Chapter 9

Case Study

Individuals with diabetes should check blood glucose levels closely before exercising. If, as in this client’s case, blood glucose is <100 mg/dL, the client should consume a small amount of carbohydrate such as a piece of fruit, a glass of juice, or a few crackers before beginning to exercise. Wait a short time, and then check blood glucose level again. If it is between 100 and 250 mg/dL, it is safe for her to begin exercising. If it equals or exceeds 250 mg/dL, be careful. In this case, test the urine for ketones. If ketones are present, avoid exercise until the ketone level normalizes.

Individuals with diabetes should carry a source of carbohydrates along with them in case of hypoglycemia. This is especially crucial if long bouts of exercise are planned. If duration is long, check blood glucose every 30 minutes during the workout. If blood glucose is \( \leq 70 \text{ mg/dL} \), stop exercising and consume something that elevates blood glucose such as 2 to 3 glucose tablets, \( \frac{1}{2} \text{ cup of orange juice} \), 4 oz of regular soda—not diet soda— or 5 pieces of hard candy. Recheck blood glucose 15 minutes later. Repeat until blood glucose exceeds 70 mg/dL.

Thinking Critically

1. Physicians typically use one of three tests to diagnose diabetes. The fasting plasma glucose test (FPG) is the easiest to administer. It requires that the patient abstain from eating for at least 8 hours after which blood glucose is measured. A normal value for blood glucose under these conditions is \( \leq 99 \text{ mg/dL} \). A reading of 100 to 125 mg/dL suggests prediabetes, and a
measure of 126 mg/dL indicates diabetes. A physician usually performs this test at least two times before confirming a diagnosis. The oral glucose tolerance test (OGT) is not as convenient as the FPG, but it is much more reliable. It requires 8 hours of fasting followed by a measurement of blood glucose levels. After this initial assessment, the patient must consume a liquid containing 75 grams of glucose. The physician then measures blood glucose levels again 2 hours after ingestion to determine whether diabetes or prediabetes exists. A normal value for blood glucose 2 hours after consuming the glucose drink is ≤139 mg/dL. A reading of 140 to 199 mg/dL suggests prediabetes, while a measure of ≥200 mg/dL indicates diabetes. As with the FPG test, a physician performs this test at least two times before confirming diabetes. The random plasma glucose test (RPG), which is effective in determining diabetes but not as reliable for prediabetes, measures blood glucose levels without requiring a fasting period. A reading of ≥200 mg/dL suggests diabetes if the patient also complains of frequent urination, excessive thirst, and unexplained weight loss. To confirm the diagnosis, a physician usually follows the RPG test with an FPG or OGT.

2. The pancreas releases hormones that help maintain blood glucose levels. Beta cells in the pancreas release insulin in response to elevated blood glucose levels after a meal. Among its many functions, insulin permits the transport of glucose into body cells so that it can be used to make energy. It also enhances the liver’s ability to store glucose for later release. Alpha cells in the pancreas release glucagon in response to low blood glucose levels that occur in between meals. Among its many functions, glucagon stimulates the liver to release glucose to restore blood levels. It also stimulates the liver to undergo gluconeogenesis when glycogen supplies diminish. If the pancreas is damaged or functions abnormally, insulin will not be released in
response to increasing blood glucose levels. Consequently, blood glucose remains high (which can cause damage to small blood vessels), and cells are denied access to glucose (which means they can starve to death).

3. Type 1 diabetes is an autoimmune disorder that results when pancreatic beta cells are not functioning. If the beta cells are not producing insulin, blood glucose levels remain elevated after a meal. Type 2 diabetes is thought to result from improperly functioning insulin receptors on body cells. Although the pancreas continues to produce insulin, that insulin is unable to bind to receptors on body cells, so blood glucose levels remain elevated after a meal. Type 2 diabetes often occurs as a result of overweight or obesity. It is thought that excess fat storage alters the shape of nearby receptors, rendering them incapable of binding insulin.

Risk factors for type 1 diabetes include the following: family history of type 1 diabetes; personal or family history of autoimmune diseases; exposure to cow’s milk before age 1; cessation of breastfeeding before 3 months of age; and early exposure to certain viruses including rubella, Epstein-Barr, and coxsackie B. Risk factors for type 2 diabetes include the following: family history of diabetes; being overweight or obese; history of gestational diabetes or delivery of a baby weighing 9 pounds or more; HDL < 35 mg/dL or triglycerides > 250 mg/dL; and blood pressure of 140/90 mm Hg or higher.

