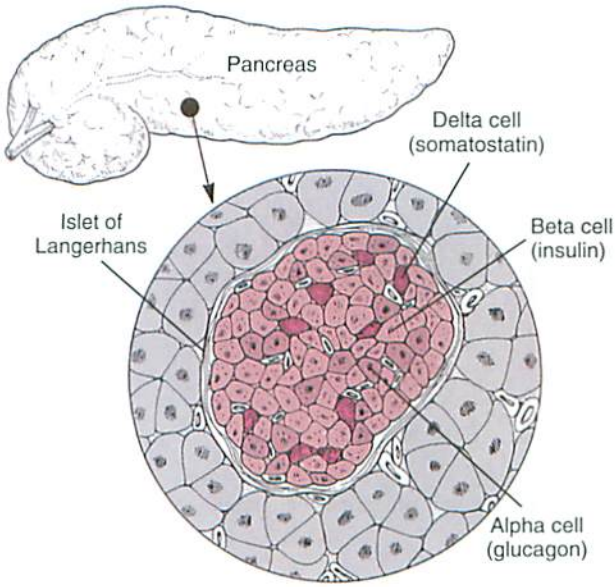


Figure 20-3 The islets of Langerhans, which are located in the pancreas.

- Influencing the burning of glucose for constant energy as needed

Glucagon. Glucagon is a hormone that acts in an opposite manner of insulin to balance the overall blood glucose control. It can rapidly break down stored glycogen (i.e., glycogenolysis). This action raises blood glucose concentrations as needed to protect the brain and other tissues during sleep or fasting. Glucagon is produced in the α cells of the pancreatic islets, which are arranged around the outer rim of each of these glands and make up about 30% of the gland's total cell mass.

Somatostatin. Somatostatin is the pancreatic hormone that acts as a referee for several other hormones that affect blood glucose levels. Somatostatin is produced in the δ cells of the pancreatic islets, which are scattered between the α and β cells and make up approximately 10% of each islet's cells. Somatostatin inhibits the secretion of insulin, glucagon, and other gastrointestinal hormones (e.g., gastrin, cholecystokinin). Because it has more generalized functions in the regulation of circulating blood glucose, somatostatin also is produced in other parts of the body (e.g., the hypothalamus).

Abnormal Metabolism in Uncontrolled Diabetes

When insulin activity is insufficient, such as it is in a patient with uncontrolled diabetes, the normal controls for blood glucose levels do not function properly. As a result, abnormal metabolic changes and imbalances occur among the three macronutrients.

Glucose

In the presence of hyperglycemia, glucose is absorbed into the pancreatic cells (no insulin is needed for transport in the pancreas) and triggers the secretion of insulin into the bloodstream. Insulin is then circulated throughout the blood, and it attaches to insulin receptor sites on cell membranes throughout the body. Once bound, a signaling cascade begins that phosphorylates GLUT4 vesicles (within the cell) and results in the migration of GLUT4 vesicles to the cell membrane. Ultimately, GLUT4 transporters allow for the uptake of glucose into the cell (Figure 20-4). If this process cannot happen, cells are essentially starved for glucose.

Fat

In the absence of functioning insulin, fat tissue formation (lipogenesis) decreases, and fat tissue breakdown (lipolysis) increases. However, normal lipolysis requires an adequate supply of glucose, which in turn relies on the help of insulin to accept glucose into the cell. Therefore, intermediate products of fat breakdown, called *ketones*, accumulate in the body. Ketones are acids, and their excess accumulation leads to diabetic ketoacidosis. The appearance of the ketone *acetone* in the urine is one indicator of poor glucose control as well as of the adverse development of ketoacidosis.

glucagon a hormone secreted by the α cells of the pancreatic islets of Langerhans in response to hypoglycemia; it has an effect opposite to that of insulin in that it raises the blood glucose concentration and thus is used as a quick-acting antidote for a low blood glucose reaction; it also counteracts the overnight fast during sleep by breaking down liver glycogen to keep blood glucose levels normal and to maintain an adequate energy supply for normal nerve and brain function.

GLUT4 an insulin-regulated protein that is responsible for glucose transport into cells.

ketones the chemical name for a class of organic compounds that includes three keto acid bases that occur as intermediate products of fat metabolism.

acetone a major ketone compound that results from fat breakdown for energy in individuals with uncontrolled diabetes; persons with diabetes periodically take urinary acetone tests to monitor the status of their diabetes control.

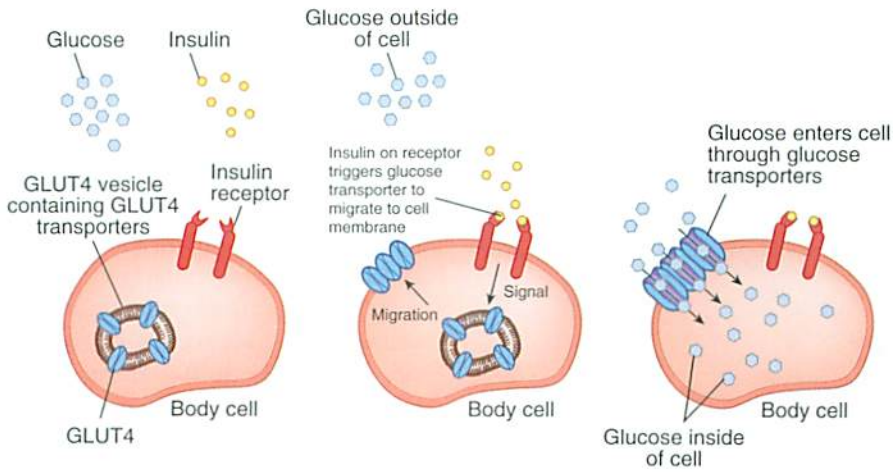


Figure 20-4 Insulin allows glucose to enter the cell through the glucose channel.

Protein

Protein tissues are also broken down in the body's effort to secure energy sources, thereby causing weight loss, muscle weakness, and urinary nitrogen loss.

Long-Term Complications

The long-term complications associated with diabetes result from continuous hyperglycemia. These health problems mainly relate to microvascular and macrovascular dysfunction in the vital organs. Individuals with good blood glucose control can avoid many such complications.

Retinopathy

Retinopathy involves small hemorrhages from broken arteries in the retina that involve yellow, waxy discharge or retinal detachment. Diabetic retinopathy is the leading cause of new cases of blindness in adults between the ages of 20 and 74 years. The risk for retinopathy significantly increases with incessant hyperglycemia (i.e., a fasting blood glucose of 120 mg/dL or more). Retinopathy has few warning signs; however, 28.5% of people with diabetes who are older than 40 years old have diabetic retinopathy.[15] Some treatment modalities (e.g., laser photocoagulation therapy) can prevent or at least delay the onset of this condition; thus, ongoing eye evaluations are an important part of the care plan. The American Diabetes Association recommends that individuals with type 1 diabetes go for a first-time eye examination within 5 years after diagnosis and that those with type 2 diabetes have their first eye examination shortly after diagnosis. Examinations with dilation should continue annually from that point forward.[16] The strict control of the blood glucose level and intensive intervention can reduce retinopathy progression and decrease the development of severe diabetic retinopathy.[17]

Retinopathy should not be confused with the blurry vision that sometimes occurs as one of the first signs of diabetes. Blurry vision is caused by the increased glucose concentration in the fluids of the eye, which bring about brief changes in the curved, light-refracting surface of the eye.

