Diabetes Type 2
Prevention, Symptoms, and Treatment

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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 persons with type 2 diabetes. Specific learning objectives include:

- Review the underlying causes of diabetes.

- Describe the incidence, prevalence, costs, and groups at risk of developing type 2 diabetes.

- Discuss prevention strategies for persons at risk of developing type 2 diabetes.

- Describe the assessment and screening criteria used to diagnose and monitor patients.

- Review current recommendations for treating persons with type 2 diabetes.

- Describe the components of a long-term plan of care for persons with diabetes.

- Explain the necessary lifestyle modifications for these individuals.

- Discuss the most serious 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 34.2 million people, or 10.5% of the U.S. population, has diabetes.

- Around 7.3 million people have undiagnosed diabetes.

- Nearly half of American adults have diabetes or prediabetes.

- 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.

- An estimated 6 million Americans use insulin.
  (CDC, 2020; ADA, 2020a)

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 include oral medications, non-insulin injectable medications, and insulin injections.

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 that increase tissue responsiveness to insulin.

Of the various forms of diabetes, the two most common are (ADA, 2020a):

- **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, 2020; ADA, 2020a). 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 diagnosed when fasting glucose levels are elevated in the range of 101–125 mg/dL on more than one occasion (CDC, 2020).

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 can also be avoided or delayed with regular screening for and treatment of complications (WHO, 2020). The most successful model for managing diabetes is a team approach. 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 gland. 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.

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 individual'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 later in life.

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 (ADA, 2019).

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.

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. This is thought to be due to an autoimmune process that occurs in the beta cells. Type 1 diabetes occurs most commonly in young people, although it can occur in any age group (ADA, 2020b).

TYPE 2 DIABETES

Insulin-insensitive diabetes, on the other hand, is generally categorized as type 2 diabetes. Type 2 diabetes occurs most often in older adults, although it can occur at any age. Type 2 diabetes develops when the tissues in the body become resistant to insulin that is made by the pancreas or

when the pancreas is unable to produce enough insulin. This is called *insulin resistance* (ADA, 2020b).

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 often 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, 2020b).

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 individual (or person with diabetes) has more frequent and higher episodes of hyperglycemia, which over time damage the eyes, kidneys, nerves, and blood vessels (ADA, 2020b).

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 estimates that over 34 million Americans have diabetes. The disease affects 10.5% of all Americans. Among people aged 18 years or older, 88 million (34.5% of the U.S. adult population) also have prediabetes. The National Diabetes Statistics Report for 2020 reveals higher rates of diabetes among several racial and ethnic minorities compared to the general population (CDC, 2020).

Worldwide, the number of people with diabetes has risen from 108 million in 1980 to 422 million in 2014 (WHO, 2020). 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 2016, an estimated 1.6 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.

DIABETES BY AGE AND RACE

Diabetes is more common in older people. According to the CDC (2020), 11.5 million people aged 65 years or older have diabetes.

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, 2017–2018 national survey data for people aged 18 years or older reveal the following prevalence rates for diagnosed diabetes:

- 14.7% of American Indians/Alaska Natives

- 11.7% of non-Hispanic Blacks

- 12.5% of Hispanics

- 9.2% of Asian Americans

- 7.5% of non-Hispanic Whites
  (CDC, 2020)

The CDC continues to gather data and update information regarding the incidence and prevalence of diabetes and prediabetes in the United States. Additional data from 2017–2018 include the following (the race groups include people of both Hispanic and non-Hispanic origin):

- 1.5 million new cases of diabetes were diagnosed.

- Compared to adults age 18 to 44 years, incidence rates of diagnosed diabetes were higher among adults age 45 to 64 years and in adults age 65 years and older.

- Non-Hispanic Blacks (8.2 per 1,000 persons) and people of Hispanic origin (9.7 per 1,000 persons) had a higher incidence compared to non-Hispanic Whites (5.0 per 1,000 persons).
  (CDC, 2020)

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 has significantly increased in non-Hispanic Black children (CDC, 2020).

Obesity and sedentary lifestyle are key factors driving the dramatic increase of type 2 diabetes in our society. Type 2 diabetes is associated with increased associated comorbid conditions and early mortality (CDC, 2020).

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 must be developed and implemented as this new generation of people with type 2 diabetes matures. As these individuals 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 (CDC, 2020). This group may also have an increase in frequency of diabetes during the reproductive years, which may further increase diabetes in the next generation (ADA, 2020b).

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 2017 the total economic burden in the United States of diagnosed diabetes was $327 billion, including $237 billion in direct costs and $90 billion in indirect costs (e.g. disability, early death, lost work time).

- People with diagnosed diabetes have healthcare costs over two times higher than what expenditures would be in the absence of diabetes.

- The cost of diabetes medications (notably insulin) is an ongoing barrier to treatment. Up to 25% of patients who are prescribed insulin report not using it because of cost barriers.

- 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 over 40% 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, 2020c)

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.

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.

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 (Khardori, 2020).

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 (Khardori, 2020).

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

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 (ADA, 2020b).

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, 2017)

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.

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.

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.

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 (ADA, 2020b).

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 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 (ADA, 2020b).

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 (Khardori, 2020).

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*.

Some research shows that insulin resistance can be reduced by following low-carbohydrate and ketogenic diets (Diabetes.co.uk, 2017). 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. Others caution the use of a ketogenic diet due to the high fat content (especially unsaturated fats) combined with eating fewer nutrient-rich fruits and vegetables for long-term cardiovascular health (Abasi, 2018).

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.

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 (Merck Manual, 2020a).
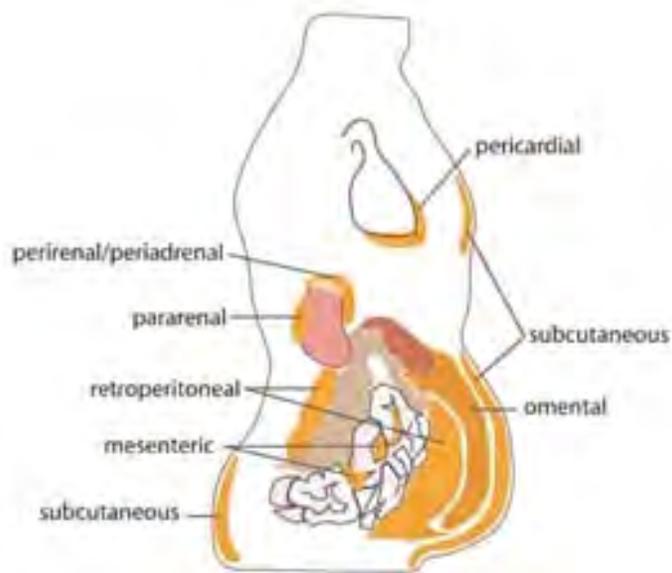
Abdominal fat distribution in the body, showing subcutaneous and various types of visceral fat. (Source: Cook A & Cowan C, Adipose (March 31, 2009), StemBook, ed. The Stem Cell Research Community, StemBook, doi/10.3824/stembook.1.40.1, via Wikimedia Commons.)

