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Contact Hours: **7**

Diabetes Mellitus, Type 2

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LEARNING OUTCOME AND OBJECTIVES: Upon completion of this continuing education course, you will demonstrate increased knowledge of evidence-based guidelines for caring for patients with type 2 diabetes. Specific learning objectives include:

- Review the underlying causes of types 1 and 2 diabetes.
- Describe the incidence, prevalence, costs, and groups at risk of developing type 2 diabetes.
- Discuss prevention strategies for patients at risk of developing type 2 diabetes.
- Describe the assessment and screening criteria used to diagnose and monitor patients.
- Review current recommendations for treating patients with type 2 diabetes.
- Describe the components of a long-term plan of care for patients with type 2 diabetes.
- Explain the necessary lifestyle modifications for patients.
- Discuss the most serious patient complications associated with type 2 diabetes and their effective treatment interventions.

WHAT IS DIABETES?

Diabetes mellitus—or, simply, diabetes—is a chronic illness in which the body is exposed to continual high levels of blood glucose, a condition known as hyperglycemia. In the short term, extreme hyperglycemia can lead to life-threatening dehydration and coma. Over the long term, hyperglycemia damages capillaries and larger blood vessels by thickening their walls and narrowing their inner diameters. This reduces the blood flow to many areas of the body and causes permanent tissue damage, notably to the retinas and the kidneys. Long-term high blood glucose levels also damage nerve endings.

- An estimated 29.1 million people, or 9.3% of the U.S. population, has diabetes.
- As many as 1 in 3 American adults will have diabetes by 2050 if present trends continue.
- Diabetes was the seventh leading cause of death in the United States in 2010, and studies further suggest that diabetes may be underreported as a cause of death. Diabetes kills more Americans annually than AIDS and breast cancer combined.
- People with diabetes have higher rates of death due to cardiovascular disease and higher rates of hospitalization for heart attacks and stroke.
- Diabetes is a leading cause of kidney failure, retinopathy, and nontraumatic lower limb amputations.
- About 9.2% of pregnancies are affected by gestational diabetes (GDM). Women who have had GDM have up to a 70% lifetime risk of developing type 2 diabetes.
- An estimated 6 million Americans use insulin.
(CDC, 2014; ADA, 2015)

Almost all forms of diabetes stem from problems in the body's production and use of insulin, the hormone that is responsible for keeping blood glucose levels in check. One cause of diabetes is the inability to produce enough insulin; for this problem, treatments range from oral medications that increase insulin secretion (e.g., secretagogues) to injections of insulin itself.

Another cause of diabetes is the inability of body tissues to respond sufficiently to normal amounts of insulin, or insulin resistance; here, the treatments include exercise, weight loss, and when needed, oral medications (i.e., insulin sensitizers) that increase tissue responsiveness to insulin.

Of the various forms of diabetes, the two most common are (ADA, 2017b):

- **Type 1 diabetes**, which is characterized by destruction of the insulin-secreting cells (beta cells) of the pancreas
- **Type 2 diabetes**, which is characterized by insulin resistance and progressively reduced secretion of insulin by beta cells

About 90% to 95% of people with diabetes have the type 2 form; 5% have type 1; and 1% to 5% have other rare types (CDC, 2014; ADA, 2015). The typical patient with type 2 diabetes is an adult who has had the disease for many years before it worsens sufficiently to cause symptoms prompting healthcare intervention.

People who do not have especially high levels of blood glucose but who do have inefficient ("impaired") mechanisms for handling blood glucose have a condition called *prediabetes*, which is identified by finding fasting plasma glucose levels elevated to the range of 100–125 mg/dl on more than one occasion (Rodwell et al., 2015; WebMD, 2016).



Currently, diabetes is incurable, and it takes daily management to prevent or delay further damage to the body. Consuming a healthy diet, participating in regular physical activity, maintaining a normal body weight, and avoiding tobacco use are ways to prevent or delay the onset of type 2 diabetes.

Diabetes can be treated and its consequences avoided or delayed with diet, exercise, medication, and regular screening for and treatment of complications (WHO, 2016). The most successful model for treating diabetes is a team effort. The patient is the daily healthcare manager, and a group of professionals—including physicians, nutritionists, nurses, and other allied health professionals—act as guides, advisors, monitors, and counselors.

History of Diabetes

Type 2 diabetes is one of the two main forms of diabetes mellitus, a disease that has been a problem during all of recorded human history. *Diabetes* is a Greek word that means “to pass through.” *Diabetes* was the name given to diseases in which a person continually drinks great quantities of fluid, which then pass through the body and are excreted as great quantities of urine. Diabetes is thus characterized by polydipsia (prodigious drinking) and polyuria (prodigious urinating).

Even in early times, two different diabetes diseases were distinguished: diabetes insipidus and diabetes mellitus. People with diabetes insipidus have symptoms of dilute, watery urine. This disease is now known to be caused most often by the insufficient secretion of ADH (antidiuretic hormone) by the pituitary. In contrast, people with diabetes mellitus produce urine that is denser than normal and that leaves crystals of sugar when the water in the urine is evaporated. Diabetes insipidus is rare, and even before the physiologic bases of the diseases were understood, when someone spoke simply of “diabetes,” they were usually referring to diabetes mellitus (Bartelmo, 2013; Durkin, 2013).

DIABETES IN THE PAST

Before the twentieth century, diabetes mellitus was usually fatal. Most often, diabetes occurred in people who were older than 50 years of age and obese. The disease came on gradually, with increasing thirst and correspondingly voluminous urination. The patient’s mouth and skin were always dry, and the breath often had a sweetish odor.

The disease progressed inexorably, bringing with it a host of problems. Eyesight failed from cataracts and nerve problems. Muscles weakened, skin infections and pneumonias were common, and people developed gangrene of the lower limbs. Diabetes led to digestive troubles, kidney disease, and heart failure. Death was usually from what was then called *diabetic coma* (now called *diabetic ketoacidosis*), which came on suddenly and was always fatal within a few days.

In the less-common cases in which children, teenagers, or young adults developed diabetes, the disease worsened much more rapidly. There were no good treatments for diabetes, although a



low-carbohydrate diet slowed the progression of the disease in some individuals with obesity who developed the disease late in life (Porter, 2013).

THE DISCOVERY OF INSULIN

By the early 1800s, pancreatic damage was recognized in autopsies of people who died of diabetes, and late in that century German scientists showed that removing the pancreas from a dog would cause diabetes in the animal. However, diabetes could be prevented in these dogs if a piece of pancreas was sewn under the dog's skin, and this suggested that the pancreas made a substance that prevented diabetes.

Attempts to extract this substance failed because the pancreas also makes a number of destructive enzymes, the presence of which in the extracts would destroy the key antidiabetes substance. In the early 1920s, the Canadian surgeon Frederick Banting and his assistant Charles Best, a medical student, devised a way to rid the pancreas of most of its destructive enzymes. From the remaining pancreatic tissue they extracted a hormone that would decrease the amount of sugar in the bloodstream and in the urine of diabetic dogs. They named this antidiabetes hormone *insulin*. Before the discovery and purification of insulin, diabetes was a fatal disease; after Banting and Best's work, diabetes became a chronic illness (MacGill, 2016).

Identifying the Two Types of Diabetes

At the beginning of the twentieth century, diabetes mellitus was considered one disease, although young people who developed the disease died much more quickly than people who first became ill in middle or old age. The new treatment with insulin, however, began to highlight a number of other differences. As early as the 1930s, clinicians found that people with diabetes could be divided into two classes according to the way they reacted to an injection of insulin.

People with insulin-sensitive diabetes (who tended to be young and prone to developing ketosis, a build-up of ketone bodies in body tissues and fluids, leading to nausea, vomiting, and stomach pain) easily disposed of an oral dose of glucose after receiving an injection of insulin. In contrast, people with insulin-insensitive diabetes (who were usually middle-aged and did not have ketotic episodes) did not significantly reduce their blood glucose levels after receiving the same amount of insulin (Porter, 2013).

TYPE 1 DIABETES

Today, insulin-sensitive diabetes is usually categorized as type 1 diabetes. In type 1 diabetes, the pancreas produces little or no insulin because the beta cells (the insulin-making endocrine cells in the islets of Langerhans of the pancreas) are not functioning. Type 1 diabetes occurs most commonly in young people, although it can occur in any age group (ADA, 2014a).



TYPE 2 DIABETES

Insulin-insensitive diabetes, on the other hand, is generally categorized as type 2 diabetes. Type 2 diabetes usually occurs in older adults, although it can occur at any age. A distinguishing feature of type 2 diabetes is that, even when there is a normal amount of circulating insulin, body tissues do not take up glucose as readily as normal. This is called *insulin resistance*, a condition in which normal concentrations of insulin in the blood produce less than the normal effects in the body (ADA, 2014a).

More than 90% of people with diabetes have the type 2 form, previously called *insulin-insensitive diabetes*, *non-insulin-dependent diabetes*, or *adult-onset diabetes*. In type 2 diabetes, the pancreas produces enough insulin to prevent ketone (a chemical produced in the liver when fat is used for energy) formation but, because of insulin resistance, not enough to prevent hyperglycemia.

Although there is a hereditary (i.e., genetic) predisposition for the disease, type 2 diabetes does not appear to have a single cause. Aging, a sedentary lifestyle, or excess intra-abdominal fat can activate or enhance a person's predisposition to develop type 2 diabetes (ADA, 2014a).

Type 2 diabetes worsens quickly if it is not treated. Both hyperglycemia and higher-than-normal circulating insulin levels (hyperinsulinemia) increase the existing insulin resistance. Hyperglycemia also injures the beta cells (the insulin-manufacturing cells) in the pancreas, and this makes it increasingly difficult for the pancreas to lower high levels of blood glucose. As these processes continue and interact with each other, the patient has more frequent and higher episodes of hyperglycemia, which over time damage the eyes, kidneys, nerves, and blood vessels (ADA, 2014a).

Incidence and Prevalence of Type 2 Diabetes

Type 2 diabetes is now considered a worldwide epidemic. The U.S. Centers for Disease Control and Prevention (CDC, 2014) estimates that over 29 million Americans have diabetes. The disease affects 9.3% of all Americans and 12.3% of those aged 20 years or older. Notably, an estimated 8.1 million Americans with diabetes are undiagnosed (ADA, 2017b). It is estimated that 1.4 million Americans are diagnosed with diabetes annually. The National Diabetes Statistics Report for 2014 reveals higher rates of diabetes among several racial and ethnic minorities compared to the general population (ADA, 2017i; CDC, 2014).

Worldwide, the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014 (WHO, 2016). Additional statistics published by the WHO offer an alarming picture of diabetes throughout the world. These data include:

- The global prevalence of diabetes among adults over 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014.
- Diabetes prevalence has been rising more rapidly in middle- and low-income countries.



- Diabetes is a major cause of blindness, kidney failure, heart attacks, stroke, and lower limb amputation.
- In 2012, an estimated 1.5 million deaths were directly caused by diabetes and another 2.2 million deaths were attributable to high blood glucose.
- Almost half of all deaths attributable to high blood glucose occur before the age of 70 years. WHO projects that diabetes will be the seventh leading cause of death globally in 2030.

Undiagnosed type 2 diabetes is thought to be common around the world; it is estimated that half of the cases remain undiagnosed (Burant & Young, 2012).

The CDC estimates that 86 million adults living in the United States have prediabetes, including 51% of those aged 65 years or older (CDC, 2014). People with prediabetes have an increased risk for developing type 2 diabetes, heart disease, and stroke.

DIABETES IN THE U.S. POPULATION

- 21 million people living with diagnosed diabetes
- 8.1 million people living with undiagnosed diabetes
- 1.7 million people aged 20 years or older newly diagnosed with diabetes in 2012
- 86 million people aged 20 years or older with prediabetes

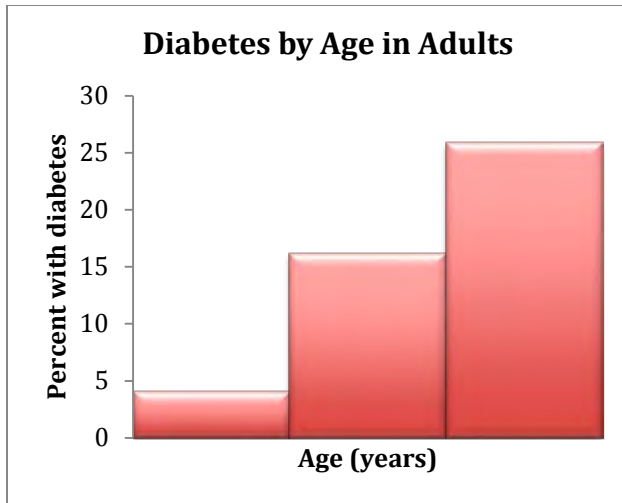
Source: ADA, 2017i; CDC, 2014.

DIABETES BY AGE AND RACE

The following information comes from results of a major national survey and was published by the CDC in 2014.

Diabetes is more common in older people. According to the CDC (2014), 11.2 million people aged 65 years or older—25.9% of all people in this age group—have diabetes.





Diagnosed and undiagnosed diabetes among people aged 20 years or older, United States, 2012. (Source: 2009–12 National Health and Nutrition Examination Survey.)

The rate of diabetes varies by race. In the United States, diabetes is more common among non-whites than whites. After adjusting for population age differences, 2010–2012 national survey data for people aged 20 years or older reveal the following prevalence rates for diagnosed diabetes:

- 15.9% of American Indians/Alaska Natives
 - 13.2% of non-Hispanic blacks
 - 12.8% of Hispanics
 - 9.0% of Asian Americans
 - 7.6% of non-Hispanic whites
- (CDC, 2014)

The CDC continues to gather data and update information regarding the incidence and prevalence of diabetes in the United States. Additional data from 2014–2016 include the following (the race groups include people of both Hispanic and non-Hispanic origin):

- From 1980 to 2014, the number of Americans with diagnosed diabetes has increased fourfold.
- Up to 25% of American adults who have diabetes do not know that they have it or that they could be developing serious complications.
- From 1980 to 2014, the age-adjusted rates of diagnosed diabetes per 100 U.S. civilian, noninstitutionalized population increased 152% for white males. For white females, the age-adjusted rates per 100 increased 116% from 1990 to 2009. Rates in this group changed little from 1980 to 1990 and from 2009 to 2014.



- The age-adjusted rates per 100 for black males increased 136% from 1980 to 2014. For black females, the age-adjusted rates per 100 changed little from 1980 to 1997 and then increased 30% from 1997 to 2014.
- From 1997 to 2014, the age-adjusted rates per 100 increased 93% for Asian males and changed little for Asian females. No data were available for Asians before 1997.
(CDC, 2016, 2015a, 2015b)

CHILDREN AND ADOLESCENTS

In the past two decades, type 2 diabetes has been reported among children and adolescents in the United States with an increasing frequency. The epidemic of obesity, the low level of physical activity among young people, and exposure to diabetes in utero may be contributing factors.

Children diagnosed with type 2 diabetes are usually between 10 and 19 years old, obese, and have a strong family history for type 2 diabetes. The prevalence of type 2 diabetes is increasing in children of all ethnic groups, however it is more commonly seen in non-white groups. American Indian children have the highest prevalence of type 2 diabetes (CDC, 2013; Dabelea et al., 2014).

Obesity and sedentary lifestyle are key factors driving the dramatic increase of type 2 diabetes in our society. If this trend continues, 1 in 3 American children born in 2000 faces the probability of developing type 2 diabetes, with increased associated comorbid conditions and early mortality (Burant & Young, 2012; CDC, 2016; Mayo Clinic, 2014a).

The increase in prevalence of type 2 diabetes among children and adolescents is a new challenge for healthcare providers and the health system to monitor and manage. New strategies for prevention, early detection, and treatment need to be developed and implemented as this new generation of patients with type 2 diabetes matures. As these patients enter the adult years, they may have unique health challenges and may be at risk for developing early complications because of the early onset of disease. This group may also have an increase in frequency of diabetes during the reproductive years, which may further increase diabetes in the next generation (Dabelea et al., 2014; Mayo Clinic, 2017b).

Costs of Diabetes

The impact of diabetes is significant in monetary terms. Costs related to care and complications of the disease are dramatic and include the following factors:

- In 2012 the total economic burden in the United States of diagnosed diabetes was \$245 billion, including \$176 billion in direct costs and \$69 billion in indirect costs (e.g. disability, early death, lost work time).
- In 2012 the cost of diagnosed diabetes, undiagnosed diabetes, prediabetes, and gestational diabetes was \$322 billion.



- People with diagnosed diabetes have healthcare costs 2.3 times higher than what expenditures would be in the absence of diabetes.
- Hospitalization rates for stroke were 1.5 times higher among adults with diabetes compared to those without diabetes.
- Diabetes is the leading cause of kidney failure, accounting for 44% of all new cases of kidney failure.
- About 60% to 70% of people with diabetes have mild to severe forms of neuropathy.
- Hearing loss is about twice as common in adults with diabetes as those who do not have the disease.
- More than 60% of nontraumatic lower limb amputations occur in people with diabetes. (ADA, 2015)

NORMAL GLUCOSE METABOLISM

Since diabetes is associated with abnormal levels of blood glucose, it is useful to understand how the body metabolizes glucose.

What Is Glucose?

Carbohydrates come in all sizes. Large carbohydrates, such as polysaccharides (e.g., starch), are chains of individual sugar molecules. The smallest carbohydrates are monosaccharides, or individual sugar molecules. Glucose, which is a small water-soluble molecule, is a monosaccharide.

Glucose is an essential molecule, but most tissues of the body can survive when there are low levels of blood glucose. The brain, however, is quite sensitive to low blood glucose, and it suffers irreversible damage if hypoglycemia lasts more than about half an hour. The dependence of the brain on continuous supplies of glucose makes it crucial that the body maintain sufficient blood glucose levels at all times (Nair & Peate, 2015).

What Is Glycogen?

Excess blood glucose is stored in the liver and muscles as long chains (polysaccharides) called *glycogens*. After a meal, insulin in the bloodstream lowers the amount of circulating glucose by encouraging its storage in the form of glycogen molecules. Between meals, liver glycogen is broken down to maintain sufficient glucose in the bloodstream, and the production of glucose from glycogen is encouraged by another pancreatic enzyme, glucagon (Adeva-Andany et al., 2016).

In this way, two pancreatic hormones—insulin and glucagon—balance the amount of glucose in the bloodstream: insulin lowers the level of plasma glucose by encouraging liver cells to take up



glucose and store it in the form of glycogen, while glucagon raises the level of plasma glucose by encouraging the liver to break down stored glycogen and release the resulting glucose molecules (Adeva-Andany et al., 2016; Khardori, 2017).

The Role of Insulin

Glucose is the primary stimulus for insulin secretion. The pancreas releases insulin in response to the blood levels of amino acids or when signaled by the parasympathetic (vagal activity) nervous system. Insulin is continuously released from the pancreas into the bloodstream. Even though insulin is rapidly destroyed within five to six minutes, the impact on body cells may last as long as 1 to 1-1/2 hours (University of California, 2017).

Insulin is the only hormone that works to significantly reduce the blood glucose level. Insulin accomplishes this by facilitating the entry of glucose into the cells, which promotes glycogenesis and stimulates glucose catabolism (Rader, 2013).

A fasting blood glucose level less than 100 mg/dL is normal. A fasting blood glucose level from 100 to 125 mg/dL is considered prediabetes. A fasting blood glucose reading of 126 mg/dL or higher on two separate tests is diagnostic of diabetes (Mayo Clinic, 2014b).

It is important to note that a number of factors can interfere with fasting blood glucose levels. These include, but are not limited to:

- Caffeine, which may cause increased levels
- Tricyclic antidepressants, antipsychotics, beta adrenergic blocking agents, corticosteroids, and diuretics, which may cause increased levels
- Acetaminophen, alcohol, anabolic steroids, monoamine oxidase inhibitors, and propranolol, which may cause decreased levels
(Pagana & Pagana, 2014)

There are many types of drugs that can affect the results of glucose testing, and the preceding list is not all inclusive. Therefore, it is important to know which drugs a patient is taking and to check if such drugs interfere with blood glucose test results.

Normal Insulin Secretion

Under normal conditions, insulin molecules bind to receptors located on the cells of the body. When activated by insulin, portals open to allow glucose to enter the cells, where it is converted to energy (Bartelmo, 2013).

In the pancreas, nests of cells referred to as islets of Langerhans contain both beta and alpha cells. The majority of the cells are beta cells, which produce and store insulin until needed. The remaining cells, alpha cells, make and store glucagon, the hormone that counteracts the effects of insulin (Healthcommunities.com, 2015).



Normally, pancreatic hormonal secretion is perfectly balanced. Beta and alpha cells monitor blood glucose levels on an ongoing basis and release insulin or glucagon as appropriate. In diabetes, however, beta cells secrete inadequate amounts of insulin (or sometimes no insulin at all). Thus, glucose is unable to enter the cells of the body, and the necessary fuel for energy production remains ineffectively in the bloodstream (Healthcommunities.com, 2015).