Nephropathy

Diabetes is the leading cause of end-stage renal disease in the United States, and it accounts for 44% of all new kidney failure cases.[15] As with retinopathy, nephropathy is exacerbated by poor blood glucose control. The primary symptom is **microalbuminuria**. Nephropathy and end-stage renal disease cannot be cured, but, with better blood glucose control and antihypertensive therapy, disease progression can be slowed.[17] Recommendations for screening are the same as for retinopathy: within 5 years of diagnosis for type 1 and at diagnosis for type 2, with annual follow-up.[16]

Neuropathy

Current estimates are that 60% to 70% of people with diabetes have mild to severe forms of nervous system damage.[15] Changes in the nerves involve injury and disease in the peripheral nervous system, especially in the legs and feet, that cause prickly sensations, increasing

microalbuminuria low but abnormal levels of albumin in the urine.

pain, and the eventual loss of sensation from damaged nerves. The loss of nerve reaction can lead to further tissue damage and infection from unfelt foot injuries such as bruises, burns, and deeper **cellulitis**. Amputations and foot ulcerations are the most common results of severe neuropathy. The risk for such complications is increased for individuals who have had diabetes for more than 10 years; those who are male; those who have poor glucose control; and those who have concurrent complications such as cardiovascular, retinal, or renal disease.[18] Diabetic neuropathy is also linked to chronic problems such as motor deficits, cardiac ischemia, hypotension, gastroparesis, bladder dysfunction, and sexual dysfunction. As with other microvascular complications, annual screening is recommended.

Heart Disease

CVD is the major cause of death for people with diabetes, and it occurs two to four times more frequently in this population compared with the general population.[15] The standards of medical care for individuals with diabetes include recommendations for the prevention and management of CVD that are specifically aimed at blood lipid levels, blood pressure, aspirin use, and smoking cessation.[16] Glycemic control is not as strongly related to dyslipidemia and hypertension as it is to other long-term microvascular complications of diabetes (i.e., retinopathy, nephropathy, and neuropathy). However, the comorbid conditions of hyperglycemia and dyslipidemia greatly increase the risk of CVD; thus, evaluation and treatment must be part of the overall health care plan for individuals with diabetes.

Dyslipidemia. Elevated triglyceride levels and decreased high-density lipoprotein (HDL) cholesterol levels are characteristic of dyslipidemia in patients with type 2 diabetes. The management of dyslipidemia is prioritized as follows: (1) lifestyle modifications that focus on the reduction of saturated fats, trans fats, and cholesterol intake; weight loss, if indicated; and increased physical activity; (2) lowering low-density lipoprotein cholesterol levels; (3) raising HDL cholesterol levels; and (4) lowering triglyceride levels. Intensive glycemic control reduces the development of coronary artery calcification, which is an index of atherosclerosis, especially among patients with high triglyceride levels and poor glucose control.[19] Recommendations for lipid profiles for adults with diabetes are as follows[16]:

- *Low-density lipoprotein cholesterol:* less than 100 mg/dL; if the patient has advanced CVD, reduce the low-density cholesterol level to less than 70 mg/dL
- *HDL cholesterol:* more than 40 mg/dL for men and more than 50 mg/dL for women
- *Triglycerides:* less than 150 mg/dL

Hypertension. Hypertension affects the majority of adults with diabetes, and it is a major risk factor for microvascular complications. CVD mortality is doubled for people with both diabetes and hypertension, thereby making blood pressure evaluation and treatment an important part of the health care plan. The recommendation for blood pressure in adults with diabetes is less than 130/80 mm Hg. To achieve such a level of blood pressure, patients are encouraged to adopt lifestyle modifications such as reducing sodium intake; losing weight (if indicated); increasing the consumption of fruits, vegetables, and low-fat dairy products (i.e., following the DASH diet; see Chapter 19); moderating alcohol intake; and increasing physical activity levels.[16]

GENERAL MANAGEMENT OF DIABETES

Early Detection and Monitoring

The guiding principles for the treatment of diabetes are early detection and the prevention of complications. Community screening programs and annual physical examinations help to identify people with elevated blood glucose levels who may benefit from a glucose tolerance test (e.g., fasting and 2-hour tests with a measured glucose dose) and medical evaluation. An additional monitoring aid is the HbA1c assay (normal range, 4% to 6%), which provides an effective tool for evaluating the long-term management of diabetes and the degree of control. Because glucose attaches itself to the hemoglobin molecule over the life of the red blood cell, this test reflects the average level of blood glucose over the preceding 3 months. Other tests such as fructosamine and C-peptide are sometimes used for diagnostic purposes. However, HbA1c is currently the most accurate assessment tool for monitoring ongoing blood glucose control and the risk for complications. Box 20-3 outlines the criteria for the diagnosis of diabetes mellitus, and Table 20-2 gives the correlation between HbA1c values and plasma glucose.

cellulitis the diffuse inflammation of soft or connective tissues (e.g., in the foot) from injury, bruises, or pressure sores that leads to infection; poor care may result in ulceration and abscess or gangrene.

BOX 20-3 CRITERIA FOR THE DIAGNOSIS OF DIABETES MELLITUS

- HbA1c ≥ 6.5%. The test should be performed in a laboratory using a method that is National Glycohemoglobin Standardization Program (NGSP) certified and standardized to the Diabetes Control and Complications Trial (DCCT) assay.*

or

- Fasting plasma glucose level of at least 126 mg/dL (7.0 mmol/L)
  The term *fasting* is defined as no caloric intake for at least 8 hours.*

or

- A 2-hour plasma glucose level of at least 200 mg/dL (11.1 mmol/L) during an oral glucose tolerance test
  The oral glucose tolerance test should be performed as described by the World Health Organization with the use of a glucose load that contains the equivalent of 75 g of anhydrous glucose dissolved in water.*

or

- In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose level of at least 200 mg/dL (11.1 mmol/L)

*In the absence of unequivocal hyperglycemia, results should be confirmed by repeat testing.
Modified from American Diabetes Association. Standards of medical care in diabetes-2011. *Diabetes Care*. 2011;34(1 suppl): S11-S62.

TABLE 20-2 CORRELATION BETWEEN GLYCOSYLATED HEMOGLOBIN A1C AND PLASMA GLUCOSE LEVELS

	MEAN PLASMA GLUCOSE LEVEL	
HbA1c	mg/dL	mmol/L
6	126	7.0
7	154	8.6
8	183	10.2
9	212	11.8
10	240	13.4
11	269	14.9
12	298	16.5

From American Diabetes Association. Standards of medical care in diabetes-2011. *Diabetes Care*. 2011;34(1 Suppl):S11-S62.

Basic Goals of Care

General Objectives

The health care team is guided by three basic objectives when working with patients with diabetes: maintaining optimal nutrition, avoiding symptoms, and preventing complications.

TABLE 20-3 SUMMARY OF RECOMMENDATIONS FOR ADULTS WITH DIABETES

Parameter	Recommendation
Glycosylated hemoglobin A1c level	< 7.0%
Preprandial capillary plasma glucose level	70 to 130 mg/dL (3.9 to 7.2 mmol/L)
Peak postprandial capillary plasma glucose level*	< 180 mg/dL (< 10.0 mmol/L)
Blood pressure	< 130/80 mm Hg
Low-density lipoprotein level	< 100 mg/dL (< 2.6 mmol/L) for individuals without overt cardiovascular disease < 70 mg/dL (< 1.8 mmol/L) for individuals with overt cardiovascular disease
Triglyceride level	< 150 mg/dL (< 1.7 mmol/L)
High-density lipoprotein level	> 40 mg/dL (> 1.0 mmol/L) for men > 50 mg/dL (> 1.3 mmol/L) for women

- Goals should be individualized on the basis of the following:
  - Duration of diabetes
  - Patient's age and life expectancy
  - Comorbid conditions
  - Known cardiovascular disease or advanced microvascular complications
  - Hypoglycemia unawareness
  - Individual patient considerations
- More or less stringent glycemic goals may be appropriate for individual patients.
- Postprandial glucose may be targeted if HbA1c level goals are not met despite reaching preprandial glucose goals.

