Metabolic Syndrome
Risk, Diagnosis, 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 related to caring for patients with metabolic syndrome. Specific learning objectives include:

- Describe metabolic syndrome.
- Identify characteristics of patients who are at risk for metabolic syndrome.
- Discuss the assessment and screening criteria used to diagnose metabolic syndrome.
- Review current treatment guidelines and management strategies for patients with metabolic syndrome.
- Identify other diseases and health problems associated with metabolic syndrome.
- Explain the necessary lifestyle changes for controlling risk factors associated with metabolic syndrome.
- Identify serious comorbidities associated with metabolic syndrome and their effective treatment interventions.
- Discuss strategies for the prevention of metabolic syndrome.

WHAT IS METABOLIC SYNDROME?

Metabolic syndrome is a cluster of health problems associated with diabetes. In 1947, the French physician Jean Vague noted that upper-body obesity appeared to be linked to an increased risk for atherosclerosis, diabetes, kidney stones, and gout. Then, Avogaro, Crepaldi, and colleagues reported on six obese patients who were able to demonstrate improvements in their diabetes, elevated blood cholesterol, and high triglycerides when they adhered to a low-calorie and low-carbohydrate diet (Mandal, 2015).
The term *metabolic syndrome* was first used in the 1950s and became commonly used in the 1970s. In 1977, Herman Haller used the term while studying risk factors associated with atherosclerosis. The following year, Gerald Phillips described risk factors for myocardial infarction as a “constellation of abnormalities” that included glucose intolerance; hyperinsulinemia; and a high level of triglycerides, glucose, cholesterol, and insulin. In 1988, Gerald Reaven hypothesized that “insulin resistance could be the underlying factor linking this constellation of abnormalities,” which he named *syndrome X* (Mandal, 2015).

Metabolic syndrome has become increasingly common in the United States, and it is a major public health problem. Metabolic syndrome increases the risk of cardiovascular disease, diabetes, stroke, and coronary artery disease.

The primary causes of metabolic syndrome include obesity, physical inactivity, and possible genetic factors. The primary treatment of choice for metabolic syndrome includes lifestyle modifications such as increasing physical activity; eating a heart-healthy diet; and lowering blood glucose, blood cholesterol, and blood pressure (AHA, 2014).

The Phenomenon of Insulin Resistance

In the early 1920s, the Canadian surgeon Frederick Banting and his assistant Charles Best, a medical student, extracted from the islets of Langerhans in the pancreas a compound that they named *insulin*. When injected into diabetic dogs, this compound decreased the level of sugar in the dogs’ blood and reduced the amount of sugar in the dogs’ urine (Medical News Today, 2016). Before the discovery and purification of insulin, childhood diabetes was a fatal disease; after Banting and Best’s work, diabetes became known as a chronic illness.

In 1936, Sir Harold Percival Himsworth published work in which he differentiated type 1 and type 2 diabetes as different entities (Mandal, 2017). Patients 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 when they also received a subcutaneous insulin injection. In contrast, patients with “insulin-insensitive” diabetes (who were usually middle-aged and who did not have ketotic episodes) did not significantly reduce their blood glucose levels after receiving the same amount of insulin (Wild & Byrne, 2014).

Today, persons who are insulin-sensitive are categorized as having type 1 diabetes. In *type 1 diabetes*, the pancreas produces little or no insulin because the beta cells in the islets of Langerhans of the pancreas are not functioning. Type 1 diabetes shows up most commonly in young people, although it can occur in any age group (Durkin, 2013).

On the other hand, persons who have insulin-insensitive diabetes are categorized as having type 2 diabetes. *Type 2 diabetes* usually shows up in older adults, but it can occur at any age. A distinguishing feature of type 2 diabetes is that even when there is a normal amount of circulating insulin body tissues do not take up glucose as readily as normal. This is referred to as *insulin resistance*, a condition in which normal concentrations of insulin in the blood produce less than the
normal effects in the body, resulting in hyperinsulinemia, or high levels of insulin in the bloodstream (Durkin, 2013).

At first, insulin resistance was thought of in terms of diabetes. Later, however, insulin resistance began to be recognized in patients who did not have diabetes. Many of these insulin-resistant people also had certain other systemic problems—notably obesity, hypertension, lipid disorders, and coronary heart disease. Insulin resistance was also found to be common in women with polycystic ovarian syndrome (PCOS), a disorder of the ovaries caused by numerous small cysts in both ovaries and characterized by absent menstruation, sterility, obesity, and a distribution of body hair more characteristic of men (Olatunbosun, 2015).

In the 1980s, researchers stepped back from their focus on diabetes and realized that insulin resistance frequently occurred as part of a particular cluster of systemic metabolic disorders. This cluster includes:

- Intra-abdominal obesity
- Insulin resistance
- High blood levels of triglycerides
- Low blood levels of high-density lipoprotein (HDL) cholesterol
- High blood pressure
  (Sherif, 2017)

Looking back, researchers discovered that a similar cluster of metabolic problems had already been identified as a special health risk in the 1920s. Putting all the data together in the late 1980s, clinicians proposed that it would be useful to call this cluster of metabolic disorders a syndrome and give it a name (Mandal, 2015).

**Defining Metabolic Syndrome**

Metabolic syndrome is not a disease in the usual sense. Instead, it is a condition, characterized by a collection of factors that impact the body’s ability to maintain circulation of useful but not excessive levels of energy molecules (i.e., glucose and lipids) in the bloodstream. Initially, when the resulting health problems arise, they interact to worsen each other. Eventually, the set of problems (i.e., hyperglycemia, hyperlipidemia) becomes severe enough to lead to serious health consequences. At this point, clinicians say that a person has metabolic syndrome (Durkin, 2013).

From studies of large populations of people, the most common cluster of signs has been found to include obesity, insulin resistance, dyslipidemia (either too much or too little fat in the blood), and hypertension (NHLBI, 2016b).
DEFINITION OF METABOLIC SYNDROME

According to the guidelines from the National Heart, Lung, and Blood Institute and the American Heart Association, a diagnosis of metabolic syndrome is made if at least three of the following are present:

- Abdominal obesity: Waist circumference >102 cm (>40 inches) in men, >89 cm (>35 inches) in women
- Hypertriglyceridemia: Blood triglycerides >150 mg/dL (or on triglyceride-lowering medication)
- Low high-density lipoprotein cholesterol: Blood HDL cholesterol <40 mg/dL in men, <50 mg/dL in women
- High blood pressure: BP >130/85 mmHg or already diagnosed with hypertension
- High fasting glucose: Blood glucose >100 mg/dL

Source: AHA, 2014; NHLBI, 2016b.

DEMOGRAPHICS

It is estimated that 47 million Americans have metabolic syndrome, but many may not even know they have it (Sherif, 2017). Unfortunately, research findings show that the prevalence of metabolic syndrome among Americans has increased significantly over the past decade.

From 2003 to 2012, the overall prevalence of metabolic syndrome in the United States was 33%, with significantly higher prevalence in women compared with men (35.6% versus 30.3%, respectively). When stratified by race/ethnicity, the highest prevalence of metabolic syndrome was found in Hispanics, followed by non-Hispanic whites, and then blacks (Aguilar et al., 2015).

Trends from 2007 to 2012 show that overall prevalence of the metabolic syndrome remained relatively stable, from 36.1% to 34.7%. Also during this latter period, metabolic syndrome prevalence among men and all race/ethnic groups remained stable, whereas prevalence among women decreased from 39.4% to 36.6% (Aguilar et al., 2015).

Prevalence of metabolic syndrome increased with age. Prevalence was 18.3% among persons aged 20 to 39 years and increased to 46.7% among persons aged 60 and older. In patients 60 years and older, more than 50% of women and Hispanics had metabolic syndrome (Aguilar et al., 2015).

Almost 35% of all adults and 50% of those who are 60 years of age or older are estimated to have metabolic syndrome (Aguilar et al., 2015). Additionally, research shows that the risk of metabolic syndrome in women begins to increase around perimenopause, which seems to be associated with increases in testosterone during that time period (Sherif, 2017).
CAUSES/RISK FACTORS FOR METABOLIC SYNDROME

In some diseases, the initiating events act on a common target. For example, most of the causes of type 1 diabetes act, ultimately, to disable the beta cells in the pancreas. In contrast, metabolic syndrome appears to result from the interaction of a number of disorders that can be initiated separately.

The development of metabolic syndrome is related to three issues:

- **Weight.** It is estimated that approximately 22% of people who are overweight and 60% of people who are obese have metabolic syndrome. The risk is believed to be directly related to the amount of abdominal fat, which is defined by waist circumference. However, not everyone who is overweight or obese has metabolic syndrome, and people who are of normal weight can develop metabolic syndrome.

- **Lack of exercise.** Lack of exercise has been shown to be linked to a variety of diseases, including heart disease, cancer, and diabetes. Additionally, lack of exercise contributes to weight gain, being overweight, and becoming obese.

- **Genetics.** Research indicates that there may be a genetic link for the development of metabolic syndrome among family members. (Durkin, 2013; Sherif, 2017)

Although the specific chain of events leading to the appearance of metabolic syndrome is still not clear, much is known about the development and interactions of its separate components. Here is a summary of the causes of the individual components of metabolic syndrome.

