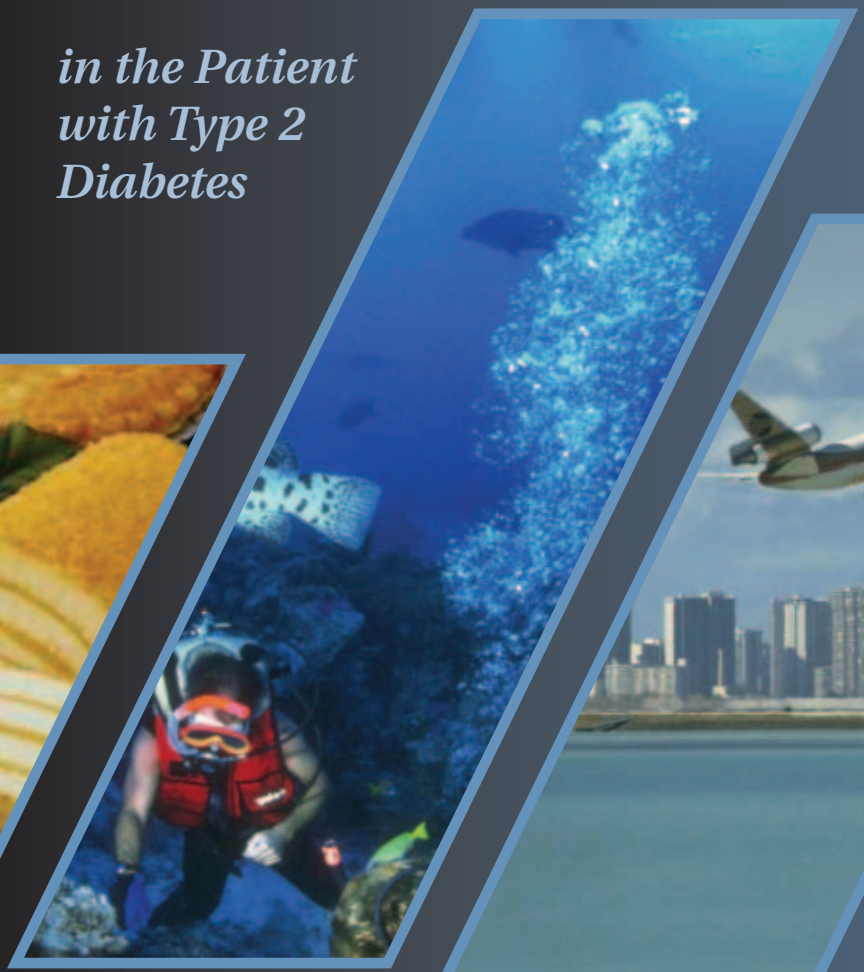
An educational activity intended for physicians, pharmacists, nurses, and dietitians who care for patients with type 2 diabetes.

Strategies for Managing Special Situations

in the Patient with Type 2 Diabetes



Program Goal

The goal of this program is to provide theoretical and practical knowledge to healthcare providers regarding the design of insulin regimens for patients with type 2 diabetes who have special situations.

Target Audience

This activity is intended for physicians, pharmacists, nurses, and dietitians who care for patients with type 2 diabetes.

Educational Objectives

Upon completion of this monograph, participants should be able to:

- Identify frequently occurring and uncommon special situations that necessitate individually tailored insulin regimens for persons with type 2 diabetes.
- Provide patient education regarding the benefits of frequent self-monitoring of blood glucose for persons with special situations.
- Select the appropriate insulin and insulin delivery methods for persons with special situations.
- Identify key resources that provide guidance for developing insulin regimens for persons with special situations.

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Strategies for Managing Special Situations in the Patient with Type 2 Diabetes

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Introduction

Overview

Many individuals with type 2 diabetes have special situations that necessitate individually tailored insulin regimens. These may involve activities that affect insulin requirements, unpredictable schedules, or both. Special situations that arise frequently include intensive exercise, travel, diet-related situations including irregular mealtimes and weight-loss programs, and religious or cultural practices. Special situations that occur infrequently include colonoscopy preparation and emergencies such as natural disasters.