CAUSES OF TYPE 2 DIABETES

The etiology of type 2 diabetes is believed to be the result of complex interactions between environmental and genetic factors. The disease develops in response to a diabetes-prone lifestyle (i.e., excessive caloric intake, obesity, lack of exercise) in conjunction with a susceptible genotype.

Genetic Causes

Some aspects of all these predisposing problems are inherited, and in this way, the propensity for developing type 2 diabetes is inherited. The specific genetic causes are not known in detail for most variants of type 2 diabetes, but most cases appear to be polygenic—that is, they involve more than one inherited problem (Burant & Young, 2012).

The genetics of type 2 diabetes are not completely known. They are complex, and current evidence suggests that multiple genes in pancreatic beta cell failure and insulin resistance are involved. Specifically identified genetic variants account for about 10% of the heritable component of most cases of type 2 diabetes.

Some forms of diabetes have an evident link to genetic abnormalities. The syndrome historically known as maturity onset diabetes of youth (MODY) is now known to be a variety of defects in beta cell function. This accounts for 2% to 5% of persons with type 2 diabetes who present at a young age and have only mild disease.

Diabetes can also be found in other, more severe mitochondrial disorders such as Kearns-Sayre syndrome and mitochondrial encephalomyopathy, lactic acidosis, and stroke-like episode (MELAS). Some research also suggests that a genetically associated low birth weight increases a person's risks for developing type 2 diabetes (Kardori, 2017).

Insulin Resistance

Insulin resistance is a molecular problem in which most tissues do not respond normally to insulin in the bloodstream, whether the insulin has been secreted by the pancreas or has been administered therapeutically.

Insulin resistance is the predominant factor that leads to type 2 diabetes, gestational diabetes, and prediabetes. When the body becomes resistant to insulin, it attempts to compensate by producing



more insulin. Thus, individuals with insulin resistance are frequently producing more insulin than those who are healthy. Producing too much insulin is referred to as *hyperinsulinemia*.

Current research shows that insulin resistance can be reduced by following low-carbohydrate and ketogenic diets (Diabetes.co.uk, 2017b). Ketogenic diets are high-fat, adequate protein, and low-carbohydrate. This type of diet alters the way energy is used in the body. Fat is converted into fatty acids and ketone bodies. This helps to lower glucose levels and reduces insulin resistance. This diet has also been found to reduce the incidence of epileptic seizures (Charliefoundation.org, 2017).

EFFECTS OF INSULIN RESISTANCE

In a person with insulin resistance, a normal amount of circulating insulin produces:

- Less than the normal amount of glucose transport into cells
- Less than the normal use of intracellular glucose
- Less than the normal storage of glucose in the form of glycogen
- More than the normal release of glucose into the circulation by the liver

All people with type 2 diabetes have insulin resistance. Insulin resistance exists in a person years before the diabetes is diagnosed, and the presence of insulin resistance in an asymptomatic person predicts the high probability of developing type 2 diabetes. Although diabetes is often thought of as a disease of the pancreas, insulin resistance is a problem in the cells throughout the body that respond to insulin. Usually, it is a problem in the molecular mechanisms by which cells recognize the insulin molecule and then produce the intracellular effects of this recognition.

There are many separate molecular sites that can be the source of insulin resistance. Insulin receptors (which are in the membranes of responding cells) are complex structures made of a number of separate subunits. The malfunctioning or mutation of any of these subunits can make them work inefficiently or make them insensitive to insulin, leading to insulin resistance. Insulin resistance can also be caused by the malfunctioning of any of the components of the intracellular cascade that connects the insulin receptors in the cell membrane to the glucose-processing machinery inside the cell (Burant & Young, 2012).

EXCESS VISCERAL FAT

Intra-abdominal fat is strongly associated with insulin resistance—more so than is extra-abdominal (subcutaneous) fat. Intra-abdominal fat is visceral fat, and an overabundance of visceral fat cells both triggers and worsens insulin resistance.

About 90% of body fat is subcutaneous fat, which is the kind of fat that is felt when the skin is pinched. The remaining 10% is intra-abdominal fat, which is located beneath the abdominal muscles and can only be detected by MRI (healthliving.azcdentral.com, n.d.).





Abdominal fat distribution in the body, showing subcutaneous and various types of visceral fat. (Source: Cook A & Cowan C, Adipose (March 31, 2009), StemBook, ed. The Stem Cell Research Community, StemBook, doi/10.3824/stembook.1.40.1, via Wikimedia Commons.)

Signals within the sympathetic nervous system cause fat cells to break down and release their stored fat. Insulin gives the opposite message: insulin signals fat cells to slow or stop the release of fat. Since visceral fat cells are less responsive to insulin, having too many visceral fat cells leads to too much free fatty acid in the bloodstream, and the high level of free fatty acid eventually leads to hyperglycemia.

Hyperglycemia stimulates the pancreas to release more insulin. In this way, the excess free fatty acids have indirectly triggered, at least temporarily, higher-than-normal levels of circulating insulin (i.e., hyperinsulinemia).

If it had been subcutaneous fat cells that were releasing the excess fatty acids, the newly released insulin would turn off the tap by slowing or stopping the fatty acid release. Visceral fat cells, however, are less sensitive to insulin signals, and the feedback circuit is not very effective. When visceral fat is the source of excess free fatty acids, the natural balancing mechanisms do not work well, and the hyperinsulinemia persists. This persistent hyperinsulinemia is a direct cause of insulin resistance (Burant & Young, 2012).

FROM EXCESS FATTY ACIDS TO INSULIN RESISTANCE

1. Persistent elevation of circulating free fatty acids causes hyperglycemia.
2. Persistent hyperglycemia causes hyperinsulinemia.
3. Persistent hyperinsulinemia causes insulin resistance.

This sequence of events shown in the box above can be expressed as the formula:

Fatty acids → Hyperglycemia → Hyperinsulinemia → Insulin resistance



The sequence can be triggered by anything that causes high blood levels of free fatty acids, glucose, or insulin. Conditions that lead to insulin resistance through this mechanism include high levels of glucocorticoids (e.g., Cushing's disease or long-term treatment with prednisone), nonalcoholic fatty liver disease, and chronic elevated triglyceride levels (Burant & Young, 2012).

OBESITY

Obesity has long been associated with a risk for type 2 diabetes. Risk factors for obesity include:

- **Genetics.** Genes may affect the amount of body fat a person has and where it is distributed. Genetics may also influence how efficiently the body converts food into energy and how the body burns calories during exercise.
- **Family lifestyle.** Family members generally share similar eating and activity behaviors.
- **Inactivity.** Without adequate exercise, people take in more calories than they burn, which can lead to weight gain.
- **Unhealthy diet.** Unhealthy diets can easily lead to obesity. Such diets are generally high in calories, lack adequate amounts of fruits and vegetables, and include fast food, oversized portions, and high-calorie beverages.
- **Medical conditions.** Cushing's syndrome and/or conditions that decrease activity, such as arthritis, can lead to weight gain.
- **Medications.** Some medications that can lead to weight gain include certain classes of some antidepressants, antiseizure medications, and beta blockers.
- **Age.** As one ages, hormonal changes and a less active lifestyle can contribute to weight gain.
- **Lack of sleep.** Getting too much or too little sleep can cause hormonal changes that increase appetite.

(Mayo Clinic, 2015)

DRUGS THAT CAN CAUSE WEIGHT GAIN

- Neurologic drugs (e.g., anti-epileptic drugs such as valproate)
- Steroids (e.g., hormonal contraceptives and prednisone)
- Antidiabetic drugs (e.g., insulin)
- Antihistamines
- Beta-blockers

Source: Comerford, 2017.



DRUGS THAT CAN CAUSE WEIGHT GAIN

- Psychiatric drugs (e.g., lithium, antipsychotics such as chlorpromazine and clozapine, and antidepressants such as the tricyclics)

Because obesity puts a person at risk for type 2 diabetes, all the causes of obesity, from genes to lifestyle habits to medications, can contribute to a person's tendency to develop type 2 diabetes (Burant & Young, 2012).

IMMUNE SYSTEM ABNORMALITIES

There is now significant evidence to indicate that an overactive immune system response may actually target the beta cells of the pancreas, thus damaging these insulin-producing cells and adversely affecting insulin production. This phenomenon occurs mainly in patients with insulin-dependent diabetes and may be an indication of an autoimmune cause of the disease (HealthHype.com, 2017).

Abnormal Insulin Secretion

In addition to insulin resistance, people with type 2 diabetes have another key disorder. The beta cells in their pancreases do not secrete insulin normally. Together, insulin resistance and poorly functioning beta cells lead to the continual hyperglycemia that characterizes type 2 diabetes.

Insulin resistance means that a higher-than-normal amount of insulin in the bloodstream is needed to keep the plasma glucose levels at a normal level (<100 mg/dl). To maintain healthy blood glucose levels, the pancreatic beta cells in a person with insulin resistance are forced to secrete more than the normal amount of insulin. Therefore, people with insulin resistance generally have hyperinsulinemia.

People with type 2 diabetes have insulin resistance; therefore, they often have hyperinsulinemia. But even when they have hyperinsulinemia, the blood insulin levels are not high enough to prevent hyperglycemia. In other words, even when secreting high levels of insulin, their pancreas does not keep up with the demand. Part of the problem is that people with type 2 diabetes have fewer beta cells than normal. In addition, the existing beta cells in patients with type 2 diabetes do not secrete insulin as quickly and in as large amounts as normal.

Even before type 2 diabetes develops, beta cell problems can be detected in glucose tolerance tests, which give abnormal test results in prediabetic individuals. As with insulin resistance, beta cell dysfunction precedes the development of overt hyperglycemia by many years.

In another parallel with insulin resistance, treating type 2 diabetes can improve the functioning of the beta cells, but it cannot bring beta cell functioning up to normal. At present, both insulin resistance and beta cell dysfunction can be improved but not cured (Burant & Young, 2012).



Metabolic Syndrome

Metabolic syndrome is the name for a particular group of characteristics or health problems that are frequently found together. It is also sometimes called *insulin resistance syndrome*, or *syndrome X*.

Core problems of metabolic syndrome are obesity and insulin resistance. Three additional problems are high blood pressure, high blood levels of triglycerides, and low blood levels of high-density lipoprotein cholesterol (HDL). It is not clear whether metabolic syndrome causes type 2 diabetes, but it has been shown that having the syndrome increases a person's chances of developing type 2 diabetes and cardiovascular disease (Burant & Young, 2012).

DEFINITION OF METABOLIC SYNDROME

A diagnosis of metabolic syndrome is made if at least three of the following are present:

- Large waist circumference: A waistline that measures at least 35 inches (89 cm) for women and 40 inches (102 cm) for men
- Hypertriglyceridemia: 150 mg/dl or 1.7 millimoles per liter, or higher
- Low high-density lipoprotein (HDL) cholesterol: Less than 40 mg/dL in men or less than 50 mg/dL in women of this “good” cholesterol
- High blood pressure: 130/85 mmHg or higher
- High fasting glucose: 100 mg/dl or higher

Source: Mayo Clinic, 2016b.

CASE

George is a 40-year-old male being treated for hypertension. He arrives to the clinic for an annual physical. After stepping onto a scale, he is found to have gained 10 pounds over the previous year. His blood pressure has gradually been increasing over the past two years as well, with a current measurement of 140/88.

As his medical and family history is taken, George mentions that his mother and uncle were both diagnosed with diabetes after age 50. The nurse takes a measurement of his waist circumference, which is 105 cm (41 in).

After discussing the clinical picture with the primary care physician, a lipid panel is ordered. Three days later, the results of George's blood test show blood triglycerides of 156 mg/dl and an HDL cholesterol level of 38 mg/dl.

George is diagnosed with metabolic syndrome; he is started on an antilipemic agent and instructed on incorporating lifestyle interventions (e.g., diet, exercise) and given a referral to a



dietitian at his request. A follow-up appointment is scheduled for three months later to assess how George is doing with initial management.

When George returns for his follow-up visit, he reports that he has been following his diet and exercise plan and feels that this has made a difference in how he is feeling. He has lost 8 pounds, his blood pressure is now 124/78, his triglycerides have improved to 130 mg/dl, and his HDL cholesterol has increased to 52 mg/dl.

George continues to be motivated to make changes in order to improve his health and states that he feels better than ever. He adds that his wife has been very supportive—together they are following a Mediterranean diet for meals and exercising on a regular basis.

SCREENING AND PREVENTION

Screening for Diabetes

Testing to detect type 2 diabetes and assess risk for future diabetes in patients who are asymptomatic should be conducted for patients who are overweight or obese, or have one or more additional risk factors for diabetes, such as:

- Physical inactivity
- First-degree relative with diabetes
- High-risk race/ethnicity (e.g., African American, Latino, Native American, Asian American, Pacific Islander)
- Woman who delivered a baby weighing 9 pounds or more or was diagnosed with gestational diabetes (diabetes diagnosed during pregnancy that is not clearly overt diabetes)
- Hypertension (140/90 mmHg or higher or receiving therapy for hypertension)
- HDL cholesterol level of 35 mg/dl or lower and/or a triglyceride level of 250 mg/dl or higher
- Woman with polycystic ovarian syndrome
- A1C of 5.7% or higher, impaired glucose tolerance (IGT), or impaired fasting glucose (IFG) on previous testing (see “Laboratory Tests” later in this course)
- Other clinical conditions associated with insulin resistance (e.g., severe obesity, acanthosis nigricans [skin condition characterized by areas of dark, velvety discoloration in body folds and creases], metabolic syndrome)
- History of cardiovascular disease
(Burant & Young, 2012; NDEI, 2016)



In the absence of the above risk factors, testing for diabetes should begin at age 45 years. If results are normal, testing should be repeated at least at three-year intervals; more frequent testing should be considered depending on initial results and risk status (NDEI, 2016; NHLBI, 2015; Nettina, 2014).

Prevention and Prediabetes

People whose bodies do not handle blood sugar optimally have a condition called *prediabetes*, which places them at high risk of developing type 2 diabetes (Burant & Young, 2012). Most people with prediabetes are unaware they have it.

DEFINITION OF PREDIABETES

The diagnosis of prediabetes is made by a finding, on two different days, of either:

- Fasting plasma glucose = 100–125 mg/dl
- **or**
- 2-hour oral glucose tolerance test = 140–199 mg/dl

Source: Nettina, 2014.

SCREENING FOR PREDIABETES

The ADA recommends screening for prediabetes for all adults aged 45 and older. Testing should also be completed every three years starting at age 29 for those who are overweight (defined as a BMI >25 kg/m²) and have additional risk factors, including:

- Cardiovascular disease
- Hypertension
- High triglycerides or low HDL
- Sedentary lifestyle
- Non-white race
- Family history (first-degree relative) of diabetes
(Burant & Young, 2012; NIDDK, 2016)

Prediabetes can be recognized through the same screening tests used to diagnose diabetes. The simplest test is the fasting plasma glucose (FPG) level. In prediabetes, FPG is in the impaired range (100–125 mg/dl) in measurements taken on two different days. Alternately, an oral glucose tolerance test (OGTT) in the impaired range (140–199 mg/dl at 2 hours), again on two different days, can be used to diagnose prediabetes (NIDDK, 2016).

In addition to signaling a person's risk for developing type 2 diabetes, prediabetes warns that the person also has a higher risk for heart disease and stroke.



TREATING PREDIABETES

A program of weight loss and increased physical activity can improve the problems underlying prediabetes, and many times, lifestyle changes alone can prevent people with prediabetes from going on to develop diabetes.

Recently, a task force of experts issued a set of guidelines for people diagnosed with prediabetes. The new guidelines prompted the ADA to recommend the same cardiovascular treatment goals for prediabetes as for diabetes. These goals include:

- LDL cholesterol levels <100 mg/dl
- HDL cholesterol levels >50 mg/dl for women and >40 mg/dl for men
- Triglyceride levels <150 mg/dl
- Blood pressure measured at every routine visit with healthcare providers
- Blood pressure <140/90 mmHg (Lower systolic and diastolic blood pressure targets, such as 130/80 may be appropriate for persons at high risk of cardiovascular disease if these targets can be achieved without undue treatment burden.)

(ADA, 2017a)

In terms of what needs to be done if a person is diagnosed with prediabetes, the first step is to initiate **lifestyle changes**, including exercising and eating a healthy diet (e.g., fruits, nonstarchy vegetables, lean meats, nonfat dairy products). Data from the Diabetes Prevention Program study suggest that people with prediabetes who lose about 10% of their body weight and exercise regularly (30 to 60 minutes, 5 days per week) are 71% more likely to prevent or at least delay diabetes than those who do not adhere to these lifestyle recommendations (Burant & Young, 2012).

Additionally, people with prediabetes should not smoke and should avoid excessive alcohol consumption (i.e., no more than one drink a day for women and two drinks for men).

Antidiabetes drug therapy may be considered for patients with prediabetes who are unable to control their blood sugar with weight loss and exercise. Research shows that drugs such as metformin (Glucophage) or acarbose (Precose) can delay the onset of type 2 diabetes in people with prediabetes, but not nearly as effectively as lifestyle changes (Comerford, 2017; WebMD, 2017b).

ASSESSMENT AND DIAGNOSIS OF HYPERGLYCEMIA

The health problems of diabetes are caused directly from hyperglycemia, and the medical diagnosis of the disease is not based on its cause but rather on evidence of persistent high plasma glucose levels, regardless of the cause.



Diabetes is diagnosed in the presence of any **one** of these hyperglycemic conditions (NDEI, 2016):

- An A1C level of 6.5% or higher* (The American Diabetes Association has recommended A1C as a primary diagnostic test for diabetes.)
- A fasting plasma glucose level of 126 mg/dl or higher*
- A 2-hour plasma glucose level of 200 mg/dl or higher in an oral glucose tolerance test (OGTT)*
- A random plasma glucose level of 200 mg/dl or higher and classic symptoms of hyperglycemia or hyperglycemic crisis

* In the absence of unequivocal hyperglycemia, results should be confirmed by repeat testing.

Laboratory Tests

An initial diabetes examination screens for abnormalities and also establishes baseline values that are used to evaluate the treatment program and to follow the progress of the disease objectively. Patients with diabetes may have frequent testing to assess the effectiveness of the treatment plan and measure changes in various lab values. Nurses and diabetes educators may be the primary point of contact for discussing the results of laboratory tests as a patient's progress is tracked.

BLOOD GLUCOSE TESTS

Fasting Plasma Glucose (FPG)

Among the various measurements of the body's ability to produce and use glucose, the blood level of glucose after an 8-hour fast is the standard. After 8 or more hours without eating, the body should maintain plasma glucose levels in the range of 90–100 mg/dl. (Plasma glucose levels are also sometimes given in millimoles per liter, mmol/l.)

People whose fasting blood levels (i.e., for at least 8 hours after eating) of glucose are slightly elevated (100–125 mg/dl) are not able to use glucose optimally and are considered to have prediabetes; they also have impaired fasting glucose (IFG). When a person's fasting blood glucose levels are ≥ 126 mg/dl, the person is said to have diabetes (WebMD, 2015).

CATEGORIES OF GLUCOSE METABOLISM	
Category	Fasting Plasma Glucose Level
Normal	70–99 mg/dl
Prediabetes	100–125 mg/dl
Diabetes	≥ 126 mg/dl



Oral Glucose Tolerance Test (OGTT)

A more complicated test, the oral glucose tolerance test, can also be used to diagnose diabetes and gestational diabetes. In an OGTT, the patient drinks a sugar-water solution (75 g glucose in 300 ml water), and the plasma glucose level is measured after two hours. (For values, see the table above.) Again, high plasma glucose levels must be confirmed by a test on a second day. For an OGTT, constraints include:

- Test must be given after an overnight fast.
- Patient must have been receiving at least 150–200 g of carbohydrates daily for the three days preceding the test.
- Patient must not have an acute illness.
- Patient must not be taking medications that affect glucose tolerance, such as diuretics, contraceptive pills, glucocorticoids, niacin, or phenytoin. (Burant & Young, 2012; Pagana & Pagana, 2014)

A1C Test

The A1C test is also called the *A1c*, *hemoglobin A1c*, *HbA1c*, *glycohemoglobin*, *glycated hemoglobin*, and *glycosylated hemoglobin test*. This test is used to monitor a patient's blood glucose levels during treatment and has been adopted by the ADA as a recommended diagnostic test for diabetes (ADA, 2014a). (For patients already diagnosed with diabetes, A1C levels are also checked at each office visit to monitor the patient's progress.)