**Intra-Abdominal Obesity**

Abdominal obesity is a significant predictor of metabolic syndrome. This is because abdominal (visceral) fat tends to be more resistant to insulin than fat in other areas of the body (Durkin, 2013). The amount of visceral fat, which tends to accumulate more in women after menopause, is the most important risk factor for metabolic syndrome (Sherif, 2017).

Having a large waistline means that there is excess body weight around the waist. A waist measurement of 35 inches or more for women or 40 inches or more for men is indicative of risk for metabolic syndrome. A large waistline is also a risk factor for other health problems such as cardiovascular disease (NHLBI, 2016a).

**GENETIC FACTORS THAT CONTRIBUTE TO OBESITY**

In the past few decades, obesity has reached epidemic proportions in the United States. Genetics can play a significant role in the development of obesity. Studies of comparisons among family members, twins, and adoptees provide evidence that a sizable part of the variations in weight among adults is linked to genetic factors. Additionally, studies have also identified variants in
several genes that may contribute to the development of obesity by increasing hunger and food intake. Rarely, inherited obesity is caused by a specific variant of a single gene (CDC, 2013).

At this time, genetic testing is not helpful for developing a person’s diet or physical activity plan of care. The research that focuses on the genetic factors that contribute to the development of metabolic syndrome is at an early stage (CDC, 2013).

NONGENETIC FACTORS THAT CONTRIBUTE TO OBESITY

- **Prenatal.** There are a number of factors that increase the risk for obesity that begin with fetal development. These include:
  - Maternal smoking during pregnancy. Research shows that the children of women who smoke during pregnancy are more likely to be obese than the children of women who do not.
  - Gestational weight gain. Research shows that children of women who gained an excessive amount of weight during pregnancy had more than four times the risk of being overweight at age 3, compared with children of women who gained an “inadequate” amount of weight.
  - Gestational diabetes. Weight gained during pregnancy is mostly adipose tissue. Excess adipose tissue is often accompanied by relative insulin resistance that starts in mid-pregnancy. This can subject the fetus to periods of high blood glucose and elevated insulin levels, which can lead to increased body fat and may contribute to the development of obesity.
    (Harvard School of Public Health, 2017)
- **Stress and anxiety.** Stress and anxiety, especially when accompanied by a mental health problem such as major depressive episode, generalized anxiety disorder, or bipolar disorder, can lead to overeating in an attempt to control negative emotions and find comfort. Sometimes referred to as stress eating, this type of eating can lead to significant weight gain (Stuart, 2013).
- **Pharmacologic.** Many medications have weight gain as a side effect, and it is important to monitor persons taking these medications. They include:
  - Psychiatric drugs (e.g., lithium, “atypical” antipsychotics such as clozapine and olanzapine, and antidepressants such as the tricyclics)
  - Neurologic drugs (e.g., antiepileptic drugs such as valproate)
  - Steroids (e.g., hormonal contraceptives and prednisone)
  - Antidiabetic drugs (e.g., insulin)
  - Antihistamines
  - Beta-blockers
    (Comerford, 2017)
SUGAR-SWEETENED BEVERAGES AND WEIGHT GAIN

There is significant evidence that drinking too many sugar-sweetened beverages that contain added sugars in the form of high fructose corn syrup or table sugar (sucrose) can lead to weight gain and an increase in risk of developing type 2 diabetes and cardiovascular disease. Research findings show that consuming one or more sugar-sweetened beverages a day is associated with greater weight gain and obesity (ACC, 2015).

CASE

Judy, Age 52

Judy is a 52-year-old white woman with no previous history of diabetes or metabolic syndrome who presents to the clinic with mild hyperglycemia (152 mg/dL) and low high-density lipoprotein (HDL) cholesterol (33 mg/dL). Judy appears to be overweight, and the nurse, Robert, calculates her body mass index (BMI) to be 32 kg/m² (a BMI over 30 is classified as obese). Judy also reports a lack of energy and that her weight has been slowly increasing over the past eight years. Judy is already on a beta-blocker for high blood pressure, which was diagnosed two years ago.

Robert continues the patient assessment by asking Judy about any classic symptoms or complications of diabetes, such as weakness, fatigue, blurred vision, headache, dizziness, or dehydration. Judy confirms that she sometimes feels fatigued and reports occasional headaches. Robert also asks Judy about her family history of diabetes and discovers that her mother had type 2 diabetes.

Robert suspects that Judy may have either diabetes or metabolic syndrome based on the clinical and laboratory findings of elevated blood pressure, blood sugar, and low HDL levels as well as Judy’s other physical assessment findings (e.g., high BMI, fatigue, headaches) and family history. After Robert discusses the results of his nursing assessment with Judy’s primary care physician, a full panel of diagnostic studies are initiated.

Insulin Resistance

Insulin triggers the mechanisms that cells use to take up glucose from their surroundings. In addition, insulin tells cells to:

- Use their internal glucose for generating energy
- Store any excess internal glucose in the form of glycogen
- Stop releasing internal stores of glucose into the circulation

The body’s cells have specialized roles in metabolism. Most of the body’s glucose uptake, oxidation, and storage are carried out in skeletal muscle cells and fat cells. On the other hand, most of the release of stored glucose into the circulation comes from liver cells. Insulin is the signal to all these cells.
Under normal conditions, insulin molecules bind to the receptors on the cells of the body. When cell portals are activated by insulin, they open to allow glucose to enter the cell, where it is converted to energy (Bartelmo, 2013).

Insulin resistance exists when a given amount of insulin produces a less-than-expected biologic effect. In insulin resistance there is an increased insulin secretion to maintain normal glucose and lipid homeostasis (Olatunbosun, 2017).

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

- Less than the normal amount of glucose transport into cells
- Reduced use (metabolism) of intracellular glucose
- Reduced storage of excess internal glucose in the form of glycogen
- Increased glucose release into the circulation (mainly, by the liver) (Olatunbosun, 2017)

In insulin resistance, the basic problem lies in the responding cells, specifically in the mechanisms by which these cells recognize insulin and then produce the intracellular effects of the insulin signal.

The insulin receptor molecule in the membrane of the responding cell is a complex structure with a number of subunits. The malfunctioning or mutation of any of the receptor 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.

Insulin resistance plays a major pathogenic role in the development of metabolic syndrome. Metabolic syndrome may include any or all of the following:

- Hyperinsulinemia
- Type 2 diabetes or glucose intolerance
- Central obesity
- Hypertension
- Dyslipidemia that includes high triglyceride levels
- Low HDL cholesterol level and small, dense low-density lipoprotein (LDL) particles
- Hypercoagulability
  (Olatunbosun, 2017)
GENETICS AND INSULIN RESISTANCE

As with many pathologic processes, insulin resistance develops most readily in people with a genetic predisposition for it. In predisposed people, it is possible that certain genes produce poorly functioning insulin receptor subunits or other molecules in the intracellular chain leading from the receptor to the actual glucose utilization machinery. It is still not clear, however, if any of these potential problems are common causes of the genetic predisposition to develop insulin resistance.

A family history of diabetes, lipid disorders, hypertension, or heart disease increases the risk for development of metabolic syndrome (Scholten, 2013).

EXCESS VISCERAL FAT AND INSULIN RESISTANCE

Abdominal (visceral) obesity is a powerful predictor of metabolic syndrome because visceral fat tends to be more resistant to insulin than fat in other areas of the body. This resistance increases the release of free fatty acids into the portal system, which leads to increased apolipoprotein B, increased LDL, decreased HDL, and increased triglyceride levels. Because of elevated “bad” cholesterol and decreased “good” cholesterol, the risk of cardiovascular diseases also increases (Durkin, 2013).

Additionally, the effect of too many visceral fat cells is too much free fatty acid in the bloodstream. High levels of free fatty acids stimulate the liver to release excess glucose into the bloodstream. High levels of free fatty acids also reduce the amount of glucose taken up by cells throughout the body, even when there is sufficient insulin available. The result of both of these effects is hyperglycemia. The pancreas responds to hyperglycemia by secreting more insulin, so at least temporarily, hyperglycemia always leads to hyperinsulinemia (Durkin, 2013).

Insulin resistance 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 disease or long-term treatment with prednisone), nonalcoholic fatty liver disease, and treatment with protease inhibitors (e.g., for HIV).

Dyslipidemias

In the bloodstream, most lipids are carried in lipoproteins, a group of conjugated proteins in which at least one of the components is a lipid. The surface of a lipoprotein is made up of the more water-soluble lipids, cholesterol and phospholipids. The least soluble lipids, cholesteryl esters and triglycerides, are carried in the centers of the lipoproteins. This spherical package is held together by apolipoproteins, which are specialized fat-carrying proteins.

There are five types of lipoproteins:

- Chylomicrons: These are the largest and least dense of the lipoproteins and have the highest triglyceride content. Chylomicrons are synthesized in the liver.
- VLDL (very low density lipoprotein): VLDL is composed of protein, fats, and cholesterol.
• IDL (intermediate density lipoprotein): IDL is created by the metabolism of VLDL.

• LDL (low density lipoprotein): This is the last remnant of VLDL and contains mostly cholesterol.

• HDL (high density lipoprotein): HDL has the highest protein/lipid ratio and is the densest lipoprotein. It is referred to as good cholesterol because it transports cholesterol away from the tissues to the liver, which lowers blood cholesterol levels. (Thomas, 2015)

Dyslipidemia is an unhealthy amount of lipid circulating in the bloodstream. The specific dyslipidemias of metabolic syndrome include an increase in blood triglycerides and a decrease in blood HDL lipoproteins.