General Considerations

The population of persons with type 2 diabetes who use insulin is extremely diverse, ranging from individuals with almost total reliance on insulin to those who use insulin in addition to their oral diabetes medication. Therefore, although general advice can be given, tailoring insulin to special situations must be done on an individual basis. Determining the best regimen for a particular individual usually takes time and requires learning both the art and science of diabetes management.[1] **Table 1** summarizes general guidelines developed by the American Diabetes Association (ADA) for all persons who use insulin, including those with special situations.

Other important skills are learning how to store insulin, test strips, and other diabetes supplies.[3] Insulin should not be exposed to light, heat sources, or excessive agitation and should not be left in a car or in checked baggage on an airplane. It should be kept at the recommended temperatures (**Table 2**); insulin that has been improperly stored should not be used unless absolutely necessary. Insulin should be inspected for signs of damage each time it is used, and damaged or questionable insulin should be replaced.[2,3] Similarly, insulin pens and cartridges should be stored according to the manufacturers' instructions.[3] Glucose monitors and test strips should be used within the manufacturers' recommended ranges for temperature (usually about 10°C–30°C [59°F–86°F]) and relative humidity (about 20%–80%).[4] Manufacturers' recommendations concerning the reuse of syringes and needles should be followed,[2] and used syringes, pen nee-

Table 1. American Diabetes Association Guidelines for Individuals Who Use Insulin[2]

- Learn where to inject insulin and how to draw or dial up a dose
- Become familiar with the signs and symptoms of hypoglycemia and hyperglycemia and develop strategies for treating these conditions in different situations
- Maintain adequate hydration at all times
- Identify yourself as having diabetes by wearing a bracelet, neck charm, or other identifier
- Ensure that at least 1 companion knows that you have diabetes and how to handle an emergency

Table 2. Effects of Temperature on Insulin[*1-7]*

Temperature	*Effects on Insulin*
<2°C (36°F)	■ Risk of freezing. Do not use insulin products that have been frozen ■ Short-acting insulin (soluble): usually no damage. Change to new vial as soon as possible ■ Long- or intermediate-acting insulin: probable loss of biological activity. Change to new vial as soon as possible
2°C–8°C (36°F–46°F)	■ Ideal storage temperature for most insulin products, including unopened vials, cartridges, and prefilled syringes ■ Insulin pens containing insulin cartridges should not be refrigerated
8°C–30°C (46°F–86°F)	■ No significant effect on insulin activity for 28 days
30°C–45°C (86°F–113°F)	■ Acceptable for very short periods (days).[†] Loss of biological activity possible

** Check all insulins regularly for clumping or precipitation.*
† Do not use insulin aspart if it has been exposed to temperatures >37°C (98.6°F).

dles, insulin pump infusion needles and lines, and other diabetes supplies should be disposed of safely, in accordance with local regulations.[2,3]

Intensive Insulin Therapy and Special Situations

Selected persons with special circumstances can benefit from intensive insulin therapy (IIT), whether achieved through multiple daily injections (MDIs) of insulin or continuous subcutaneous insulin infusion (CSII) therapy.[8,9]

Candidates for MDI therapy are motivated individuals who reliably demonstrate and continue to employ self-care measures, including frequent self-monitoring of blood glucose (SMBG), insulin injections, carbohydrate counting (and/or other approaches for matching insulin needs with carbohydrate consumption), and problem solving.[8,9] MDI mimics physiologic insulin secretion more closely than conventional therapy, and this benefit is enhanced when an insulin analog rather than human insulin is used. MDI also allows for greater flexibility in terms of diet and exercise.[8] Limitations are the inability to make quick changes to basal insulin and the challenge of incorporating frequent injections into busy lifestyles. Many individuals who use MDI therapy favor reusable or disposable insulin pen devices, since they offer an insulin-delivery option that is convenient and discreet, as well as being more accurate than vials and syringes.[10]

Candidates for CSII therapy have the characteristics of candidates for MDI therapy. In addition, they have realistic expectations of CSII therapy, can develop the required technical skills, have adequate support systems, and have health insurance that covers the cost of an insulin pump and supplies for patients with type 2 diabetes (not just type 1 diabetes) or adequate financial resources.[8] With insulin pumps, the prescribed insulin dose is delivered accurately, to within one hundredth of a unit with some models, and insulin is predictably absorbed from a continuous insulin depot. Because they generally use rapid-acting insulin analogs, insulin pumps provide predictable physiologic delivery of insulin,[8] mimicking mealtime and basal insulin secretion without an increased risk of hypoglycemia.[11] Basal rates can be changed quickly to accommodate altered needs during periods of unusual physical activity, stress, or illness, and use of a temporary basal rate can compensate for a period of intense activity or a sick day.[8] CSII permits patients to tailor insulin delivery to irregular meal schedules, unplanned activities, and travel.[8,9] However, it also has some disadvantages, including the risk of technical or mechanical failure, the possibility of infection or inflammation at the needle site, and high initial and ongoing costs for individuals whose insurance plans cover only 80% of the associated costs.[9,11]