*Postprandial glucose measurements should be made 1 to 2 hours after the beginning of the meal; this is generally when peak levels are seen in patients with diabetes.
From the American Diabetes Association. Standards of medical care in diabetes—2011. *Diabetes Care*. 2011;34(1 Suppl):S11-S62.

Maintaining Optimal Nutrition. The first objective is to sustain a high level of nutrition for general health promotion, adequate growth and development, and the maintenance of an appropriate weight.

Avoiding Symptoms. This objective seeks to keep a person relatively free from symptoms of hyperglycemia, hypoglycemia, and glycosuria, which indicate poor blood glucose control.

Preventing Complications. The consistent control of blood glucose levels helps to reduce the risks of chronic complications. Table 20-3 summarizes recommendations for adults with diabetes as defined by the American Diabetes Association.

Importance of Good Self-Care Skills

To accomplish these objectives, a person with diabetes must learn and regularly practice good self-care. Daily self-discipline and informed self-care are necessary for sound diabetes management, because all people with diabetes must ultimately treat themselves, with the support of a good health care team. More emphasis is now being given to comprehensive diabetes education programs that encourage more self-care responsibility.

Basic Elements of Diabetes Management

Balancing three basic elements is essential for the good control of blood glucose levels. First, the healthy diet described here is essential for good glucose management. Second, physical activity provides an important balance to maintain good blood glucose control. Third, to ensure adequate insulin activity, some people require medications (e.g., insulin injections or oral hypoglycemic agents). However, a fourth element—stress management—may well be added in today's stressful world.

Special Objectives During Pregnancy

When a woman with diabetes becomes pregnant or when the pregnancy induces GDM, her body metabolism changes to meet the increased physiologic needs of the pregnancy while battling the manifestations of diabetes (see Chapter 10). A team of specialists usually works closely with the mother. Careful team monitoring of the mother's diabetes management is essential to ensure her health and the health of her baby. Potential problems of fetal damage, perinatal death, stillbirth, prematurity, and macrosomia are serious concerns during this time.

MEDICAL NUTRITION THERAPY FOR INDIVIDUALS WITH DIABETES

Glycemic control is the primary focus of diabetes management for all patients with diabetes. Medical nutrition therapy (MNT) will be discussed below in terms of recommendations, energy balance, nutrient balance, food distribution, and diet management.

Medical Nutrition Therapy

The MNT recommendations and interventions for all people with diabetes or who are at high risk for developing diabetes are as follows[16,20]:

Prediabetes

For individuals at risk for type 2 diabetes or with prediabetes: decrease the risk of diabetes and CVD by promoting healthy food choices and at least 150 minutes per week of physical activity to promote and maintain weight loss of 5% to 10% of body weight.

Diabetes

For individuals with diagnosed type 1 or type 2 diabetes, the MNT goals are as follows:

1. Achieve and maintain the following:
   - Blood glucose levels in the normal range or as close to normal as is safely possible
   - A lipid and lipoprotein profile that reduces the risk for vascular disease
   - Blood pressure levels in the normal range or as close to normal as is safely possible
2. Prevent or at least slow the rate of the development of the chronic complications of diabetes by modifying nutrient intake and lifestyle.
3. Address individual nutrition needs by taking into account personal and cultural preferences and willingness to change.
4. Maintain the pleasure of eating by only limiting food choices when indicated by scientific evidence.

Additional Considerations

The goals of MNT that apply to specific situations include the following:

1. For youth with type 1 diabetes, youth with type 2 diabetes, pregnant and lactating women, and older adults with diabetes, meet the nutrition needs of these unique times of the life cycle.
2. Provide self-management training for the safe conducting of exercise, including the prevention and treatment of hypoglycemia and diabetes treatment during acute illness.

Total Energy Balance

Normal Growth and Weight Management

Type 1 diabetes most commonly begins during childhood; therefore, the normal height/weight charts for children provide a standard for adequate growth and development. During adulthood, maintaining a lean weight continues to be a basic goal. Because type 2 diabetes usually occurs in overweight adults, a major goal is weight reduction and control.

Energy Intake

The total energy value of the diet for a person with diabetes should be sufficient to meet individual needs for normal growth and development, physical activity and exercise, and the maintenance of a desirable lean weight. Exercise is always an important factor in diabetes control, because it improves the cellular uptake of glucose. Energy intake is adjusted to equal energy output, or a negative energy balance should be achieved if weight loss is the goal. The Dietary Reference Intakes for children and adults (see the inside cover of this text) can serve as guides for total energy needs, with appropriate reductions in kilocalories made for overweight adults (see Chapter 15).

Nutrient Balance

The ratios of carbohydrate, fat, and protein in the diet are based on current recommendations for ideal glucose regulation and lower fat intake to reduce the risks of cardiovascular complications. There is not a specific set ratio of calories from each of the macronutrients that is recommended for all individuals with diabetes. The Dietary Reference Intake recommendations for the Acceptable Macronutrient Distribution Range are the basic guide for planning daily food intake: 45% to 65% from carbohydrate, 20% to 35% from fat, and 10% to 35% from protein. The diet for any person with diabetes is always based on the normal nutrition needs of that person for positive health, with a consideration of personal preferences, appetite, and schedule of meals and physical activity.

Carbohydrate

The primary focus in diabetes care is glycemic control, which involves the regulation of the body's primary fuel: blood glucose. The American Diabetes Association recommends a diet that includes carbohydrates from fruits, vegetables, whole grains, legumes, and low-fat milk for good health (Box 20-4). Carbohydrate intake should be consistently distributed throughout the day on a day-to-day basis and adjusted in response to blood glucose self-monitoring. Low-carbohydrate diets that involve the intake of less than 130 g/day of total carbohydrates are not recommended for the management of diabetes.[16,21]

Starch and Sugar. Carbohydrate-containing foods make up a large portion of the food supply. The most obvious of these are breads, cereals, grains, and sugary sweets. Almost all of the calories provided by fruits and vegetables are carbohydrate as well. Individuals with diabetes should not avoid carbohydrate-containing foods, because these represent an important source of energy, vitamins, minerals, and fiber. Monitoring carbohydrate intake—whether by carbohydrate counting, exchanges, or experience-based estimation—remains a key strategy for achieving and maintaining glycemic control. Sucrose-containing foods do not have to be eliminated from the diet completely. For individuals with diabetes who choose to eat such foods, the sucrose-containing foods can be substituted for other carbohydrate-containing foods for a specific meal or snack.[21]

Glycemic Index. A food's **glycemic index** is determined by measuring the increase in blood glucose after the ingestion of a 50-g carbohydrate sample of the food compared with a 50-g sample of a known source, usually white bread or pure glucose. The rate of digestion and absorption determines the glycemic index value. The glycemic index theory of carbohydrate foods indicates that starchy foods greatly differ from one another with regard to their ability to raise plasma glucose levels, thereby contradicting the notion that all complex carbohydrates are created equal. Although carbohydrates differ with regard to their ability to raise blood glucose, no clear trend separates simple sugars from complex carbohydrates (see Chapter 2). For example, potatoes and white bread—both of which are complex carbohydrates—have glycemic indices that are similar to pure glucose. Therefore, the use of the glycemic index for individuals with diabetes may provide a modest benefit for glycemic control; however, there is conflicting evidence of its effectiveness.[16,21] For now, personal preference dictates the use of glycemic index values.

Fiber. As it is for all individuals, the consumption of dietary fiber is encouraged for patients with diabetes. There are no reasons for these individuals to consume greater amounts of fiber than what is recommended for the general public. Current recommendations are to consume approximately 25 to 30 g/day, with special emphasis on soluble fiber (i.e., 7 to 13 g/day).[21]

Sugar Substitutes and Sweeteners. Nutritive and nonnutritive sweeteners may be used in the diet in moderation. Various sugar substitutes are available. Approved noncaloric sweeteners include products such as saccharin, neotame, aspartame, acesulfame-K, and sucralose. Aspartame is made from two amino acids, phenylalanine and aspartic acid, and it is metabolized as such. The use of caloric sweeteners (e.g., sucrose, fructose, sorbitol) should be accounted for in a meal. However, many people

glycemic index the increase above fasting in the blood glucose level more than 2 hours after the ingestion of a constant amount of that food divided by the response to a reference food.