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.

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.

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 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.
  (Merck Manual, 2020a)

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 (ADA, 2020a; Merck Manual, 2020a).

DRUGS THAT CAN CAUSE WEIGHT GAIN

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

- Neurologic drugs (e.g., anti-epileptic drugs such as valproate)

- Steroids (e.g., hormonal contraceptives, prednisone)

- Antidiabetic drugs (e.g., insulin, sulfonylureas)

- Antihistamines

- Beta blockers
  (Comerford, 2017)

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.

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 (Merck Manual, 2019a).

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 (Merck Manual, 2020b).

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 ≥35 inches (89 cm) for women and ≥40 inches (102 cm) for men

- Hypertriglyceridemia: ≥150 mg/dL or 1.7 millimoles per liter

- Low high-density lipoprotein (HDL) cholesterol: ≥40 mg/dL in men or ≥50 mg/dL in women of this "good" cholesterol

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- High blood pressure: ≥130/85 mmHg

- High fasting glucose: ≥100 mg/dL
  (Merck Manual, 2020b)

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 who 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 treatment 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
  (ADA, 2020b; Merck Manual 2019b)

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 (ADA, 2020b).

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 (ADA, 2020b). 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
  (ADA, 2020b)

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/m^2) 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
  (ADA, 2020b)

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 (ADA, 2020b).

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:

- 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, 2020c)

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). Weight loss goals for people with prediabetes include losing 7% of their body weight and doing moderate-intensity physical activity (such as brisk walking) at least 150 minutes/week (ADA, 2020d).

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 high-risk 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 (ADA, 2020d).

ASSESSMENT AND DIAGNOSIS OF TYPE 2 DIABETES

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 based on the following criteria:

- A1C level of $\geq$6.5%* (The American Diabetes Association has recommended A1C as a primary diagnostic test for diabetes.)

- Fasting plasma glucose level of $\geq$126 mg/dL*

- 2-hour plasma glucose level of $\geq$200 mg/dL in an oral glucose tolerance test (OGTT)*

- Random plasma glucose level of $\geq$200 mg/dL along with classic symptoms of hyperglycemia or hyperglycemic crisis
  (ADA, 2020b)

  * In the absence of unequivocal hyperglycemia, diagnosis requires two abnormal test results from the same sample or in two separate test samples.

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 70–99 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 (ADA, 2020b).

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.
  (Pagana & Pagana, 2017)

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, 2020b). (For patients already diagnosed with diabetes, A1C levels are also checked every 3 to 6 months 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, 2020b; Pagana & Pagana, 2017).

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 chart shows the average plasma glucose levels that are indicated by various A1C values.

A1C-GLUCOSE CHART		
Range	**A1C Value**	**Estimated Average Blood Glucose (mg/dL)**
Alert Range	10%	240
	9.5%	226
	9%	212
Elevated Range	8.5%	197
	8%	183
	7.5%	169
Goal Range for Most Patients	7%	154
	6.5%	140
	6%	126
(ADA, 2020m)		

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 American Association of Clinical Endocrinologists (AACE) recommends that patients should aim for an A1C ≤6.5%, which differs slightly from the ADA's recommendation of <7% (ADA, 2020b). 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.

Less stringent A1C goals (such as <8% [64 mmol/l]) may be appropriate for patients with a history of severe hypoglycemia, limited life expectancy, advanced microvascular or macrovascular complications, extensive comorbid conditions, or long-standing diabetes in whom the goal is difficult to achieve despite DSME, appropriate glucose monitoring, and effective doses of multiple glucose-lowering agents including insulin (ADA, 2020b).

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 (e.g., first thing in the morning, prior to meals, at bedtime, and sometimes two hours after meals). Also, A1C values will not reflect short swings in plasma glucose levels, as often happens when blood glucose levels are particularly labile.

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 (Merck Manual, 2019a; ADA, 2020b).

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, 2020b).

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	
Lipids	**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 (or <70 mg/dL in patients with cardiovascular disease) • 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 with statins or other lipid-lowering therapies (ADA, 2020e).

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 instead of glucose are being used for energy. 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, 2017).

Albumin Levels

Protein (albumin) leaking into the urine of a person with diabetes usually indicates kidney damage. Significant kidney damage is preceded by microalbuminuria, which is the presence of a small amount of albumin in the urine, an amount less than that detectable by regular reagent strips (e.g., Albustix).

RENAL FUNCTION TESTS

Diabetes is the leading cause of end-stage renal disease. Therefore, it is important to monitor indicators of kidney function. At least once a year, urinary albumin (e.g., spot UACR) and eGFR should be checked in persons with type 1 diabetes with duration of ≥5 years and in all people with type 2 diabetes regardless of treatment. Persons with urinary albumin >30 mg/g Cr and/or an eGFR <60 mL/min/1.73 m^2 should be monitored twice annually to guide therapy (ADA, 2020f).

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 individual from head to toe. For a person who has or is suspected of having diabetes, there are five specific objectives (ADA, 2020f):

- 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, 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 person with suspected type 2 diabetes, the clinician 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 individuals 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 educational 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?
- Do you have social support from friends and family?

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, 2020f)

PHYSICAL EXAM

Many people with type 2 diabetes already have complications present at the time of diagnosis. For instance, the Hoorn Screening study (2004) published results that reported the prevalence of complications in newly diagnosed persons with type 2 diabetes. Microvascular complication rates reached 48.3% for impaired foot sensitivity, 26.7% for microalbuminuria, and 7.6% for retinopathy. The prevalence of macrovascular complications reached 39.5% for ischemic heart disease, 13.3% for myocardial infarction, and 10.6% for peripheral arterial disease (Cornell et al., 2019).

Therefore, 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, 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 (Merck Manual, 2020a).

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. A large waist circumference—one that measures at least 35 inches (89 cm) for women and 40 inches (102 cm) for men—is also one of the criteria for metabolic syndrome (Merck Manual, 2020b).

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:

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

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/m²)**
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
(NHLBI, 2020; Merck Manual, 2020a)		

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

Blood pressure should be measured at every routine clinical visit. Patients found to have elevated blood pressure (≥140/90 mmHg) should have blood pressure confirmed using multiple readings, including measurements on a separate day, to diagnose hypertension (ADA, 2020f).

Patients and clinicians should engage in a shared decision-making process to determine individual blood pressure targets. Potential adverse effects of antihypertensive therapy (e.g., hypotension, syncope, falls, acute kidney injury, and electrolyte abnormalities) should also be taken into account. Patients with older age, chronic kidney disease, and frailty have been shown to be at higher risk of adverse effects of intensive blood pressure control (ADA, 2020f).