GENETICS AND DYSLIPIDEMIAS

A number of different genetic mutations that affect fat cells will cause the dyslipidemias of metabolic syndrome. In addition, certain genetic mutations of apolipoproteins (e.g., familial combined hyperlipidemia) will cause high blood levels of triglycerides and low blood levels of HDL cholesterol.

Beyond direct genetic causes, the dyslipidemias of metabolic syndrome can result from a variety of problems.

METABOLIC DISORDERS AND DYSLIPIDEMIAS

The most common causes of dyslipidemias are other metabolic problems. Examples of such problems include:

• Diabetes
• Hypothyroidism
• Polycystic ovary syndrome
  (MedlinePlus, 2017)

Women with a history of polycystic ovarian syndrome are at an increased risk for the development of metabolic syndrome (Durkin, 2013).

LIFESTYLE AND DYSLIPIDEMIAS

The same habits that tend to make a person obese will also cause lipid problems. Dyslipidemias can result from insufficient physical activity and a high-calorie diet with excess carbohydrates and too many saturated fats.
KIDNEY PROBLEMS AND DYSLIPIDEMIAS

Patients with chronic renal failure develop high blood triglycerides and decreased levels of blood HDL cholesterol. Later, if they receive kidney transplants, patients are put on immunosuppressive drugs, typically glucocorticoids and cyclosporine; these drugs also raise blood triglycerides and reduce blood HDL cholesterol (Comerford, 2017).

PHARMACOLOGIC CONSIDERATIONS

There are a number of medications that can elevate blood triglycerides, including:

- Antihypertensives
- Corticosteroids
- Antipsychotics
- Isotretinon
- HIV treatment
- Estrogen
  (Healthgrades.com, 2016)

Hypertension

Blood pressure depends on two factors: cardiac output (how much blood is ejected with each heartbeat) and vascular resistance (how much opposition the bloodstream encounters from arteries and veins).

The first factor, cardiac output, depends on blood volume, which is normally regulated by the kidneys. The second factor, vascular resistance, is normally regulated by a balance of vasoconstrictors (e.g., angiotensin II, sympathetic nervous system activity) and vasodilators (e.g., prostaglandins, nitric oxide). High blood pressure can be caused by an increase in cardiac output, an increase in vasoconstriction, or a combination of the two factors (Bartelmo, 2013).

There are two main types of hypertension: essential (also referred to as primary or idiopathic) and secondary (which is related to disease processes that increase peripheral vascular resistance or cardiac output) (Bartelmo, 2013).

PRIMARY HYPERTENSION

Hypertension, which affects 25% of adults in the United States, develops when there is an increase in cardiac output, peripheral resistance, or both. There are a number of factors that play a role in the development of hypertension. These include:

- Family history
• Race (most common in blacks)
• Stress
• Obesity
• Diet high in saturated fats or sodium
• Tobacco use
• Hormonal contraceptives
• Sedentary lifestyle
• Aging
  (Bartelmo, 2013; Durkin, 2013)

SECONDARY HYPERTENSION

A number of conditions may cause secondary hypertension. These include:

• Renal vascular disease
• Pheochromocytoma
• Primary hyperaldosteronism
• Cushing’s syndrome
• Thyroid, pituitary, or parathyroid dysfunction
• Coarctation of the aorta
• Pregnancy
• Neurologic disorders
• Hormonal contraceptives
• Cocaine
• Cyclosporine
  (Durkin, 2013)

The most common cause of secondary hypertension is chronic renal disease. Because of renal
damage there may be impairment of sodium excretion, functioning of the renin-angiotensin-
aldosterone system, or renal perfusion. Any or all of these cause elevations in blood pressure
(Bartelmo, 2013).
Other conditions associated with secondary hypertension include:

- Cushing’s syndrome: Elevated cortisol levels elevate blood pressure by increasing renal sodium retention, angiotensin II levels, and vascular response to norepinephrine.
- Primary aldosteronism: This disease leads to increased intravascular volume, changes in vessel wall sodium concentration, and vasoconstriction.
- Pheochromocytoma: This secreting tumor of the chromaffin cells causes hypertension because of an increase in the secretion of epinephrine and norepinephrine. Epinephrine increases cardiac contractility and heart rate, and norepinephrine increases peripheral vascular resistance. (Barelmo, 2013)

**Pregnancy**

For most pregnant women, a healthy pregnancy modestly increases the risk of metabolic syndrome even after accounting for excess weight gain and reduced physical activity. For women who have a history of gestational diabetes, the lifetime risk of developing metabolic syndrome is higher than that in non-child-bearing women; women who have a history of gestational diabetes are also more likely to develop diabetes later in life (Gunderson et al., 2014).

**DIAGNOSING METABOLIC SYNDROME**

**Medical History**

Diagnosing metabolic syndrome requires a physical examination and blood tests. Nonetheless, the medical history offers important information that can confirm the diagnosis and help determine the extent of the problem.

A person who has metabolic syndrome may already have been diagnosed with some components of the syndrome, such as obesity, hypertension, or dyslipidemia. A major complication of the syndrome (atherosclerotic artery disease, ischemic heart disease, diabetes) may also be present.

In addition, the person may come with a diagnosis (or the signs and symptoms) of one of a number of other medical problems that occur especially frequently with metabolic syndrome. Diseases that are often found with metabolic syndrome include:

- Obesity
- Polycystic ovary syndrome (PCOS)
- Cardiovascular disease
- Nonalcoholic fatty liver disease
- Chronic kidney disease (NDIC, 2014)
Any of these problems should alert one to the possibility of metabolic syndrome.

**Diagnostic Criteria**

According to the NHLBI (2016a), metabolic syndrome is diagnosed if three or more of the following traits are present:

- Large waist circumference: Waistline measuring at least 35 inches for women and 40 inches for men
- High triglyceride level: 150 mg/dL (1.7 mmol/L) or higher
- Reduced high-density lipoprotein (HDL) cholesterol: Less than 40 mg/dL (1.04 mmol/L) in men or less than 50 mg/dL (1.3 mmol/L) in women
- Increased blood pressure: 130/85 mmHg or higher
- Elevated fasting blood sugar: 100 mg/dL or higher

**INTRA-ABDOMINAL FAT**

Today, the standard physical examination of a patient includes height and weight but it does not usually include a measurement that is essential for diagnosing metabolic syndrome: the patient’s waist circumference. The specific aspect of obesity that best warns of future cardiovascular problems is the amount of fat concentrated inside the abdomen (AHA, 2014), and waist circumference is a good measure of intra-abdominal fat.

**Measuring Obesity**

Obesity is a condition identified with having more stored body fat than is considered normal. Clinically, obesity is measured indirectly. The simplest obesity tables compare two external physical measurements—height and weight—and obese is then defined as “more than the normal weight for a given height.”

The most commonly used measure of obesity is the **body mass index (BMI)**. This is measured using the formula:

\[
\text{BMI} = \frac{\text{weight in kilograms}}{\text{height in meters squared}}
\]

or

\[
\text{BMI} = \frac{\text{weight in pounds} \times 703}{\text{height in inches squared}}
\]

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. The BMI obesity definitions for adults are as follows (CDC, 2016):
Obese people are more likely than people of normal weight to suffer from certain medical problems, including diabetes, hypertension, dyslipidemias, polycystic ovarian syndrome, degenerative joint disease, sleep apnea, cancer (specifically, breast, colon, endometrial, prostatic), gastroesophageal reflux disease, fatty liver disease, and gallstones. For class 3 (extremely) obese people, the list is longer.

All overweight people have an increased risk of developing metabolic syndrome. In overweight and class 1 obese people, the risk of having or developing metabolic syndrome is much greater if their excess fat is located inside the abdomen (i.e., visceral).

When excess fat is concentrated in the abdomen, a person will have a round, apple shape. This is called android obesity, and of all shapes, it is the most strongly predictive of metabolic syndrome–related conditions such as diabetes, hypertension, dyslipidemias, and atherosclerotic cardiovascular disease. (Another common shape of obesity has excess fat concentrated lower on the body, in the hips and thighs. This gives a person a pear shape and is called gynecoid obesity.)

**Measuring Waist Circumference**

Many large studies have shown that simply measuring a person’s waist circumference gives a good indication of the amount of excess body fat that is located inside the abdomen. A waist circumference of >94 cm (37 inches) in men and >80 cm (31.5 inches) in women is considered a warning sign, and a circumference of >102 cm (40 inches) in men and >88 cm (35 inches) in women puts the person in the high or very high risk category for developing metabolic syndrome and its serious health consequences.

In addition to being an indicator for metabolic syndrome, increased waist circumference is correlated with other health problems. These include decreased pulmonary functioning, lessened quality of life, increased disability in older adults, increased osteoarthritis in the knees, increased likelihood of asthma, increased risk of colon cancer, and increased risk of age-related macular degeneration.

The waist is the narrow band of the abdomen below the lowest margin of the ribs and above the top (iliac crest) of the hipbones. To measure the waist:

- Place the tape measure around the abdomen, just above the hip bone.
• Hold the tape measure snug to the skin and parallel to the floor.
• Measure with the patient relaxed and breathing normally.

Measuring tape position for waist circumference. (Source: Adapted from CDC.gov.)