BOX 20-4 NUTRITION RECOMMENDATIONS FOR THE MANAGEMENT OF DIABETES

Carbohydrate

- A dietary pattern that includes carbohydrate from fruits, vegetables, whole grains, legumes, and low-fat milk is encouraged for good health.
- Monitoring carbohydrate—whether by carbohydrate counting, exchanges, or experienced-based estimation—remains a key strategy for the achievement of glycemic control.
- The use of the glycemic index and load in conjunction with carbohydrate counting may provide a modest additional benefit over that observed when total carbohydrate is considered alone.
- Sucrose-containing foods can be substituted for other carbohydrates in the meal plan or, if they are added to the meal plan, they can be considered with regard to the dosage of insulin or other glucose-lowering medications. Care should be taken to avoid excess energy intake.
- As for the general population, people with diabetes are encouraged to consume a variety of fiber-containing foods. However, evidence is lacking to recommend a higher fiber intake than that suggested for the population as a whole.
- Sugar alcohols and nonnutritive sweeteners are safe when they are consumed within the daily intake levels established by the U.S. Food and Drug Administration.

Fat

- Limit saturated fat to less than 7% of total calories.
- The intake of trans fats should be minimized.
- In individuals with diabetes, limit dietary cholesterol to less than 200 mg/day.
- Two or more servings of fish per week (with the exception of commercially fried fish filets) provide omega-3 polyunsaturated fatty acids and are recommended.

Protein

- For individuals with diabetes and normal renal function, evidence is insufficient to suggest that usual protein intake (i.e., 15% to 20% of energy) should be modified.
- For individuals with type 2 diabetes, ingested protein can increase the insulin response without increasing plasma glucose concentrations. Therefore, protein should not be used to treat acute hypoglycemia or to prevent nighttime hypoglycemia.
- High-protein diets are not recommended as a method for weight loss at this time. The long-term effects of protein intake of more than 20% of calories on diabetes management and its complications are unknown. Although such diets may produce short-term weight loss and improved glycemia, it has not been established that these benefits are maintained for the long term, and the long-term effects on the kidney functioning of persons with diabetes are unknown.

Alcohol

- If adults with diabetes choose to use alcohol, daily intake should be limited to a moderate amount (i.e., one drink per day or less for women and two drinks per day or less for men).
- To reduce the risk of nocturnal hypoglycemia among individuals who are using insulin or insulin secretagogues, alcohol should be consumed with food.
- For individuals with diabetes, moderate alcohol consumption (when ingested alone) has no acute effect on glucose and insulin concentrations, but carbohydrate ingested with alcohol (e.g., in a mixed drink) may raise blood glucose levels.

Micronutrients

- No clear evidence demonstrates a benefit from vitamin or mineral supplementation in people with diabetes (as compared with the general population) who do not have underlying deficiencies.
- Routine supplementation with antioxidants (e.g., vitamins E and C, carotene) is not advised because of a lack of evidence of efficacy and concern related to long-term safety.
- The benefits of chromium supplementation for individuals with diabetes or obesity have not been clearly demonstrated and therefore cannot be recommended.

Adapted from the American Diabetes Association. Nutrition recommendations and interventions for diabetes. *Diabetes Care*. 2008; 31(1 Suppl):S61-S78.

cannot tolerate a high intake of sorbitol, and they may have significant diarrhea when sorbitol is used in excess. Nutritive and nonnutritive sweeteners are safe to consume in moderation and as part of a nutritious and well-balanced diet.

Protein

Standard requirements as outlined in the Dietary Reference Intakes can be a guide for protein intake. In general, approximately 10% to 35% of the total energy as protein is sufficient to meet growth needs in children and to maintain tissue integrity in adults. Excessively high protein intake is not recommended because of its unnecessary stress on the kidneys for patients with diabetic nephropathy.

Fat

No more than 7% of the diet's total kilocalories should come from saturated fat. Lower cholesterol intake (i.e., no more than 200 mg/day) is also recommended. The control of fat-related foods, which contribute to the development of atherosclerosis and coronary heart disease, helps to

lessen the increased risk for CVD. An emphasis is placed on polyunsaturated fats (e.g., fish oil) and the avoidance of trans fats.

Guidelines for macronutrient, micronutrient, and alcohol intake are based on the recommendations from the American Diabetes Association position statement and outlined in Box 20-4.

Food Distribution

As a general rule, fairly even amounts of food should be eaten at regular intervals throughout the day and adjusted *in* response to blood glucose levels. This basic pattern helps to provide a more even blood glucose supply and to prevent extremes in high and low levels. Snacks between meals may be needed. Physical activity and medication use are significant factors for determining ideal food distribution on an individual basis.

Daily Activity Schedule

Food distribution must be planned ahead, especially when using insulin, and adjusted according to each day's scheduled activities and blood glucose monitoring to prevent episodes of **hypoglycemia**. The careful distribution of food and snacks is especially important for children and adolescents with diabetes to balance with insulin during the growth spurts and changing hormone patterns of puberty. Practical consideration should be given to school and work schedules, athletics, social events, and stressful periods. A stressful event caused by any source (e.g., injury, anxiety, fear, pain) brings an adrenaline (epinephrine) rush. This fight-or-flight effect counteracts insulin activity and can contribute to a glycemic response.

Exercise

Current recommendations for people with type 1 or type 2 diabetes are to perform at least 150 minutes per week of moderate-intensity aerobic physical activity (i.e., 50% to 70% of maximum heart rate). In addition, people with type 2 diabetes should be encouraged to perform resistance training three times per week in the absence of contraindications.[16] Regular moderate-intensity exercise programs help individuals with type 2 diabetes to control their blood glucose levels and to reduce their risk for cardiovascular disease, hyperlipidemia, hypertension, and obesity.

For people who are using insulin, any exercise or additional physical activity must be covered in the food distribution plan (Table 20-4). The energy demands of exercise are discussed separately in Chapter 16. The following guidelines are recommended for regulating the glycemic response to exercise in individuals with diabetes[22]:

1. Achieve metabolic control before physical activity.
   - Avoid physical activity if fasting glucose levels are higher than 250 mg/dL and if ketosis is present, and use caution if glucose levels are higher than 300 mg/dL and if no ketosis is present.
   - Ingest added carbohydrate if glucose levels are less than 100 mg/dL.
2. Monitor blood glucose levels before and after physical activity.
   - Identify when changes in insulin or food intake are necessary.
   - Learn the glycemic response to different physical activity conditions.
3. Monitor food intake.
   - Consume added carbohydrate as needed to avoid hypoglycemia.
   - Carbohydrate-based foods should be readily available during and after physical activity.

TABLE 20-4 MEAL PLANNING GUIDE FOR ACTIVE PEOPLE WITH TYPE 1 DIABETES

Activity Level	Exchange Needs	Sample Menus
Moderate		
30 minutes	1 bread *or* 1 fruit	1 bran muffin *or* 1 small orange
1 hour	2 bread + 1 meat *or* 2 fruit + 1 milk	Tuna sandwich *or* ½ cup fruit salad + 1 cup milk
Strenuous		
30 minutes	2 fruit *or* 1 bread + 1 fat	1 small banana *or* ½ bagel + 1 tsp cream cheese
1 hour	2 bread + 1 meat + 1 milk *or* 2 bread + 2 meat + 2 fruit	Meat and cheese sandwich + 1 cup milk *or* Turkey sandwich + 1 cup orange juice

hypoglycemia a low blood glucose level; a serious condition in diabetes management that requires immediate sugar intake to counteract, followed by a snack of complex carbohydrate (e.g., bread, crackers) and protein (e.g., lean meat, peanut butter, cheese) to maintain a normal blood glucose level.