Individuals with type 1 diabetes need to take exogenous insulin for the remainder of their lives. Those with type 2 diabetes can often manage diabetes through weight loss, exercise, and diet.
4. Complications associated with diabetes include heart disease, stroke, hypertension, blindness, nervous system disorders, amputation, pregnancy problems, respiratory infection, and gum disease. High blood pressure develops as elevated blood glucose levels damage the linings of blood vessels. This effect is particularly noticeable in smaller vessels. Damaged vessels then develop plaques that eventually harden—a condition called atherosclerosis. This triggers a cycle of events that sustains high blood pressure because hardened arteries have narrow passageways that are under increasing pressure from the heart’s pumping action. Chronic hypertension then increases the risk for coronary artery disease, heart failure, stroke, and peripheral vascular disease. Peripheral vascular disease, or hardening of the arteries in the lower extremities, restricts blood flow to the legs, thus forcing the heart to work even harder. This burden in turn increases blood pressure, which might cause existing inflexible blood vessels supplying the heart or the brain to burst—resulting in a heart attack or stroke. Poor circulation in the lower extremities might eventually necessitate amputation as cells and tissues die in the absence of adequate oxygen supply.

5. The liver performs the following functions: stores glucose as glycogen, releases glucose to restore blood levels, undergoes gluconeogenesis, stores fat, converts ammonia to urea, detoxifies harmful substances, stores vitamins and minerals, and makes bile for fat emulsification. The liver is the most metabolically active organ in the body. It is critical for blood glucose maintenance.

6. Hyperglycemia is a condition defined by chronically elevated blood glucose levels, even during a fasting state. Occasional incidences of hyperglycemia in the absence of a formal
Diagnosis of diabetes typically suggest the onset of diabetes. Mild symptoms include sweating, trembling, rapid heart rate, hunger, frequent urination, and increased thirst. In individuals with diabetes, hyperglycemia can result in ketoacidosis, a condition that promotes electrolyte imbalances and lowers pH.

7. Individuals with type 1 diabetes who inject insulin have circulating insulin levels that do not respond normally to exercise because their pancreas is not functioning properly and therefore cannot decrease insulin release during exercise. Consequently, individuals with type 1 diabetes who inject normal doses of insulin before exercise have relatively high blood levels during exercise. Couple this with the fact that body cells become more sensitive to insulin during physical activity, and it is understandable that these individuals are prone to hypoglycemia (because blood glucose levels will drop rapidly in response to the high levels of insulin present during exertion).

8. The benefits of exercise experienced by individuals with diabetes include the following: improved insulin sensitivity and glucose tolerance, reduced risk for cardiovascular disease, improved work capacity, reduced need for medication, improved mood and well-being, and better weight management.

9. For cardiovascular training, perform aerobic activity at a moderate intensity of 50% to 80% \( \dot{V}O_2 \) (12 to 16 RPE) for 20 to 60 minutes. Walking, low-impact floor aerobics, water aerobics, or the elliptical trainer is a safe option. Be aware that hypoglycemia might develop during and after exercise. Resistance training is safe for those without retinopathy, recent laser
treatment, or any other contraindications. Train at 60% to 80% of 1-RM. Perform 8 to 12 repetitions for 8 to 10 different exercises targeting all major muscle groups. Avoid sustained tight gripping and isometric exercises.

10. Nutritional therapy is essential in managing blood glucose levels in both type 1 and type 2 diabetes. By obtaining the appropriate nutrients in the proper amounts, the individual with diabetes minimizes the risk of hypoglycemia, long-term complications, excess weight gain, undesirable lipid levels, and overall quality of life. Obviously, specific nutritional advice differs for different individuals based on age, medication, lifestyle factors, and usual eating patterns; however, the American Diabetes Association (ADA) sets general suggestions that apply to most individuals with diabetes.

   Individuals with diabetes should not restrict carbohydrate intake to less than 130 grams per day, but actual intake will vary depending on activity level and insulin therapy. They should consume 14 grams of fiber per 1,000 kilocalories they ingest. All individuals with diabetes should closely monitor carbohydrate intake using the exchange lists or carbohydrate counting to achieve glycemic control. The ADA suggests that no more than 15% to 20% of a diabetic’s diet come from proteins. This equals about 75 to 100 grams of protein per day on a 2,000-kilocalorie per day diet. Fat may contribute 20% to 35% to the total energy intake, but the source must be closely monitored. Limit saturated fat intake to less than 7% of intake, and limit cholesterol to less than 200 mg per day.