Exercise

Introduction

The ADA recommends aerobic and resistance exercise for many individuals with type 2 diabetes, including those receiving insulin therapy.[12] Modest amounts of regularly scheduled moderate exercise have consistently shown beneficial effects.[12] However, just like individuals without diabetes, many patients prefer to engage in exercise of high intensity or long duration, enjoy unplanned exercise, or participate in adventurous types of exercise. Research on the physiology of fuel metabolism and practical experience have led to the development of useful guidance for individuals who want to pursue more intensive, unscheduled, or extreme forms of exercise.

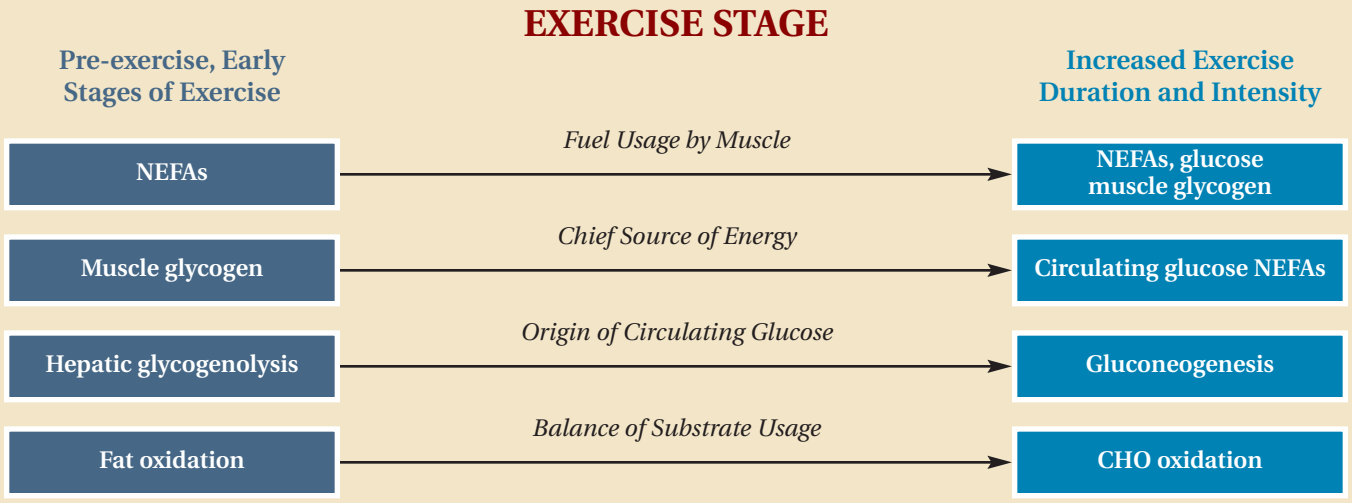
Physiology of Fuel Metabolism During Exercise

The overall effects of exercise are increased insulin sensitivity and glucose utilization, as well as decreased hepatic glucose production.[13] A 2004 ADA technical review entitled "Physical Activity/Exercise and Type 2 Diabetes" contains an extensive literature review on the physiology of exercise as it relates to type 2 diabetes.[14] The following paragraphs summarize key sections of that publication.

During exercise, the working muscle has a change in fuel source, from mainly nonesterified fatty acids (NEFAs) to a mixture of NEFAs, glucose, and muscle glycogen.[14] The origin of circulating glucose changes from hepatic glycogenolysis to gluconeogenesis, and the balance of substrate use shifts from fat oxidation to greater carbohydrate oxidation as exercise intensifies (**Figure 1**). The neuroendocrine system is the main regulator of fuel mobilization during aerobic exercise, and insulin secretion decreases while levels of glucagon, catecholamines, and other hormones increase during sustained exercise.