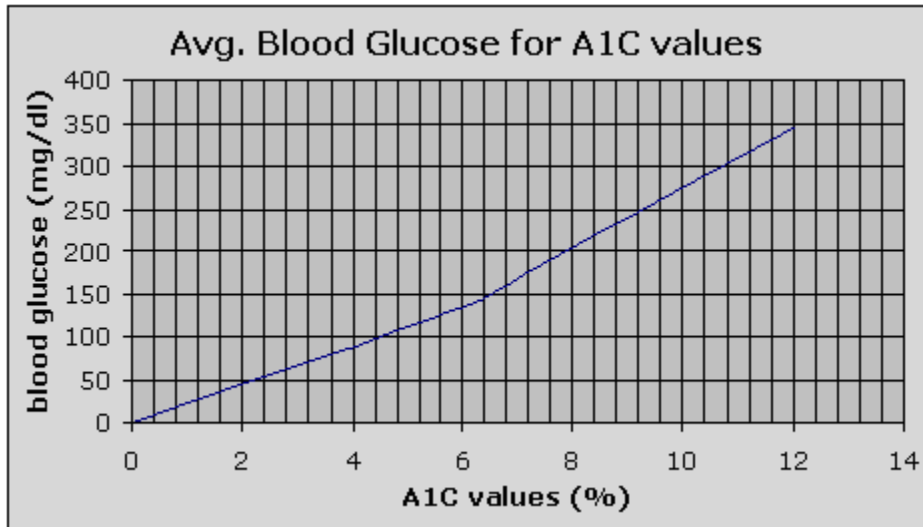
It is important for clinicians to understand A1C values and be able to explain what this level means to a patient who is diagnosed with diabetes. Overall monitoring of A1C levels is also important as an indicator for patients who are at increased risk for chronic complications of diabetes.

The A1C test measures the percent of hemoglobin to which glucose molecules have become attached (i.e., the percent of glycosylated hemoglobin). As a person's plasma glucose level rises, more hemoglobin molecules become glycosylated, a condition wherein glucose sticks indiscriminately to proteins; this is a slow process that happens more quickly when there is an excess of glucose. Red blood cells (and their hemoglobin) are replaced after about four months, and the amount of glycosylated hemoglobin at any one time reflects the average plasma glucose level over the last two to three months (ADA, 2014b; Pagana & Pagana, 2014).

The exact level of “normal” for an A1C test varies somewhat from laboratory to laboratory. Another caveat is that the A1C test can be inaccurate when the patient has genetic mutations of the hemoglobin, conditions that change the amount of red blood cells in the circulation (e.g., bleeding, hemolysis, anemia), renal failure, or alcoholism.



The following graph shows the average plasma glucose levels that are indicated by various A1C values.



The overall average blood glucose level for the past two to three months as indicated by various A1C values. (Source: Author.)

A 1% change in an A1C value reflects a change of about 30 mg/dl in average plasma glucose. Normal levels of plasma glucose produce an A1C value of about 5%. As the A1C value increases, so does the likelihood of complications.

In its latest guidelines, the AACE recommends that patients should aim for an A1C $\leq 6.5\%$, which differs slightly from the ADA's recommendation of $<7\%$ (ADA, 2014b). In other words, people with diabetes should try to keep their average blood glucose levels below 170 mg/dl. This has been shown to be a realistic goal and one that will improve the health of a wide variety of people with type 2 diabetes.

A1C values are averages, and A1C values will decrease (and therefore appear to be improved) if there are significant periods of excessively low plasma glucose levels (i.e., hypoglycemia). To ensure that it has not been artificially lowered by periods of hypoglycemia, it is important to have the patient record blood glucose readings at key times each day (e.g., first thing in the morning and two hours after meals). Also, A1C values will not reflect short swings in plasma glucose levels, as often happens with brittle diabetes (a diabetic condition in which the blood glucose level easily swings from too low to too high and back again).

To recognize hypoglycemic periods or short-term shifts in plasma glucose levels, patients should monitor their glucose levels regularly. The true level of glycemic control (using lifestyle changes and medications to avoid hyper- and hypoglycemia) can be seen best through a combination of A1C tests and daily blood glucose readings (Mertig, 2012; ADA, 2014b).

As with most diagnostic tests, a test result indicative of diabetes should be repeated to rule out laboratory error, unless the diagnosis is clear on a clinical basis (e.g., hyperglycemic crisis or classic symptoms of hyperglycemia and a random plasma glucose ≥ 200 mg/dl). Ideally, the same test should be repeated for confirmation, as this can provide a greater likelihood of concurrence. However, if two different tests (e.g., A1C and FPG) are both above the diagnostic thresholds, the diagnosis of diabetes is also confirmed. On the other hand, if two different tests produce discordant results in an individual, the test whose result is above the diagnostic threshold should be repeated, and the diagnosis is made on the basis of the confirmed test (ADA, 2014b).

CASE

Sharon is a 46-year-old woman who presents to her primary care clinic reporting excessive urination over the last two months. An A1C test is ordered, and the results indicate a level of 6.8%. Additionally, her fasting plasma glucose is measured at 128 mg/dl, and her 2-hour plasma glucose is 188 mg/dl. A repeat A1C test comes in at 7.2%, confirming a diagnosis of hyperglycemia and type 2 diabetes.

Sharon has a family history of diabetes as well as high blood pressure. The nurse meets with Sharon to provide initial education, support, and resources. The nurse reviews the importance of monitoring A1C levels and explains to Sharon that this test gives the best idea of overall glucose control. The nurse stresses that the ideal A1C level is less than 7.0%. The nurse reviews Sharon's personal goals for daily blood sugar checks as well as A1C testing every three months.

BLOOD LIPID TESTS

Dyslipidemia (i.e., an unhealthy level of blood lipids) increases a person's risk of developing a variety of health problems, most notably atherosclerotic cardiovascular disease. Type 2 diabetes is characteristically accompanied by dyslipidemia. Dyslipidemia, which is a component of metabolic syndrome and is associated with obesity, includes:

- Elevated blood levels of triglycerides
- Reduced blood levels of high-density lipoproteins (HDL)
- LDL particles that are smaller and denser than usual and contain more than the normal amounts of free cholesterol. This means the cholesterol in type 2 diabetes is more easily added to atherosclerotic plaque.

FASTING PLASMA LIPID LEVELS	
Triglycerides	Normal, <150 mg/dl
	Borderline high, 150–199 mg/dl
	High, ≥ 200 mg/dl



HDL cholesterol	Low, <40 mg/dl
	High, ≥60 mg/dl
LDL cholesterol	Optimal, <100 mg/dl
	Borderline high, 130–159 mg/dl
	High, ≥160 mg/dl

The dyslipidemia of type 2 diabetes is not always improved by simply reducing the patient’s hyperglycemia; the dyslipidemia may need direct treatment (Unger, 2013).

LIVER ENZYMES

Baseline liver function tests are important to monitor in the patient with type 2 diabetes, as most of the medications used to lower blood glucose levels are deactivated in the liver. If the liver is not functioning properly or if it later develops problems, the dosages or types of medications may need to be adjusted.

URINE TESTS

At one time, diabetes treatment was monitored by measuring the amount of glucose in the urine. Finger-stick blood glucose measurements are more sensitive and more accurate, and they have replaced urine tests for monitoring daily plasma glucose levels.

Glucose Levels

In the kidneys, glucose that is initially filtered from the blood is almost fully reabsorbed before the urine is excreted. This reabsorption is very efficient, even when there is an excess of blood glucose up to levels of about 180 mg/dl. (Reabsorption is not absolute—normal urine does contain a small amount of glucose.)

By the time measurable sugar appears in the urine, hyperglycemia is already at an unhealthy level. Nonetheless, urine testing is an easy and quick warning of mild hyperglycemia, and urine tests are sometimes used for screening. Commercial plastic or paper strips (e.g., Clinistix, Diastix, Multistix, Uristix) can be dipped in fresh urine and will change color based on the different concentrations of sugar.

Ketone Levels

Ketones are released into the blood when fatty acids are being used for energy instead of glucose. Under normal conditions no ketones are found in the urine. In persons with diabetes that is poorly controlled, massive fatty acid catabolism can occur. This catabolism is the body’s attempt to provide an energy source when glucose cannot be transferred into the cells (Pagana & Pagana, 2014). When significant amounts of ketones are found in the urine of a person with diabetes, his or her hyperglycemia is usually >300



mg/dl. Patients on insulin therapy who have not taken sufficient insulin have measurable ketones in the urine (Mertig, 2012).

Albumin Levels

Protein (albumin) leaking into the urine of a person with diabetes usually indicates kidney damage. Significant kidney damage is preceded by microalbuminuria—the presence of a small amount of albumin in the urine, an amount less than that detectable by regular reagent strips (e.g., Albustix). This early sign of diabetic kidney damage can be qualitatively recognized using specialized reagent strips (Micral-Test) or tablets (Micro-Bumintest) (Unger, 2013).

RENAL FUNCTION TESTS

Diabetes is the leading cause of end-stage renal disease. Therefore, it is important to monitor indicators of kidney function. A periodic record should be kept of serum creatinine and blood urea nitrogen levels, and a glomerular filtration rate should be calculated with each blood test.

Patient Examination

A patient examination and assessment is a team effort and may include a medical examination, a nursing assessment, as well as input from specialty care providers to rule out and diagnose any comorbid conditions that are related to diabetes. The goal of an initial evaluation is to understand the health of the patient from head to toe. For a person who has or is suspected of having diabetes, there are five specific objectives (ADA, 2017c):

- Confirm the diagnosis and classify the diabetes
- Detect diabetes complications and potential comorbid conditions
- Review previous treatment and risk factor control in patients with established diabetes
- Begin patient engagement in the formulation of a care management plan
- Develop a plan for continuing care

MEDICAL HISTORY

The key elements of a medical history include assessment of the following:

- Age and onset of symptoms of diabetes
- Family history of diabetes
- Diet and nutrition patterns, including growth and development and weight history
- Previous treatment regimens and response to therapy (laboratory values and A1C patterns)



- Previous diabetes education or nutritional counseling
- Diabetes-related complications
 - Microvascular: retinopathy, nephropathy, neuropathy (sensory/hands and feet, autonomic/sexual dysfunction, and gastroparesis)
 - Hypoglycemia awareness
 - Macrovascular: coronary heart disease, cerebrovascular disease, peripheral arterial disease
- Other endocrine-related disorders

LIFESTYLE AND SOCIAL HISTORY

On the basis of creating a plan of care for the patient with suspected type 2 diabetes, the nurse collects information about lifestyle and social history. It is also important to collect baseline information about dietary habits; therefore, an important component is to have patients write down their typical daily diet.

A practical approach for assessing educational needs is also an important consideration for healthcare professionals. The following questions may assist in collecting baseline patient education needs:

Diet Habits

- What do you eat for breakfast, lunch, and dinner?
- Do you have snacks between breakfast and lunch, lunch and dinner, dinner and bedtime? If so, what do you eat?
- What do you drink during the day?

Lifestyle and Social Habits

- How much exercise do you get each week?
- Do you smoke or have you ever smoked?

Educational Needs

- How do you prefer to learn new information?
- What information and resources have you already accessed?
- What do you know about diabetes and diabetes self-care?
- Do you have family or others who will be involved in your care?
(ADA, 2017c; Burant & Young, 2012)



PHYSICAL EXAM

The physical exam should include an assessment for signs and symptoms of diabetic complications and other problems—such as abdominal obesity or hypertension—that may compound the risks posed by diabetes. (See also “Hyperglycemia-Related Illnesses and Complications” later in this course.)

Primary components of a physical exam include the following assessments:

- Height, weight, and BMI measurements
- Blood pressure, including orthostatic measurements
- Fundoscopic exam
- Thyroid palpation
- Skin examination (acanthosis nigricans)
- Foot examination (pulses, reflexes, and sensation)

Obesity and BMI

As a broad generalization, the excess fat on people with type 2 diabetes tends to be central (in the face, neck, chest, and abdomen) rather than in the arms or legs. When there is excess intra-abdominal fat, the person has a round, “apple” shape. Intra-abdominal fat is visceral fat, which is the more dangerous type of fat. This form of obesity is associated with metabolic syndrome. A diabetic person with intra-abdominal obesity also has a high risk of developing atherosclerotic cardiovascular disease (Mayo Clinic, 2017a).

Studies have shown that simply measuring a person’s waist circumference gives a good indication of the amount of visceral fat. Waist circumference is determined by measuring around the smallest (minimal) circumference anywhere in the waist region (below the ribs and above the top margins of the hip bones). A waist circumference of >37 inches (94 cm) in men and >31.5 inches (80 cm) in women is considered a warning sign, and a circumference of >40 in (102 cm) in men and >35 in (88 cm) in women also puts a person in a high-risk category for developing cardiovascular disease (Burant & Young, 2012). A large waist circumference—one that measures at least 35 inches (89 cm) for women and 40 inches (102 cm) for men—is one of the criteria for metabolic syndrome (Mayo Clinic, 2016b).

The most commonly used measure of obesity is the body mass index (BMI). BMI has been shown to be a good indirect indication of the percentage of body fat, and it is the most commonly used measure of total body fat. It is measured using the formula:

$$\text{BMI} = \text{weight in kilograms} / \text{height in meters squared}$$

or

$$\text{BMI} = \text{weight in pounds} \times 703 / \text{height in inches squared}$$



When weight is measured in kilograms and height in meters, the BMI obesity definitions for adults are shown in the table below:

WEIGHT CLASSIFICATIONS		
Definition		BMI (kg/m ²)
Normal		18.5–24.9
Overweight		25.0–29.9
Obese	Class 1	30.0–34.9
	Class 2	35.0–39.9
	Class 3 (extreme obesity)	>40.0
Source: NHLBI, 2017.		

The ADA recommends that testing for diabetes should be considered in all adults who are overweight (BMI >25 kg/m²) and have one or more additional risk factors for diabetes.

Vital Signs

In 2013 the ADA guidelines raised the target systolic blood pressure for patients with diabetes from <130 mmHg to <140 mmHg based on evidence that there is not a great deal of additional value in reducing macrovascular and microvascular complications in aiming for the lower target, but there is an increase in risk of CAD in pushing systolic pressure lower than 140 mmHg (American Diabetes Association, 2013c).

Skin

Autonomic neuropathy can cause reduced sweating, which may make the patient’s skin (especially on the hands and feet) dry and itchy. Diabetes also can increase the patient’s risk for infections and cause delayed healing. A complete skin assessment should be completed with regular skin exams, paying close attention to the legs and feet for new injuries and any changes. Patients with diabetes may have ulcers and skin erosions, especially in places on the peripheral extremities that are bumped frequently, such as the pretibial regions and the feet. In patients using insulin, skin areas that are used as injection sites should be assessed regularly (Merck Manual, 2017).

Eyes

Patients with diabetes may develop retinopathies, cataracts, and glaucoma. Regular dilated-eye exams are important to screen and monitor for any eye complications. An exam should be performed upon diagnosis of diabetes, then repeated every year or two depending upon the results of the initial exam. To check for diabetic autonomic neuropathy, it is necessary to assess for miotic or constricted pupils with sluggish light reflexes (Merck Manual, 2017).



Mouth

Dental diseases, such as periodontal (gum) disease, are more common in people with diabetes. Regular dental exams and dental hygiene are important in the management of diabetic patients. Patients who have a very high blood sugar (over 400 mg/dl) may exhibit symptoms of ketoacidosis. Ketoacidosis gives a fruity, acetone-like odor to a person's breath (Merck Manual, 2017).

Cardiovascular System

Patients with diabetes are at increased risk for coronary artery disease (CAD) and cardiovascular disease (CVD), including an increase in the incidence of myocardial infarction (MI) and stroke. Medical management of cardiovascular risk factors is a key component for reducing risk in patients with type 2 diabetes. This includes assessment, management, and ongoing monitoring of hypertension, hyperlipidemia, and obesity.

Diagnostic testing for CAD and CVD should be considered in patients with any atypical cardiac signs or symptoms or an abnormal ECG. Patients may need to undergo additional screening with stress tests or echocardiogram (ADA, 2017a; Burant & Young, 2012).

Macrovascular problems lead to poor peripheral vascular circulation in patients with diabetes. Vascular exams, including monitoring all the peripheral pulses, provide a baseline for the patient's circulation (especially in the ankles and feet).

Extremities

In diabetes, the feet and ankles can suffer from reduced micro- and macrovascular circulation, poor healing, and peripheral neuropathy (damage to the nerves outside of the brain and spinal cord). The skin on the feet and toes should be assessed regularly for erosions, ulcers, and infections. Additionally, assessment should include checking for capillary refill under the nails of the toes and whether the patient's feet are cool and pale. The ankle and foot joints should be assessed for deformities and injuries (Merck Manual, 2017).

Nervous System

Diabetic neuropathies usually occur only after many years of hyperglycemia. Peripheral sensory and motor neuropathies injure the longest nerves first and show up in the feet before the hands. Over the years, peripheral neuropathies slowly move proximally. Sensory problems include paresthesias, numbness, and pain; motor problems include reduced deep tendon reflexes and muscle weakness (Merck Manual, 2017).



AUTONOMIC NEUROPATHY

One common complication after many years of hyperglycemia is autonomic neuropathy, which is damage to the nerves that supply the internal organs, including the heart, stomach, and intestines. A thorough review of systems can help to identify damage to the autonomic nervous system. Be sure to ask whether the patient has been having any of these problems:

- Cardiovascular: High heart rate at rest, dizziness or fainting when the patient stands suddenly, difficulty exercising
- Gastrointestinal: Difficulty swallowing, bloating, nausea, constipation, diarrhea, leaking of feces
- Genitourinary: Impotence, reduced vaginal lubrication, inability to empty the bladder, recurrent urinary tract infections
- Skin: Reduced sweating of hands or feet

Source: ADA, 2013a; Burant & Young, 2012.

Newly Discovered Hyperglycemia

Patients who do not know that they have diabetes may come to an office, clinic, or emergency department with hyperglycemia. Sometimes their hyperglycemia is discovered incidentally and with no other clues. On the other hand, these patients may have symptoms of diabetes, such as polydipsia, polyuria, weakness, fatigue, blurred vision, headache, dizziness, or dehydration. At times, such patients already have diabetic complications (e.g., coronary artery disease, peripheral vascular problems, nonhealing wounds, or recurrent skin or genitourinary tract infections). Moderate to severe hyperglycemia in a person not previously known to have diabetes may be triggered by another recent medical problem such as an acute infection or acute cardiac or kidney problems.

CASE

Carol is a 52-year-old white woman with no previous history of diabetes who presents to the clinic with mild hyperglycemia (290 mg/dl), low HDL cholesterol (33 mg/dl), and microalbuminuria. Carol appears to be overweight, and the nurse calculates her BMI to be 29 kg/m². She is also complaining of recurrent urinary tract infections (previous infections twice in the past four months).

The nurse continues the assessment by asking Carol about any classic symptoms or complications of diabetes, such as weakness, fatigue, blurred vision, headache, dizziness, or dehydration. The nurse also asks Carol about her family history of diabetes and discovers that her mother has been diagnosed with type 2 diabetes.

Based on her assessment of Carol, the nurse suspects diabetes. The nurse discusses Carol's case with the primary care physician, and diabetes clinical studies are initiated for Carol.



TREATMENT PLAN

Although the treatment plan for a patient with type 2 diabetes must be tailored to the individual patient, the usual progression begins with lifestyle interventions. Next, oral hypoglycemics are added. Finally, if needed, the treatment may be changed to include insulin therapy.

Care Management Team

Ideally, patients with type 2 diabetes are treated by a multidisciplinary team of healthcare professionals working together. The many necessary interactions with a patient among the team, especially at the beginning of therapy, should be coordinated based on each patient's individual needs.

- **Primary care provider:** Leads the team in the care and management of the patient with type 2 diabetes. Coordinates the initial diagnosis and medical recommendations for treatment.
- **Registered nurses:** Work closely with the primary care provider, patient, family, and other team members to educate and support the patient and family as the plan of care and treatment are initiated. Nursing support continues as the patient receives ongoing monitoring.
- **Dietitians:** Work closely with the patient and family to assist in educating and supporting the patient about dietary recommendations, including any special diets for weight reduction and later maintenance.
- **Ophthalmologists:** Provide specialty examinations focused on eye health, including annual fundoscopic, dilated-eye assessments.
- **Podiatrists:** Provide regular support and specialty care with assessment, evaluation, and management of foot care, including prevention and treatment strategies.
- **Dentists and registered dental hygienists:** Work closely with the patient to provide regular cleaning and hygiene, screening exams for gum and tissue changes, and treatment for dental caries.
- **Pharmacists:** Provide support and education on how to organize and administer diabetes medications, recognize precautions or interactions with other medications, and note any side effects and long-term effects of the patient's medication regimen.
- **Physical therapists:** Evaluate and create a plan to address any physical rehabilitation, functional mobility, and therapeutic exercise/activity needs, with ongoing monitoring of progress. Recommend and fit assistive devices to assist the patient with ambulation or other forms of mobility as needed.



- **Occupational therapists:** Evaluate and create a plan to address the patient's activities of daily living and assess for and recommend assistive devices.
- **Exercise physiologists:** Create and monitor the patient's plan for initiating a formal exercise plan, which may include goals for weight loss and healthy exercise habits.
- **Psychological counselors:** Address and provide support for the emotional and psychological impact of a diagnosis of diabetes, including an increased risk for depression and social isolation.
- **Diabetes educators:** Provide education, direct care, and self-management interventions for patients with diabetes and their families.