**CASE**

Sharon, Age 52
Sharon is a 52-year-old female patient who has come to the primary care provider’s office for an initial appointment to help manage her hypertension and joint pain. Sharon appears to be obese, with an android shape, prompting the nurse, Jennifer, to measure her waist circumference, which is 92 cm. After weighing Sharon and measuring her height, Jennifer calculates the patient’s BMI as 35.2 kg/m². Sharon’s blood pressure is measured today at 187/93 mmHg, after resting for 5 minutes.

Jennifer draws the patient’s blood and sends the samples to the lab for a fasting glucose level and total lipid panel. Jennifer then asks Sharon about her recent medical history. Sharon reports having pain in her joints, occasional difficulty breathing, excessive thirst, and having to get up several times during the night to urinate.

Sharon also reports that her mother has a diagnosis of type 2 diabetes and her father has heart disease; additionally, both of her parents have high cholesterol, which they are taking medication for. She states that for the past 10 years, she has had increasing problems keeping her weight under control, and even more so now that she has gone through menopause. She states that she would like to exercise more, but with the excess weight and joint pain, she has not been able to perform any regular exercise.

Jennifer suspects that Sharon may have metabolic syndrome, with possible coexisting hypertension, osteoarthritis, diabetes, dyslipidemia, and asthma, and discusses her beliefs with
Sharon’s provider. They also discuss Sharon’s desire to incorporate exercise into her normal routine. Jennifer helps Sharon with scheduling an initial appointment with a physical therapist for an evaluation and exercise recommendations in the setting of potential osteoarthritis.

Sharon is scheduled for a return visit to review the results of her blood tests and discuss possible therapeutic recommendations, including both lifestyle changes and medications to control her blood pressure and manage her other coexisting conditions.

(continues)

HIGH BLOOD PRESSURE

The second component of metabolic syndrome that can be picked up in a physical exam is high blood pressure. To be used as a diagnostic condition for metabolic syndrome, a person’s blood pressure must be $>130/85$ mmHg. (If a person is already taking antihypertensive medication, it is assumed that his or her blood pressure would normally be $>130/85$ mmHg.)

**Hypertension** is defined as blood pressure of $>140/90$ mmHg. As with most clinical measurements, the blood pressure values found in people grade smoothly between the healthy and the unhealthy ranges. The boundary of 140/90 mmHg was chosen because it is at this value that, on average, the benefits of treatment outweigh the risks. The risks of living with hypertension include stroke, myocardial infarction, heart failure, peripheral vascular disease, aortic dissection, and chronic renal failure.

Hypertension has been referred to as a silent killer because, unless they are told their blood pressure measurements, people are usually unaware of any problem. Hypertension is a chronic illness that is largely asymptomatic until it leads to heart, brain, or kidney damage.

**Prehypertension** is the borderline region of blood pressures of 120 to 139 mmHg systolic and 80 to 89 mmHg diastolic (CDC, 2014). Prehypertension warns of future health risks; for example, people with prehypertension are twice as likely to progress to hypertension when compared to people with lower blood pressures.

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<th>BLOOD PRESSURE RANGES (mmHg)</th>
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<td><strong>Level</strong></td>
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<tr>
<td>Normal</td>
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<td>Prehypertensive</td>
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Epidemiologic studies have shown that prehypertension (specifically, $>130/85$ mmHg, is a sufficient criterion for making a diagnosis of metabolic syndrome (Mayo Clinic, 2017a).
Measuring Blood Pressure

The basic rule is: “Measure on more than one occasion.” Blood pressure varies dramatically throughout a 24-hour period, and blood pressure will be raised by stress, recent meals, and recent physical activity. To take variation into account, two or more readings on two or more different days are needed to estimate a person’s usual blood pressure.

Other basic rules for measuring blood pressure include:

- **Sitting.** The patient should have had no caffeine or tobacco for at least 30 minutes and must have been sitting or lying quietly for at least five minutes. When blood pressure readings are taken, the patient should be sitting or lying with the back supported. The arm from which the reading is taken should be resting and supported, and it should be positioned horizontally at the level of the patient’s heart.

- **Cuff size.** General guidelines for cuff size are as follows:
  - Arm circumference 22 to 26 cm: small adult cuff (12 x 22 cm)
  - Arm circumference 27 to 34 cm: adult cuff (16 x 30 cm)
  - Arm circumference 35 to 44 cm: large adult cuff (16 x 36 cm)
  - Arm circumference 45 to 52 cm: adult thigh cuff (16 x 42 cm)

- **Technique.** Begin by palpating the radial artery as the cuff is inflated. The radial pulse will disappear at the systolic value. Continue to inflate the cuff 20 mmHg beyond that point. Put the bell of the stethoscope lightly over the brachial artery next to the lower edge of the cuff. Deflate the cuff slowly, at a rate of 3 to 5 mmHg/sec, noting the pressure at which the first sound is heard (the systolic value) and at which the last sound disappears (the diastolic value).

(Durkin, 2013; Verywell.com, 2016)

**CASE**

**Sharon, Age 52 (continued)**

Sharon returns for a follow-up appointment with her primary care provider. At her previous appointment, her blood pressure was 187/93 mmHg. The nurse, Jennifer, measures the patient’s blood pressure once again; this time the reading is 189/94 mmHg.

At this time, Sharon’s blood test results have come in, and they show a blood triglyceride level of 155 mg/dL and an HDL cholesterol level of 43 mg/dL. Her fasting blood glucose level is 142 mg/dL.

Based on the previous visit’s assessment of an abnormal waist measurement and hypertension, the nurse suspects that Sharon has metabolic syndrome. The provider confirms the diagnosis of metabolic syndrome and outlines a treatment plan for Sharon, including appropriate diet and
exercise as well as adhering to her prescribed medication regimen to control her blood sugar, lipid, and blood pressure levels. The physician refers Sharon to a dietitian for nutrition recommendations, as well as instructs her to continue to see the physical therapist for an individualized exercise program.

At the next followup appointment, Jennifer reviews with Sharon her new treatment recommendations for following a Mediterranean diet from the dietitian and exercise recommendations from the physical therapist to make sure that she understands and is incorporating the recommended elements of therapy. Sharon reports that she is scheduled to see the physical therapist again soon, who will continue to monitor her progress over the next four weeks. Jennifer then reminds the patient to schedule another follow-up visit in one month with the physician and herself to monitor Sharon’s symptoms and progress.

**Laboratory Tests**

It is important to measure two factors that contribute to metabolic syndrome: insulin resistance and dyslipidemias. In evaluating a patient who is at risk for metabolic syndrome, laboratory information should include both fasting glucose levels and fasting lipid profiles.

**ASSESSING INSULIN RESISTANCE**

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 probably the simplest. Fasting glucose levels are a well-calibrated standard that is now widely used to screen for insulin resistance, a common cause of diabetes.

**Diabetes**

Diabetes mellitus is an endocrine disease that disrupts the body’s energy metabolism. In diabetes there is an insufficient amount of insulin available to the cells, and therefore glucose is not used efficiently throughout the body. One cause of the insulin insufficiency can be a reduced production of insulin by the beta cells in the pancreas (i.e., type 1 diabetes); another cause can be a reduced effect of the available insulin, known as insulin resistance (i.e., type 2 diabetes). Both causes can occur in the same person.

Without sufficient effective insulin, body tissues cannot take up all the glucose that is circulating in the bloodstream, and a hallmark of diabetes is hyperglycemia, the presence of more than the normal amount of glucose in the blood. After an 8-hour fast, the body should maintain blood glucose levels at <110 mg/dL, typically in the range of 95–100 mg/dL.

The health problems of diabetes are caused directly by 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 when any one of the following hyperglycemic conditions is present (Durkin, 2013; Mayo Clinic, 2017c):
• Fasting blood glucose level is found to be ≥126 mg/dL
• Hemoglobin A1C level (an index measuring the amount of glucose sticking to hemoglobin inside red blood cells, and which indicates a person’s average blood glucose level over the past two to three months) is ≥6.5%
• Two-hour plasma glucose level is ≥200 mg/dL in an oral glucose tolerance test
• Random plasma glucose level is ≥200 mg/dL, accompanied by classic symptoms of hyperglycemia or hyperglycemic crisis

**Hyperglycemia**

Hyperglycemia can result from a variety of causes. A fasting blood sugar above 100 mg/dL is indicative of metabolic syndrome (Mayo Clinic, 2017a). The two most common causes are decreased secretion of insulin and insulin resistance. Other causes include Cushing’s syndrome, polycystic ovarian syndrome, surgery or trauma, steroids, and infections (Drugs.com, n.d.).

**ASSESSING DYSLIPIDEMIAS**

Dyslipidemias are conditions in which the bloodstream contains unhealthy amounts of lipids. The dyslipidemias of metabolic syndrome are: 1) elevated blood levels of triglycerides and 2) reduced blood levels of high-density lipoproteins. Metabolic syndrome is often accompanied by additional dyslipidemias, although these abnormalities are not necessary for the diagnosis of the syndrome.

Classification of blood lipid levels are given in the table below:
Metabolic syndrome is characterized by fasting blood triglycerides >150 mg/dL and fasting blood HDL cholesterol <40 mg/dL in men and <50 mg/dL in women (NHLBI, 2016a).

**CASE**

**George, Age 45**

George is a 45-year-old male patient who comes to the clinic for his 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 145/88 mmHg.