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. Persons 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 persons using insulin, skin areas that are used as injection sites should be assessed regularly (ADA, 2020f).

Eyes

Persons 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 on 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 (ADA, 2020f).

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 persons with diabetes. Those who have a very high blood sugar (>400 mg/dL) may exhibit symptoms of ketoacidosis. Ketoacidosis gives a fruity, acetone-like odor to a person's breath (ADA, 2020f).

Cardiovascular System

Persons 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 people with any atypical cardiac signs or symptoms or an abnormal ECG. Some individuals may need to undergo additional screening with stress tests or echocardiogram (ADA, 2020e).

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

Extremities

In persons with 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 feet are cool and pale. The ankle and foot joints should be assessed for deformities and injuries (ADA, 2020f).

Nervous System

Diabetic neuropathies may be present even in those newly diagnosed with diabetes. Often, elevated glucose levels may have been present for a number of years before a formal diagnosis occurs. 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 (ADA, 2020f).

AUTONOMIC NEUROPATHY

One common complication of diabetes 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. It is important 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
  (ADA, 2020f)

Newly Discovered Hyperglycemia

Persons 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 individuals may have symptoms of diabetes, such as polydipsia, polyuria, weakness, fatigue, blurred vision, headache, dizziness, or dehydration. At times, they 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 also 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/m^2. 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 person with type 2 diabetes must be tailored to the individual, the usual progression begins with lifestyle interventions and metformin. Next, other oral or non-insulin injectable medications or insulin itself may be added.

Care Management Team

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

- **Primary care provider or endocrinologist:** 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 person with diabetes, their family, and other team members to educate and support the individual and family as the plan of care and treatment are initiated. Nursing support continues through 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 cavities.

- **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 patients for low vision, cognitive impairment, and fine motor skills and create a plan to address the patient's activities of daily living and assess for and recommend home health care needs, referral to social services, and 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.

- **Certified diabetes care and education specialists (CDCES):** Provide education, direct care, and self-management interventions for patients with diabetes and their families.

Persons with diabetes are more likely than most people without diabetes to present with a variety of physical comorbidities as well as emotional distress. Those 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 client's health.

DIABETES EDUCATORS

Diabetes self-management education and support should be patient-centered and may be provided in group or individual settings and/or use technology for support. Good communication with the entire diabetes care team is key. 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 Care and Education Specialist (CDCES) 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 may be 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 (ADA, 2020g).

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 persons with newly diagnosed diabetes.

Smoking worsens insulin resistance and may accelerate the onset of diabetic complications. People who smoke 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, they may find that formal programs that include support, counseling, and the availability of smoking cessation 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 persons 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, 2020d).

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 ≥5% is needed to produce beneficial outcomes in glycemic control, lipid levels, and blood pressure. Sustained weight loss of ≥7% is optimal (ADA, 2020d).

The ADA (2020f) recommends that persons with diabetes have their BMI calculated and documented in the medical record on an annual basis. BMI should be calculated from height and weight and be classified to determine the presence of overweight or obesity, discussed with the individual, and documented in the medical record.

A Mediterranean diet rich in nutrient-dense foods such as whole grains, vegetables, fruits, legumes, low-fat dairy, lean meats, nuts, and seeds is recommended for body weight management (ADA, 2020d).

DIET AND NUTRITION

The ADA recommends that nutrition therapy for persons 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 (ADA, 2020f).

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 (ADA, 2020g).

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 (such as low-fat sweetened cereals, yogurt, cookies, and snacks) is strongly discouraged (ADA, 2020g).

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, 2020g).

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, 2020g).

Artificial Sweeteners

When consumed in moderation, nonnutritive and hypocaloric sweeteners have the potential to reduce overall caloric and carbohydrate intake and may be preferred to sugar (ADA, 2020g). However, research suggests that there may be some risk associated with the consumption of large amounts or frequent use of such sweeteners (e.g., using nonnutritive sweeteners as substitutes for nutrient-dense foods such as milk and fruits). Small amounts in moderation may be acceptable. However, patients should consult with their healthcare providers regarding use of artificial sweeteners (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) (ADA, 2020g).

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, 2020g). 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, 2020g).

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 recommends that:

- Children and adolescents with type 1 or type 2 diabetes or prediabetes engage in 60 minutes per day or more of moderate to 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 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 engage in two to three sessions/week of resistance exercise on nonconsecutive days.

- All adults (especially those with type 2 diabetes) decrease the amount of time spent in daily sedentary behavior.

- Flexibility training and balance training two to three times per week for older adults with diabetes.
  (ADA, 2020g, 2020h)

YOGA AND TAI CHI

Yoga and tai chi have shown positive results for patients 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 (ADA, 2020g).

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/m^2, 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 describes his 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, 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, healthy nutrition, exercise, and oral or non-insulin injectable medications (CDC, 2020).

ORAL AND NON-INSULIN INJECTABLE HYPOGLYCEMICS

Along with lifestyle changes, the addition of an oral hypoglycemic medication is often recommended as first-line therapy. Metformin is usually recommended as a first choice because it is generic (and therefore least expensive). It has proved to be effective when added to lifestyle changes, it can be combined with most other hypoglycemics if needed, and it rarely if ever causes hypoglycemia (ADA, 2020i).

The addition of metformin is given a 3- to 6-month trial. If this succeeds in producing A1C values to <7%, the regimen is continued and the patient is evaluated (and A1C levels are measured) every 3 to 6 months. Treatment with metformin should continue for as long as tolerated as long as it is not contraindicated. 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 (ADA, 2020i; Meneghini, 2020).

The next step in treating type 2 diabetes with medications is much more individualized. When choosing an additional drug or combination of drugs, it is useful to have records of fasting morning blood glucose levels. A patient-centered approach is then used to guide the choice of treatment. Considerations include cardiovascular comorbidities, risk of hypoglycemia, impact on weight, cost, risk for side effects, and patient preferences (ADA, 2020i).

There are many classes of **type 2 diabetes medications**. Each one works in a different way to help the body lower blood glucose.

Metformin

Metformin 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 (Meneghini, 2020; Comerford, 2017). Metformin may cause nausea and diarrhea, but these side effects often resolve with time (ADA, 2020i).

GLP-Receptor Agonists

Most of these medications are taken by injection. This class of drugs work by slowing digestion and helping lower blood glucose. Their use may be associated with weight loss. Side effects may include nausea and increased risk of pancreatitis (ADA, 2020i; Meneghini, 2020). This medication may help reduce the risk of cardiovascular disease

and stroke in patients with high risk. Examples include exenatide (Byetta, Bydureon), iraglutide (Victoza), and semaglutide (Ozempic).