Patients with diabetes are more likely than most people without diabetes to present with a variety of comorbidities. Patients with medical complications may be referred to specialty providers, such as ophthalmologists, cardiologists, renal specialists, podiatrists, psychiatrists, and prosthetists. The team of health professionals caring for a person with diabetes should take a holistic approach to caring for their patient's health.

DIABETES EDUCATORS

Diabetes self-management may be coordinated by one or more trained professionals with specialty certification in diabetes. Diabetes educators are specialty educated and licensed and may include registered nurses, registered dietitians, pharmacists, or other specialists. Diabetes educators have the opportunity to earn two different credentials: Certified Diabetes Educator (CDE) or Board Certified-Advanced Diabetes Management (BC-ADM). The BC-ADM credential is for advanced-level practitioners.

PREGNANCY AND DIABETES

Women with diabetes who are pregnant pose special challenges and therefore require special care. During pregnancy, weight-loss programs should be terminated, oral hypoglycemic medications are contraindicated, and insulin therapy should be intensified. Congenital malformations are more common in diabetic pregnancies when the diabetes is not well controlled, and infants are often of larger-than-normal birth weight. These and other potential complications make it important for women of reproductive age with diabetes to understand the risks of a pregnancy, and their diabetes care teams should include nurse-midwives or obstetricians specializing in diabetes.

Lifestyle Changes

The primary lifestyle changes used to treat type 2 diabetes are weight loss, increased physical activity, smoking cessation, and nutrition management. Weight loss, increased physical activity, and improved diet can all reduce hyperglycemia in a person with type 2 diabetes, while weight loss and exercise are the most effective ways to reduce the insulin resistance that causes type 2



diabetes. These lifestyle changes will also improve many of the health problems that often accompany type 2 diabetes, notably obesity, hypertension, and dyslipidemia.

Changing one's lifestyle requires guidance and willpower. Losing weight takes encouragement, monitoring, and practical advice—even for people who are only mildly overweight. Moving from a sedentary pattern to a program of physical activity is also extremely challenging for patients with newly diagnosed diabetes.

Smoking worsens insulin resistance and may accelerate the onset of diabetic complications. Patients should be counseled on the medical consequences of smoking and strongly encouraged to stop smoking. Since it is often difficult for smokers to quit on their own, patients may find that formal programs that include support, counseling, and the availability of smoking cessation medications are helpful.

If lifestyle changes prove to be ineffective, antidiabetic medication may be added to the treatment plan (see “Medications” later in this course).

WEIGHT MANAGEMENT

Body weight management is critical for patients with type 2 diabetes who are overweight or obese. There is strong, ongoing evidence that modest persistent weight loss can delay the progression from prediabetes to type 2 diabetes (ADA, 2017e).

Modest weight loss is defined as a sustained reduction of 5% of one's initial body weight. Such loss has been shown to improve glycemic control and to reduce the need for glucose-lowering medications. For many persons with type 2 diabetes, weight loss $\geq 5\%$ is needed to produce beneficial outcomes in glycemic control, lipid levels, and blood pressure. Sustained weight loss of $\geq 7\%$ is optimal (ADA, 2017e).

Nutrient-dense foods such as whole grains, vegetables, fruits, legumes, low-fat dairy, lean meats, nuts, and seeds are recommended for body weight management (ADA, 2017e).

The ADA (2017g) recommends that at each patient encounter BMI should be calculated and documented in the medical record. BMI should be calculated from height and weight and be classified to determine the presence of overweight or obesity, discussed with the patient, and documented in the medical record.

DIET AND NUTRITION

The ADA recommends that nutrition therapy for patients with type 2 diabetes should be an ongoing process throughout management of their condition. To achieve weight loss and prevent excess weight gain, a multifaceted approach is needed, including nutrition interventions, physical activity, lifestyle changes, and ongoing support (Warshaw, 2012).



Carbohydrates

Research regarding the ideal amount of carbohydrate intake for persons with diabetes is inconclusive. However, monitoring carbohydrate intake and consideration of blood glucose response to carbohydrate consumption are important for improving postprandial glucose control. The literature indicates that whole-grain consumption is not necessarily associated with improvements in glycemic control in patients with type 2 diabetes (ADA, 2017e).

Patients with diabetes should be encouraged to replace refined carbohydrates and added sugars with whole grains, legumes, vegetables, and fruits. Consumption of sugar-sweetened beverages and processed low-fat or nonfat food products with high amounts of refined grains and added sugars is strongly discouraged (ADA, 2017e).

For patients taking insulin on a fixed, daily schedule, meal planning should focus on a relatively fixed carbohydrate consumption pattern with respect to both time and amount (ADA, 2017e).

Protein

To date, there is no evidence that adjusting the daily level of protein consumption will improve the health of individuals without diabetic kidney disease. Research is inconclusive regarding the ideal amount of dietary protein to optimize either glycemic control or cardiovascular disease risk. For persons who have diabetic kidney disease, dietary protein should be maintained at the recommended daily allowance of 0.8g/kg. For persons with type 2 diabetes, ingested protein may enhance insulin response to dietary carbohydrates (ADA, 2017e).

Artificial Sweeteners

When consumed in moderation, nonnutritive sweeteners have the potential to reduce overall caloric and carbohydrate intake and may be preferred to sugar (ADA, 2017e). However, research suggests that there may be some risk associated with the consumption of large amounts of such sweeteners (e.g., using nonnutritive sweeteners as substitutes for nutrient-dense foods such as milk and fruits). Patients should consult with their healthcare providers regarding use of artificial sweeteners (WebMD, 2017a; Sharma et al., 2016).

Dietary Fat

For patients who are overweight or obese, dietary fat should be watched carefully. Reducing the overall calories in a person's diet will improve the lipid profile. Reducing the amount of fat improves the lipid profile even further.



It is important to remove foods that are high in saturated fats, such as:

- Fatty meats (e.g., bacon and sausage)
- Chicken or turkey when they are eaten with the skin
- Egg yolks
- Butter
- Lard and shortening
- Hydrogenated and partially hydrogenated vegetable oils
- Cream, half-and-half, and ice cream
- Cookies, cakes, muffins, and pastries

Fat-rich foods should be replaced with foods that have high water and fiber content (e.g., fruits, vegetables, legumes, and low-fat soups) (Unger, 2013).

The ideal amount of dietary fat for persons with diabetes is a subject of some controversy. The Institute of Medicine has defined an acceptable macronutrient distribution for total fat for all adults to be 20% to 35% of energy (ADA, 2017e). When looking to achieve metabolic goals and reduce CVD risk, it is more important to monitor the type of fats consumed rather than the total amount of fat. Research shows that a Mediterranean-style eating pattern (eating primarily plant-based foods, replacing butter with healthy fats such as olive oil, using herbs and spices instead of salt, limiting red meat consumption to no more than a few times a month, and eating fish and poultry at least twice a week) can improve both glycemic control and blood lipids (ADA, 2017e).

INCREASED PHYSICAL ACTIVITY

A regular exercise program has independent metabolic effects that reduce insulin resistance in people with type 2 diabetes. It also helps lower blood triglycerides, raise blood HDLs, and reduce hypertension. Exercise immediately reduces blood glucose levels, and regular exercise reduces a person's average level of hyperglycemia (i.e., it lowers A1C values). Exercise also contributes to losing weight and to maintaining weight loss; nonetheless, exercise alone rarely leads to significant weight loss, and a reduced-calorie diet is usually necessary.

The ADA (2017e) recommends that:

- Children and adolescents with type 1 or type 2 diabetes or prediabetes should engage in 60 minutes per day or more of moderate or vigorous intensity aerobic activity with vigorous muscle-strengthening and bone-strengthening activities at least three days per week.
- Most adults with type 1 and type 2 diabetes should engage in 150 minutes or more of moderate to vigorous intensity physical activity per week, spread over at least three days per week with no more than two consecutive days without activity. Shorter durations may



be sufficient for younger and more physically fit patients.

- Adults with type 1 and type 2 diabetes should engage in two to three sessions/week of resistance exercise on nonconsecutive days.
- All adults (especially those with type 2 diabetes) should decrease the amount of time spent in daily sedentary behavior.
- Flexibility training and balance training are recommended two to three times per week for older adults with diabetes.

YOGA AND TAI CHI

Yoga and tai chi have shown positive results for patient with type 2 diabetes. Evidence supports these two forms of exercise as strategies to improve balance and peripheral neuropathy symptoms. The positive effects of tai chi include an increase in quality of life and improvements in glucose control, balance, and neuropathic symptoms. Patients in these studies performed tai chi two to three times per week for 12 weeks. Patients with neuropathy who practiced yoga also experienced an increase in nerve conduction.

Source: Whyte, 2013.

CASE

Dwayne, a 55-year-old African American male with a family history of diabetes, is referred to the clinic for a diabetes workup. He reports having to urinate two or three times a night, frequent fatigue, weight gain of seven pounds over the last month, and slight numbness in his feet. Upon examination, Dwayne is found to have a BMI of 31 kg/m², a waist circumference of 108 cm (42.5 inches), an A1C level of 6.6%, and an FPG of 130 mg/dl. Further examination reveals evidence of hypertension (140/90 mmHg), dyslipidemia (HDL 22 mg/dl), and early signs of renal dysfunction, confirming the diagnosis of type 2 diabetes.

When presented with the results of his examination, Dwayne admits to having a sedentary lifestyle; frequent consumption of fried, fatty foods and soft drinks; infrequent consumption of fruits and vegetables; and frequent snacking.

The nurse counsels him on the importance of a healthy diet, proper nutrition, and regular exercise. The nurse, when consulting with the primary care provider, suggests that Dwayne would benefit from a referral to a dietitian for development of a diet plan as well as a physical therapist to formulate a therapeutic exercise program.

The patient is also scheduled to have a consultation with his primary care provider to discuss additional strategies and new medications that may be needed to manage his high blood pressure and dyslipidemia.



Medications

At some point, the treatment for type 2 diabetes usually includes medications. People with type 1 diabetes need regular doses of insulin. Some people with type 2 diabetes also need insulin, but most people with type 2 diabetes are treated with a mix of weight loss, proper diet, exercise, and oral medications (CDC, 2014).

ORAL HYPOGLYCEMICS

When lifestyle changes are insufficient to keep A1C values low, an oral hypoglycemic medication may be added. There is currently insufficient scientific data to dictate a first choice. Metformin is usually recommended because it is generic (and therefore least expensive). It has proved to be effective when added to lifestyle changes, it can be paired with most other hypoglycemics if needed, and it rarely if ever causes hypoglycemia (Burant & Young, 2012; ADA, 2017h). Metformin should not be given to people who are being treated for heart failure (Comerford, 2017).

The addition of metformin is given a 3- to 6-month trial. If this succeeds in producing A1C values <7%, the regimen is continued and the patient is evaluated (and A1C levels are measured) every 3 to 6 months. If the 3- to 6-month trial does not lead to an A1C value <7%, the patient should continue the lifestyle changes along with additional medications (Burant & Young, 2012).

The next step in treating type 2 diabetes with medications is more individualized. When choosing an additional drug, it is useful to have records of fasting morning blood glucose levels. If these levels are low (most of them <130 mg/dl) and if A1C is >7%, it is likely that there is a significant hyperglycemic peak after meals. Therefore, the best choices for the second antidiabetes medication are usually drugs that lower after-meal glucose peaks, such as:

- An alpha-glucosidase inhibitor, which slows the absorption of glucose from the intestine
- A glinide (nateglinide or repaglinide), which lowers postprandial glucose levels
- A short-acting insulin, which lowers postprandial glucose levels

In contrast, if morning blood glucose levels are high (most of them >200 mg/dl), it is usually necessary to directly increase insulin levels. This means adding sulfonylureas, glinides, or insulin injections. Experience and detailed information about the individual patient are needed for this decision (Burant & Young, 2012).

Oral medications for treating type 2 diabetes fall roughly into six classes. The two most commonly prescribed classes are insulin secretagogues (drugs that increase insulin secretion) and insulin sensitizers (drugs that decrease insulin resistance). The lesser-used classes include alpha-glucosidase inhibitors (drugs that slow glucose absorption in the intestines), incretin-related drugs (hormones that work to increase insulin secretion), and glucagon suppressors. All the oral antidiabetic medications should be used cautiously or not at all in people with significant liver or kidney problems (Burant & Young, 2012).



Insulin Secretagogues

Sulfonylureas stimulate beta cells to release insulin. Sulfonylureas cannot be used for type 1 diabetes because the beta cells are not functioning; on the other hand, sulfonylureas are the most-prescribed drugs for the treatment of type 2 diabetes. Sulfonylureas are secretagogues, and their main adverse effect is hypoglycemia, especially in older adults (Burant & Young, 2012; Comerford, 2017).

INSULIN SECRETAGOGUES		
Sulfonylureas (Second-generation)		
Glimepiride (Amaryl)	Typically taken once daily, acts over 24 hours	Possible side effects include hypoglycemia, weight gain, nausea, skin rash
Glipizide (Glucotrol, Glucotrol XL)	Typically taken once daily, acts over 24 hours	
Glyburide (DiaBeta, Glynase)	Typically taken once daily, acts over 16–24 hours	
Meglitinides		
Nateglinide (Starlix)	Typically taken before each meal, acts quickly and briefly, blood levels peak within 1 hour, acts over a short period (<4 hours)	Possible side effects include hypoglycemia (can be severe), weight gain, nausea, back pain, headache
Repaglinide (Prandin)	Typically taken before each meal, acts quickly and briefly, blood levels peak within 1 hour, acts over a short period (<4 hours)	

Insulin Sensitizers

Metformin, a biguanide, is the classic insulin sensitizer. It counteracts insulin resistance by reducing the amount of glucose released by the liver and, to a lesser extent, by improving the ability of muscle cells to extract glucose from the circulation. Technically, metformin is antihyperglycemic, not hypoglycemic. It does not cause insulin to be released from the pancreas, and therefore, it rarely causes hypoglycemia, even in large doses (Burant & Young, 2012; Comerford, 2017).

INSULIN SENSITIZERS		
Biguanides		
Metformin (Fortamet, Glucophage, Glucophage XR)	Typically taken with meals, acts over 24 hours	Possible side effects include nausea, diarrhea, lactic acid buildup (rare)



Thiazolidinediones		
Pioglitazone (Actos)	Typically taken once daily with breakfast, acts over 24 hours (Patients with heart failure should not take pioglitazone.)	Possible side effects include liver disease, stroke, heart failure, myocardial infarction
Rosiglitazone (Avandia)	Typically taken once daily with breakfast, acts over 24 hours	

Alpha-Glucosidase Inhibitors

Alpha-glucosidase inhibitors are glucose absorption retardants that slow the digestion and absorption of glucose; this lowers the hyperglycemic peak that occurs after a meal. These drugs work locally (in the intestine) and temporarily (Burant & Young, 2012; Comerford, 2017).

ALPHA-GLUCOSIDASE INHIBITORS		
Acarbose (Precose)	Typically taken three times daily, with the beginning of each meal	Possible side effects include stomach pain, gas, diarrhea
Miglitol (Glyset)	Typically taken three times daily, with the beginning of each meal	

Incretin-Related Drugs

The incretins are gastrointestinal hormones that have a number of hypoglycemic effects, including the stimulation of insulin secretion. One type of incretin-related drug, GLP-1 receptor agonists, enhances the actions of a gut peptide called glucagon-like peptide 1, thereby mimicking incretin actions; examples include exenatide and liraglutide. The other major type, DPP-4 inhibitors, block an enzyme called *dipeptidyl peptidase 4*, which breaks down gut peptides such as GLP-1; these agents, which include sitagliptin and saxagliptin, prolong incretin actions (Burant & Young, 2012; Comerford, 2017).

INCRETIN-RELATED DRUGS		
Exenatide (Byetta)	Administered by injection twice daily, 1 hour before breakfast and dinner	Possible side effects include hypoglycemia, nausea, vomiting, headache, redness at injection site
Liraglutide (Victoza)	Administered by injection once daily	
Sitagliptin (Januvia)	Oral medication taken once daily	Possible side effects include upper respiratory infection, sore throat, headache, pancreatic inflammation



Saxagliptin (Onglyza)	Oral medication taken once daily	Possible side effects include upper respiratory infection, sore throat, headache
Linagliptin (Tradjenta)	Oral medication taken once daily	

Glucagon Suppressors

Amylin is a natural hormone that suppresses the secretion of glucagon, delays the emptying of the stomach, and decreases appetite. Pramlintide is a synthetic analogue of amylin (Burant & Young, 2012; Comerford, 2017).

GLUCAGON SUPPRESSORS		
Pramlintide (Symlin)	Administered by injection three times daily, prior to each major meal	Possible side effects include hypoglycemia, nausea, vomiting, headache, redness at injection site

Sodium-Glucose Cotransporter 2 Inhibitors

A relatively **new classification** of oral drugs is sodium-glucose cotransporter 2 (SGLT2) inhibitors. When filtering the blood, the kidneys typically reabsorb all of the filtered glucose and return it to the bloodstream. One of the main proteins responsible for this reabsorption is SGLT2. The drugs in this classification work by inhibiting the action of SGLT2, which in turn blocks reabsorption of glucose by the kidneys. This promotes glucose loss in the urine and thus lowers blood glucose levels (diabetesselfmanagement.com, 2014).

FDA-approved drugs in this classification are indicated in the table below (Comerford, 2017):

SODIUM-GLUCOSE COTRANSPORTER 2 INHIBITORS		
Canagliflozin (Invokana)	Typically taken once daily before the first meal of the day; acts about 24 hours	Possible side effects include genital fungal infections, urinary tract infections (UTIs), decline in kidney function, hypotension, and dizziness
Dapagliflozin (Farxiga)	Typically taken once daily in the morning; can be given without regard for food; acts about 24 hours	Possible side effects include dizziness, hypotension, decline in kidney function, genital mycotic infections, and UTIs



Empagliflozin (Jardiance)	Typically taken once daily in the morning; may be given without regard for food; acts about 24 hours	Possible side effects include hypotension, UTIs, genital mycotic infections, and renal impairment
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INSULIN THERAPY

When the combination of lifestyle changes and hypoglycemic agents cannot reduce A1C values below 7%, insulin therapy may be initiated. Insulin therapy often begins as an adjunct to oral therapy: an antidiabetic plus a daily bedtime injection of insulin glargine. Patients prefer simple treatment regimens, but over time, patients may require a more complex schedule of insulin injections (Burant & Young, 2012).

Over the years, the ability of pancreatic beta cells to secrete insulin continues to decrease in patients with type 2 diabetes. When the pancreas can only secrete 20% to 30% of the normal amount of insulin, a patient begins to need insulin therapy.

Typically, type 2 diabetes is diagnosed when a person has already lost about half of his or her normal insulin-producing ability, and the majority of people with type 2 diabetes begin to need insulin less than 10 years after their diagnosis (ADA, 2017b; Burant & Young, 2012).

The initial aim of insulin therapy is to increase the basal supply of insulin (i.e., that which is essential for maintaining fundamental vital activities), and this is usually done with intermediate- or long-acting insulin. Some patients may also require prandial (meal-associated) therapy with short- or rapid-acting insulin (ADA, 2017h; Burant & Young, 2012).

If A1C targets are not achieved with insulin therapy, treatment can be intensified via addition of an agent from a different drug class. The overall objective is to achieve and maintain control of blood glucose and to change interventions when therapeutic goals are not being met (ADA, 2017e; ADA, 2017h).

The idea of taking insulin injections can cause anxiety in patients, but by reducing the levels and durations of their hyperglycemic episodes, patients can delay or prevent the otherwise inevitable debilitating complications of the disease. When insulin injections are incorporated into the treatment of poorly controlled diabetes, patients feel better and report that their quality of life has improved (Burant & Young, 2012).

Types of Insulin

Three characteristics distinguish the available forms of insulin: how fast they act, when they peak, and how long they act.



Regular insulin is **short acting**. It begins acting in 30 to 60 minutes, reaches its peak of action in 2 to 3 hours, and acts for 5 to 8 hours:

- Regular insulin (Humulin R, Novolin R)

Three insulin analogues are **rapid acting**. They begin acting in 5 to 15 minutes, reach their peak of action in 1 hour, and act for 3 to 6 hours. They include:

- Insulin aspart (NovoLog)
- Insulin lispro (Humalog)
- Insulin glulisine (Apidra)

Intermediate-acting insulin begins acting in 2 to 4 hours, reaches a peak of action in 6 to 10 hours, and acts for 10 to 16 hours:

- NPH insulin (Humulin N, Novolin N)

The effects of **long-acting** insulins can last for up to a day. They include:

- Insulin glargine (Lantus) is a long-acting insulin analogue. It reaches a steady state in 2 to 3 hours, it does not have a peak of activity, and it acts steadily for 20 to 24 hours.
- Insulin detemir (Levemir) is a long-acting insulin analogue. It reaches a steady state in 3 to 8 hours, it does not have a peak of activity, and it acts steadily for 6 to 24 hours.