During moderate exercise, there is a close relationship between endogenous glucose production and increased muscle glucose uptake.[14] The exercise-induced increase

Figure 1. The Main Effects of Exercise on Fuel Utilization[14]



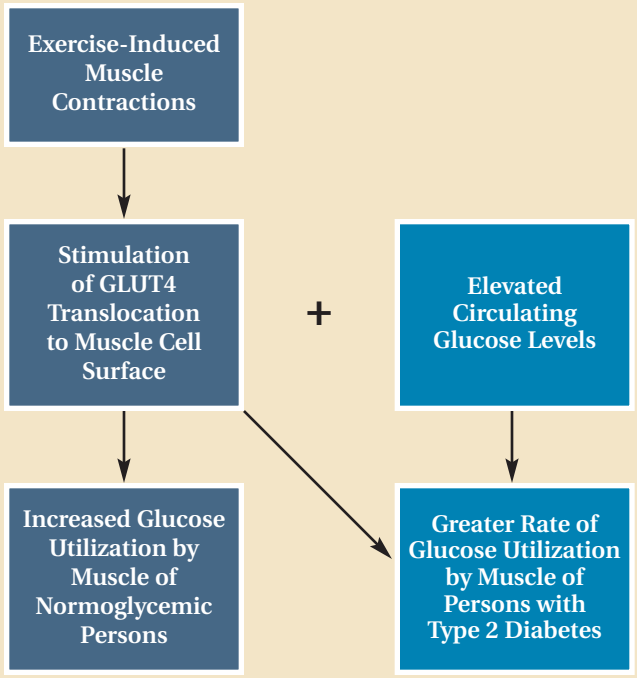
CHO, carbohydrate; NEFAs, nonesterified fatty acids

in glucagon stimulates glycogenolysis and gluconeogenesis. Glucagon also stimulates hepatic amino acid metabolism and fat oxidation, providing precursors for gluconeogenesis and energy to fuel it. The decrease in insulin during exercise is necessary for the full glycogenolytic response. If the liver did not release more glucose in response to exercise, hypoglycemia would result.

Exercise-induced muscle glucose uptake requires the delivery of glucose from the blood to the muscle, transport of glucose across the muscle membrane, and phosphorylation of glucose within the muscle. During exercise, blood flow (and, consequently, glucose delivery) to working muscles increases greatly. Exercise increases glucose transport by stimulating translocation of the GLUT4 glucose transporter to the muscle cell surface. Phosphorylation is the first step in glucose metabolism, and exercise stimulates muscle hexokinase II gene transcription.

Exercise increases insulin-independent muscle glucose uptake. Although individuals with type 2 diabetes are usually insulin resistant, they are not resistant to the stimulatory effects of exercise on glucose utilization. Therefore, they retain the ability to translocate GLUT4 to the sarcolemma in response to exercise. The recruitment of GLUT4 transporters, together with elevated circulating glucose levels, can lead to a greater rate of glucose utilization by the muscle of persons with type 2 diabetes compared with the muscle of normoglycemic persons (**Figure 2**).

Figure 2. Insulin-Independent Muscle Glucose Uptake in Normoglycemic Persons and Persons with Type 2 Diabetes[14]



Exercise also increases insulin-dependent glucose uptake (insulin sensitivity).[14] Although the main route of insulin-mediated glucose metabolism in the resting and postexercise states is nonoxidative metabolism, exercise shifts the route of insulin-stimulated glucose disposal so that all glucose consumed by the muscle is oxidized. The effects of this increased insulin action are important in intensively treated persons with diabetes, whose insulin levels are higher than those that normally accompany exercise.

Carbohydrate ingestion slows the mobilization of endogenous fuels during prolonged exercise and either slows the decline in circulating glucose that would otherwise occur or increases circulating glucose. Increased glucose availability attenuates or eliminates the exercise-induced decrease in insulin and the increase in glucagon. The metabolic availability of ingested carbohydrate depends both on the composition of the carbohydrate and on the intensity, duration, and type of exercise. During exercise, the maximum absorption rate of carbohydrate in the gut is about 1 gram per minute.

Stimulation of muscle glucose uptake persists long after exercise, and the added glucose taken up after exercise is channeled into glycogen. Glycogen repletion is characterized by a marked, persistent increase in insulin action. Like muscle, the liver is more insulin sensitive after exercise, and exercise increases the liver's ability to consume glucose.