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 (Meneghini, 2020). Possible side effects include genital fungal infections, urinary tract infections (UTIs), decline in kidney function, hypotension, and dizziness (ADA, 2020i; Meneghini, 2020). Examples include canagliflozin (Invokana), dapagliflozin (Farxiga), and empagliflozin (Jardiance).

DPP-4 Inhibitors

DPP-4 inhibitors reduce glucagon and blood glucose levels, although their effect is quite modest. Side effects may include joint pain. Examples include sitagliptin (Januvia), Saxagliptin (Onglyza), and Linagliptin (Tradjenta) (Meneghini, 2020; Comerford, 2017).

Thiazolidinediones

This class of medications makes the body's tissues more sensitive to insulin. Side effects may include weight gain and other serious side effects, such as anemia and increased risk of heart failure (Meneghini, 2020). Examples of this medication include rosiglitazone (Avandia) and pioglitazone (Actos).

Sulfonylureas

This class of medication helps the body increase secretion of insulin. Side effects may include low blood glucose and weight gain (Meneghini, 2020). Examples include glyburide (DiaBeta, Glynase), glipizide (Glucotrol), and glimepiride (Amaryl).

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 injection of long-acting insulin. People prefer simple treatment regimens, but over time patients may require a more complex schedule of insulin injections (Meneghini, 2020).

Over the years, the ability of pancreatic beta cells to secrete insulin continues to decrease in persons 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 their 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, 2020i; Meneghini, 2020).

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, 2020i; Meneghini, 2020).

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, 2020i).

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 debilitating complications of the disease. Insulin can be administered in more convenient delivery forms such as via injection pens, pumps, as well as inhaled insulin (if not contraindicated). When insulin is incorporated into the treatment of poorly controlled diabetes, patients feel better and report that their quality of life has improved (Meneghini, 2020; ADA, 2020i).

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.

- 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.

- **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.

- The effects of **long-acting** insulins can last for up to a day.
  (Meneghini, 2020)

Most often, people with type 2 diabetes start with one long-acting insulin injection. As time goes on, they may need to switch to a more complex insulin regimen to match the daily changes in blood glucose levels (i.e., high after meals and low during the night).

An insulin-dependent person may need to mix two types of insulin. **Mixed injections** have a rapid or short onset, give two peaks, and last for 10 to 16 hours. For convenience, insulins are available in a few dual-acting, pre-mixed formulations (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 may be combined with lifestyle changes and can result in loss of 5% to 10% of body weight. Medications should only be used in people who have a BMI >27 kg/m^2 and one or more obesity-associated comorbid conditions. Each medication has risks and benefits and should be used under close medical supervision (ADA, 2020j; Meneghini, 2020).

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. For most supplements, however, there is not evidence to support a beneficial effect on diabetes or its complications. 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 (NCCIH, 2018).

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

- Aloe vera
- Bilberry extract
- Bitter melon
- Cinnamon
- Fenugreek
- Ginger
- Okra
  (NCCIH, 2018)

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. 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, 2020j).

Typically, surgery is only recommended for those with a BMI ≥40 kg/m^2 (BMI >37.5 kg/m^2 in Asian Americans), especially if their diabetes or associated comorbidities are difficult to control with lifestyle changes and drug therapy. Surgery may also be considered as an option for adults with type 2 diabetes and BMI between 30.0–34.9 kg/m^2 (27.5–32.4 kg/m^2 in Asian Americans) who do not achieve sustained weight loss and improvement in comorbidities (ADA, 2020j).

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 therapist, occupational therapist, 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 for a center to demonstrate that it offers high-quality care to patients in the setting of a multidisciplinary team approach (MBSAQIP, 2020).

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). Examples of bariatric surgery are listed below:

- **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.

(Merck Manual, 2019b)

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 is an important part of long-term recovery, with assistance from occupational therapists to teach activities of daily living and physical therapists to create and monitor a regular exercise and strengthening program (ADA, 2020j).

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. People 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 an integral member of the treatment team and must understand and be involved in developing their 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, 2020g; Meneghini, 2020). The diabetes nurse educator is an important member of the healthcare team. Additionally, the Association of Diabetes Care and Education Specialists (ADCES) provides the names of local diabetes educators and contact information for education programs throughout the country.

PATIENT EDUCATION CORE CONTENT AREAS: ADCES SELF-CARE BEHAVIORS

- Diabetes pathophysiology and treatment options

- Healthy eating

- Physical activity

- Medication usage

- Monitoring and using patient-generated health data

- Preventing, detecting, and treating acute and chronic complications

- Problem solving

- Healthy coping with psychosocial issues and concerns
  (ADCES, 2020)

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 their glucose level varies and is an individualized determination. Patients beginning insulin therapy are usually asked to monitor their blood glucose level four 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 as directed by their provider. 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

- Before going to sleep

- 1 to 2 hours after each meal
  (Nettina, 2019; ADA, 2017a)

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 home test results fall out of the prescribed goal range. Patients are also instructed to bring a log of all the interim blood glucose values to each office visit (Nettina, 2019).

Using 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 that the home numbers can be compared directly to the published standards.

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.

Continuous glucose monitoring (CGM) measures interstitial glucose and includes sophisticated alarms. The FDA has recently approved CGM devices to monitor glucose. CGM allows real-time glucose monitoring to make treatment decisions and is most often used for those patients who are on insulin therapy (ADA, 2020k).

ADDRESSING HYPOGLYCEMIA RISK

It is important to educate persons with type 2 diabetes who are on insulin therapy or sulfonylureas about hypoglycemia, which is a serious risk. (Hypoglycemia is defined as blood glucose <70 mg/dL.) 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 of 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 must recognize the following symptoms of hypoglycemia in their patients:

- 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
  (Merck Manual, 2019a)

Treatment

People may be instructed to treat hypoglycemia if they are experiencing symptoms even if their blood glucose is only relatively low compared to their usual readings. Sugar is the treatment for hypoglycemia.

When symptoms of hypoglycemia are experienced, persons with diabetes should:

1. Test blood glucose (to determine if hypoglycemia is indeed the cause of symptoms)

2. If blood glucose is low, treat using "the rule of 15," which means, eat or drink 15 grams of fast-acting carbohydrate (i.e., 1/2 cup fruit juice or sugared soda; 4 glucose tablets; or 1 tablespoon sugar, honey or syrup), then wait 15 minutes before retesting

3. If repeat test is still <100 mg/dL, treat with another 15 grams fast-acting carbohydrate (as noted above) and repeat cycle

If treatment does not improve the symptoms, the patient is directed to go to a physician, clinic, or hospital for care (Nettina, 2019).