As his medical and family history is taken, George mentions that his mother has type 2 diabetes and that his uncle was diagnosed with heart disease after suffering a heart attack at age 55. The nurse takes a measurement of his waist circumference, which is 105 cm (41 inches).

After discussing George’s physical assessment findings with the primary care physician, a lipid panel is ordered. Three days later, the results of George’s lipid panel show a blood triglyceride level of 156 mg/dL and a HDL cholesterol level of 38 mg/dL.

George is diagnosed with metabolic syndrome; he is started on appropriate therapy, instructed on incorporating lifestyle interventions (e.g., diet, exercise), and referred to a dietitian at his request. A follow-up appointment is scheduled for three months later to assess how he is doing with initial management of his condition.

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 124/68, 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 joined the local Weight Watchers to support a healthy diet and weight loss program, and they are exercising on a regular basis.

Two Possible Coexistent Diagnoses

Patients with intra-abdominal obesity, high fasting glucose levels, high blood pressure, high blood levels of triglycerides, and low blood levels of HDL cholesterol have metabolic syndrome and should be treated. Yet it is important to remember that a patient may simultaneously have other diseases with similar or overlapping symptoms. Two specific disorders to keep in mind are Cushing’s syndrome and hypothyroidism.

CUSHING’S SYNDROME

Cushing’s syndrome is caused by excess glucocorticoid (any of a group of steroid hormones that are produced by the adrenal cortex and are involved in protein, carbohydrate, and fat metabolism)—either excess intrinsic cortisol (as is produced by the adrenal glands in Cushing’s disease) or excess extrinsic glucocorticoids (e.g., prednisone), which might have been prescribed to treat another disorder. Typically, a person with Cushing’s syndrome has weight gain, skin striae (stretch marks), hirsutism, and proximal muscle weakness (Durkin, 2013).

As in metabolic syndrome, Cushing’s syndrome leads to central (as opposed to peripheral) obesity, although the fat in Cushing’s syndrome tends to be most noticeable on the back of the neck, upper shoulders, and in the cheeks. Cushing’s syndrome also includes hypertension, elevated blood glucose levels, and dyslipidemias, including an elevated level of blood triglycerides. Moreover, patients with Cushing’s syndrome are more susceptible to cardiovascular disease (Durkin, 2013).

HYPOTHYROIDISM

Hypothyroidism is caused by a decreased secretion of thyroid hormone from the thyroid gland, slowing metabolic processes throughout the body. People who have hypothyroidism are typically slow talking, slow to respond, tired, and depressed. Their skin is cool and dry, they look apathetic, they have slow reflexes, and they are constipated. Often, they have an enlarged thyroid gland (Durkin, 2013).

As in metabolic syndrome, people with hypothyroidism tend to be overweight and inactive. They also have dyslipidemia and, sometimes, mild hypertension. Moreover, patients with hypothyroidism are more likely than normal to have cardiovascular disease. On the other hand, unlike metabolic syndrome, low blood glucose levels are typical of hypothyroidism (Durkin, 2013).
CASE

Robert, Age 55
Robert is a 55-year-old male patient who was recently diagnosed with metabolic syndrome. The nurse in the clinic, Monica, who has not previously met Robert, immediately notices that Robert has several physical characteristics indicative of Cushing’s syndrome. Robert is obese and is carrying excess fat in his cheeks, trunk, upper shoulders, and back of the neck.

Monica introduces herself and starts to ask Robert a few questions. Robert appears fatigued and is slow to respond to her questions. When asked about recent symptoms, Robert reports that he has had more weakness in his legs recently and feels “completely worn out.” He also reports recent weight gain despite changing his diet. When asked if he has any other concerns, Robert shows her the pigmented stretch marks on his abdomen and questions why he has developed these.

The nurse suspects that Robert may have Cushing’s syndrome and possibly hypothyroidism and discusses this with his primary care provider. After the provider assesses Robert, he is scheduled to have additional tests to rule out both conditions.

COMORBID DISEASES ASSOCIATED WITH METABOLIC SYNDROME

People who have metabolic syndrome tend to have many associated health problems, although it is not always known whether the person’s metabolic syndrome is the direct cause. Two serious comorbidities that may result from long-term metabolic syndrome are coronary heart disease and type 2 diabetes.

Coronary Heart Disease

The most striking risk posed by metabolic syndrome is coronary heart disease (also known as coronary artery disease or atherosclerotic cardiovascular disease). By themselves, the dyslipidemias of metabolic syndrome (i.e., high triglycerides and low HDL cholesterol levels) encourage plaque to form along the walls of arteries. When combined with the other components of metabolic syndrome, these atherogenic dyslipidemias (i.e., those that tend to cause atherosclerotic plaque) put a person at high risk for developing serious atherosclerotic vascular disease with coronary artery blockage.

People who have metabolic syndrome often also have low-level inflammation throughout the body and blood clotting defects that increase the risk of developing blood clots in the arteries. These conditions contribute to increased risk for cardiovascular disease (NDIC, 2014).

Metabolic syndrome also worsens heart failure, and even when no heart disease is apparent, metabolic syndrome makes a person more likely to develop certain arrhythmias (notably, paroxysmal atrial fibrillation or flutter).
Type 2 Diabetes

Metabolic syndrome is a precursor to type 2 diabetes. The mechanism is as follows: The insulin resistance of metabolic syndrome forces the pancreas to secrete higher than normal amounts of insulin. Meanwhile, some hyperglycemia persists even with the excess circulating insulin. The continuous hyperglycemia and hyperinsulinemia are toxic to the beta cells in the pancreas, and over time these cells sicken and the amount of insulin that they produce decreases. Eventually, the pancreas cannot cope with hyperglycemia, and the patient develops diabetes.

A person with diabetes is at risk for serious health problems and additional complications. These include, but are not limited to:

- Renal disease
- Nontraumatic amputations
- Hyperlipidemia
- Hypertension
- Cardiovascular disease (e.g. stroke, ischemic heart disease)
  (CDC, 2017a)

Other Disorders Associated with Metabolic Syndrome

People with metabolic syndrome are at risk for a long list of health problems. It is not always clear whether metabolic syndrome is the cause or whether the related disorders share common causes with the components of metabolic syndrome. In all cases, however, the presence of metabolic syndrome indicates a higher than normal risk that a person will also have:

- Renal disease and microalbuminuria
- Atherosclerotic plaques in the carotid arteries
- Left ventricular hypertrophy
- Polycystic ovarian syndrome
- Nonalcoholic fatty liver disease
- Erectile dysfunction
- Venous thromboemboli
- Periodontal disease
- Low testosterone levels in men
- Hyperuricemia
- Pancreatitis
TREATING METABOLIC SYNDROME

The individual components of metabolic syndrome—abdominal obesity, high triglycerides, low HDL cholesterol, high blood pressure, and high fasting glucose—would not always be treated if found in isolation. When found together, however, metabolic syndrome is typically diagnosed, indicating the need for treatment. That is, metabolic syndrome lowers the threshold for the treatment of its components.

Treatment goals for metabolic syndrome are:

- Treat underlying causes
- Prevent the development of type 2 diabetes
- Treat cardiovascular risk factors
  (Stoppler, 2016)

Treatment for metabolic syndrome consists of the following main therapeutic strategies:

1. Weight loss and increased physical activity focused on reversing the direct causes of the condition
2. Medications designed to treat the condition’s various components, such as dyslipidemia, hypertension, prothrombic conditions, and insulin resistance
3. Dietary management focused on lowering cholesterol and restricting calories from simple carbohydrates (emphasis on low-fat dairy, whole grains, and fresh fruits and vegetables)
  (Stoppler, 2016)

Treatment of the components of metabolic syndrome begins with lifestyle changes. Because lifestyle changes are easy to prescribe but difficult to carry out, often medications must be added to ensure that the treatment regimens succeed.

Therapeutic Lifestyle Changes

Lifestyle modification is the preferred treatment of metabolic syndrome. Therapeutic lifestyle changes—such as increased physical exercise, improved diet, and weight reduction—are the cornerstones of the treatment of obesity, hypertension, insulin resistance, and most dyslipidemias. Reducing dietary calories and fats (especially saturated fats) and increasing exercise can significantly reduce the risk of developing diabetes and atherosclerotic cardiovascular disease
  (Stoppler, 2016).

EXERCISE

All aspects of metabolic syndrome benefit from increased physical activity. Physical exercise helps in losing weight and in maintaining weight loss, and it has additional independent metabolic
effects that directly reduce insulin resistance. Physical activity is usually a safe and beneficial
treatment for people with metabolic syndrome and its consequences, atherosclerotic cardiovascular
disease and type 2 diabetes.

The American Heart Association (2016a) recommends the following physical activity for adults:

- For overall cardiovascular health:
  - At least 30 minutes of moderate-intensity at least 5 days per week for a total of 150
    minutes or
  - At least 25 minutes of vigorous aerobic activity at least 3 days per week for a total
    of 75 minutes, or a combination of moderate-and vigorous-intensity aerobic activity
    and
  - Moderate- to high-intensity muscle-strengthening activity at least 2 days per week
    for additional health benefits

- For lowering blood pressure and cholesterol:
  - An average 40 minutes of moderate- to vigorous-intensity aerobic activity 3 or 4
    times per week

For high-risk patients with comorbidities who are deconditioned or have had recent cardiac events,
careful supervision of physical rehabilitation is recommended. Referral to a physical therapist or
exercise physiologist to evaluate, plan, and monitor the patient’s progress with his or her exercise
program is an important consideration (Kaur, 2014).