(Burant & Young, 2012)

To match the daily changes in blood glucose levels (i.e., high after meals and low during the night), an insulin-dependent patient must mix a variety of insulins. **Mixed injections** have a rapid onset, give two peaks, and last for 10 to 16 hours. For convenience, insulins are available in a few dual-acting, pre-mixed formulations:

- 70/30 NPH/regular
 - 50/50 NPH/regular
 - 75/25 lispro (NPH-like)/lispro (Humalog Mix 75/25)
 - 70/30 aspart (NPH-like)/aspart (NovoLog Mix 70/30)
- (Comerford, 2017)

ANTIOBESITY DRUGS

Lifestyle changes and counseling are the first steps in treating patients with obesity and type 2 diabetes. When these steps do not lead to sufficient weight loss, antiobesity medications can be



tried. Pharmacotherapy for the treatment of obesity in people with type 2 diabetes is considered safe and, when combined with lifestyle changes, can result in loss of 5% to 10% of body weight. Medications should only be used in people who have a BMI >27 kg/m² and one or more obesity-associated comorbid conditions. Each medication has risks and benefits and should be used under close medical supervision (ADA, 2017g; Burant & Young, 2012).

HERBS, SUPPLEMENTS, AND DRUG COMPLICATIONS

There are claims that multiple herbs and spices have blood glucose–lowering properties that make them helpful in the treatment of people with type 2 diabetes, and recent research suggests that there is a potential link between herbal therapies and improved blood glucose control. However, such supplements also have the potential to interact with other medications, including antidiabetic agents, thus increasing the risk of severe hypoglycemia and other complications. Herbs and other supplements should never be added to the diet without the knowledge and approval of the patient’s primary healthcare provider (diabetes.co.uk, 2017a).

Plant-based therapies that have shown, in some studies, to have antidiabetic properties include:

- Aloe vera
- Bilberry extract
- Bitter melon
- Cinnamon
- Fenugreek
- Ginger
- Okra

(diabetes.co.uk, 2017a)

CASE

Barb, a 60-year-old female patient whose type 2 diabetes had been well controlled with sulfonylurea therapy, presents with a fasting plasma glucose level of 68 mg/dl. After prompting from the nurse, Barb reveals that she has been supplementing her diet lately with aloe vera. The nurse counsels Barb that, although they may produce positive effects, natural supplements may lower blood sugar to dangerous levels when used in combination with prescribed antidiabetic medications, and their use must be closely monitored. The nurse recommends discontinuing the aloe vera until Barb’s glucose levels return to normal. The nurse also advises Barb to consult again with the clinician and/or a dietitian before resuming supplementation.

Bariatric Surgery

Lifestyle changes and medications work least often in patients who are severely obese. For these patients, bariatric surgery is an option. Surgery is considered if the patient has tried monitored dieting, exercise regimens, and medications without success. Typically, surgery is only recommended for those with a BMI ≥ 40 kg/m² (BMI >37.5 kg/m² in Asian Americans),



especially if their diabetes or associated comorbidities are difficult to control with lifestyle changes and drug therapy (ADA, 2017g).

A significant body of evidence now exists that shows that metabolic surgery achieves superior glycemic control and reduction of cardiovascular risk factors in patients with type 2 diabetes who are obese compared with various lifestyle/medical interventions (ADA, 2017g).

BARIATRIC SURGERY ACCREDITATION

The best hospitals for bariatric surgery are those that perform a significant number of the surgeries and that use a team (physician, psychologist, physical and occupational therapists, and dietitian) to treat patients. Patients making the decision to have surgery should be aware of quality and standards for centers that perform bariatric surgery.

The American College of Surgeons and the American Society for Metabolic and Bariatric Surgery combined their respective national bariatric surgery accreditation programs into a single, unified program to achieve one national accreditation standard for bariatric surgery centers: the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP). MBSAQIP accreditation is important because it provides an objective and measurable way in which a center demonstrates that it offers high-quality care to patients in the setting of a multidisciplinary team approach.

Source: MBSAQIP, 2014.

TYPES OF BARIATRIC SURGERY

Bariatric surgery assists with weight loss in two ways: restriction of the amount of space in the stomach (limiting intake of food) and malabsorption by shortening or bypassing the small intestine (reducing absorption). There are four types of bariatric surgery (Mayo Clinic, 2016a):

- **Roux-en-Y gastric bypass** (gastric bypass) is one of the most common bariatric surgical procedures, in which the surgeon creates a small pouch at the top of the stomach and attaches a narrow portion of the small intestine directly to the pouch, limiting the amount of food a person can eat as well as the amount of calories and nutrients absorbed.
- **Laparoscopic adjustable gastric banding** (lap banding) is a procedure that involves placing a band with an inflatable balloon around the upper part of the stomach. The band restricts the size of the stomach as well as narrows the opening to the rest of the stomach. A port placed under the skin in the abdominal area is connected and used to inflate or deflate the band to adjust the size. This procedure restricts the amount of food intake, with an early feeling of fullness.
- **Sleeve gastrectomy** (gastric sleeve) is a procedure involving the surgical removal of a section of the stomach. The remaining part of the stomach is formed into a smaller tube-like structure. The smaller stomach restricts the amount of food intake and decreases the production of ghrelin (a hormone that regulates the appetite).



- **Duodenal switch with biliopancreatic diversion** begins with the removal of a large part of the stomach, leaving the connection to the first part of the small intestine (duodenum). The middle section of the small intestine is closed off and reattached to the end of the intestine, allowing the bile and pancreatic juices to flow normally. As a result, the patient has a smaller stomach, restricting food intake as well as limiting absorption because food bypasses most of the small intestine.

POST-SURGICAL CARE

Clinical guidelines have been developed for nutrition care after bariatric surgery, with an emphasis on detection and management of complications such as vitamin and mineral deficiencies, osteoporosis, and hypoglycemia. The goals of nutrition care after surgery are to provide adequate energy and nutrition to support lean body mass during extreme weight loss, support tissue healing, and encourage foods and liquids that maximize weight loss and promote weight maintenance while minimizing side effects of reflux, dumping syndrome, and early satiety (Franz & Evert, 2017).

After surgery, life-long lifestyle support and medical monitoring is necessary. Physical therapists and occupational therapists are an integral part of the rehabilitation team supporting patients in the postoperative and recovery period. Early mobilization, with assistance from occupational therapists who teach activities of daily living and physical therapists who create and monitor a regular exercise and strengthening program, is an important part of long-term recovery (ADA, 2017g).

LONG-TERM DIABETES MANAGEMENT

After 6 to 12 months of implementing and modifying an initial treatment plan, the frame of a long-term program takes shape. Patients have a schedule of regular visits with their physician and with other members of the diabetes care team. At each visit, the team reviews patient outcomes including A1C values, daily blood glucose records, and the development and/or progression of diabetic complications, as well as offers support and help with problems in daily healthcare routines. When lab values or the clinical picture suggest the treatment routine needs to be changed, the patient meets with the healthcare team more frequently until optimal health outcomes are again stabilized.

Patient Education for Self-Management

The overall treatment plan for a person with diabetes includes a patient education program. The patient is the frontline member of the treatment team and must understand and believe in his or her particular plan.

Patient education is an entire program of its own, with trained educators who meet with the patient regularly and who are available for questions between visits (ADA, 2017e; Burant & Young, 2012). The diabetes nurse educator is an important member of the healthcare team.



Additionally, the American Association of Diabetes Educators provides the names of local diabetes educators and contact information for education programs throughout the country.

TOPICS FOR PATIENT EDUCATION

- The basics of how diabetes affects the body
- How to make decisions about what and when to eat
- Why a regular exercise program is important
- How to match medications to eating and exercising schedules
- How to take care of the feet
- How to monitor blood glucose levels
- What to do when contracting another illness (e.g., the flu)
- Symptoms of hypoglycemia, situations most likely to cause it, and how to treat it
- Symptoms of hyperglycemia, situations most likely to cause it, and what to do if it occurs
- How to delay or prevent major complications of diabetes
- How diabetes affects one's reproductive life
- Community agencies available for help and information
- When, and under what circumstances, patients should call their healthcare providers

Source: Mertig, 2012.

HOME BLOOD GLUCOSE MONITORING

A key part of the patient education program is teaching patients how to check their blood glucose levels. Patients measure their blood glucose levels for two reasons:

- It provides a detailed record so that the healthcare team can recommend adjustments to meals, exercise, or medications.
- It gives the patient immediate feedback on how daily routines are affecting blood sugar levels.

Monitoring Frequency and Schedule

All patients with diabetes should check their blood glucose levels at a variety of times. This makes the abstract values more meaningful to the patient. It also builds a detailed record of the daily variation of glucose levels, which is especially useful while the initial treatment



plan is being adjusted. Moreover, if patients watch their blood glucose levels over an extended period of time, they will learn to recognize the feeling of hypoglycemia and help to distinguish it from other uncomfortable sensations.

The frequency with which a patient checks glucose levels is an individualized determination. Patients beginning insulin therapy are usually asked to monitor their blood glucose level 4 times a day until an optimal regimen of meals, exercise, and injections is established. After they have established a stable pattern, patients can reduce the number of blood tests to 2 or 3 times a day. Patients are advised to test their glucose level more frequently when their life pattern changes, when they get symptoms of hypoglycemia, or when they develop another illness.

Patients with type 2 diabetes who do not take insulin usually settle into a schedule of checking blood glucose levels once a day. Typically, they are asked to vary the test time so that within each week they check levels:

- First thing in the morning
- Before lunch
- Before dinner
- 1 to 2 hours after each meal
- Before going to sleep

(Mertig, 2012)

Occasionally, patients should set an alarm and check their blood glucose level in the middle of the night. In addition, they should measure their blood glucose level when they get symptoms of hypoglycemia and when they develop another illness.

In all cases, patients should be given a target range of glucose values and told to report by telephone or email to a member of their diabetes team when a home test value falls out of the range. Patients are also instructed to bring a log of all the interim blood glucose values to each office visit (Mertig, 2012).

Continuous glucose monitoring (CGM) measures interstitial glucose and includes sophisticated alarms. The FDA has not yet approved these devices as a sole device to monitor glucose. CGM requires calibration with a self-monitoring blood glucose (SMBG) level, and SMBG is still necessary to make treatment decisions (ADA, 2017d).

Using Handheld Glucose Meters

Blood glucose meters are pocket-sized, handheld electronic devices. Most home meters measure the glucose concentration in a drop of whole capillary blood from a finger prick (some blood glucose meters also work with blood from other sites, such as the forearm or palm area below the thumb). Clinical laboratories, however, measure the glucose concentration in plasma from venous blood. Glucose is about 15% more concentrated in



plasma than in whole blood. The newer home meters make this correction, so the home numbers can be compared directly to the published standards.

Blood glucose meters must be calibrated occasionally to ensure the reliability of their readings. One method for checking the accuracy of patients' meters is to ask them to bring their meter with them each time blood is being drawn for a laboratory test. The patient takes a reading using the home meter within 1 to 2 minutes of when the lab technician draws a blood sample. In this way, the meter's reading can be compared directly with the laboratory test result.

Home testing supplies come with a variety of features, and they are changing and improving continually. The American Diabetes Association publishes an updated "Consumer Guide" in their magazine *Diabetes Forecast* that provides the latest updates on blood glucose testing meters and equipment, consumer health applications (apps), oral hypoglycemics, insulins, insulin delivery devices, and hypoglycemic treatments used by people with diabetes.

ADDRESSING HYPOGLYCEMIA RISK

It is important to educate patients with type 2 diabetes who are on insulin therapy about hypoglycemia, which is its most serious risk. Hypoglycemia can cause unconsciousness and, if not corrected by the addition of glucose to the bloodstream, can eventually be fatal. A very low blood glucose level (<10 mg/dl) begins causing irreversible brain damage in as little as 30 minutes.

As a rule, hypoglycemia is less a risk for people with type 2 diabetes than for those with type 1 diabetes, but it still occurs. All diabetes patients should learn to recognize the symptoms of hypoglycemia. Initially, patients and their family members/significant others should test their blood glucose levels in different situations to compare their subjective sensations with the actual glucose levels. They should also occasionally check blood glucose levels in the middle of the night to make sure they are not getting too hypoglycemic while sleeping.

Causes and Symptoms

For people on insulin therapy, missing a meal or exercising vigorously are the most common causes of hypoglycemia. Patients with type 2 diabetes who take antisympathetic drugs, such as beta-blockers, should be warned that these medications blunt the symptoms of hypoglycemia, making a potentially life-threatening situation less obvious.

Health professionals monitoring patients with type 2 diabetes who engage in significant physical exertion need to recognize the following symptoms of hypoglycemia:

- Weakness
- Shakiness
- Dizziness
- Faintness



- Feeling warm
 - Sweating
 - Increased heart rate
 - Increased respiratory rate
 - Hunger
 - Headache
 - Irritability
 - Mood swings
 - Confusion
 - Pale skin
 - Blurred vision
 - Seizures and coma
- (Mertig, 2012)

Treatment

Sugar is the treatment for hypoglycemia. Patients are told to take 15 g of glucose (1/2 cup of fruit juice, five small pieces of hard candy, or three standard glucose tablets) if they report symptoms of hypoglycemia. If the symptoms persist for more than 10 to 15 minutes, they should repeat the 15-g dose of sugar. If both doses do not improve the symptoms, the patient should go to a physician, clinic, or hospital for care (Mertig, 2012).

All patients who take critical medications such as insulin or insulin secretagogues should carry medical identification, such as a Medic-Alert tag. Patients on insulin therapy are also given specific instructions about how to handle hypoglycemic episodes. These patients should always have with them tablets of sugar or hard candy. At home, they should have an emergency glucagon kit, and family and friends should be taught how and when to give an intramuscular injection of glucagon (Durkin, 2013; Mertig, 2012).

Monitoring Blood Glucose Levels

An important aspect of managing type 2 diabetes is establishing blood glucose targets and monitoring blood glucose levels. Two sets of data are used to review a patient's glycemic control: A1C values and daily blood glucose records.

The **A1C values** show the average level of hyperglycemia in the preceding two to three months. (See graph earlier in this course to translate A1C values into average blood glucose levels.) The target for adults with diabetes is an A1C of <7%, or about 170 mg/dl. Although the ideal would be an A1C of <7%, it is difficult for most people with diabetes to get these low A1C values without having significant periods of hypoglycemia (ADA, 2017d; Burant & Young, 2012).



In addition to following A1C values, the patient's **daily glucose levels** are reviewed regularly. Patients whose blood glucose values are close to the targets should be re-examined every six months. Patients whose blood glucose values are out of the target range or whose medications have changed are re-examined every three months.

Monitoring for Complications

People with type 2 diabetes are at risk for developing cardiovascular disease; therefore, **blood pressure and lipid profiles** are monitored. Over time, elevated blood glucose can damage cardiovascular blood vessels, which in turn impedes cardiovascular blood flow and increases the risk for cardiovascular disease. Target goals for blood pressure and cholesterol are:

- Blood pressure <130/80 mmHg
- Fasting plasma LDL-cholesterol <100 mg/dl
- Fasting plasma HDL-cholesterol >40 mg/dl in men, >50 mg/dl in women
- Fasting plasma triglycerides <150 mg/dl

The **liver** is the major site of the degradation of most antidiabetes drugs, including insulin. Liver dysfunction can lead to abnormally high or prolonged levels of these drugs in the blood; thus, liver function should be monitored by checking liver enzymes periodically.

Kidney damage is a classic complication of diabetes. When the small blood vessels in the kidneys are damaged due to elevated glucose levels, the kidneys are damaged and cannot function properly. Thus, the body retains more sodium and water, and waste materials build up in the blood. Among the values to be monitored are serum creatinine levels and urine albumin levels. Estimates of glomerular filtration rates (GFR) should be calculated from the creatinine values.

At each visit, the patient's **feet** should be assessed for tissue or joint damage and the ability of the feet to sense stimuli.

The blood vessels of the retina in patients with diabetes can be injured because of elevated blood glucose levels. This increases the risk for eye problems in these patients. People with diabetes therefore need regular **eye** exams to check for glaucoma, cataracts, and retinal damage. An annual dilated-eye examination provides the best information about the health of each eye and an indication of total vascular health.

Long-Term Exercise Management

For exercise to have a substantial role in treating diabetes, the activities must be regular and long-term. Therefore, exercise must fit realistically into the patient's life. Duration and frequency of exercise is important in order to improve and maintain glycemic control along with weight management. Recommendations for people with type 2 diabetes are to include physical activity



at least three days a week with no more than two consecutive days without exercise (ADA, 2017e; Burant & Young, 2012).

Many patients with type 2 diabetes have lived sedentary lives before the time of their diagnosis. For this group of patients, an exercise schedule begins gradually, with short regular walks or brief exercise sessions according to individual tolerance. Over time, the length and intensity of the exercise sessions are increased. Depending on each patient’s individual functional status and exercise needs, progress may be monitored by an exercise physiologist, physical therapist, and/or occupational therapist.

EXERCISE AND BLOOD GLUCOSE MONITORING

Patients with type 2 diabetes may need to monitor their blood glucose levels to assess for any fluctuations that occur with exercise. Exercise is contraindicated if the patient is experiencing hypoglycemia (glucose level of <70 mg/dl) or hyperglycemia (glucose level >300 mg/dl). The patient is instructed to monitor blood glucose levels and plan according to the following recommendations.

EXERCISE AND BLOOD GLUCOSE MONITORING		
Blood Glucose	Action	Additional Suggestions
70–100 mg/dl	Carbohydrate snack	15 g of carbohydrate snack for every hour of intense exercise
100–300 mg/dl	Proceed with exercise	Blood glucose levels should be rechecked after exercise to see if there is an improvement in levels.
>300 mg/dl and on oral medications	Try 10–15 minutes of exercise	If blood glucose rises, stop exercise. If blood glucose drops, continue with exercise and recheck blood glucose every 10–15 minutes.
>300 mg/dl and on insulin	Check for ketones (urine dip stick)	If positive for ketones, avoid exercise. If ketones are negative, participate in exercise with close blood glucose monitoring.
Source: ADA, 2013b.		

EXERCISE AND DIABETIC COMPLICATIONS

The diabetes team screens each patient for health problems that must be accommodated in the exercise program. Very few problems preclude adding more physical activity to the daily life of a person with diabetes, but certain problems put special constraints on those activities.

Insulin or insulin secretagogues. An exercise session uses up circulating glucose. If a patient takes insulin or insulin secretagogues, their effect may suddenly be too much for the lowered level of blood glucose during exercise. In this case, the person becomes hypoglycemic. The



general solution is for people who take insulin or insulin secretagogues to eat additional carbohydrates before exercising.

Cardiovascular disease. Before a sedentary patient with diabetes and cardiovascular risks starts a new exercise program, the patient undergoes a medical exam, including a stress test to assess cardiac function. This may not be needed for young, otherwise healthy people with diabetes. If the test shows cardiovascular problems, it is still possible to create a gradually increasing exercise plan, with the patient warned not to overexert and to watch for symptoms of angina, including chest, jaw, or arm tightness or pain and palpitations or shortness of breath.

Hypertension. The general rule is to bring a patient's blood pressure into a healthy range before initiating an exercise program.

Retinopathy. Proliferative diabetic retinopathy (damage to the retina) or severe nonproliferative retinopathy puts a patient at risk for vitreous hemorrhages or retinal detachment. There is controversy over whether vigorous exercise can cause these problems, therefore the patient should be examined by a retinal ophthalmologist before adding exercise into the management plan for those with diabetic retinopathy.

Peripheral neuropathy. A patient who lacks the ability to fully sense injury to the feet, ankles, and legs can damage skin and joints without realizing it. Peripheral neuropathy can often affect balance and equilibrium. Therefore, diabetic patients with peripheral neuropathy work with a physical therapist or exercise physiologist to incorporate an individualized plan of care for rehabilitation. Patients with significant peripheral neuropathy should not participate in strenuous exercise such as prolonged walking, treadmill use, jogging, or step exercise (Tabloski, 2014).

Autonomic neuropathy. Damage to the autonomic nervous system can cause reduced or inappropriate responses to exercise. Patients with diabetes who have autonomic neuropathy are given a thorough cardiac examination before beginning a new exercise program.

CASE

Brian is a 53-year-old male patient who is being treated for newly diagnosed type 2 diabetes, hypertension, and dyslipidemia. He has been referred for an initial evaluation with the physical therapist due to several recent falls that occurred at the factory where he is employed.

In the initial patient interview, Brian states that he has fallen on the job at least five times during the past six months. Two falls occurred when he tripped over a large wooden crate and three occurred when he may have tripped on something but "wasn't sure what." In addition to describing the falls, Brian also complains of slight numbness, tingling, and decreased sensation in his feet over the past several months. He states that he has not exercised regularly for over ten years, but that he previously enjoyed playing basketball and golf.

Brian tells the therapist that he understands the importance of overall fitness in helping him to best manage his diabetes and that he would like to be able to be more active in the activities that he used to enjoy. He states that he has been hesitant to participate in sports, however, due



to fear of falling. Brian describes his goals for physical therapy as being able to perform his job without fear of falling and to find meaningful and enjoyable fitness activities for himself.