In individuals with type 2 diabetes who exercise regularly, 2 major metabolic adaptations occur. Reduced secretion of insulin by pancreatic β-cells leads to reduced basal and glucose-stimulated insulin levels. Both aerobic exercise and resistance training lead to increased muscle GLUT4, which appears to contribute to the increased capacity for insulin-stimulated glucose transport in persons who exercise regularly.

Key ADA Recommendations on Exercise in Diabetes

To improve glycemic control, assist with weight maintenance, and reduce the risk of cardiovascular disease, the ADA recommends at least 150 minutes per week of moderate-intensity aerobic physical activity (50%–70% of maximum heart rate) and/or at least 90 minutes per week of vigorous aerobic exercise (≥70% of maximum heart rate).[12,15] This physical activity should be distributed over at least 3 days per week, with no more than 2 consecutive days without physical activity. In the absence of contraindications, people with type 2 diabetes should perform resistance exercise 3 times per week, targeting all major muscle groups, progressing to 3 sets of 8 to 10 repetitions at a weight that cannot be lifted more than 8 to 10 times. A graded exercise test with electrocardiogram monitoring should be seriously considered before undertaking aerobic physical activity with intensity exceeding the demands of everyday living (more intense than brisk walking) in previously sedentary individuals whose 10-year risk of a coronary event is likely to be ≥10%. For planned exercise, reduction in insulin dosage is the preferred method to prevent hypoglycemia. For unplanned exercise, intake of additional carbohydrate is usually needed.

Aerobic Exercise

Aerobic exercise consists of rhythmic, repeated, and continuous movements of the same large muscle groups for at least 10 minutes at a time.[14] Examples include walking, bicycling, jogging, and continuous swimming. Aerobic exercise is often described as "moderate" when it is at 40%–60% of VO_{2max} (~50%–70% of maximum heart rate) and "vigorous" when it is at >60% of VO_{2max} (>70% of maximum heart rate). In persons with type 2 diabetes, aerobic exercise improves A1C values and insulin sensitivity, increases VO_{2max}, reduces abdominal visceral and subcutaneous fat, decreases overall cardiovascular risk, and reduces cardiovascular and overall mortality. These benefits may increase greatly in individuals who engage in extremely vigorous aerobic exercise (≥75% of VO_{2max}).

Resistance Exercise

Resistance exercise consists of activities that use muscular strength to move a weight or work against a resistive load.[14] Examples include weight lifting and exercises using weight machines. Resistance exercise is often considered to be of "high" intensity if the resistance is ≥75% of the maximum that can be lifted at a single time (≥75% of 1-RM [repetition maximum]) and "moderate" if resistance is 50%–74% of 1-RM. In patients with type 2 diabetes, resistance exercise improves A1C levels and insulin sensitivity, increases muscle mass and endurance, enhances weight loss, reduces body fat, increases lean body mass, and reduces systolic blood pressure and free fatty acid concentrations. As with aerobic exercise, more

intense exercise is associated with greater benefits. To optimize the benefits of resistance exercise and minimize the risk of injury, initial supervision and periodic reassessment by a qualified exercise specialist is recommended.

Avoiding Exercise-Induced Hypoglycemia: Overview

In individuals treated with insulin, physical activity can cause hypoglycemia if the medication dose or carbohydrate consumption is not altered.[12] Adjusting insulin therapy to reduce iatrogenic hyperinsulinemia is intended to mimic the fall of serum insulin levels early during exercise and allow for increased insulin sensitivity during and after physical activity.[16] Changing the insulin injection site usually cannot prevent exercise-induced hypoglycemia.[16] Insulin should be injected into the subcutaneous fat layer, and intramuscular injection should be avoided because muscle contractions accelerate the absorption of insulin into the circulation.[1] SMBG is the primary tool for managing glycemia and participating safely in athletics.[16]

Insulin Dose Modification to Avoid Hypoglycemia

Michael Berger, MD, has developed useful recommendations for avoiding exercise-induced hypoglycemia in insulin-treated patients (**Table 3**).[16] Planned adjustments to insulin therapy are usually required when exercise of moderate or higher intensity exceeds 30 minutes. Clinicians should calculate the percentages by which patients reduce their dosages of short- and long-acting insulin preparations or insulin infusion rates before, during, and after physical activity. Important considerations for fine-tuning the insulin dosage are the interval between the start of exercise and the previous insulin injection, the type of insulin used, and the strategy for insulin substitution. The more prolonged the physical activity and the better the patient is physically trained and adapted to exercise, the more drastic the insulin dose reduction needs to be.