Drug Therapy

The food distribution pattern is also influenced by any form of drug therapy (i.e., type, amount, and dose schedule of insulin or oral hypoglycemic agent) that is necessary for glucose control. Successful self-care means that the patient can adjust his or her diet, medications, and exercise on the basis of the result of blood glucose monitoring.

Diet Management

General Planning

The nature of an individual's diabetes, his or her treatment regime, and his or her health status largely determine the necessary personal diet management. Table 20-5 provides guidelines for dietary strategies for type 1 and type 2 diabetes.

Individual Needs

Every person with diabetes is unique, with a particular form and degree of diabetes as well as a different living situation, a different background, and different food habits. All of these personal needs must be considered (as discussed in Chapters 14 and 17) if appropriate and realistic care is to be planned. The nutrition counselor, who usually is the clinical dietitian or certified diabetes educator, should determine these various needs as part of a careful initial nutrition assessment that includes medical, socioeconomic, and psychosocial needs as well as personal lifestyle characteristics. This information provides the basis for determining the diet prescription.

A major principle of diabetes management is the variety of methods and dietary guidelines that the nutrition team can use when planning for and supporting patients. Of these dietary guides, carbohydrate counting and the food exchange method—when tailored to meet individual needs—remain the two most commonly used approaches. Materials that can be used for planning the diet are available from the American Diabetes Association and the Academy of Nutrition and Dietetics in both English and Spanish.

Carbohydrate Counting

Carbohydrate counting is a way to balance the carbohydrate intake with insulin injections (i.e., the insulin-to-carbohydrate ratio). Patients count the total number of carbohydrates for a meal and then inject an appropriate amount of insulin to process the glucose. One carbohydrate serving equals 15 g of carbohydrate. Insulin may be injected manually or with an insulin pump (Figures 20-5 and 20-6). There are multiple resources (e.g., books, online programs, handheld devices, phone applications) available that list grams of carbohydrates for thousands of foods. One benefit of carbohydrate counting is that meal plans are much less stringent and flexibility is more easily accommodated. For this type of meal and insulin planning to work, the patient must be well versed in calculating the total number of carbohydrate grams consumed per meal or snack.

Additional information and tool kits for dietary planning based on carbohydrate counting can be found on the American Diabetes Association Web site (www.diabetes.org) and the Academy of Nutrition and Dietetics Web site (www.eatright.org).

TABLE 20-5 DIETARY STRATEGIES FOR TYPE 1 AND TYPE 2 DIABETES MELLITUS

Dietary Strategy	Type 1	Type 2
Decrease energy intake (kilocalories)	No	Yes, if weight loss is recommended
Increase frequency and number of feedings	Yes	Usually no
Have regular daily intake of kilocalories from carbohydrate, protein, and fat	Very important	Yes
Plan consistent daily ratio of protein, carbohydrate, and fat for each feeding	Desirable	Yes, but not as tightly controlled
Use extra or planned food to treat or prevent hypoglycemia	Very important	Usually not necessary
Plan regular times for meals and snacks	Very important	Yes
Use extra food for unusual exercise	Yes	Usually not necessary
During illness, use small, frequent feedings of carbohydrates to prevent starvation ketoacidosis	Important	Usually not necessary because of resistance to ketoacidosis

Food Exchange System

The dietitian uses the food exchange system to calculate a patient's energy and nutrient needs as well as to distribute foods in a balanced meal and snack pattern. The food exchange system is called this because people with diabetes use the system to select a variety of foods from the various food groups in accordance with their personal diet plans.

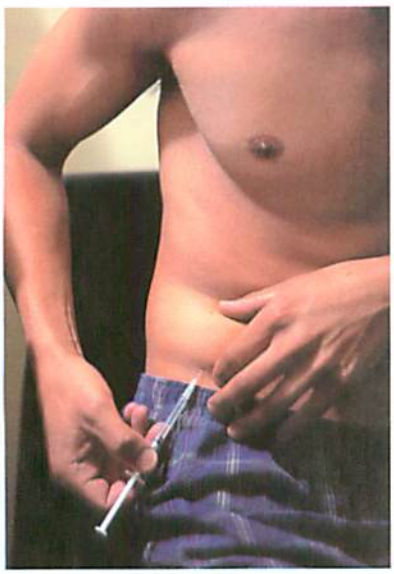


Figure 20-5 A man with diabetes injecting himself with insulin. (Copyright PhotoDisc.)

Figure 20-6 Insulin pump and monitor.

With this system, commonly used foods are grouped into basic exchange lists according to roughly equal macronutrient values in the portions indicated. Thus, a variety of foods may be chosen from these lists to fulfill the food plan while the basic diet prescription of total energy and a balanced ratio of nutrients are maintained. The designated food values for each of the food exchange groups are shown in Table 20-6. The booklet entitled "Choose Your Foods: Exchange Lists for Diabetes" is available for purchase from the Academy of Nutrition and Dietetics. Its colorful illustrations, clear content, and style provide a helpful tool for patient and client education. Table 20-7 illustrates a calculated 2200-kcal diet and food pattern example that uses the exchange system, and Box 20-5 outlines a sample menu that is based on this pattern.

Special Concerns

Special concerns come up in daily living and become an important part of ongoing dietary counseling. Some suggestions for these concerns are given in the following sections.

Special Diet Food Items. Little need exists for special "diabetic" foods. People with diabetes should eat the regular, well-balanced diet that is recommended for the general population to promote health and prevent disease. This kind of a healthful diet primarily makes use of regular fresh foods from all of the basic food groups, with the limited use of processed foods (noting the grams of carbohydrate per serving on the label) and an increased use of nonfat seasonings. The simple principles of moderation and variety should guide food choices and amounts.

Alcohol. The occasional use of alcohol in an adult diabetic diet can be planned, but caution must be exercised. Individuals with type 1 diabetes who consume alcohol must be reminded of the following: (1) to eat when they drink; and (2) to not increase their insulin doses, because the overall effect of alcohol is to lower the blood glucose level. Occasional use is defined as moderate intake: one drink or less per day for women and two drinks or less per day for men. Equivalent portions are 1 oz of liquor, 4 oz of wine, and 12 oz of beer. The same precautions for the use of alcohol that apply to the general public apply to people with diabetes.

A person with type 1 diabetes should not substitute alcohol for food exchanges in the diet. When a person's blood glucose levels begin to drop, the liver typically responds to the hormone glucagon and releases glucose into the blood to reestablish normal blood glucose levels. However, when alcohol is in the system, the liver's primary role is to detoxify the blood of alcohol, and it will not respond to impending hypoglycemia until the alcohol is cleared. Therefore, alcohol should only be consumed in moderation and in conjunction with food. Alcohol may be used in cooking as desired because it vaporizes in the cooking process and contributes only its flavor to the finished product.

Hypoglycemia. The brain depends on a constant supply of glucose for metabolism and proper function; a prolonged lack of glucose can lead to permanent brain damage. Hypoglycemia (i.e., a blood glucose level of less than 70 mg/dL) may occur from too much insulin or oral hypoglycemic agents that act by stimulating the islet cells in the pancreas to secrete more insulin. Hypoglycemia can also occur if a person with diabetes delays a meal or snack, does not eat enough carbohydrate, or exercises too much without sufficient food. Table 20-8 lists symptoms

TABLE 20-6 AMOUNT OF NUTRIENTS IN ONE SERVING FROM EACH EXCHANGE LIST

Food List	Carbohydrate (g)	Protein (g)	Fat (g)	Calories (g)
Carbohydrates				
Starch: breads, cereals, and grains; starchy vegetables; crackers and snacks; and beans, peas, and lentils	15	0 to 3	0 to 1	80
Fruits	15	—	—	60
Milk				
Fat free, low fat, 1%	12	8	0 to 3	100
Reduced fat, 2%	12	8	5	120
Whole	12	8	8	160
Sweets, desserts, and other carbohydrates	15	Varies	Varies	Varies
Nonstarchy vegetables	5	2	—	25
Meat and Meat Substitutes				
Lean	—	7	0 to 3	45
Medium fat	—	7	4 to 7	75
High fat	—	7	8+	100
Plant-based proteins	Varies	7	Varies	Varies
Fats	—	—	5	45
Alcohol	Varies	—	—	100

From the American Diabetes Association; American Dietetic Association: *Choose your foods: exchange lists for meal planning*, Chicago, and Alexandria, Va: American Diabetes Association and American Dietetic Association; 2008.