The physical therapist completes an initial evaluation of his functional status, which reveals the following pertinent objective information about Brian:

- Range of motion and manual muscle testing within functional limits for upper and lower extremities
- Berg Balance score of 37/56, indicating significant compromise of static and dynamic balance
- Ability to stand on his right foot for 7 seconds without losing balance and on his left foot for 3 seconds before losing balance
- Ability to maintain Romberg position for approximately 25 seconds before losing balance
- Inability to maintain sharpened Romberg position without external support
- Decreased proprioception at both ankles and diminished two-point discrimination on the plantar surfaces of both feet
- Frequent loss of balance when attempting to walk on uneven or soft surfaces

Together, the physical therapist and Brian develop the following goals to address both his current functional deficits and his long-term personal objectives:

Short-Term Goals

- Brian will be independent and compliant with a home exercise program that addresses static and dynamic balance, skin inspections to both feet, and proprioceptive activities.
- Brian will improve his Berg Balance score by at least 3 points.

Long-Term Goals

- Brian will demonstrate a Berg Balance score of 49 or above to ensure that he is safe with independent ambulation and at minimal risk of falling.
- Brian will demonstrate consistently safe ambulation over all surfaces (including soft, uneven, or sloped surfaces) without loss of balance.
- Brian will successfully navigate his work environment without loss of balance or falls for a period of 30 days.
- Brian will be independent and active in a long-term plan of preferred fitness activities for which he has been medically cleared for participation (such as swimming, water polo, walking, or cycling) in order to optimize his overall activity and fitness level as a component to helping him most effectively manage his medical condition.



The physical therapist recommends a plan of care to include outpatient physical therapy two times weekly for a period of four to six weeks in order to address static and dynamic balance training, proprioceptive activities, training in foot inspections, workplace and community safety awareness training, and structuring and tailoring of an overall, long-term fitness plan.

Long-Term Nutrition Management

The American Diabetes Association and the American Dietetic Association make available many detailed recommendations about healthy eating for people with diabetes. Frequently, however, it is necessary for diabetes educators to translate the recommendations into terms that are practical and understandable for individual patients. For this task, a diabetes treatment team needs trained dietitians or nutritionists.

For all types of diabetes, a fundamental part of treatment is controlling the composition and quantity of meals. People with type 2 diabetes who take fixed doses of insulin or insulin secretagogues must strictly schedule their meals and their medications to avoid periods of hypo- and hyperglycemia. For these people, as with people who have type 1 diabetes, counting carbohydrates and using exchange lists are important parts of their daily eating plan.

Most people with type 2 diabetes do not take fixed doses of insulin. For these people, the top priority of a proper diet is striking a balance that minimizes hyperglycemia, encourages weight loss (when needed), reduces dyslipidemia, and lowers blood pressure. These goals can be accomplished when the person's meals have reduced calories, low saturated and trans fat, low cholesterol, and low amounts of sodium, with an appropriate overall mix of carbohydrates, fats, and proteins. Detailed carbohydrate counting of each meal is not necessary (Franz & Evert, 2017).

There is no exact mix of nutrients that comprises the optimal diet for people with type 2 diabetes. The recommended balance for all healthy adults is also the best guide for people with diabetes; however, when building a diet with this overall mix of macronutrients, there are some special recommendations for people with type 2 diabetes.

HOW TO READ FOOD LABELS

The "Nutrition Facts" label is required by the U.S. Food and Drug Administration (FDA) on most packaged foods and beverages. The label provides detailed information about a food's nutrient content, such as the total amount of calories, serving size, and amount and kinds of fat, sodium, fiber, and other nutrients. Knowing how to read food labels is especially important for patients with diabetes who need to follow a special diet. It also makes it easier to compare similar foods to decide which is a healthier choice.



Nutrition Facts
Serving Size 1 cup (228g)
Servings Per Container about 2

Amount Per Serving
Calories 250 Calories from Fat 110

	% Daily Value*
Total Fat 12g	18%
Saturated Fat 3g	15%
Trans Fat 3g	
Cholesterol 30mg	10%
Sodium 470mg	20%
Total Carbohydrate 31g	10%
Dietary Fiber 0g	0%
Sugars 5g	
Proteins 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	4%

* Percent Daily Values are based on a diet of other people's misdeeds.
Your Daily Values may be higher or lower depending on your calorie needs:

	Calories: 2,000	2,500
Total Fat	Less than 65g	80g
Saturated Fat	Less than 20g	25g
Cholesterol	Less than 300mg	300mg
Sodium	Less than 2,400mg	2,400mg
Total Carbohydrate	300g	375g
Dietary Fiber	25g	30g

1 Serving Size
2 Amount of Calories
3 Limit these Nutrients
4 Get Enough of these Nutrients
5 Percent (%) Daily Value
6 Footnote with Daily Values (DVs)

For educational purposes only. This label does not meet the labeling requirements described in 21 CFR 101.9.

Nutrition Facts label. (Source: U.S. Food and Drug Administration.)

The following tips can help patients with diabetes read and understand food labels:

1. Start by reading the **servicing size** and the number of servings in the package. Serving sizes are standard, making it easier to compare similar foods. Serving sizes are usually listed in common terms, such as cups or pieces, as well as in metric amount (e.g., grams).
2. Next review the **calories and calories from fat**. This section provides information on how much energy (in calories) is provided in the food. Patients should understand that the total amount of calories that originate from fat is an important consideration regarding the risk for cardiovascular disease.
3. The following section of the label contains information about **specific nutrients**. Nutrients listed in the first section are those that may need to be limited (e.g., fat, saturated fat, trans fat, cholesterol, or sodium). Listed next, total carbohydrates are a key component, and patients should understand their goals for total carbohydrates for each meal and decide the portion size to match. Nutrients listed in the last part of this section are important to include in a balanced diet (e.g., dietary fiber, vitamin A, vitamin C, calcium, and iron).



4. The footnote area of the label provides information on **Daily Values** (DVs) for each nutrient listed and are based on public health experts’ advice. DVs are recommended levels of intakes. DVs in the footnote are based on a 2,000- or 2,500-calorie diet.

Source: U.S. FDA, 2014.

CARBOHYDRATES

A person with diabetes should aim for approximately 130 grams of carbohydrates each day. Although low-carbohydrate diets (i.e., <130 g/day) might seem to be a logical approach to lowering blood glucose levels after a meal, foods containing carbohydrates are important sources of energy, fiber, vitamins, and minerals. Fruits, vegetables, whole grains, legumes, and low-fat milk are all recommended. Foods with whole grains have been shown to reduce insulin sensitivity.

Carbohydrate intake should be based on each individual patient’s lifestyle, medications, BMI, and level of activity. Patients who are very active will be able to have higher carbohydrate intake than those patients who are not active or who are active on a weight-loss plan. For each meal, a good general guide is to recommend that patients start with 45 to 60 grams of carbohydrates and adjust according to their individual needs (ADA, 2017e; Franz & Evert, 2017).

There is no need to avoid a moderate use of sucrose as a sweetener, and naturally occurring fructose is also not harmful. The standard reduced-calorie sweeteners—such as mannitol, sorbitol, and xylitol—are safe for people with diabetes and have about one half the calories of equivalent amounts of sugar. Likewise, artificial (non-nutritive) sweeteners—such as neotame, saccharine, acesulfame potassium, sucralose, stevia, and aspartame—are safe in moderation for people with diabetes (Franz & Evert, 2017). However, excessive use of such sweeteners may have adverse effects. Patients should consult with their healthcare providers regarding the use of artificial sweeteners.

CARBOHYDRATE CONSUMPTION	
Recommend	Limit
Whole grain breads and pasta, brown rice, bulgur, quinoa, barley, oatmeal	White breads, cakes, cookies
Fresh fruits	Fruit juices, sodas, juice drinks
Fresh vegetables, legumes, dried beans, lentils	Starchy vegetables such as potatoes, peas, corn
Nonfat milk, nonfat yogurt, soy and almond milk	Whole milk, sweetened whole-fat yogurt
Whole grain crackers	Chips, fried snacks



Glycemic Index

The glycemic index is a standard way to compare the effects of different foods on the blood glucose level after a meal. Foods with a lower glycemic index cause less of a spike in blood glucose after they are eaten. Low-glycemic index foods include oats, barley, bulgur, beans, lentils, legumes, pasta, pumpernickel (coarse rye) bread, apples, oranges, milk, yogurt, and ice cream. Theoretically, these foods should make blood glucose control easier for people with diabetes; in reality, studies show that diets with low-glycemic index foods make glycemic control only slightly easier than diets with high-glycemic index foods (ADA, 2017e; Franz & Evert, 2017).

Carbohydrate Counting

Limiting the intake of excessive carbohydrates in the diet is a key part of controlling hyperglycemia. When regular doses of insulin or insulin secretagogues are needed to manage the glucose load after meals, it is important for patients to match the dose to the amount of carbohydrates that are eaten at each meal. Patients can estimate the carbohydrates in their meals by summing the approximate grams in each serving. The labels of most foods help patients to make these estimates.

Another way to keep track of carbohydrates is through a standardized set of foods and portions in the form of exchange lists. A single carbohydrate serving is considered to have 15 grams of carbohydrates, and a person with diabetes should have 8.5 to 9 servings of carbohydrates each day, divided among four meals. On an exchange list, specific foods are listed in terms of portions equivalent to one carbohydrate serving, so a person can choose preferred foods to fill out the daily allotment.

EXCHANGE LIST	
Food	Portions equal to one carbohydrate serving
Starches	<ul style="list-style-type: none"> • 1 slice of bread • 1/3 cup cooked pasta • 3/4 cup dry cereal • 4–6 crackers
Fruits	<ul style="list-style-type: none"> • 1 small piece of fruit • 1/2 cup fruit juice
Milk	<ul style="list-style-type: none"> • 1 cup nonfat (skim) milk • 1/2 cup yogurt
Desserts	<ul style="list-style-type: none"> • 2 small cookies • 1/2 cup ice cream

Exchange lists are copublished by the American Dietetic Association and the American Diabetes Association. Nutritionists, dietitians, and diabetes educators have these lists, and the websites of the two associations tell how to obtain copies of exchange lists for meal



planning. The best way for a patient to learn how to estimate the carbohydrate content of his meals is through individualized education sessions with certified diabetes educators (ADA, 2014b).

FATS

Dietary fats contribute to the total calories consumed, but the amount of fat in a meal has only a small effect on the level of blood glucose after the meal. The more important consideration for people with type 2 diabetes is their risk for developing coronary heart disease. Dietary fats play a major role in the formation of atherosclerotic plaque. To reduce the likelihood of atherosclerotic cardiovascular disease, a person—especially, a person with type 2 diabetes—should limit saturated fatty acids, trans fatty acids, and cholesterol in meals (ADA, 2017e; Franz & Evert, 2017).

Fats should make up 20% to 35% of a person’s total daily calories. Saturated fats should be limited to less than 7% of total daily calories, trans fats minimized, and cholesterol limited to less than 200 mg per day. Most of the daily fat intake should be monounsaturated or polyunsaturated (a “Mediterranean” diet) (Franz & Evert, 2017).

FAT CONSUMPTION	
Recommend	Limit
Fresh fish	Commercial fried fish
Seeds, nuts	Fried snacks (e.g., potato chips)
Olive oil, olives	Butter, margarine
Nut butters (almond butter, peanut butter)	n/a

Plant sterols and stanols (types of natural vegetable fats) can lower blood cholesterol levels and are good substitutes for other fats (Franz & Evert, 2017). To increase the sterols and stanols in the diet, patients can replace other types of fat with commercial margarine spreads (e.g., Benecol, Take Control) or dietary supplement capsules (e.g., Benecol Softgels, Cholest-Off, Cholesterol Success Plus).

PROTEIN

As with fats, proteins in a meal do not significantly raise after-meal glucose levels. Proteins (actually, the amino acids derived from the proteins) do increase insulin secretion, and in this way, eating protein with carbohydrates helps a person with type 2 diabetes to reduce the spike of blood glucose after a meal. For the same reason, however, proteins are not good snacks for preventing the hypoglycemia of vigorous exercise or hypoglycemic episodes in the middle of the night. In a healthy diet, proteins should contribute about 15% to 20% of a day’s total calories (Franz & Evert, 2017).



PROTEIN CONSUMPTION	
Recommend	Limit
Poultry, veal, fish	Beef, sausage, pork
Eggs, nonfat milk	Whole-milk products
Nonfat or low-fat cheese	Whole-milk cheese
Soy products (e.g., tofu)	n/a

FIBER

Some plant carbohydrates—such as cellulose, gums, and pectins—cannot be broken down and digested by humans. These are called *dietary fiber*. Insoluble dietary fiber, such as cellulose (e.g., bran), speeds the movement of food through the digestive tract. Soluble dietary fiber, such as gums and pectins (e.g., oatmeal), slows the rate of absorption of digestible nutrients. A high quantity of soluble fiber in a patient’s diet can reduce blood cholesterol and can modestly reduce hyperglycemia and insulin resistance.

The recommendation for the general public is 14 grams of fiber for every 1,000 calories in a person’s everyday diet. For people with diabetes, the recommendation is higher—a total of 50 grams of fiber per day, regardless of the total daily calories. Plants contain dietary fiber. Legumes, cereals with ≥ 5 g fiber/serving, fruits, vegetables, and whole-grain products are recommended (Franz & Evert, 2017).

MICRONUTRIENTS

As with the general population, people with diabetes need sufficient vitamins and minerals in their diets to meet the body’s daily needs. Poorly controlled diabetes or weight-loss diets can cause nutritional deficiencies, and the minimum daily vitamin and mineral needs may require the patient to take daily supplements. Other people with diabetes who may need supplements are older adults, pregnant women, lactating women, and strict vegetarians (Franz & Evert, 2017).

No scientific evidence currently exists that any vitamins or antioxidants have special beneficial effects for people with diabetes who do not have vitamin deficiencies. Although not absolutely necessary, some clinicians recommend that patients with type 2 diabetes take a daily supplement of 0.4–1.0 mg folic acid, 0.4 mg vitamin B₁₂, and 10 mg pyroxidine (Franz & Evert, 2017). Similarly, no mineral supplements have clear beneficial effects for diabetes beyond their role in general health.

BEVERAGES

High-calorie beverages should be replaced by no-calorie or artificially sweetened drinks. Most fruit juices contain more sugar than people realize, and juices should not be drunk by people with diabetes merely to quench their thirst.



Drinking high amounts of alcohol brings a host of health problems, including an increased risk for developing diabetes. Those people with diabetes who choose to drink alcohol should drink only moderately. Generally speaking, moderate drinking means one drink per day for men and less than one drink per day for women.

Mixed drinks can also contain significant amounts of carbohydrates, so people with diabetes should pay attention to the content of their drinks. It is also best for those who drink alcohol to do so with food, especially at night, in order to avoid a later episode of hypoglycemia.

Alcohol should not be drunk by women who are pregnant or by people with liver disease, pancreatitis, advanced neuropathy, or very high levels of blood triglycerides (Franz & Evert, 2017).

According to the ADA, moderate alcohol consumption does not have major detrimental effects on long-term blood glucose control in people with diabetes. However, risks associated with alcohol consumption include hypoglycemia, weight gain, and hyperglycemia (ADA, 2017e).

HYPERGLYCEMIA-RELATED ILLNESSES AND COMPLICATIONS

People with diabetes face both acute and chronic health threats. Acute complications include diabetic ketoacidosis and hyperglycemic hyperosmolar state. (Another possible emergency—hypoglycemia—is discussed above under “Insulin Therapy.”) Diabetes also continually injures tissues microscopically, and as these microscopic injuries accumulate, they lead to observable chronic problems such as heart disease or kidney failure.

Acute Complications

Before the discovery of insulin, most people with diabetes died of a condition known as diabetic coma, which came on suddenly and was fatal by the second or third day. Typically, this fatal condition was characterized by dehydration and precipitated by the occurrence of some other disease. Today, diabetic coma is called *diabetic ketoacidosis*.

Diabetic ketoacidosis and hyperosmolar hyperglycemic state (also called *hyperosmotic hyperglycemic nonketotic state*) are two emergency conditions that threaten patients with both type 1 and type 2 diabetes. Both conditions involve a high level of blood glucose that leads to dehydration beyond the body’s ability to cope. The person becomes tired and weak, is thirsty and urinates excessively, and often has an altered mental state, ranging from confusion to coma. Dehydration causes hypotension and acute renal failure, and if not treated with IV fluids and insulin, the condition leads to serious electrolyte abnormalities, brain injury, and death.



DIABETIC KETOACIDOSIS

Diabetic ketoacidosis develops when there is so little insulin that the body begins to use fat as a major fuel. Diabetic ketoacidosis is seen primarily in people with type 1 diabetes, although some people with type 2 diabetes may develop the condition.

Diabetic ketoacidosis is characterized by acidic ketones (the result of fat metabolism) in the blood and urine, and ketones can be smelled on the patient's breath, giving a fruity or acetone-like odor. The resulting acidosis—a drop in blood pH below 7.3 (normal pH is 7.38 to 7.44)—causes the body to adopt a deep, sighing pattern of respiration called *Kussmaul breathing* or *air hunger*. Diabetic ketoacidosis, which usually comes on quickly (within a day or two), also produces nausea, vomiting, and abdominal pain (Bartelmo, 2013).

HYPEROSMOLAR HYPERGLYCEMIC STATE

Hyperosmolar hyperglycemic state (HHS) develops when there is sufficient insulin for the body to use glucose as a fuel but there is not enough insulin to keep blood glucose levels in a safe range. HHS is primarily seen in older adults with type 2 diabetes.

Unlike diabetic ketoacidosis, HHS produces no ketones. The condition is caused directly by very high blood glucose levels, typically greater than 600 mg/dl and often higher than 1,000 mg/dl. Without acidic ketones, there is no Kussmaul breathing and usually no abdominal distress. HHS tends to develop slowly, over days or weeks, and by the time it is apparent, the patient may already be confused or stuporous.

Both diabetic ketoacidosis and HHS are precipitated by sudden stresses that change the body's balance of insulin and glucose. The stress can be a new illness (such as a serious infection, a heart attack, or a stroke), or the stress can be an injury. Alternately, the stress can be the addition of a new drug, such as a corticosteroid, thiazide, anticonvulsant, or sympathomimetic. Diabetic ketoacidosis, which is almost always a condition of insulin-dependent diabetics, can also develop when a patient does not take prescribed insulin.

Both conditions are emergencies and are treated in the same way. The patient is given insulin to lower the hyperglycemia and fluids to reverse the dehydration. The blood electrolyte levels are corrected, and for diabetic ketoacidosis, the pH balance of the body is shifted back toward normal. Typically, both conditions are precipitated by another recent stressor, so this problem, too, must be identified and corrected. The patient is usually monitored in an intensive care unit.

Chronic Complications

MICROSCOPIC INJURY

Because continual hyperglycemia is the cause of the chronic complications of diabetes, any reduction of average blood glucose levels (i.e., A1C values) reduces the chances of developing chronic complications. Prolonged hyperglycemia has a number of deleterious effects. Two types



of microscopic cell and tissue damage seem to be involved in most of the long-term complications of diabetes (ADA, 2017f).

When there is excess glucose in the bloodstream, glucose molecules stick indiscriminately to proteins in a process called *glycosylation*. (For example, excess glucose binds to hemoglobin, and this is the basis of the A1C index of hyperglycemia.) Higher blood glucose levels produce more glycosylated proteins, and these glycosylated proteins tend to cross-link (bind together) into abnormal complexes. The complexes then add to atherosclerotic plaque, damage kidneys, and disrupt the structure of extracellular matrices.

Excess glucose also amplifies the amount of certain rarely produced chemicals in the body. These chemicals include sorbitol, diacylglycerol, and fructose-6-phosphate, all of which, in sufficient quantities, are detrimental to the normal functioning of cells.

Both types of molecular problems damage blood capillaries, endothelial cells of larger blood vessels, and nerves. The accumulation of these microscopic injuries leads to the macroscopic damage that produce the long-term complications of diabetes.

MACROSCOPIC INJURY

Over the years, the continual hyperglycemia of diabetes takes its toll on tissues everywhere in the body. The chronic complications of diabetes are caused by the macroscopic damage that occurs after the accumulation of 10 to 20 years of microscopic damage. In type 2 diabetes, hyperglycemia may have been present for many years before the disease is recognized. Therefore, many people with type 2 diabetes may already have macroscopic damage when they are first diagnosed (ADA, 2017f).

In the United States, the major long-term health problems from diabetes are:

- Heart disease
 - Stroke
 - Hypertension
 - Blindness
 - Kidney disease
 - Nervous system disease
 - Amputations
 - Dental disease
 - Complications of pregnancy
- (Bartelmo, 2013; Durkin, 2013)

The most common long-term complications of diabetes are damage to arteries, kidneys, eyes, nerves, and feet.



CARDIOVASCULAR DISEASES

People with type 2 diabetes develop atherosclerotic coronary artery disease more frequently than people without diabetes because elevated blood glucose levels can damage small cardiovascular blood vessels. Atherosclerosis causes myocardial infarction, heart failure, stroke, and insufficient circulation to the feet. Today, 80% of the people with type 2 diabetes die from some form of cardiovascular disease.