All patients with type 2 diabetes should wear medical identification, such as a Medic-Alert bracelet. Patients may be given specific instructions about how to handle hypoglycemic episodes. Some patients should also have an emergency glucagon kit, and family and friends should be taught how and when to give a glucagon by inhalation or injection (Nettina, 2019).

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 table 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. With this in mind, less stringent goals are set for some individuals (ADA, 2020i; Meneghini, 2020).

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 <140/90 mmHg (less stringent goals may be set for some individuals)

- Fasting plasma HDL-cholesterol >40 mg/dL in men, >50 mg/dL in women

- Fasting plasma triglycerides <150 mg/dL
  (ADA, 2020f)

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 (ADA, 2020f).

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 for each individual.

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 (ADA, 2020f).

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. Patients with diabetes should perform aerobic and resistance exercise regularly. Aerobic activity should last at least 10 minutes, with the goal of 30 minutes/day or more on most days of the week with no more than two consecutive days without exercise (ADA, 2020f; Meneghini, 2020).

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

Depending on their medication regimen, persons with type 2 diabetes may need to monitor their blood glucose levels to assess for any fluctuations that occur with exercise. About 30 minutes after exercise begins, most people's blood glucose level rises, then it begins to fall. Many things affect blood glucose levels during exercise:

- Fitness level of individual
- Time of day
- Type of exercise/activity
- Prevailing glucose level prior to exercise
- Duration and intensity of exercise

The patient is instructed to monitor blood glucose levels and plan according to the following recommendations:

- Check blood glucose before exercise and every one to two hours during exercise.

- Check blood glucose again after exercise to see how exercise affects glucose levels. This is beneficial in planning for future exercise and whether medication adjustment or carbohydrate intake is needed.

- Always have a carbohydrate food or drink available during exercise.

- If blood glucose was within the goal range before exercise and it falls more than 30–50 mg/dL or hypoglycemia occurs, eat one carbohydrate serving (15 grams) every 30–60 minutes during exercise.

- The effect of exercise on glucose levels can last for several hours after activity; be prepared for the possibility of delayed hypoglycemia.

- If rapid, short, or intermediate-acting insulin is being used as treatment, it may be necessary to decrease the dose of insulin taken prior to exercise by 10%–30% (long-acting insulin is not generally adjusted for exercise) as directed by the primary care provider.

- Whenever possible, exercise should be planned for times when insulin is not peaking. (ADA, 2020f)

Patients should not exercise:

- If blood glucose level is >300 mg/dL. Postpone exercise until it is <300 mg/dL.

- If blood glucose is <70 mg/dL. Eat one or two carbohydrate servings and make sure the blood glucose level is back in goal before starting exercise.

- When feeling ill.

- Prior to bedtime. This reduces the risk of hypoglycemia during the night. If evening exercise is necessary, patients may be instructed to take an extra carbohydrate serving before bed and wake up during the night to test blood glucose. (ADA, 2020f)

EXERCISE PRECAUTIONS AND DIABETIC COMPLICATIONS

The diabetes team screens each person 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.

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 (ADA, 2020g).

Hypertension. The general rule is to bring a patient's blood pressure into a healthy range before initiating an exercise program (ADA, 2020g).

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 (ADA, 2020g).

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 also often affect balance and equilibrium. Therefore, diabetic patients with peripheral neuropathy may benefit from working closely with a physical therapist or exercise physiologist to incorporate an individualized plan of care for rehabilitation that is appropriate for their specific situation. Patients with significant peripheral neuropathy should not participate in strenuous exercise such as prolonged walking, treadmill use, jogging, or step exercise unless specifically instructed and monitored by an appropriate healthcare professional (ADA, 2020g).

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 (ADA, 2020g).

CASE

Alessandro 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 a physical therapist due to several recent falls that occurred at the factory where he is employed.

In the initial patient interview, Alessandro 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, Alessandro 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.

Alessandro 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 sports he used to enjoy. He states that he has been hesitant to participate in sports, however, due to fear of falling. Alessandro 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 Alessandro:

- 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 Alessandro develop the following goals to address both his current functional deficits and his long-term personal objectives:

Short-Term Goals

- Alessandro will be independent and compliant with a home exercise program that addresses static and dynamic balance, skin inspections to both feet, and proprioceptive activities.

- Alessandro will improve his Berg Balance score by at least 3 points.

Long-Term Goals

- Alessandro 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.

- Alessandro will demonstrate consistently safe ambulation over all surfaces (including soft, uneven, or sloped surfaces) without loss of balance.

- Alessandro will successfully navigate his work environment without loss of balance or falls for a period of 30 days.

- Alessandro 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 schedule their meals and their medications to avoid periods of hypo- and hyperglycemia.

The priority for meal planning is striking a healthy 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).

The Mediterranean, low-carbohydrate, and vegetarian/plant-based diets are all examples of healthy eating that have shown positive results in research. Individualized meal planning should focus on personal preferences, needs, and goals. Reducing overall carbohydrate intake for patients with diabetes has the most evidence for improving glycemia control (ADA, 2020g).

The Diabetes Plate Method is often taught to individuals managing type 2 diabetes. This method provides a visual way to plan a meal of healthy vegetables, lean proteins, and limited higher carbohydrate foods that can cause a spike in blood glucose.

THE DIABETES PLATE METHOD

(Source: CDC.gov)

Start with a 9-inch dinner plate:

- Fill half with nonstarchy vegetables, such as salad, green beans, broccoli, cauliflower, cabbage, and carrots.

- Fill one quarter with a lean protein, such as chicken, turkey, beans, fish, or eggs.

- Fill one quarter with a grain or starchy food, such as potatoes, rice, or pasta. (Hamilton, 2015)

Patients with type 2 diabetes not meeting glycemic targets or for whom reducing glucose-lowering drugs is a priority, reducing overall carbohydrate intake with a low- or very-low-carbohydrate eating plan may be an option to try. 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 one of the best guides for people with diabetes (ADA, 2020g).

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, added sugar, 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

8 servings per container

Serving Size → **Serving size**   2/3 cup (55g)

Amount of Calories → Amount per serving
Calories   **230**

% Daily Value*

Total Fat 8g	**10%** ← **Percent Daily Value**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 240mg	6%

Nutrients → (points to the nutrient section)

Footnote → * The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

(For educational purposes only. These labels do not meet the labeling requirements described in 21 CFR 101.9.)

(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 **serving 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**. This section provides information on how much energy (in calories) is provided in the food.

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 right-hand column and footnote area of the label provide 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-calorie diet.

(U.S. FDA, 2020)

CARBOHYDRATES

A person with diabetes should include a healthy balance of carbohydrates in their meal plan each day. Although low-carbohydrate diets 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 (ADA, 2020g).

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. A general guideline for an adult woman is to limit carbohydrates intake to 30–45 grams for each of three meals per day and adult men to limit carbohydrate intake to 45–60 grams for each of three meals per day (ADA, 2020g; Franz & Evert, 2017).