TABLE 20-7 CALCULATION OF A DIABETIC DIET USING THE EXCHANGE SYSTEM (2200 KCAL)

FOOD GROUP	TOTAL DAY'S EXCHANGES	CARBOHYDRATES: 275 g (50% kcal)	PROTEIN: 110 g (20% kcal)	FAT: 75 g (30% kcal)	BREAKFAST	LUNCH	DINNER	SNACKS	
								Afternoon	Bedtime
Carbohydrates									
Starch	11.5	172	34.5	—	3	3	3	1	1.5
Fruits	3	45	—	—	1	1		1	
Milk									
Fat free	2	24	16		1	—	—	—	1
Sweets, Desserts and Other Carbohydrates	1	15	Varies	Varies	—	—	1		
Nonstarchy Vegetables	4	20	8	—	—	2	2		
Meat and Meat Substitutes									
Very lean	2	—	14	0 to 1	—	—	—	1	1
Lean	3	—	21	9	—	—	3		
Medium fat	2	—	14	10	1	1			
Fat	11	—	—	55	3	3	3	1	1
Total grams		276	107.5	75					

of both hyperglycemia and hypoglycemia. Because behavior is often irrational and movements are uncoordinated, patients in this state may be mistaken for being intoxicated. Thus, an identification bracelet or pendant is an ideal means of informing others about the true condition so that proper treatment—glucose replacement in the form of a food or beverage or an injection of glucagon—can be given. (Note the 15-g carbohydrate replacement portions listed in the bread/cereal [starch] and fruit exchange groups [see Table 20-6].) People with type 1 diabetes should always carry a convenient form of sugar (e.g., sugar lumps or glucose tablets) with them to take at the first sign of a hypoglycemic attack and then follow this sugar as soon as possible with a snack of

BOX 20-5 SAMPLE MENU PRESCRIPTION: 2200 KCAL

- 275 g carbohydrate (50% kcal)
- 110 g protein (20% kcal)
- 75 g fat (30% kcal)

Breakfast
- 1 medium fresh peach
- 1 serving shredded wheat cereal
- 1 poached egg on whole-grain toast
- 1 bran muffin
- 1 tsp margarine
- 1 cup low-fat milk
- Coffee or tea with nonnutritive sweetener only

Lunch
- Vegetable soup with wheat crackers
- Tuna sandwich on whole-wheat bread
  - Tuna (½ cup, drained)
  - Mayonnaise (2 tsp)
  - Chopped dill pickle
  - Chopped celery
- 1 fresh pear

Dinner
- Pan-broiled pork chop (well trimmed)
- 1 cup brown rice
- ½ cup green beans
- Tossed green salad
  - Italian dressing (1 to 2 Tbsp)
- ½ cup applesauce
- 1 bran muffin

Afternoon Snack
- 10 crackers with 2 Tbsp peanut butter
- 1 medium orange

Evening Snack
- 3 cups plain popped popcorn
- 1 oz cheese
- 1 cup low-fat milk

complex carbohydrate and protein (e.g., peanut butter crackers, granola bar and yogurt, ham and cheese sandwich).

Illness. When general illness occurs, food and insulin should be adjusted accordingly. The texture of the food can be modified to make use of easily digested and absorbed liquid foods. This type of liquid substitution can be used for meals that are not eaten. In general, people with diabetes who are ill should do the following:

- Maintain food intake every day; do not skip meals.
- Do not omit insulin; follow an adjusted dosage if needed.
- Monitor the blood glucose level frequently.
- Replace carbohydrate solid foods with equal liquid or soft foods, if necessary, and drink plenty of fluids.
- Contact a physician if the illness lasts for more than 24 hours.

TABLE 20-8 SYMPTOMS OF HYPERGLYCEMIA AND HYPOGLYCEMIA

Factor	Hyperglycemia	Hypoglycemia
Cause	Too much food, not enough insulin, illness, or stress	Not enough food, too much insulin, too much exercise, or alcohol intake without food
Symptoms	Polydipsia Polyuria Polyphagia Dry or itchy skin Blurred vision Drowsiness Nausea Fatigue Shortness of breath Weakness Confusion Coma	Sudden shaking Nervousness Sweating Anxiety and irritability Dizziness Impaired vision Weakness Headache Hunger Confusion Tingling sensations around the mouth Seizure

Travel. When a trip is planned, the dietitian and client should confer to make decisions about food choices that depend on what will be available to the traveler. In general, preparation activities may include the following:

- Review meal-planning skills, the number and type of exchanges at each meal, basic portion sizes, and tips on eating out.
- Learn about foods that will be available (e.g., ordering a diabetic meal ahead from an airline).
- Select appropriate snacks to carry, and plan time intervals for their use.
- Plan for time-zone changes with regard to medication, exercise, and diet routines.
- Carry some quick-acting form of carbohydrate (e.g., sugar lumps, glucose tablets) at all times, and tell companions about the signs, symptoms, and treatment of hypoglycemia.
- Wear an identification bracelet or pendant.
- Secure a physician's letter that addresses syringes and insulin prescriptions.

Eating Out. In general, people with diabetes should plan ahead so that food that is eaten at home before and after a meal out can be accommodated to maintain the continuing day's balance. Choosing restaurants wisely also makes menu selection easier. Timing insulin doses to food arrival is important, because taking insulin too long before eating will result in hypoglycemia.

Stress. Any form of physiologic or psychosocial stress affects diabetes control because of the hormonal responses that are antagonistic to insulin. People with diabetes, especially those who use insulin, should learn useful stress-reduction exercises and activities as part of their self-care skills and practices. Stress-reducing activities can vary greatly from one person to the next (e.g., meditation, running, yoga, journaling, playing music). Finding the best coping mechanism may require trial and error.

DIABETES EDUCATION PROGRAM

Goal: Person-Centered Self-Care

During the past decade, the traditional roles of health care professionals and their patients have been changing. Patients are taking much more active and informed roles in their own health care. These actions are especially true of people with diabetes. As a result of the nature of the disease process and the necessity of daily survival skills, people with diabetes must practice regular daily self-care (see the Clinical Applications box, "Case Study: Richard Manages His Diabetes"). Thus, any effective and successful diabetes education program must focus on personal needs and informed self-care skills.

Diabetes Self-Management Education

The overall objectives of diabetes self-management education, as defined by the American Diabetes Association Standards of Medical Care, are to improve health status and quality of life by supporting informed decision making, self-care behaviors, problem solving, and active collaboration with the health care team.[23] Certified diabetes educators and the American Diabetes Association have developed guidelines for diabetes self-management education that are based on the learning needs, skills, and content areas that are necessary for the self-care of patients with diabetes.

Necessary Skills

The elements that are involved in a patient's diabetes self-management education program may involve any or all of the following content areas, depending on the specific needs of that individual.[23,24]

Healthy Eating. People with diabetes should develop a lifestyle that involves healthy eating choices that are based on individual nutrition needs, living and working situations, and food habits. Such planning includes understanding how the food plan relates to the maintenance of good blood glucose control and the promotion of positive health.