Coronary heart disease and stroke—the two predominant types of cardiovascular disease—claim the lives of almost two thirds of people with diabetes. That is 2 to 4 times higher than the rate in the general population. When people with diabetes take steps to control their blood pressure, cholesterol, and other cardiovascular risk factors, they can reduce their risk of CVD, or possibly slow its progression (Burant & Young, 2012).

Patients with type 2 diabetes should be screened annually for signs, symptoms, and risk factors of cardiovascular disease. Recommendations suggest a referral to cardiology for evaluation and cardiac stress tests for patients with diabetes who also have:

- Cardiac symptoms
- An abnormal resting ECG
- Peripheral or carotid artery disease
- Autonomic neuropathy affecting the cardiovascular system

(Burant & Young, 2012)

By controlling their blood glucose levels, people with type 2 diabetes reduce the likelihood of having heart and artery problems. The risk of cardiovascular disease can be reduced still further by reducing high blood pressure, correcting dyslipidemia, and taking aspirin prophylactically. These three tasks should be added to the long-term treatment plan for all people with type 2 diabetes.

Hypertension

The majority of people with type 2 diabetes also develop hypertension.

Individuals with diabetes are advised to keep their blood pressure below 130/80 mmHg, which is lower than the 140/90 mmHg or less recommended for the general population. Even with lifestyle changes, most people with type 2 diabetes and hypertension need antihypertensive medications (often two or more drugs) to reach this target. Maintaining a low blood pressure may also help ward off other complications of diabetes such as vision loss and kidney failure (Burant & Young, 2012).

Lifestyle therapy for hypertension treatment consists of reducing excess body weight through caloric restriction, restricting sodium intake (<2,300 mg/day), increasing consumption of fruits and vegetables (8–10 servings per day) and low-fat dairy products (2–3 servings per day), avoiding excessive alcohol consumption (no more than 2 servings



per day in men and no more than 1 serving per day in women), and increasing activity levels (ADA, 2017a).

Lowering of blood pressure with regimens based on a variety of antihypertensive agents, including ACE inhibitors, angiotensin receptor blockers (ARBs), diuretics, and calcium channel blockers has been shown to be effective in reducing cardiovascular events (ADA, 2017a).

The lifestyle changes recommended for treating type 2 diabetes will also improve a patient's blood pressure. Specifically, weight loss and maintaining a healthy weight; eating a low-fat diet of fruits, vegetables, and low-fat dairy products; avoiding excess alcohol; not smoking; and exercising regularly will reduce hypertension. For genetically predisposed people, low-salt diets will also improve blood pressures.

Lifestyle modifications and exercise programs for those patients with diabetes and cardiovascular disease may benefit greatly from supervision and direction from a physical therapist and/or occupational therapist. Physical rehabilitation programs are an important component to the ongoing self-management of patients who may struggle with adding safe and appropriate physical activity to their daily routines.

Dyslipidemia

Dyslipidemia increases a person's chances of developing cardiovascular diseases. The fasting lipid levels of people with type 2 diabetes should be screened yearly, and unhealthy lipid levels treated.

In terms of reducing cardiovascular risk, the primary goal is a fasting LDL cholesterol level of <100 mg/dl. Secondary goals are fasting triglyceride levels of <150 mg/dl and fasting HDL cholesterol levels of >40 mg/dl in men and >50 mg/dl in women. People who already have some form of cardiovascular disease should aim for a lower LDL cholesterol level, namely <70 mg/dl (ADA, 2017a).

Statin drugs are the most effective medications for controlling total and LDL cholesterol. Patients with diabetes who are over the age of 40 should be taking a statin (even if LDL cholesterol levels are less than 100 mg/dL) and should also consider daily aspirin therapy, which can prevent the aggregation or clumping of platelets in the blood from forming clots that can block blood flow to the heart or the brain (Burant & Young, 2012).

As with hypertension, the lifestyle changes recommended for treating type 2 diabetes will also improve a patient's dyslipidemia. The addition of a statin drug is recommended for patients who do not meet the lipid target goals after changing their lifestyles. (Pregnant women should not take statins.)



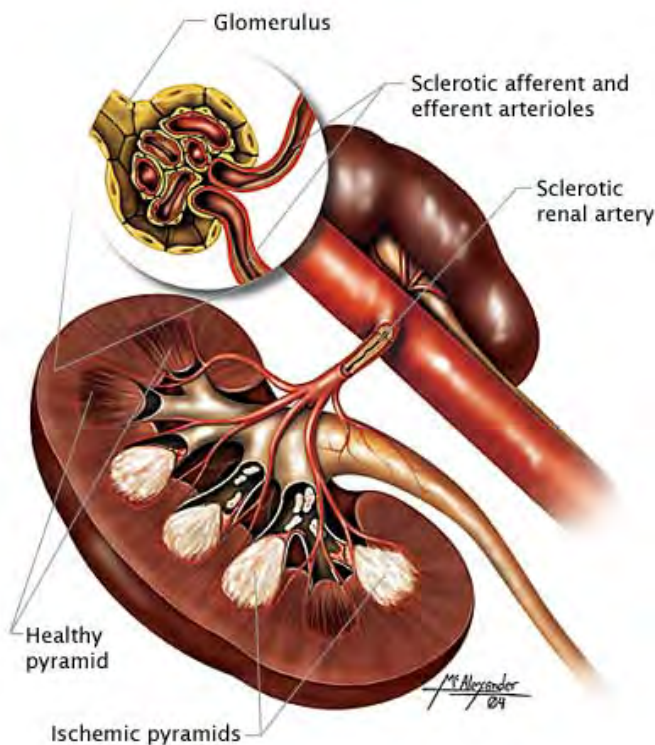
Prothrombotic State

In the prothrombotic state, a condition in which the blood clots inside blood vessels more easily than normal, unnecessarily high levels of clotting molecules in the bloodstream increase a person's risk for developing coronary artery disease and stroke. A low dose (75–162 mg/day) of enteric-coated aspirin is recommended for most people with type 2 diabetes to help prevent cardiovascular disease. Patients with aspirin allergies, bleeding disorders, recent gastrointestinal bleeding, or liver disease should not take aspirin (Burant & Young, 2012).

DIABETIC NEPHROPATHY

Diabetic nephropathy is a common complication of diabetes. Diabetic nephropathy can progress to end-stage renal disease, and 80% of all people with end-stage renal disease have type 2 diabetes.

Diabetes injures those cell membranes in the kidney that are responsible for filtration and absorption of fluids and molecules. One of the earliest indicators of membrane damage is seen in the kidney glomeruli, the first of the filtration sites, which become slightly leaky and allow small amounts of protein into the urine. The small amount (30–300 mg/24 hours) of protein that abnormally appears in the urine is termed *microalbuminuria*.



A cross-section of the kidney showing ischemic pyramids and sclerotic arteries and arterioles. (Source: Illustration by Jason McAlexander, © Wild Iris Medical Education.)

Without treatment, the ability of the glomeruli to keep protein out of the urine declines, and eventually the person has albuminuria—the excretion of a significant amount (>300 mg/24 hours) of protein. While glomeruli are losing their ability to exclude large molecules such as proteins from the urine, they are also becoming less able to filter fluid, and the glomerular filtration rate (GFR) declines. At the same time, blood pressure begins to rise.

Treatment for Diabetic Nephropathy

The American Diabetes Association (2017e) recommends that patients with type 2 diabetes check two indicators of kidney functioning annually:

1. Blood should be tested for serum creatinine levels, which is used to estimate the glomerular filtration rate.
2. Urine should be tested to assess albumin excretion.

In addition, blood pressure should be measured at each check-up.

By controlling all three major risk factors—blood glucose levels, blood pressure, and blood lipid levels—people with type 2 diabetes can delay the development of kidney problems. People with diabetes who already have microalbuminuria can slow its progression to diabetic nephropathy by the same interventions. When kidney problems have progressed to albuminuria and a declining GFR, it is best to consult a kidney specialist.

By itself, good control of serum glucose levels will not prevent kidney problems in people with type 2 diabetes. On the other hand, when part of a regimen that targets all the major risk factors, glycemic control does slow the onset and progression of diabetic nephropathy.

Controlling blood pressure is an effective way to delay or prevent kidney problems in people with type 2 diabetes. Hypertension accelerates the development of kidney damage as well as atherosclerosis, and all these problems feed on and worsen each other.

Some studies suggest that ARBs can delay the progression of kidney problems in people with type 2 diabetes who do not have hypertension (i.e., whose blood pressures are <130/80 mmHg) but who already have microalbuminuria. Currently, there are no agreed-upon recommendations for using either ACE inhibitors or ARBs in normotensive people (those with normal blood pressure) with type 2 diabetes.

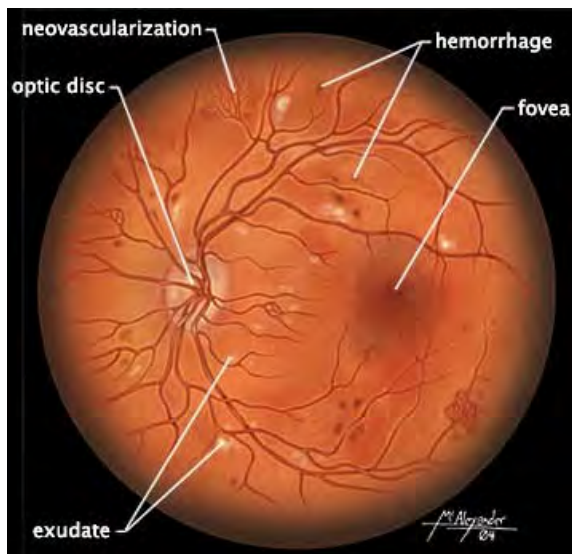
People with type 2 diabetes who have kidney problems usually also have high levels of serum cholesterol. Although it is not certain that high cholesterol levels cause or accelerate nephropathy, the American Diabetes Association (2014b) advises that long-term treatment should aim for a blood LDL cholesterol level of <100 mg/dl.



In patients with nephropathy, reducing the amount of protein in their diets slows the deterioration of the functioning of their kidneys. The American Diabetes Association (2016) suggests lowering protein intake from 15% to 20% of daily calories to 10% to 15% of daily calories, but diets with less protein than this are detrimental to the patient's health.

DIABETIC RETINOPATHY

People with diabetes get cataracts earlier and with a higher frequency than people without diabetes. The most serious eye damage, however, results from long-term (>5 years) diabetic injury to capillaries and small blood vessels of the retina.



The retina viewed through a scope showing damage due to diabetes, including light exudate splotches, mini-hemorrhages, and areas of neovascularization. (Source: Illustration by Jason McAlexander. © Wild Iris Medical Education.)

Diabetic retinopathy begins with tiny aneurysms, small (“dot”) hemorrhages, and swelling of the retinal tissue. This early retinopathy leads to areas of ischemia and infarct, which are called *cotton-wool spots*. Eventually, the continuous injury causes new blood vessels to grow along the retina, accompanied by fibrous connective tissue. Once new blood vessels begin to grow (neovascularization), the problem is called *proliferative diabetic retinopathy*, which can later cause blindness.

For effective treatment, detecting retinal damage early is critical. People with diabetes should have a full (dilated) eye examination by an ophthalmologist or a trained optometrist when they are first diagnosed and every year thereafter (unless a less frequent schedule is recommended by an ophthalmologist). A patient who already has kidney damage may already have retinopathy, so kidney damage is a warning that the patient should be seen by an ophthalmologist (ADA, 2017e).



DIABETIC NEUROPATHY

Nerve damage is a common complication for people with diabetes. The damage can decrease a patient's ability to sense actual pain, and at the same time, it can cause phantom burning pain, especially at night. Sometimes, motor nerves are affected and muscles or reflexes are weakened. When autonomic nerves are damaged, the patient can have symptoms ranging from impotence to digestive problems to dizziness on standing.

Diabetic neuropathies can take many forms. The two most common are generalized nerve injuries (called *diabetic distal symmetrical polyneuropathy*) and diabetic autonomic neuropathy.

Distal Symmetrical Polyneuropathy (DSPN)

Symptoms of DSPN show up at the ends of the longest nerves first. Typically, DSPN begins with unusual sensations such as tingling and numbness in the toes and feet. Over time, the paresthesias and numbness slowly move upward until they are distributed like socks on the feet, ankles, and legs. Before the problem reaches the knees, long nerves elsewhere in the body become affected, beginning at the fingers.

Eventually, the hands and lower arms have sensory reductions in a distribution like a pair of gloves. This “stocking-glove” pattern of sensory deficits is followed by decreased reflexes in the feet and ankles and by weakness in the muscles that spread the toes (Burant & Young, 2012).

Autonomic Neuropathy

When diabetes damages the autonomic nerves, the symptoms vary and can affect any of the internal organs. Possible symptoms include:

- Cardiovascular: Resting tachycardia (≥ 100 bpm), orthostatic hypotension (a drop in systolic blood pressure of 20 mmHg or more upon standing), fainting, exercise intolerance
- Gastrointestinal: Difficulty swallowing, slow emptying of the stomach, brittle diabetes, weak response to hypoglycemia, constipation, alternating bouts of diarrhea and constipation, nocturnal diarrhea, fecal incontinence
- Genitourinary: Impotence, reduced vaginal lubrication, inability to empty the bladder, recurrent urinary tract infections
- Skin: Reduced sweating of hands and feet (ADA, 2017f; Burant & Young, 2012)



Patients with type 2 diabetes are monitored for distal polyneuropathy. This is done by testing the ability of the patient to sense the vibration of a tuning fork in the toes of both feet and also the ability to sense the pressure of a standardized 10-g diabetes monofilament on the bottoms of the toes. The Achilles tendon reflexes at the ankles are checked as well as an exam of each foot for skin lesions, soft tissue injuries, and joint damage.

To screen for autonomic neuropathy, patients are assessed for the cardiovascular, gastrointestinal, genitourinary, or skin symptoms listed above. Patients may also experience orthostatic hypotension. The resting blood pressure of patients is taken and compared with blood pressure after standing (ADA, 2017e, 2017f).

By improving glycemic control, neurologic symptoms can sometimes be reduced, but there are no cures for the nerve damage of diabetes: treatments for diabetic neuropathy only alleviate symptoms. Symptoms of diabetic neuropathy are treated individually.

Poor sensation in the feet is managed by educating the patient about foot care, by limiting impact exercises, and by regular foot exams every 3 to 6 months. Additional management includes referral to a physical therapist for evaluation of the extent of sensation loss, functional limitations caused by diminished balance and/or proprioception, or the need for special footwear or assistive devices (such as a cane or walker) when needed. An occupational therapist consultation with the patient and family to address issues inherent to the home setting and activities of daily living is also important to consider for patients with autonomic neuropathy (Burant & Young, 2012).

Pain from neuropathy should be treated by a specialist, who will recommend a medication (or other regimen) appropriate to the particular patient.

Orthostatic hypotension should be evaluated by a neurologist. Therapy usually includes having the patient sleep with the head of the bed elevated, avoid sudden posture changes by sitting or standing slowly, and wear full-length elastic stockings.

Diarrhea from autonomic neuropathy should be evaluated by a specialist. Sometimes, the diarrhea resolves on its own, but if not, it may respond to antidiarrheal medications or to antibiotic therapy. In other cases, diarrhea can be caused by impaired neural control of sphincters and the consequent fecal incontinence.

Constipation can usually be treated with a stimulant laxative, such as senna.

Gastroparesis (decreased stomach motility, which delays digestion of food), bladder dysfunction, and impotence can usually be improved by medications.

FOOT PROBLEMS

It has been estimated that 20% of hospital admissions of diabetic patients are for foot problems. Over the years, damage to capillaries and small blood vessels reduces the ability of the



microscopic circulation to deliver oxygen to the feet of people with diabetes. In addition, many people with diabetes develop atherosclerotic peripheral vascular disease, which impedes the overall circulation to their feet (Burant & Young, 2012).

People with diabetic neuropathy can have muscle weakness and a poor sense of position. For these reasons, they tend to injure their feet, ankles, and legs. Any damage to their sensory nerves will make these frequent small injuries less likely to be noticed. To compound the problem, diabetic ischemia of the lower legs slows the healing of injuries and encourages infections.



Decreased sensation from peripheral neuropathy can lead to ulcers. Daily inspections are important to address small abrasions and sores before they develop into ulcers. (Source: Illustration by Jason McAlexander. © Wild Iris Medical Education.)

At each visit, the patient's nails, skin, and joints of both of the feet are examined. Testing includes assessing the foot and ankle pulses and the ability to feel vibration and light touch in the toes. The clinician assesses the patient as they walk, looking for uneven gait and checking shoes for uneven wear and for locations of excess pressure. The patient is asked whether they have other problems walking, such as intermittent claudication, weakness, or imbalance. Another important consideration for self-care is to determine whether the patient can safely trim toenails (Burant & Young, 2012).

Patients with diabetes should be warned about the extra risks that foot injuries pose for them. A physical therapist working with a patient who has existing neuropathy instructs the patient and family on the proper way to inspect the feet for any injuries (e.g., with the use of a hand-held mirror) on a regular basis (Whyte, 2013). Patients are encouraged to examine their feet every day and counseled on how to care for their skin and toenails and to choose appropriate footwear. If patients have difficulty examining and caring for their feet, someone else (a family member,

nurse, podiatrist, or physical therapist) is enlisted to help. Foot care is part of the initial education of all patients diagnosed with diabetes (Burant & Young, 2012).

The most common cause of foot injury is excess pressure on the skin under the bony bumps of the soles of the feet. To ease pressure points, well-fitted athletic shoes are better than dress shoes or shoes with hard soles. For feet with insufficient circulation or poor sensation, special shoes with individualized internal molds are needed so that the pressure of walking is distributed evenly; these patients should see a podiatrist along with a physical therapist to address strategies and management to decrease injury to the feet (Burant & Young, 2012).

Wounds on feet with neuropathy or poor circulation cannot be treated casually. Even small wounds should be thoroughly examined, cleaned, and debrided; they should be re-examined daily. Patients may be unaware of pressure ulcers and other wounds, as they may have lost sensation. Antibiotics are used at the first signs of infection. Walking and other foot pressures are minimized while the wounds are healing. Soft-tissue infections have to be treated aggressively with hospitalization and IV antimicrobial therapy.

When a diabetic foot becomes pale, pulseless, and painful, it is an emergency and a surgeon should be consulted.

WHAT PATIENTS NEED TO KNOW ABOUT FOOT CARE

- Cut toenails straight across and inspect the feet daily for cuts, scratches, blisters, and corns.
- Clean the feet daily with warm water and mild soap followed by thorough drying.
- Use a gentle moisturizer cream, such as Eucerin or lanolin, regularly.
- Avoid prolonged soaking, strong chemicals (e.g., Epsom salts or iodine), and any home surgery.
- Avoid hazards such as going barefoot, extreme heat or cold, and wearing tight socks or shoes.

Source: ADA, 2017f; Burant & Young, 2012.

AMPUTATION

At times, if a patient's condition is not well managed, the chronic results of limb and foot problems are damaged and deformed joints and nonhealing skin ulcers. When soft tissues or bones become infected, the destruction may become severe enough to require amputation. The highest risk of amputations is in people who have had diabetes for more than 10 years and in whom microscopic tissue damage has already shown itself as eye or kidney problems (Burant & Young, 2012).



The following conditions are associated with an increased risk of amputation:

- Peripheral neuropathy
- Altered biomechanics (limited mobility, bony deformities, and nail infections)
- Peripheral arterial disease
- History of nonhealing ulcers or amputations
(Cifu, 2015; Burant & Young, 2012)

If a patient requires amputation, initial surgery and recovery are managed inpatient with a team approach. Rehabilitation with support from physical and occupational therapists and prosthetists during the pre- and post-operative period are vital to the patient.

Pre-Operative

Pre-operative education goals include the following:

- Discuss the process and importance of rehabilitation after surgery.
- Describe the process of phantom pain.
- Discuss the healing process.
- Explain the process of prosthetic casting, fitting, and training.
(Cifu, 2015; Durkin, 2013)

Postoperative

Postoperative rehabilitation goals include:

- Pain management
- Incisional healing
- Physical therapy:
 - Bed mobility
 - Transfers
 - Lower extremity range of motion and strengthening
 - Ambulating with gait aids
 - Balance (seated, standing, walking, stairs) (Cifu, 2015)
 - Progressively increasing activities
 - Establishing a home exercise program with discharge plan for any assistive devices



- Occupational therapy:
 - Assisting with ADLs
 - Assessing need for adaptive equipment
 - Evaluating home safety
 - Developing energy conservation strategies
 - Upper extremity stretching and strengthening(Cifu, 2015; Durkin, 2013)

The goal for rehabilitation therapy after amputation is to have the patient successfully transfer back to his or her baseline or home environment. After surgical recovery, the patient may need to remain inpatient within a rehabilitation environment and/or participate in outpatient rehabilitation with a physical and occupational therapist and a prosthetist (Cifu, 2015).