CARBOHYDRATE CONSUMPTION	
Recommend	**Limit**
• Whole grain breads and pasta, brown rice, bulgur, quinoa, barley, oatmeal • Fresh fruits • Fresh vegetables, legumes, dried beans, lentils • Nonfat milk, nonfat yogurt, soy and almond milk • Whole grain crackers	• White breads, cakes, cookies • Fruit juices, sodas, juice drinks • Starchy vegetables such as potatoes, peas, corn • Whole milk, sweetened whole-fat yogurt • Chips, fried snacks
(ADA, 2020g)	

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 (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 (ADA, 2017b).

Carbohydrate counting may be done in one of two ways:

- The person takes a fixed dose of insulin at each meal and tries to eat a fixed, predetermined amount of carbohydrates that coincide with that amount of insulin.

- The person has an insulin-to-carbohydrate ratio (ICR) in which they count the carbohydrates they are going to consume and calculate the amount of insulin to take based on the ICR.
  (ADA, 2017b)

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, 2020g; Franz & Evert, 2017).

Fats should make up 20%–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 • Seeds, nuts • Olive oil, olives • Nut butters (almond butter, peanut butter)	• Commercial fried fish • Fried snacks (e.g., potato chips) • Butter, margarine

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%–20% of a day's total calories (Franz & Evert, 2017). Plant-based proteins are a good source of healthy protein and fats as well as a good source of fiber. Some research has found successful management of type 2 diabetes with meal plans that include slightly higher levels of protein (20%–30%), which may contribute to increased satiety (ADA, 2020g).

PROTEIN CONSUMPTION	
Recommend	**Limit**
• Poultry, veal, fish • Eggs, nonfat milk • Nonfat or low-fat cheese • Soy products (e.g., tofu) • Nuts and nut butters • Beans, lentils, peas	• Beef, sausage, pork • Whole-milk products • Whole-milk cheese

FIBER

Some plant carbohydrates—such as cellulose, gums, and pectin—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 pectin (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).

Vitamin B_{12} levels may be monitored in those patients who are taking metformin since B_{12} deficiency can occur in these patients (Aroda et al., 2016). Some clinicians may recommend that patients with type 2 diabetes take a daily supplement of 0.4–1.0 mg folic acid, 0.4 mg vitamin B_{12}, and 10 mg pyroxidine (Franz & Evert, 2017).

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 (ADA, 2020g). People with diabetes who choose to drink alcohol should drink only moderately. Generally speaking, moderate drinking means no more than two drinks per day for men and 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, 2020g).

DIABETES DISTRESS

Diabetes distress is a common and distinct concern for patients with diabetes. Diabetes distress is described as significant negative psychological reaction related to the emotional burden and stress a patient with diabetes may experience as a result of having to manage a severe and complicated chronic disease. Patients are dealing with multiple lifestyle and behavioral demands, including medication dosing and titration, monitoring blood glucose, food intake, and physical activity. This constant pressure to manage their condition may cause more and more distress as the disease progresses. Patients often feel guilt and distress if their condition worsens despite making lifestyle changes and taking medications.

Providers should routinely screen patients for distress using validated measures. If distress is identified, appropriate referral for additional support (social, emotional, and financial) and education may be recommended as well as a referral to a mental health provider for assessment and management (ADA, 2020f).

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 persons 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 (Nettina, 2019).

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, 2020l).

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, 2020l).

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
  (ADA, 2020l)

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 (Meneghini, 2020).

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
  (Meneghini, 2020)

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. In addition, aspirin therapy (75–162 mg/day) may be considered as a primary prevention strategy in those with diabetes who are at increased risk for cardiovascular problems and as a secondary prevention strategy in those with diabetes and a history of arteriosclerotic CVD. Patients and providers should have a comprehensive discussion on the benefits vs. the increased risk of bleeding (ADA, 2020f).

Hypertension

The majority of people with type 2 diabetes also develop hypertension. Individuals with diabetes are advised to keep their blood pressure below 140/90 mmHg. Lower blood pressure goals (<130/80 mmHg) should be considered for patients based on individual benefits and risks (ADA, 2020l).

Even with lifestyle changes, most people with type 2 diabetes and hypertension need antihypertensive medications (often two or more drugs) to reach this target. Patients with hypertension and type 2 diabetes should also perform home monitoring of their blood pressure. Maintaining a low blood pressure may also help ward off other complications of diabetes such as vision loss and kidney failure (Meneghini, 2020).

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, 2020l).

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, 2020e).

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, depending on individual needs. 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 triglyceride level 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, 2020e).

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 (Meneghini, 2020).

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 may be recommended for some 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 (ADA, 2020e; Meneghini, 2020).

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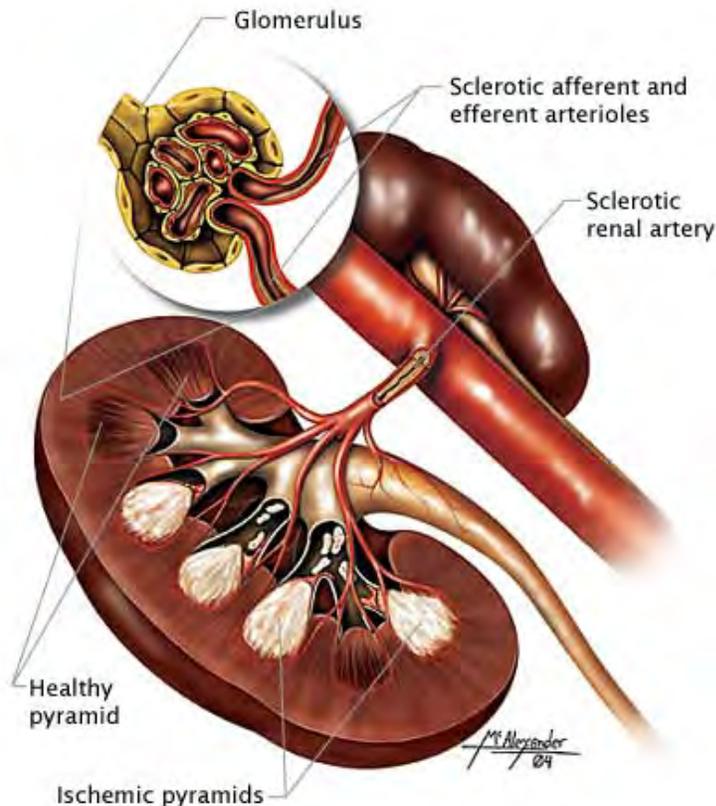
A cross-section of the kidney showing ischemic pyramids and sclerotic arteries and arterioles. (Source: Illustration by Jason McAlexander, © Wild Iris Medical Education, Inc.)