Being Active. A healthy lifestyle that includes regular physical activity is an important aspect of overall fitness, weight management, and blood glucose control. Patients can work with their health care providers to determine an appropriate activity plan and to discuss how to balance food intake with medications during exercise.

CLINICAL APPLICATIONS

CASE STUDY: RICHARD MANAGES HIS DIABETES

Richard Smith, who is 21 years old, has type 1 diabetes mellitus. He gives himself two injections per day, and each one is a combination of medium-acting insulin and regular short-acting insulin. He takes one injection before breakfast and one before dinner, and he usually tests his blood glucose level before each meal and at bedtime. Richard is a college student who is usually active in athletics.

However, this is final examination week, and Richard's schedule is irregular. He is putting in long hours of study, and he is under considerable stress. On the day before a particularly difficult examination, he is reviewing his study materials at home, and he forgets to check his blood glucose or eat lunch. During the middle of the afternoon, he begins to feel faint. He realizes that his blood glucose level is low and that an insulin reaction is imminent if he does not get a quick source of energy. He looks in the kitchen, but all he can find is orange juice, milk, a loaf of bread, and a jar of peanut butter.

Questions for Analysis

1. Which of the foods should Richard eat immediately? Why?
2. Later, when he is feeling better, Richard makes a peanut butter sandwich, pours a glass of milk, and eats his snack while he continues studying. What carbohydrate food sources of energy are in his snack?
3. Are these carbohydrate sources in a form that the cells can burn for energy? What changes must Richard's body make to these sources to get them into the basic carbohydrate fuel form?
4. What is the complex form of carbohydrate in his snack? Why is this a valuable form of carbohydrate in his diet?
5. If Richard did not take his insulin to provide the necessary control agent for metabolizing the carbohydrate, what would happen to him as the result of improper handling of fat and the accumulation of ketones?

Monitoring. The monitoring of blood glucose levels, urinary acetone levels (which indicate ketoacidosis), weight, and blood pressure is fundamental to diabetes management. This monitoring includes learning accurate self-testing procedures as well as understanding the meaning of the results and knowing what action to take in relation to food, insulin, or exercise. A variety of self-tests are now available for quick blood glucose monitoring. Small glucose testing kits can fit into purses, backpacks, and glove compartments for easy access and convenience. Some insulin pumps provide continuous interstitial blood glucose monitoring.

Medications. In accordance with their treatment plans, people with diabetes should have a thorough understanding of how their medications work and when to take them. Patients should understand the side effects, efficacy, toxicity, dosage, and effects of missed or delayed doses as well as how to store and travel with their medications. Although it is not within the scope of this book to extensively cover medications, a summary of basic information follows.

- *Insulin:* There are several types of insulin with different durations of action (Table 20-9), and there are multiple combinations of insulin use (see the For Further Focus box, "Comparative Types of Insulin"). Patients should know how insulin works in the body and how its action relates to the food plan. Learning good insulin injection technique is also an important part of the treatment plan. In addition to the standard injections, insulin can also be administered with a pump (see Figure 20-6). Newer forms of insulin-pump therapy continuously deliver insulin to the body in response to a programmed basal rate (Figure 20-7). Fast-acting insulin can then be delivered in a bolus immediately after a meal based on the number of carbohydrates that the meal contained.
- *Oral hypoglycemic agents:* Medications that stimulate insulin activity, their comparative types and effects (Table 20-10), and how to regulate them are key points that should be well understood by the patient and his or her caretakers. The Drug-Nutrient Interaction box, "Exenatide and Glucose Control," describes the action of one such hypoglycemic medication.

Problem Solving. The prevention, detection, and the treatment of acute complications require informed problem-solving skills. People should recognize the early signs of hypoglycemia and its causes and treatment. This recognition includes the following: (1) knowledge of hypoglycemia's relationship to the interactive balances among insulin, food, and exercise as the basis of the

Figure 20-7 Insulin pump with optional continuous glucose monitoring functionality. (Courtesy DexCom, Inc., San Diego, Calif.)

TABLE 20-9 TYPES OF INSULIN

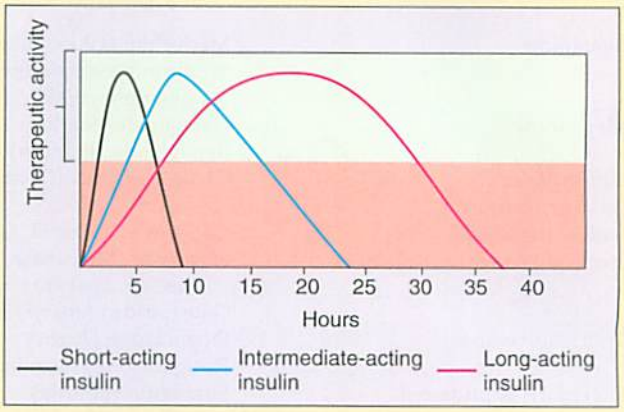
Type	Examples	Onset of Action	Peak Action	Duration of Action
Rapid acting	Humalog (Lispro) NovoLog (Aspart) Apidra (Glulisine)	<15 minutes	30 to 90 minutes	3 to 5 hours
Short acting (regular)	Humulin R Novolin R	30 to 60 minutes	2 to 4 hours	5 to 8 hours
Intermediate acting*	Humulin N (NPH) Novolin N (NPH)	1 to 3 hours	8 hours	12 to 16 hours
Long acting	Lantus (Glargine) Levemir (Detemir)	1 hour	None	20 to 26 hours

*Intermediate and short-acting mixtures are also available.
From the National Diabetes Information Clearinghouse. *Types of insulin* (website): diabetes.niddk.nih.gov/dm/pubs/medicines_ez/insert_C.htm. Accessed March 2011; and the American Dietetic Association. *ADA nutrition care manual.* Chicago: American Dietetic Association; 2010.

FOR FURTHER FOCUS

COMPARATIVE TYPES OF INSULIN

A common method of insulin use is a mixture of short-acting and longer-acting types injected twice a day (see figure). Persons with unstable diabetes or irregular mealtimes may inject short-acting insulin before each meal or snack and use a longer-acting type of insulin once or twice a day. Experienced patients self-test their blood glucose levels with finger pricks and glucose monitors. These patients have learned to adjust their insulin dosage to their test results; food patterns; work, school, and social activities; and exercise schedules. In some cases, an insulin pump that continuously delivers insulin into the bloodstream may be used to maintain better control over the body's varying insulin needs.



DRUG-NUTRIENT INTERACTION

EXENATIDE AND GLUCOSE CONTROL

Incretins are hormones that are secreted by intestinal cells in response to the presence of food. One of these incretins is known as *glucagon-like peptide 1* (GLP-1). This peptide acts by stimulating glucose-dependent insulin release by the pancreas and inhibiting glucagon secretion when glucose is present. The net effect is an overall reduction in plasma glucose.[1]

Exenatide (Byetta) is a member of the incretin mimetic class of drugs that is used for the treatment of type 2 diabetes. This drug resembles GLP-1, and it has similar effects when it is injected at mealtimes. In addition to reducing blood glucose levels, exenatide also slows gastric emptying and nutrient absorption, which enhances satiety and promotes mild weight loss. The most common side effects are nausea, vomiting, indigestion, abdominal pain, and diarrhea.[2]

The powerful interaction between exenatide and glucose is the reason for its effectiveness in the treatment of type 2 diabetes. Exenatide is shown to improve glycemic control and to reduce HbA1c by 1.0%, and it may prolong the time before insulin therapy is needed to control hyperglycemia. Patients who receive higher doses (i.e., 10 µg twice daily) are at risk for hypoglycemia, primarily when they are using exenatide with sulfonylureas.[1]

Kelli Boi

1. Norris SL, Lee N, Thakurta S, Chan BK. Exenatide efficacy and safety: a systematic review. *Diabet Med.* 2009;26(9):837-846.
2. Amylin Pharmaceuticals. *Byetta (exenatide) injection* (website): www.amylin.com/products/byetta.htm. Accessed March 2011.

diabetes care plan; (2) daily diabetic care and how to prevent such episodes; (3) the immediate emergency treatment with some form of quick-acting simple carbohydrate to counteract it; and (4) the need to follow the emergency sugar with a snack of complex carbohydrate and protein as soon as possible to sustain a normal blood glucose level. People with diabetes should learn how to deal with illness and other special needs, several of which have been discussed. This knowledge includes how to adjust one's diet and insulin intake and how to plan ahead for events of daily living such as travel, eating out, exercise, and stress.