Prosthetic training and exercises focus on care of skin, sock management, gait training, range of motion, stretching and strengthening, and how to manage care at home with the prosthesis (ADLs such as dressing, bathing, and household chores) as well as a continued program of home exercises (Cifu, 2015).

Diabetes Complications and Rehabilitation

The key to a successful rehabilitation program is individualization. Rehabilitation specialists start by evaluating the patient's baseline physical condition and any disabilities or impairments that are present either due to deconditioning or chronic effects of diabetes. Chronic effects that patients with type 2 diabetes may experience include peripheral neuropathy, orthostatic hypotension, vision changes, and cardiac decompensation (Cifu, 2015).

The patient's interests and motivation for improving their condition is an important component as well. Initial goal setting involves the patient and family to work toward mutual goals for progress.

Patients with type 2 diabetes may also need assistive devices to improve functional activities of daily living. They may have reduced sensation, weakness, gait disturbances, balance problems, and pain. Mechanical aids (e.g., cane or walker) may help reduce pain and lessen the impact of physical disability. Hand or foot braces can compensate for muscle weakness or alleviate nerve compression. Orthopedic shoes can improve gait disturbances and help prevent foot injuries in people with a loss of pain sensation (Tabloski, 2014).

Patients with orthostatic hypotension should be advised to be proactive when changing from a supine to standing position slowly and by holding on to a chair or bed for 30 seconds after standing to minimize their risk for falling. Patients may also want to wear supportive compression stockings to increase venous return (Unger, 2013).



If a patient has an existing cardiac condition, gentle exercise to increase and maintain ADLs are encouraged. These may include chair exercises, arm exercises, and other nonstrenuous movements such as tai chi or chair yoga (Tabloski, 2014).

For a patient who would like to work on increasing balance and strength, resistance exercises (such as leg extensions, chest press, and rowing); functional exercises (such as stand-sit-stand and stair climbing); and balance training (heel-toe walking, standing on one leg, etc.) can be incorporated with assistance from therapy professionals (Whyte, 2013).

QUESTIONS PATIENTS MAY ASK

Q: How do I know if I have type 2 diabetes?

A: People with type 2 diabetes can have the disease for many years before symptoms appear. When symptoms eventually show up, they can include:

- Being very thirsty
- Having to urinate frequently
- Being unusually hungry
- Being unusually tired
- Having blurry vision

The only sure way to know if you have type 2 diabetes, however, is to have a physician check the level of sugar in your blood.

Q: I have type 2 diabetes, and I've heard that I can faint from low blood sugar. What should I do to prevent this?

A: A low blood sugar level is called *hypoglycemia*. Diabetes is a disease of high blood sugar levels. In some situations, however, the medications that are used to lower high blood sugar levels overshoot the mark, and the person's blood sugar level gets too low. This happens most often when insulin is the medication that a person with diabetes is taking. Your physician can advise you if you need to be especially careful about hypoglycemia with your specific medications.

The symptoms of hypoglycemia are:

- Weakness
- Shakiness
- Dizziness



- Faintness
- Feeling warm
- Hunger
- Headache
- Irritability
- Confusion
- Pale skin

The treatment for hypoglycemia is to eat foods or drink liquids that contain sugar. It doesn't take much: 1/2 cup of fruit juice, five small pieces of hard candy, or three glucose tablets, which you can buy in any drugstore. If this doesn't make you feel better in 10 to 15 minutes, take the same amount of sugar a second time. If this still doesn't fix the problem, get someone to take you to a hospital.

Just as you've heard, hypoglycemia can make you faint. If you think you're feeling hypoglycemic, eat some form of sugar. It's better to be safe than to pass out. If you are too dizzy to eat or if you pass out, someone must get you to an emergency room immediately. This condition justifies calling 911.

Q: I have type 2 diabetes. Do I have to do anything special when I am sick?

A: Illnesses stress your body, and your body reacts by putting extra sugar into your bloodstream. In a person with diabetes, the extra sugar makes it harder to keep blood glucose levels from getting too high. High blood glucose can make a person with type 2 diabetes get dangerously dehydrated. If the illness makes you vomit or gives you diarrhea, you will get dehydrated even more quickly.

To protect yourself, you need a plan. Talk with your physician or diabetes nurse. They will probably recommend checking your blood glucose levels more frequently when you are sick. It is possible that they will tell you to take more medication if you find your blood sugar levels getting too high. They will also tell you which signs and symptoms indicate that you should call them for advice; be sure to get telephone numbers that you can call day and night.

Even from the beginning of an illness, drink lots of noncaloric liquids and be prepared by having plenty of these beverages on hand. If you can, try to stick to your normal eating pattern. If it is hard to eat your regular foods, use the equivalent soft or liquid foods, such as soups, puddings, and applesauce. Try to always have some of these foods in your cupboard. Diabetes recipe books usually have a section on easy-to-eat snacks for when you are ill.

Q: My diabetes pills are expensive—any suggestions?

A: Talk with your physician. Ask if there is a generic version of the medication you're taking. The American Diabetes Association says that single tablets of one dosage are often less



expensive than two smaller tablets of half the dosage (a 500 mg tablet can cost less than two 250 mg tablets). Ask your physician to prescribe the largest tablet strength suitable for the dose you are taking. Then you can use a pill cutter to break the pill into halves or quarters to get the specific dose you need.

You may also qualify for prescription assistance through patient assistance programs offered from the drug companies and other organizations. To find out more, visit the American Diabetes Association website.

Q: What is type 2 diabetes?

A: The main form of sugar in your blood is glucose. Diabetes is a disease in which your body uses glucose inefficiently. Too much glucose is left in your blood after you eat, and the concentration of glucose in your blood remains too high—a condition called *hyperglycemia*.

Type 2 diabetes is the result of two specific problems. First, the tissues in your body don't absorb glucose as easily as they should. Second, your pancreas doesn't produce as much insulin as it should. Insulin is the hormone that keeps glucose from piling up in your bloodstream.

Diabetes can occur at any age, but type 2 diabetes usually shows up in people older than 40. People who are overweight or who have close family members with diabetes are more likely to develop type 2 diabetes.

Q: What can be done for type 2 diabetes?

A: The three most basic treatments are:

- Get down to a reasonable weight.
- Exercise regularly.
- Eat carefully planned meals.

These can be difficult challenges, but for some people with type 2 diabetes, these three changes in their lifestyles will control their blood sugar levels. Other people need to add medications to these lifestyle changes.

You can't manage your diabetes on your own. It's best to consult with a diabetes physician. Your physician will set up a program that includes specialists who will help you to plan meals and exercise routines. You will have regular checkups, and there will be experts to whom you can ask questions between the visits. If the diabetes leads to problems with your heart, kidneys, eyes, or nerves, you will be referred to specialists in treating these complications.



Q: I've heard that people with diabetes eventually have to get their feet amputated. Is this true?

A: People with diabetes are far more likely to have a foot or part of a leg amputated than other people. The reason is that diabetes can lower the blood flow to your feet. Without enough blood circulation, your feet don't heal well when they get injured, and any infections get worse more quickly than normal. Infected wounds can get so bad that the tissues can't be revived by medications and rest, and the only protection for the remaining good tissue is amputation of the dying area.

These problems can be prevented by paying special attention to your feet. Diabetes can make your feet less sensitive to injuries, so you have to watch for injuries with your eyes. Be aware of bumps, cuts, and bruises. Look over your feet every morning before you put on your socks. For larger patients or those with other mobility limitations, a long-handled and/or angled mirror can help with skin inspections.

If your shoes are making sore spots, see a podiatrist or shoe specialist. If you think a cut isn't healing well, see a physician. If you are having trouble trimming your nails without cutting yourself, get help from a family member or go to a podiatrist for regular nail care. And, most importantly, stop smoking. Smoking is bad for your circulation, and many of the people with diabetes who end up with amputations are smokers.

Q: I have diabetes. I don't drink, but I've heard that wine is good for diabetes. Should I start drinking wine with dinner every night?

A: At the moment, the medical profession does not recommend that nondrinkers with diabetes begin drinking for health benefits. It strongly recommends against drinking for people who have had problems with excess alcohol or who are pregnant. It also recommends against drinking for people with certain diseases, such as liver disease, pancreatitis, neuropathies, or high triglyceride levels.

Nonetheless, there is no general reason that people with diabetes cannot drink a small amount of alcohol regularly. We suggest talking with your physician about your specific situation. If you do decide to add a glass of wine to your diet, drink it with a meal.

Moderate alcohol consumption does not have major detrimental effects on long-term blood glucose control in people with diabetes. Risks associated with alcohol consumption include hypoglycemia (particularly for those using insulin or insulin secretagogue therapies), weight gain, and hyperglycemia (for those consuming excessive amounts) (ADA, 2017e).

Q: What is metabolic syndrome?

A: To say someone has metabolic syndrome means that they have a specific group of health problems: too much stomach fat, too much sugar and fat circulating in their bloodstream, and



high blood pressure. Having all these problems at once makes a person more likely to get heart disease and type 2 diabetes.

Q: What is a good way to get trustworthy information about diabetes?

A: The American Diabetes Association has helpful information and advice on its website or by phone.

CONCLUSION

Type 2 diabetes continues to be a major health condition that challenges the global population. Lifestyle changes and nutrition habits have contributed to the increasing prevalence of type 2 diabetes. Additional awareness of the risk factors and physiology of prediabetes are important factors to understand as healthcare providers. Patients at risk should have regular screening and early implementation of recommended lifestyle modifications to prevent the onset and progression of type 2 diabetes.

Type 2 diabetes is a chronic illness that requires self-management and motivation on the part of the patient. As healthcare providers working with patients who are diagnosed with type 2 diabetes, it is important to understand the common complications that may occur as well as the most effective short-term and long-term management strategies to support the health and wellness of patients with type 2 diabetes and their families.



RESOURCES

American Diabetes Association
<http://www.diabetes.org>
800-DIABETES (800-342-2383)

Diabetes (CDC)
<http://www.cdc.gov/diabetes>

Diabetes Forecast (American Diabetes Association)
<http://www.diabetesforecast.org>

National Institute of Diabetes and Digestive and Kidney Diseases
<http://www.niddk.nih.gov/>

Recipes for diabetes (University of Illinois Extension)
<http://extension.illinois.edu/diabetesrecipes/>



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TEST

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1. Insulin-sensitive diabetes is a disease that:
 - a. Occurs most commonly in middle-aged persons.
 - b. Results from the body's inability to respond to insulin.
 - c. Does not have effective treatment options.
 - d. Is usually categorized as type 1 diabetes.

2. Type 1 diabetes is distinguished from type 2 diabetes in that:
 - a. The pancreas of persons with type 2 diabetes produces little or no insulin.
 - b. The body tissues of persons with type 2 diabetes do not readily utilize glucose.
 - c. Type 1 diabetes is a disease that is curable.
 - d. Type 1 diabetes is a disease that adults gradually develop.

3. Which child is at the **greatest** risk for developing type 2 diabetes?
 - a. An 11-year-old Native American documented as overweight at last three visits and with no family history of diabetes
 - b. An 8-year-old white child documented as overweight at last visit and with one cousin who has diabetes
 - c. A 15-year-old Native American documented as increasingly overweight at last three visits and whose parents both have diabetes
 - d. A 10-year-old African American documented as overweight at last visit and with no family history of diabetes

4. People with type 2 diabetes are more likely to experience high medical costs related to stroke, kidney failure, and:
 - a. Nontraumatic fractures.
 - b. Anxiety.
 - c. Psychosis.
 - d. Hearing loss.

5. Insulin reduces a patient's blood glucose level by:
 - a. Decreasing the direct process of glycogenesis.
 - b. Reducing the catabolism of glucose.
 - c. Facilitating the entry of glucose into the cells.
 - d. Facilitating the movement of glucose from the cells into the bloodstream.



- 6.** By altering the way energy is used in the body, the ketogenic diet enables the patient to:
- Produce less insulin.
 - Produce more insulin.
 - Reduce insulin resistance.
 - Increase insulin resistance.
- 7.** Insulin resistance can be caused by:
- Excessive thirst (polydipsia).
 - Excessive urination (polyuria).
 - High levels of glucocorticoids.
 - Chronically low triglyceride levels.
- 8.** In assessing a male patient, the nurse considers which finding to be a possible indicator of metabolic syndrome?
- Waist circumference greater than 102 cm (40 in)
 - Blood triglycerides greater than 100 mg/dl
 - Blood HDL-C less than 50 mg/dl in men
 - Blood glucose greater than 75 mg/dl
- 9.** Metabolic syndrome is a cluster of problems including impaired fasting glucose, dyslipidemia, and:
- Hyperadrenalism.
 - Hypercapnia.
 - Hyperthyroidism.
 - Hypertension.
- 10.** A female patient with a blood pressure of 120/76 mmHg, HDL cholesterol level of 50 mg/dl, and A1C level of 6.8%, delivers a baby who weighs 8 pounds. Which measurement or characteristic is considered to be a risk factor for the patient to develop type 2 diabetes?
- The patient's blood pressure reading
 - The patient's HDL cholesterol level
 - The patient's A1C test result
 - The baby's birth weight



- 11.** People age 29 and older who should be screened for prediabetes include:
- Women who exercise three times per week or less.
 - Men who have a high resting pulse rate.
 - Those who eat high-protein diets.
 - Those who are overweight and sedentary.
- 12.** A formal diagnosis of type 2 diabetes is based on persistent:
- Higher-than-normal plasma glucose levels.
 - Higher-than-normal urinary albumin levels.
 - Symptoms of polyuria, polydipsia, and weakness.
 - Symptoms of retinopathy, neuropathy, or nephropathy.
- 13.** A fasting plasma glucose level is considered to be a diagnosis of prediabetes if it measures between:
- 70 and 99 mg/dL.
 - 100 and 125 mg/dL.
 - 126 and 130 mg/dL.
 - 131 and 140 mg/dL.
- 14.** The A1C test measures the:
- Percent of hemoglobin to which glucose molecules have become attached.
 - Percent of glycemic indices in persons with type 1 diabetes.
 - Patient's insulin level.
 - Patient's number of functioning beta cells.
- 15.** Which blood tests are helpful in monitoring the kidney function of a patient who has had uncontrolled type 2 diabetes for 10 years?
- A hemoglobin level and white blood count
 - A serum creatinine and blood urea nitrogen levels
 - A bilirubin and alanine transaminase (ALT) levels
 - A prothrombin time and blood glucose level
- 16.** The first step in treating type 2 diabetes is usually:
- Insulin therapy.
 - Oral hypoglycemics.
 - A combination of insulin and oral medications.
 - Lifestyle changes.



- 17.** The treatment program for a patient with diabetes is best developed by the:
- Diabetes educator, because he or she is the expert.
 - Nurse practitioner, because involving physicians is not cost effective.
 - Multidisciplinary team, based on the patient's individual needs.
 - Patient alone, based on his or her preferences.
- 18.** Among lifestyle changes, the most effective way to reduce insulin resistance in a person with type 2 diabetes includes:
- Smoking cessation and blood pressure medication.
 - Weight loss and an exercise program.
 - Improved diet and glucose monitoring.
 - Electrolyte management and ketone monitoring.
- 19.** A recommendation in helping the patient with diabetes plan meals is to:
- Consume red meat no more than twice a week.
 - Eliminate all fat from the diet.
 - Consume healthy fats such as olive oil.
 - Limit egg yolks and butter to three times a week.
- 20.** Which is a **true** statement about sulfonylureas?
- Sulfonylureas act by reducing the amount of glucose released by the liver.
 - Sulfonylureas are seldom prescribed for type 2 diabetes.
 - These drugs stimulate beta cells to release insulin.
 - These drugs are useful for patients with type 1 diabetes.
- 21.** The classic insulin sensitizer medication is:
- Metformin.
 - Pramlintide.
 - Exenatide.
 - Rosiglitazone.
- 22.** Over the years, the function of pancreatic beta cells in a patient with type 2 diabetes:
- Begins to increase with use of oral antidiabetic agents.
 - Begins to recover spontaneously.
 - Declines, and the patient may require insulin therapy.
 - Declines, and the pancreatic alpha cells begin to secrete insulin.



- 23.** Which type of insulin can last up to 24 hours in duration?
- NPH insulin (Humulin N)
 - Insulin lispro (Humalog)
 - Insulin glargine (Lantus)
 - Regular insulin (Humulin R)
- 24.** When teaching patients with type 2 diabetes who have questions about herbal supplements, clinicians should explain that:
- Supplements such as aloe vera can lower blood glucose levels and do not have the potential to cause adverse effects.
 - There is no evidence that herbs can lower blood glucose levels.
 - Herbs may lower blood glucose levels but can also cause blood levels to become dangerously low.
 - Patients may discontinue taking their prescribed antidiabetic agents if they are taking herbal supplements.
- 25.** What is the name of a bariatric surgery that involves creating a small pouch at the top of the stomach and attaching a narrow portion of the small intestine directly to the pouch?
- Roux-en-Y gastric bypass
 - Laparoscopic adjustable gastric banding
 - Sleeve gastrectomy
 - Duodenal switch with biliopancreatic diversion
- 26.** When learning how to self-monitor blood glucose levels, patients with type 2 diabetes are instructed to:
- Measure their blood glucose levels once a day at a specific time.
 - Use continuous glucose monitoring as the sole means of measuring their blood glucose level.
 - Report to a member of the diabetes team if test values fall outside a target range.
 - Keep a log of blood glucose readings for self-use only.
- 27.** Treatment for patients with type 2 diabetes who experience hypoglycemia:
- Includes drinking one-half cup of fruit juice.
 - Includes taking glucagon suppressor medications.
 - Is not needed, as the hypoglycemia will go away on its own.
 - Is not needed, as hypoglycemia affects only people with type 1 diabetes.



- 28.** Patients with type 2 diabetes best control hyperglycemia episodes by:
- Tracking carbohydrate intake.
 - Tracking fat intake.
 - Eating foods with a high glycemic index.
 - Avoiding eating carbohydrates.
- 29.** A good source of protein for persons with type 2 diabetes is:
- Whole milk.
 - Red meat.
 - Soy products.
 - Pork.
- 30.** Treatment for both diabetic ketoacidosis and hyperosmolar hyperglycemic state requires:
- Insulin and fluids.
 - Oral hypoglycemics and glucose.
 - Glucose and diuretics.
 - Glucagon and three glucose tablets.
- 31.** Glycosylation is the process that occurs when glucose molecules:
- Are destroyed by alpha cells.
 - Are affected by too much insulin.
 - Produce rare chemicals in the body.
 - Stick indiscriminately to proteins.
- 32.** The most common long-term complication of diabetes involves:
- Hearing loss due to thinning of the tympanum.
 - Psychiatric illness arising from damage to the brain.
 - Damage to the digestive tract organs.
 - Damage to the arteries, kidneys, eyes, nerves, and feet.
- 33.** Eighty percent of patients with type 2 diabetes die from:
- Diabetic ketoacidosis.
 - Cardiovascular disease.
 - Overwhelming infection.
 - Diabetic neuropathy.



- 34.** Hypertension in patients with type 2 diabetes:
- Increases their risk of cardiovascular disease.
 - Increases their risk of neuropathy.
 - Decreases the effectiveness of their medication for diabetes.
 - Decreases the effectiveness of their medication for lipid control.
- 35.** In patients with type 2 diabetes, diabetic nephropathy:
- Can progress to end stage renal disease.
 - Primarily affects mobility.
 - Affects the muscles of the lower extremities.
 - Is a rare complication.
- 36.** Patients with type 2 diabetes and evidence of kidney damage function best on diets:
- Higher in carbohydrates.
 - Lower in protein.
 - Higher in fat.
 - Lower in fiber.
- 37.** Diabetic retinopathy is a complication best described as:
- Early macular degeneration.
 - A type of glaucoma.
 - Damage to the blood vessels in and around the retina.
 - An outcome of UV damage to the retina.
- 38.** Diabetic neuropathy symptoms include:
- Joint pain and stiffness.
 - Problems with memory and reasoning abilities.
 - Burning pain, especially at night.
 - Lower back pain and weakness.
- 39.** Distal symmetrical polyneuropathy (DSPN) eventually results in:
- Paresthesias and numbness in a “stocking-glove” pattern.
 - Paresthesias and numbness when wearing tight clothing on the extremities.
 - Tachycardia and fainting spells that occur in a regular pattern.
 - Signs of diabetic cardiomyopathy and weight gain due to excess fluid.



- 40.** Diabetic autonomic neuropathy can involve damage to the:
- Inner ear.
 - Functioning of the gastrointestinal tract.
 - Lining of the blood vessels.
 - Sense of smell.
- 41.** Foot wounds in patients with type 2 diabetes are:
- Made significantly worse by diabetic artery damage.
 - Unrelated to peripheral neuropathy.
 - Insignificant if a patient's A1C level is kept less than 7%.
 - Rare in contrast to patients with type 1 diabetes.
- 42.** When the foot of a patient with diabetes becomes pale, pulseless, and painful:
- Apply warm compresses and massage.
 - Apply cool compresses and elevate.
 - Increase insulin injections and suggest a better diet.
 - Treat it as an emergency and consult a surgeon.