DIETARY MODIFICATIONS

Exercise alone rarely leads to significant weight loss. A reduced-calorie diet is usually necessary,
and dieting is the second critical part of the initial treatment of metabolic syndrome. Overweight
people with metabolic syndrome must reduce the number of calories they eat each day.

Even a modest weight loss makes a difference for an overweight or obese person, and losing 5% to
7% of the original weight and keeping the weight off is a realistic goal. The ADA (2014)
recommends that patients aim for a weight loss of 7% of body weight, noting that a small but
consistent weight loss of 1/2 to 2 pounds per week is the safest way to accomplish this.

Simply reducing the overall calories in the diet will improve the lipid profile. Reducing the amount
of fat improves the lipid profile even further. It is especially important to remove foods that are
high in simple carbohydrates, refined grains, and saturated fats, such as:

- Fatty meats (e.g., bacon, sausage)
- Chicken or turkey eaten with the skin
- Egg yolks
- Butter
- Cream, half-and-half, and ice cream
- Cookies, cakes, muffins, breads, and pastries
  (Unger, 2013)

Fat-rich foods should be replaced with foods that have high water and fiber content, such as whole grains, fruits, vegetables, legumes, lean meats, seafood, nuts, seeds, and low-fat dairy products (Yeager, 2016).

**MEDITERRANEAN DIET**

The Mediterranean diet food pyramid is recognized as the “gold standard” eating pattern that promotes life-long good health:

- High consumption of monosaturated fatty acids (primarily from olives and olive oil)
- Daily consumption of fruits, vegetables, whole grain cereals, and low-fat dairy products
- Weekly consumption of fish, poultry, tree nuts, and legumes
- A relatively low consumption of red meat (approximately twice per month)
- Moderate daily consumption of alcohol (normally with meals)

Additionally, studies suggest that adherence to the Mediterranean diet can positively affect individual components of metabolic syndrome such as waist circumference, dyslipidemia, hypertension, and hyperglycemia. These findings are of considerable public health importance, because this dietary pattern can be easily adopted by all population groups and various cultures.

*Source:* foodpyramid.com, 2015; Mayo Clinic, 2017b.

**CASE**

**Judy, Age 52**

The nurse, Kathy, enters the examination room to check the blood pressure and take a blood sample from the patient, Judy, who is a 52-year-old female recently diagnosed with metabolic syndrome. After removing the blood pressure cuff from Judy’s arm, Kathy asks how well she has been controlling her weight, and the patient replies that she has been having difficulty “keeping the pounds off.” A discussion of diet and exercise ensues, during which Judy reveals that she has continued to consume fried, fatty foods and few fruits and vegetables and has not been exercising regularly.

Kathy discusses the benefits of the Mediterranean diet in managing the various components of metabolic syndrome. While reviewing the components of the diet, they look together at an educational booklet that outlines how to follow the Mediterranean diet model, with practical menu suggestions and a baseline assessment about knowledge of the healthy food choices included in the model. Judy mentions that the diet seems easier than she imagined to follow and states that she will start to shop and plan her meals better with this information.
Kathy helps the patient make an appointment with a registered dietitian with the aim of establishing an individualized diet and exercise plan based on Judy’s needs. Kathy also makes an appointment with a physical therapist, who can create an individualized activity plan to increase Judy’s strength and endurance. They plan to have a follow-up visit in six weeks to monitor Judy’s progress.

**SMOKING CESSATION**

When associated with metabolic syndrome, smoking increases the chance of developing insulin resistance, type 2 diabetes, and dyslipidemias. In addition, smoking contributes to the development of a variety of cancers, atherosclerotic cardiovascular diseases, lung diseases, gastrointestinal diseases, reproductive problems, osteoporosis, cataracts, age-related macular degeneration, and hypothyroidism.

**Medications**

**HYPERTENSION MEDICATIONS**

When lifestyle changes in diet and exercise are insufficient, persistent hypertension requires medication. For metabolic syndrome, antihypertensive drug therapy usually begins with an angiotensin-converting-enzyme (ACE) inhibitor or an angiotensin II receptor blocker (ARB). These drugs can also slow the progression of diabetic nephropathy. Beta-blockers are avoided in metabolic syndrome because they tend to cause weight gain, increased triglyceride levels, and reduced HDL cholesterol levels (ADA, 2016).

Patients with both diabetes and hypertension should be on a regimen that includes either an ACE inhibitor or an angiotensin receptor blocker but not both. If one class of drugs is not tolerated, the other should be substituted (ADA, 2016).

**HYPERGLYCEMIA MEDICATIONS**

The oral medicines for treating diabetes fall into two classes: those that increase insulin secretion (insulin secretagogues) and those that decrease insulin resistance (insulin sensitizers). Insulin sensitizers are used for metabolic syndrome.

Metformin (Glucophage) is the standard insulin sensitizer. 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 to extract glucose from the circulation.

Thiazolidinediones, including rosiglitazone (Avandia) or pioglitazone (Actos), are another commonly used class of insulin sensitizers. These drugs also reduce the blood level of circulating fatty acids and increase the blood level of HDL cholesterol.
INSULIN SENSITIZERS

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Sources: Burant & Young, 2012; Comerford, 2017.

DYSLIPIDEMIA MEDICATIONS

The dyslipidemias of metabolic syndrome have two characteristics: high blood levels of triglycerides and low blood levels of HDL cholesterol. Both of these problems can lead to atherosclerotic cardiovascular disease. Metabolic syndrome is often worsened by the presence of another dyslipidemia, hypercholesterolemia (high blood levels of LDL cholesterol), which by itself is a major contributor to the development of coronary (atherosclerotic) heart disease.

When a three- to six-month trial of therapeutic lifestyle changes does not sufficiently improve these heart-threatening features of a patient’s lipid profile, medications are added. Drug therapy usually involves statins, fibrates, or niacin.

Statins

Statins are drugs that interrupt the synthesis of cholesterol inside cells. They include rosuvastatin (Crestor), atorvastatin (Lipitor), simvastatin (Zocor), lovastatin (Mevacor), fluvastatin (Lescol), and pravastatin (Pravachol). Statins are effective at reducing the blood level of LDL cholesterol. They also lower blood triglyceride levels modestly and raise HDL cholesterol levels. Statins are the first-line dyslipidemia drugs for preventing cardiovascular disease in those patients with type 2 diabetes who also have high levels of blood cholesterol (Comerford, 2017).

Fibrates

Fibrates provide a more direct attack on the dyslipidemias of metabolic syndrome. Fibrates are fibric acid derivatives—gemfibrozil (Lopid) or fenofibrate—that speed up the conversion of triglycerides to fatty acids and raise the blood levels of HDL lipoproteins. Fibrates are second-line drugs for treating high LDL cholesterol levels, and they can be used in combination with a statin (Omudhone, 2015).
Niacin

Another medication that improves the dyslipidemias of metabolic syndrome is the B vitamin niacin, or nicotinic acid. In doses much higher than the normal recommended daily allowance, niacin lowers the production of VLDL lipoproteins (which are precursors to LDL lipoproteins), reduces blood levels of triglycerides, and increases the blood levels of HDL lipoproteins. Niacin should be used in caution with patients with diabetes, as it has been shown to increase levels of blood glucose. Using niacin in the extended-release formulation is associated with fewer side effects (Bradford, 2015).

OBESITY MEDICATIONS

Therapeutic lifestyle changes and counseling are the first steps in treating the obesity of metabolic syndrome. When these steps do not lead to sufficient weight loss, medications can be tried. Prescription medications approved for overweight and obesity treatment include:

- **Orlistat (Xenical):** Approved for adults and children age 12 and older. It works by reducing the amount of fat the body absorbs from the food that is eaten. Common side effects include diarrhea, flatulence, leakage of oily stools, and stomach pain. It is available in a lower dose form without prescription (Alli). Severe liver impairment has occurred (rarely). Patients should take a multivitamin pill daily to ensure that there are enough vitamins for food absorption.

- **Lorcaserin (Belviq):** Approved for adults, this medication helps people to feel full after eating smaller amounts of food. Side effects include constipation, cough, dizziness, dry mouth, fatigue, headaches, and nausea. Note that antidepressants or migraine medications may cause problems when taken in conjunction with lorcaserin.

- **Phentermine-topiramate (Qsymia):** Approved for adults, this medication is a mix of two medications: phentermine, which decreases appetite, and topiramate, which is used for the treatment of seizures or migraine headaches and may make people feel less hungry or fuller sooner. This drug is contraindicated in patients with glaucoma or hyperthyroidism. It may lead to birth defects if taken during pregnancy.

- **Naltrexone-bupropion (Contrave):** Approved for adults, this drug is a mixture of two medications: naltrexone, which is used to treat alcohol and drug dependence, and bupropion, which is used to treat depression or help people quit smoking. It may make people feel less hungry or feel full soon. This medications is contraindicated in patients who have uncontrolled hypertension, seizures, or a history of anorexia or bulimia nervosa. It should not be taken if dependent on opioid pain medications or withdrawing from drugs or alcohol.