Health Coping. Health care providers can help patients to address the psychologic and social issues that impede the patient's ability to manage his or her diabetes. Developing personal strategies to promote health and behavior changes may have significant and long-term effects on a patient's health status and quality of life. Patients should be able to identify appropriate coping mechanisms and support systems.

Reducing Risk. Prevention, detection, and a thorough knowledge of treatment options for chronic complications should be well understood by all patients with diabetes. Skills taught in diabetes self-management education programs include the following: blood glucose and blood pressure self-monitoring, smoking cessation, foot care, aspirin use, and the maintenance of personal care records.

TABLE 20-10 ORAL HYPOGLYCEMIC MEDICATIONS

Category of Medication	Examples	Action
α-Glucosidase inhibitor	Acarbose (Precose) Miglitol (Glyset)	Slows breakdown of starches, thereby delaying the rise in blood glucose that occurs after a meal
Biguanide	Metformin (Glucophage) Metformin extended release (Glucophage XR)	Suppresses hepatic glucose production
Meglitinide	Nateglinide (Starlix) Repaglinide (Prandin)	Stimulates the release of insulin from β cells
Sulfonylurea (first-generation)	Chlorpropamide (Diabinese)	Stimulates the release of insulin from β cells
Sulfonylurea (second-generation)	Glipizide (Glucotrol, Glucotrol XL) Glyburide (Micronase, Glynase PresTab, Diabeta) Glimepiride (Amaryl)	Stimulates the release of insulin from β cells
Thiazolidinedione	Pioglitazone (Actos) Rosiglitazone (Avandia)	Increases insulin sensitivity in muscle and fat
Dipeptidyl peptidase-4 inhibitor	Sitagliptin (Januvia) Saxagliptin (Onglyza)	Prevents the breakdown of hormones that increase insulin secretion and suppress glucagon production
Incretin mimetics	Exenatide (Byetta)	Improves the glucose-dependent secretion of insulin; decreases glucagon secretion after eating
Amylinomimetic	Pramlintide (Symlin)	Suppresses glucagon production

From the American Dietetic Association. *ADA nutrition care manual.* Chicago: American Dietetic Association; 2010.

Resources

A number of organizations with a wealth of health care tools are available, such as the American Diabetes Association, the Academy of Nutrition and Dietetics, and the American Association of Diabetes Educators. In addition, resources include certified diabetes educators, hospital and clinic dietitians, dietitians in private practice, public health nutritionists, and local chapters of the American Diabetes Association. Any resource materials used must be evaluated in terms of individual needs.

Staff Education

In the final analysis, the success of the diabetes education program in any health care facility depends on the sensitivity and training of the staff members who are conducting the program. Continuing education is essential for all professionals and their assistants. Certified diabetes educators are the recognized experts in diabetes education for both patient and staff training. The American Association of Diabetes Educators has a Web site at www.diabeteseducator.org where patients and health care providers can locate specialists.

SUMMARY

- Diabetes mellitus is a syndrome of varying forms and degrees that has the common characteristic of hyperglycemia. Its underlying metabolic disorder involves all three of the energy-yielding nutrients and influences energy balance. The major controlling hormone involved is insulin from the pancreas, and people with diabetes have either a lack of insulin or a resistance to its action.
- Type 1 diabetes affects approximately 5% to 10% of all people with diabetes; it usually presents itself first during childhood, and it is more severe and unstable. The treatment of type 1 diabetes involves regular meals and snacks that are balanced with insulin and exercise. The self-monitoring of blood glucose levels is a critical part of disease management.
- Type 2 diabetes occurs mostly among adults, especially those who are overweight. Acidosis is rare. Treatment involves weight reduction and maintenance along with regular exercise. Oral hypoglycemic medications or insulin may be needed.

- A significant keystone of care for all forms of diabetes is sound diet therapy. The basic food plan should be rich in complex carbohydrates and dietary fiber; low in simple sugars, fats (especially saturated fats), and cholesterol; and moderate in protein. Food should be distributed throughout the day in fairly regular amounts and at regular times, and it should be tailored to meet individual needs.
- Diabetes self-management education is a cornerstone of the overall success of patients who are managing their diabetes.

CRITICAL THINKING QUESTIONS

1. Define *diabetes mellitus.* Describe the nature of the underlying metabolic disorder. What is the common characteristic of all forms of diabetes mellitus?
2. Describe the major characteristics of the two main types of diabetes mellitus. Explain how these characteristics influence nutrition therapy.
3. Identify and explain the symptoms of uncontrolled diabetes mellitus. How would you explain to a patient the differences between hyperglycemia and hypoglycemia and how to recognize and treat these symptoms?
4. Describe the possible long-term complications of poorly controlled diabetes mellitus. Can these complications be avoided? If so, how?

CHAPTER CHALLENGE QUESTIONS

True-False

Write the correct statement for each statement that is false.

1. *True or False:* Most people with type 2 diabetes are underweight when the disease is diagnosed.
2. *True or False:* The two energy-yielding nutrients whose metabolism is most severely affected in patients with diabetes are fat and protein.
3. *True or False:* Insulin is a hormone that is produced by the pituitary gland.
4. *True or False:* Insulin action is influenced by both glucagon and somatostatin.
5. *True or False:* Acetone in the urine of a person with diabetes usually indicates that the diabetes is poorly controlled.
6. *True or False:* People with type 1 diabetes are taught to test their own blood glucose daily and to regulate their insulin, food, and exercise accordingly.
7. *True or False:* Coronary artery disease occurs in people with diabetes at a higher rate than that seen in the general population.
8. *True or False:* Chronic complications occur in a relatively small number of people with diabetes.
9. *True or False:* A diabetic diet involves a combination of specific foods that should remain constant.
10. *True or False:* People with unstable type 1 diabetes should follow a low-carbohydrate diet for better control.

Multiple Choice

1. The caloric value of the diet for a person with diabetes should be
   a. increased above normal requirements to meet the increased metabolic demand.
   b. decreased below normal requirements to prevent glucose formation.
   c. sufficient to maintain the person's appropriate lean weight.
   d. contributed mainly by fat to spare the carbohydrate for energy needs.
2. Carbohydrate counting is based on which of the following principles?
   a. Equivalent food exchange values
   b. The insulin-to-carbohydrate ratio
   c. Sucrose and fructose balance
   d. High fat content
3. Oral hypoglycemic agents are used for individuals with which kind of diabetes?
   a. Type 1 diabetes
   b. Type 2 diabetes
   c. Prediabetes
   d. All of the above
4. Which of the following conditions are potential long-term complications of uncontrolled diabetes? *(Circle all that apply.)*
   a. Retinopathy
   b. Nephropathy
   c. Neuropathy
   d. Heart disease

Evolve Please refer to the Students' Resource section of this text's Evolve Web site for additional study resources.

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FURTHER READING AND RESOURCES

American Association of Diabetes Educators. www.diabeteseducator.org

American Diabetes Association. www.diabetes.org

Diabetes.com. www.diabetes.com

National Institute of Diabetes and Digestive and Kidney Diseases. www.niddk.nih.gov

The preceding organizations are dedicated to providing the most current information about the evaluation, treatment, and prevention of diabetes. These Web sites are excellent resources for both health care professionals and patients.

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