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 (2020l) recommends that patients with type 2 diabetes check two **indicators of kidney functioning** annually:

- Blood should be tested for **serum creatinine levels**, which is used to estimate the glomerular filtration rate.

- 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.

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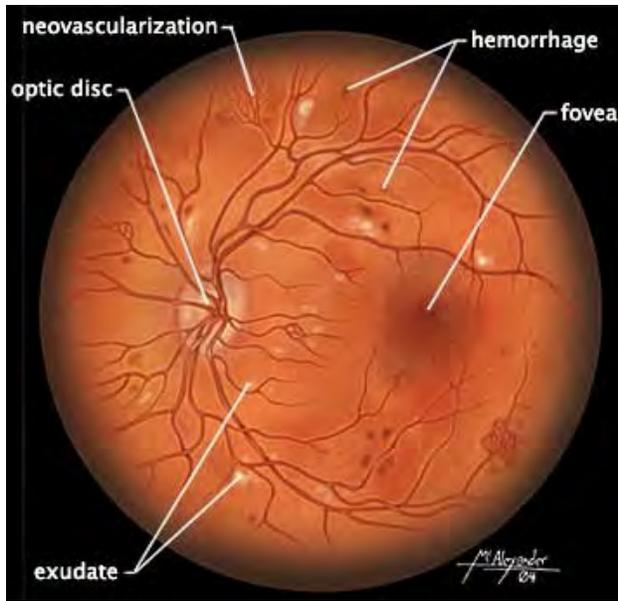
The retina viewed through a scope showing damage due to diabetes, including light exudate splotches, mini-hemorrhages, and areas of neovascularization.
(Source: Illustration by Jason McAlexander. © Wild Iris Medical Education, Inc.)

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, 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 with kidney damage may already have retinopathy, so kidney damage is a warning that the patient should be seen by an ophthalmologist (ADA, 2020l).

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 (Meneghini, 2020).

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 ($\geq$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, highly erratic or labile blood glucose levels, 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, 2020l; Meneghini, 2020)

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 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, 2020l).

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 3–6 months. The patient may benefit from a referral to a podiatrist or advanced practice nurse specializing in managing diabetic foot care. 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 and/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 (Meneghini, 2020).

Pain from neuropathy should be treated by a specialist, who may 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 GI 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 result in 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 (Meneghini, 2020).

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, Inc.)

At each visit, the patient's nails, skin, and joints of both of the ankles and feet are examined. Testing includes assessing the foot and ankle pulses for the ability to feel pressure and vibration and two-point discrimination to test sensation 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. A referral to a podiatrist for regular foot care and nail trimming can be very beneficial to preventing problems (Meneghini, 2020).

Patients with diabetes are warned about the extra risks that foot injuries pose for them. A physical therapist or other clinician working with a patient who has existing neuropathy or poor circulation 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 (ADA, 2020l). 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 (Meneghini, 2020).

The most common cause of foot injury is excess pressure on the skin on bony prominences (such as metatarsal heads, calcaneus, and malleoli) of the feet and ankles. To ease pressure points, well-fitted athletic shoes are preferable to dress shoes or shoes with hard soles. For feet with

insufficient circulation or poor sensation, special shoes with individualized internal molds may be needed in order to evenly distribute pressure during walking. Diabetic footwear includes a high, wide toe box (to maximize space and reduce pressure), removable insoles to insert orthotics if needed, and rocker soles and heel counters to provide support and stability (Physiopedia, 2020). These patients should see a podiatrist along with a physical therapist to address strategies and management to decrease injury to the feet (Meneghini, 2020).

Wounds on feet with neuropathy or poor circulation cannot be treated casually. Even small wounds must be thoroughly examined, cleaned, and debrided and 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 must 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 regularly (e.g., Eucerin or lanolin).

- 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.
  (ADA, 2020l; Meneghini, 2020)

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 (Meneghini, 2020).

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, 2020; Meneghini, 2020)

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 postoperative period are vital to the patient.

Preoperative

Preoperative **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, 2020)

Postoperative

Postoperative **rehabilitation goals** include:

- Pain management

- Incisional healing

- Postoperative limb positioning and wrapping (to prevent contractures and help manage edema)

- **Physical therapy:**
  - Bed mobility
  - Transfers
  - Lower extremity range of motion and strengthening
  - Mobility training with appropriate assistive device (walker, wheelchair, cane, etc.)
  - Balance (seated, standing, walking, stairs)

- o Progressively increasing activities to tolerance

- o Discharge planning (assistive device recommendations/training, home exercise program, determining need for further therapies at home, etc.)

- **Occupational therapy:**

  - o Assisting with ADLs

  - o Assessing need for adaptive equipment in the home

  - o Evaluating home safety and recommendations for modifications if needed

  - o Developing energy conservation strategies

  - o Upper extremity stretching and strengthening
    (Cifu, 2020)

The goal of rehabilitation therapy after amputation is to have the patient successfully transfer back to their baseline or home environment. After surgical recovery, the patient may need to remain inpatient within a more intensive and supervised rehabilitation environment, or may be able to participate in either home-based or outpatient rehabilitation. Regardless of the rehabilitation environment upon inpatient discharge, prompt follow-up with a physical therapist, occupational therapist, and a prosthetist is important in order to continue to meet patient needs (Cifu, 2020).

The patient is assessed for the appropriate prosthetic, including a preparatory limb, after a period of wound healing has taken place. Steps to transition to a prosthetic includes assessing arm strength, balance, bed-to-chair transfers, and contralateral limb strength. 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 (activities of daily living such as dressing, bathing, and household chores) as well as a continued program of home exercises (Cifu, 2020).

General Rehabilitation Management and Type 2 Diabetes

Patients with type 2 diabetes who have chronic, progressive complications or are recovering from procedures or medical/surgical interventions often require structured rehabilitation for a successful recovery. As discussed above, the most **common chronic effects** that patients with type 2 diabetes may experience include peripheral neuropathy, orthostatic hypotension, vision changes, and cardiac decompensation (Cifu, 2020).

The key to a successful rehabilitation program is individualization. Rehabilitation specialists, including physical therapists and occupational therapists, 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. 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.

ROLE OF PHYSICAL THERAPY IN REHABILITATION

Physical therapists may assist patients with diabetes in rehabilitation management through the following:

- Helping prepare a patient for the functional mobility-related aspects of surgery and recovery

- Teaching patients how to use assistive devices and/or a prosthesis

- Assessing strength, flexibility, endurance, gait, and balance (static and dynamic)

- Creating safe, individualized exercise programs to improve functional mobility, reduce pain, and improve blood glucose levels

- Assisting patients to heal and/or manage circulation and skin problems (APTA, 2017)

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/or pain. Mechanical mobility aids (such as wheelchairs, walkers, or canes) may help reduce pain and lessen the impact of physical disability. Properly fitted hand or foot/ankle braces may help compensate for muscle weakness or alleviate nerve compression. Orthopedic shoes may improve gait disturbances and help prevent foot injuries in people with a loss of pain/sensation (Tabloski, 2019). Patients with neuropathy have been shown to benefit from aquatic therapy focusing on gait training, strength, and balance control (Zivi et al., 2017).