- **Liraglutide (Saxenda):** This medication is available by injection only. It is approved for adults and may make people feel less hungry or full sooner. A lower dose is available under the name Victoza, which is approved to treat type 2 diabetes. Side effects include nausea, diarrhea, constipation, abdominal pain, headache, and elevated heart rate. This medication
may increase the chance of developing pancreatitis. It has also been found to cause a rare type of thyroid tumor in animals. (NIDDK, 2016)

Weight that has been lost with the aid of medications is typically regained when the medicine is stopped. For this reason, drug therapy works best when it is part of a treatment plan that includes therapeutic lifestyle changes and counseling.

**XENICAL/ALLI WARNING**

Notably, in May 2010 the U.S. Food and Drug Administration approved revised labeling for Xenical and Alli to include new safety information about 13 cases of severe liver injury, which resulted in two deaths from liver failure and an additional three liver transplants. Providers should weigh the benefits of weight loss with Xenical and Alli against the potential risks when determining if these medications are appropriate for patients.

The labeling also asks patients to report any symptoms of liver dysfunction, such as anorexia, pruritus, jaundice, dark urine, light-colored stools, or right-upper-quadrant pain when using these medications. If liver injury is suspected, the medications should be discontinued immediately and liver function tests and ALT and AST levels obtained.


**PROTHROMBOTIC STATE THERAPY**

Metabolic syndrome is usually accompanied by a prothrombotic state, an increased tendency of the blood to form clots. Treating the prothrombotic state will reduce the risk of coronary heart disease and stroke, and many clinicians prescribe daily low-dose aspirin as part of the therapy for metabolic syndrome (Codario, 2011; Russo, 2012).

**Psychological Counseling**

Changing one’s lifestyle requires guidance and determination. Losing weight, for example, takes encouragement, monitoring, and practical advice, even for people who are only slightly overweight. Moreover, time works against lifestyle changes. After the initial enthusiasm diminishes, exercise programs can be difficult to maintain. Likewise, lost weight is notorious for reappearing: people who diet on their own tend to regain the lost weight in less than a year.

**Surgery**

Therapeutic lifestyle changes and medications work least often in severely obese patients. For these patients, bariatric surgery is an option. Surgery is considered if the patient has tried monitored dieting, exercise regimens, and medications.
The best hospitals for bariatric surgery are those that perform a significant number of the surgeries and that use a team (physician, psychologist, physical and occupational therapists, and dietitian) to treat patients. Patients making their decision to have surgery should be aware of quality and standards for centers that perform bariatric surgery.

It is important that persons who undergo bariatric surgery receive life-long lifestyle support and medical monitoring.

**BARIATRIC SURGERY ACCREDITATION**

The American College of Surgeons and the American Society for Metabolic and Bariatric Surgery combined their respective national bariatric surgery accreditation programs into a single unified program to achieve one national accreditation standard for bariatric surgery centers: the Metabolic and Bariatric Surgery Accreditation and Quality Improvement Program (MBSAQIP). MBSAQIP accreditation is important because it provides an objective and measurable way in which a center demonstrates that it offers high-quality care to patients in the setting of a multidisciplinary team approach (MBSAQIP, 2014).

**TYPES OF BARIATRIC SURGERY**

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

- **Roux-en-Y 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.


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• **Laparoscopic adjustable gastric 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.


**Adjustable Gastric Banding**

• **Sleeve gastrectomy** 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.

• **Gastric balloons** are an alternative to bariatric surgery for patients with lower BMIs. Gastric balloons were approved in the United States in 2015 for patients with BMIs of 30 to 40 and who have not had previous weight-loss surgery. Gastric balloons are inserted orally, either by swallowing a pill or under endoscopy, in the stomach and filled with saline or air. The entire procedure takes approximately 20 minutes. There are several types of gastric balloons including:
  o **Obalon**. The balloon is inserted via a pill swallowed with a glass of water and inflated with gas. A total of three balloons are inserted. The second balloon is added a month after the first one, and the third is generally added during the second month.
- **Reshape dual weight-loss balloon.** This is the largest-capacity balloon. Two balloons are inserted during one procedure. The only other procedure required is when the balloon is removed. The use of this type of balloon requires significant coaching and support programs.

- **Orbera managed weight-loss system.** This is the oldest balloon procedure, and it also requires extensive coaching and support programs.

## 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, 2012).

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

### SUPERVISED EXERCISE

Patients with metabolic syndrome are at risk of developing neuropathy (i.e., peripheral pain, numbness) characterized by a loss of unmyelinated cutaneous axons. Unmyelinated axons are susceptible to both physical and metabolic injury. However, they are also capable of rapid regeneration. Supervised exercise has been found to improve cutaneous reinnervation capacity in patients with metabolic syndrome. In a study conducted by Singleton and colleagues (2015), a relatively brief but intensive exercise program designed to improve glucose, insulin, and lipid metabolism resulted in a clear increase in the ability of cutaneous axons to regenerate following controlled denervation.

## PREVENTION OF METABOLIC SYNDROME

At each stage of life, strategies can be implemented to reduce the chance of developing metabolic syndrome, even for those individuals who have inherited a predisposition to it.

### Prenatal

Malnutrition of mother and child during pregnancy leads to low birth weight of the infant. Such a child will have a higher than normal risk of developing hypertension, abnormal glucose tolerance, and cardiovascular disease as an adult. A pregnant mother who gets good prenatal care and who eats a healthy diet will reduce her baby’s chances of developing metabolic syndrome later in life.
Children and Adolescents

In the United States, approximately 17% (or 12.7 million) children and adolescents aged 2–19 years are obese (CDC, 2017b). Obesity in children increases the chance that they will have metabolic problems, high blood pressure, kidney problems, and cardiovascular disease as adults. It is therefore important that children be given guidance and encouragement to eat a healthy diet.

In addition, having a low level of physical exercise increases the chances that a child will develop metabolic syndrome as an adult even for children who are not overweight. Thus, children should be encouraged to be active: sedentary pastimes, such as television-watching and video/computer games, should be limited.

Adults

SCREENING

General education programs can reduce the incidence of metabolic syndrome by making everyone aware of the benefits of staying slim and exercising. People who already have metabolic syndrome can prevent many of the serious health problems by losing weight, eating a balanced, healthy diet, and exercising more. The first steps are to identify patients and then to advise them on the lifestyle changes that may benefit the condition. Carefully monitoring their condition over time is also important.

When patients come to doctors, clinics, and hospitals for any reason, healthcare providers should be aware of those who might have metabolic syndrome. Beyond this, some clinicians suggest that it would be worthwhile to institute screening programs that measure waist size, blood pressure, and blood lipid and blood glucose levels.

EDUCATION

Without treatment, metabolic syndrome poses worsening risks with age. On the other hand, young adults with metabolic syndrome who lose weight and then maintain a stable weight can avoid the higher incidence of serious health problems that would have come with advancing age.

Maintaining a reasonable body weight is a key technique for preventing metabolic syndrome. Overweight people should be advised to maintain a healthy weight. The best way to lose weight is to eat fewer calories, but this simple advice is not easy to carry out. People usually have the most success losing weight when they are part of a formal program that provides monitoring and counseling for continued support.

A second key preventive step is increasing physical activity. Although regular exercise can help a person lose weight, the most important benefits of physical activity are metabolic. Moderate exercise for >30 minutes four times a week can actually change the balance of biochemical processes in a person’s body, reducing insulin resistance, lowering triglycerides, and lowering blood pressure. (See also “Supervised Exercise” above.)
Lifestyle change strategies that include setting reasonable goals, raising awareness, identifying barriers to change, managing stress, preventing relapse, and providing ongoing support are the keys to long-term success in managing metabolic syndrome.

**QUESTIONS PATIENTS MAY ASK**

**Informational Questions**

Q: What is metabolic syndrome?

A: To say someone has metabolic syndrome means that they have a specific group of health problems: they may have excess abdominal fat, high cholesterol, excess sugar circulating in their bloodstream, and high blood pressure. Having all these problems together makes a person more likely to get heart disease and diabetes.

Q: Is metabolic syndrome different from diabetes, high blood pressure, or high cholesterol?

A: Yes. Although these problems are all closely related, a person can have diabetes, high blood pressure, or high cholesterol without having metabolic syndrome.

Q: What will metabolic syndrome do to me?

A: When metabolic syndrome is not treated, you are more likely to get diabetes, heart and kidney disease, clogged arteries, and strokes. If you have chronic illnesses, metabolic syndrome tends to make them worse.

Q: Is metabolic syndrome contagious?

A: No.

Q: Will my children get metabolic syndrome?

A: Your children may inherit a tendency to develop the same problems that you have. You can help to protect them from metabolic syndrome by teaching them to eat healthy. Provide a diet focused on fruits, vegetables, low fats, and whole grains. Limit fast food, sugary desserts, and foods made with solid fats like butter and trans-fats. In addition, encourage your children to be active. Limit their TV, smart phone, and video game time, and encourage programs such as dance and sports.
Q: What treatment will a doctor suggest?

A: A doctor may recommend losing weight, getting more exercise, and improving your diet. If these steps do not improve your metabolic syndrome, a doctor may prescribe drugs, such as high blood pressure medicine or cholesterol-lowering medicine.

Advice and Triage Questions

Q: Is metabolic syndrome an emergency?

A: Discovering that you have metabolic syndrome is not an emergency—it is a warning. Having metabolic syndrome means that you may need to change your eating habits and increase your physical activity; in addition, your doctor may need to adjust your current medicines or to prescribe additional medicines. The longer you have metabolic syndrome without treatment, the higher your chances for developing life-threatening problems such as diabetes and heart and artery disease.

Q: What kind of doctor or clinic should I go to if I am diagnosed with metabolic syndrome?

A: Start with your personal physician or a medical clinic that you normally use. A family physician or a doctor specializing in internal medicine will be able to treat metabolic syndrome.

Q: What can I do on my own for metabolic syndrome?

A: Here are four things that are safe and effective.

1. Weight loss. Aim for a 5% to 7% weight loss in a year. Losing weight is hard to do on your own. You may want to seek the help of an organized program.

2. More physical activity. Try to get in the habit of doing regular exercise for 30 minutes each day. Consider walking, swimming, bicycling, or dancing. Organized fitness programs can help you maintain healthy exercise habits.

3. Diet changes. Change your eating habits. Eat fewer fatty foods and more fruits, vegetables, and whole grains. Eat at regular times and have healthy snacks available, such as vegetables, nuts, and seeds.

4. If you do smoke, seek support to stop smoking.
CONCLUSION

Metabolic syndrome is the combination of:

- Insulin resistance
- Excess intra-abdominal fat
- Unhealthy levels of fats in the blood (too much triglyceride and too little HDL cholesterol)
- High blood pressure

Having metabolic syndrome makes a person more likely to develop diabetes and cardiovascular disease, especially men over 45 years of age and women over 55 years of age. Metabolic syndrome is a common health problem, and it is becoming increasingly common in those parts of the world where obesity is on the rise.

If they occur in isolation, some of the individual disorders that make up metabolic syndrome may not be in the range mandating treatment; on the other hand, when these disorders are found together, they should always be treated.

Treatment of metabolic syndrome begins with therapeutic lifestyle changes. Weight loss, improved diet, and regular physical exercise are the elements of the initial treatment program. Drugs are used to treat those components of metabolic syndrome that do not improve sufficiently with therapeutic lifestyle changes alone.

RESOURCES

IDF Worldwide Definition of the Metabolic Syndrome (International Diabetes Federation)
http://www.idf.org/metabolic-syndrome

Metabolic Syndrome (American Heart Association)
http://www.heart.org/HEARTORG/Conditions/More/MetabolicSyndrome/Metabolic-Syndrome_UCM_002080_SubHomePage.jsp

Metabolic Syndrome (Mayo Clinic)
http://www.mayoclinic.org/diseases-conditions/metabolic-syndrome/basics/definition/con-20027243

Metabolic Syndrome (MedicineNet.com)
http://www.medicinenet.com/metabolic_syndrome/article.htm

Metabolic Syndrome (National Library of Medicine)

What Is Metabolic Syndrome? (National Heart, Blood, and Lung Institute)
http://www.nhlbi.nih.gov/health/health-topics/topics/ms/
REFERENCES


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1. Which statement accurately describes metabolic syndrome?
   a. It is a cluster of health problems.
   b. It is caused by malnutrition.
   c. It was first identified in the late 1990s.
   d. It increases the risk of type 1 diabetes.

2. Type 1 diabetes is characterized by:
   a. Body tissues that do not take up glucose as readily as normal.
   b. Abnormal body processes generally affecting older adults.
   c. A pancreas that produces little or no insulin.
   d. A normal amount of circulating insulin in the body.

3. A 50-year-old male patient with a history of obesity and hyperlipidemia is diagnosed with type 2 diabetes. Which characteristic finding supports the patient’s diagnosis?
   a. Insulin insensitivity
   b. Rapid uptake of glucose in the tissues
   c. Low blood pressure
   d. First appearance of diabetes at an early age

4. Characteristics of metabolic syndrome include intra-abdominal obesity:
   a. Hypoglycemia, and high HDL cholesterol.
   b. Hypertension, and low HDL cholesterol.
   c. Pulmonary hypertension, and insulin sensitivity.
   d. Hypotension, and low LDL cholesterol.

5. In assessing a male patient, the clinician considers metabolic syndrome upon identifying which possible clinical sign?
   a. A waist circumference >102 cm (>40 inches)
   b. A blood triglyceride level >100 mg/dL
   c. A blood high-density lipoprotein cholesterol level <50 mg/dL
   d. A blood glucose level >75 mg/dL
6. Following the AHA/NHLBI definition of metabolic syndrome, the clinician can rule out metabolic syndrome if a patient has a normal waist circumference, normal blood pressure, and:
   a. A blood triglyceride level of 160.
   b. An elevated low-density lipoprotein cholesterol level.
   c. A fasting glucose level below 100 mg/dL.
   d. A low high-density lipoprotein cholesterol level.

7. Which is a true statement about demographic characteristics associated with metabolic syndrome?
   a. The prevalence of metabolic syndrome remains stable with age.
   b. More than 50% of those who are 60 years of age or older are estimated to have metabolic syndrome.
   c. The risk of metabolic syndrome in women is not affected by perimenopause or menopause.
   d. Metabolic syndrome is found in under 10% of persons aged 20 to 39 years.

8. Which is a true statement regarding factors that contribute to obesity?
   a. Maternal smoking during pregnancy has not been linked to obesity.
   b. Genetics plays a very small role in the development of obesity.
   c. There is no link between stress and anxiety, and obesity.
   d. Atypical antipsychotic drugs have been associated with weight gain.

9. Which health condition directly causes insulin resistance?
   a. Ovarian cancer
   b. Coronary heart disease
   c. Excess visceral fat
   d. Poor oral health

10. What is the role of high-density lipoproteins in maintaining the balance of lipids in the body?
    a. Facilitating the increase of LDL cholesterol
    b. Assisting in the transfer of proteins to the muscles
    c. Slowing or reversing the plaque formation in the vascular system
    d. Increasing the amount of cholesterol in nonliver cells
11. A woman is at risk of developing metabolic syndrome if she has a history of:
   a. Hyperinsulinemia.
   b. Having no previous births.
   c. Chronic asthma.
   d. Osteoarthritis.

12. One of the criteria for the diagnosis of metabolic syndrome is a blood pressure reading of:
   a. >120/80 mmHg.
   b. >130/80 mmHg.
   c. >130/85 mmHg.
   d. >140/90 mmHg.

13. A patient with excess weight in his or her chest and abdomen is described as having which body shape?
   a. Gynecoid (pear-shaped)
   b. Ovoid (egg-shaped)
   c. Android (apple-shaped)
   d. Droid (star-shaped)

14. Which clinical measurement or test is used to diagnose metabolic syndrome?
   a. A blood urea nitrogen level
   b. A coronary angiogram
   c. A chest X-ray
   d. A large waist circumference

15. To document the most accurate reading for a patient who is suspected of having hypertension, the clinician’s action is to measure the patient’s blood pressure:
   a. While the patient is standing.
   b. On more than one occasion.
   c. Early in the day.
   d. Both before and after exercise.

16. A formal diagnosis of 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.
17. Which fasting blood sugar level is indicative of metabolic syndrome?
   a. 45 mg/dL
   b. 60 mg/dL
   c. 80 mg/dL
   d. 110 mg/dL

18. Which borderline high fasting triglyceride level is associated with metabolic syndrome?
   a. 100 mg/dL
   b. 120 mg/dL
   c. 140 mg/dL
   d. 160 mg/dL

19. Which fasting high-density lipoprotein cholesterol level is a risk factor for metabolic syndrome in a female patient?
   a. 38 mg/dL
   b. 58 mg/dL
   c. 68 mg/dL
   d. 78 mg/dL

20. Which two comorbidities are most commonly associated with metabolic syndrome?
   a. Colon cancer and stroke
   b. Coronary heart disease and type 2 diabetes
   c. Pulmonary hypertension and portal hypertension
   d. Breast cancer and prostatic cancer

21. The dyslipidemias of metabolic syndrome are associated with subsequent development of:
   a. Type 1 diabetes.
   b. Atherosclerotic plaque.
   c. Hyperinsulinemia.
   d. Hyperglycemia.

22. Which is a true statement about treatment for metabolic syndrome?
   a. Glucose levels can be ignored until other risk assessment components are present.
   b. Triglyceride levels can be ignored until other risk assessment components are present.
   c. Metabolic syndrome lowers the threshold for the treatment of all its components.
   d. Metabolic syndrome requires treating only blood pressure levels >140/90 mmHg.
23. Physical exercise provides patients with metabolic syndrome with which important benefit?
   a. Increased blood levels of LDL cholesterol
   b. Reduced blood levels of HDL cholesterol
   c. Reduced insulin resistance
   d. Increased blood pressure

24. Statins are the first choice drugs for lowering blood levels of:
   a. Low-density lipoprotein cholesterol.
   b. High-density lipoprotein cholesterol.
   c. Fatty acids.
   d. Glucose.

25. A patient with metabolic syndrome who is found to have an accompanying prothrombotic state is initially prescribed which therapy?
   a. Heparin injections, daily
   b. Warfarin (Coumadin)
   c. Vitamin K
   d. Low-dose, daily aspirin

26. Self-care measures to prevent metabolic syndrome include:
   a. Increasing calories and adding fats to the diet.
   b. Drinking fruit juices and taking a multivitamin.
   c. Maintaining a healthy weight and regular exercise.
   d. Avoiding smoking and ignoring signs of stress.