Patients with orthostatic hypotension should be advised to be proactive when changing from a supine to standing position by moving slowly and holding onto a chair or bed for 30 seconds after standing to minimize their risk for falling. Patients may also be advised to wear supportive compression stockings to increase venous return (Tabloski, 2019).

If a patient has an existing cardiac condition, gentle daily exercise to increase and maintain the ability to perform ADLs is often encouraged. These may include chair exercises, arm exercises, and other nonstrenuous movements such as tai chi or chair yoga (Tabloski, 2019).

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.) may be incorporated with appropriate guidance from therapy professionals (Cifu, 2020).

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 for healthcare providers to understand. 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- and long-term management strategies to support the health and wellness of patients with type 2 diabetes and their families.

RESOURCES

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

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

Diabetes Forecast (ADA)
http://www.diabetesforecast.org

eAG/A1C Conversion Calculator (ADA)
https://professional.diabetes.org/diapro/glucose_calc

Glucose-lowering medications in type 2 diabetes (ADA)
https://care.diabetesjournals.org/content/43/Supplement_1/S98

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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1. Type 1 diabetes is distinguished from type 2 diabetes in that:

    a. The pancreas of persons with type 2 diabetes produces no insulin.

    b. The body tissues of persons with type 2 diabetes become resistant to insulin made by the pancreas.

    c. Type 1 diabetes is a disease that is curable.

    d. Type 1 diabetes is a disease that adults gradually develop over a period of years due to a problem with the pituitary gland.

2. Which child is at the **greatest** risk for developing type 2 diabetes?

    a. An 11-year-old Hispanic child 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 African American child documented as increasingly overweight at last three visits and whose parents both have diabetes

    d. A 10-year-old African American child documented as overweight at last visit and with no family history of diabetes

3. 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 from the bloodstream into the cells.

    d. Facilitating the release of glucose from the cells out into the bloodstream.

4. Insulin resistance can be caused by:

    a. Excessive thirst (polydipsia).

    b. Excessive urination (polyuria).

    c. High levels of glucocorticoids.

    d. Chronically low triglyceride levels.

5. In assessing a male patient, the nurse considers which finding to be a possible indicator of metabolic syndrome?

    a. Waist circumference >102 cm (40 in)

    b. Blood triglycerides >100 mg/dL

    c. Blood HDL-C <50 mg/dL in men

    d. Blood glucose >75 mg/dL

6. People age 29 and older who should be screened for prediabetes include:

    a. Women who exercise three times per week or less.

    b. Men who have a high resting pulse rate.

    c. Those who eat high-protein diets.

    d. Those who are overweight and sedentary.

7. A formal diagnosis of type 2 diabetes is based on persistent:

    a. Higher-than-normal plasma glucose levels.

    b. Higher-than-normal urinary albumin levels.

    c. Symptoms of polyuria, polydipsia, and weakness.

    d. Symptoms of retinopathy, neuropathy, or nephropathy.

8. A fasting plasma glucose level (with confirmed testing) indicates a diagnosis of diabetes if it measures:

    a. 70 to 99 mg/dL.

    b. 126 mg/dL or higher.

    c. 100 to 110 mg/dL.

    d. 110 to 120 mg/dL.

9. The A1C test measures the:

    a. Percent of hemoglobin to which glucose molecules have become attached.

    b. Percent of glycemic indices in persons with type 1 diabetes.

    c. Patient's insulin level.

    d. Patient's number of functioning beta cells.

10. The first step in treating type 2 diabetes is usually:

    a. Insulin therapy.

    b. Oral hypoglycemics.

    c. A combination of insulin and oral medications.

    d. A combination of lifestyle changes and metformin.

11. Over the years, the function of pancreatic beta cells in a patient with type 2 diabetes:

    a. Begins to increase with use of oral antidiabetic agents.

    b. Begins to recover spontaneously.

    c. Declines, and the patient may require insulin therapy.

    d. Declines, and the pancreatic alpha cells begin to secrete insulin.

12. When learning how to manage their condition, patients with type 2 diabetes:

    a. Should measure their blood glucose levels only when they have symptoms of hypoglycemia.

    b. Do not need to regularly check their blood glucose levels.

    c. Should report to a member of the diabetes team if blood glucose values fall outside their target range.

    d. Are encouraged to keep a log of blood glucose readings for self-use only.

13. Treatment for patients with type 2 diabetes who experience hypoglycemia:

    a. Includes drinking one-half cup of fruit juice.

    b. Includes taking glucagon suppressor medications.

    c. Is not needed because the hypoglycemia will go away on its own.

    d. Is not needed because hypoglycemia affects only people with type 1 diabetes.

14. Which focused diet plan has shown positive results for patients with type 2 diabetes:

    a. High carbohydrate diet

    b. Mediterranean diet

    c. High-fat diet

    d. Low-protein diet

15. Which is a **correct** statement regarding diabetes distress?

    a. It refers to a negative physiologic reaction when a person's blood sugar is too high.

    b. It describes the emotional burden and stress of having to manage chronic diabetes.

    c. It refers to the fear of letting others know about receiving a diagnosis of diabetes.

    d. It is likely to lessen as the disease progresses.

16. Treatment for both diabetic ketoacidosis and hyperosmolar hyperglycemic state requires:

    a. Insulin and fluids.

    b. Oral hypoglycemics and glucose.

    c. Glucose and diuretics.

    d. Glucagon and three glucose tablets.

17. The most common long-term complication of diabetes involves:

    a. Hearing loss due to thinning of the tympanum.

    b. Psychiatric illness arising from damage to the brain.

    c. Damage to the digestive tract organs.

    d. Damage to the arteries, kidneys, eyes, nerves, and feet.

18. Eighty percent of patients with type 2 diabetes die from:

     a. Diabetic ketoacidosis.

     b. Cardiovascular disease.

     c. Overwhelming infection.

     d. Diabetic neuropathy.

19. Hypertension in patients with type 2 diabetes:

     a. Increases their risk of cardiovascular disease.

     b. Increases their risk of neuropathy.

     c. Decreases the effectiveness of their medication for diabetes.

     d. Decreases the effectiveness of their medication for lipid control.

20. Diabetic retinopathy is a complication best described as:

     a. Early macular degeneration.

     b. A type of glaucoma.

     c. Damage to the blood vessels in and around the retina.

     d. An outcome of UV damage to the retina.