For patients who desire exercise of prolonged duration and high intensity, who wish to exercise according to changing daily schedules and preferences, or who are competitive athletes in need of intensive physical training, the required insulin dosage adjustments can only be made within the framework of IIT.[16] Most patients receiving IIT who have completed a comprehensive educational program can participate in sports without an excessively high risk of hypoglycemia.

Table 3. Guidelines for Avoiding Exercise-Induced Hypoglycemia in Insulin-Treated Patients[16]

- Measure blood glucose before and after exercise
- Measure blood glucose during prolonged exercise (eg, 2 hr) of moderate or greater intensity
- Consume extra carbohydrates (eg, 20–30 g/30 min of exercise) before unplanned exercise and decrease insulin after exercise if necessary
- If exercise is planned, decrease insulin dosages before and after exercise, according to the intensity and duration of exercise and the patient's personal experience (Insulin dosage reductions may amount to 50%–90% of daily insulin requirements)
- Consume easily absorbable carbohydrates during exercise if necessary
- Consume an extra carbohydrate-rich snack after exercise if necessary
- Contact the Diabetes Exercise and Sports Association for assistance in obtaining a specific education program for self-treatment
- Use intensified insulin therapy if you wish to engage in exercise of prolonged duration and high intensity, if you want to exercise irregularly based on changing daily schedules and preferences, or if you are a competitive athlete in need of intensive physical training

Although insulin dosage reductions must be determined on an individual basis, it is typical to reduce the prebreakfast insulin dose by >50% before extended exercise that begins in the morning and by at least 80% on a day of marathon running.[16] Postexercise dose reduction is often necessary after prolonged endurance exercise, sometimes even on the following day. Because the risk of nocturnal hypoglycemia is particularly high when exercise is performed in the evening, a reduction of at least 50% of the predinner insulin dose may be required. *The Diabetic Athlete*, by Sheri Colberg, PhD, contains detailed tables that summarize typical modifications to insulin doses and carbohydrate supplementation strategies based on an individual's type of physical activity (eg, endurance sports, power sports, fitness activities, or recreational sports) and the type of insulin therapy used.[17]

Shorter-term, extremely intense, and stressful forms of exercise, such as highly competitive sports, may lead to transient phases of hyperglycemia, especially in less well-trained individuals.[16] In this situation, injection of extra insulin, together with the postexercise increase in insulin sensitivity, can lead to an episode of potentially severe hypoglycemia.

Carbohydrate Ingestion to Avoid Hypoglycemia

If adjusting insulin therapy is impossible or unnecessary (eg, because exercise was not anticipated or lasted for <30 minutes), supplemental carbohydrates before and during exercise may be used to counterbalance hyperinsulinemia.[16] If an individual exercises soon after a meal or customary snack, no extra food may be needed, but if the exercise takes place >2 hours after a meal, a snack should be eaten within 15 minutes of the start of exercise.[1]

Wasserman and colleagues have developed recommendations for preventing exercise-related hypoglycemia or hyperglycemia on the basis of preexercise glucose levels.[18] If blood glucose readings are <90 mg/dL, the risk of hypoglycemia is great and exercise should not be started before ingesting glucose or carbohydrate. If fasting blood glucose exceeds 250 to 300 mg/dL and ketone bodies are present in urine, more insulin should be administered and exercise should be delayed. It is important to consider not only the absolute glycemic level when monitoring blood glucose, but also the rate at which a change in glycemia may occur. Thus, for example, a stable glucose level of 100 mg/dL may reflect a safe situation, but a level of 100 mg/dL that was preceded by a reading of 150 mg/dL indicates an imbalance between glucose production and utilization that requires further attention. Athletes who use insulin may benefit from the use of glucose sensors, which allow continuous, accurate monitoring of blood glucose levels and provide trending data before, during, and after exercise.

Continuous Subcutaneous Insulin Infusion and Intensive Exercise

Insulin pump therapy provides great flexibility for adjusting meal doses and basal insulin requirements for exercise.[19] For activities that involve excessive contact, movement, or sweating, patients can remove their pumps for short periods (<1 hour) without consequences. Pump removal for a longer period requires subcutaneous administration of a bolus dose of insulin to cover the disconnect time. Skill in modifying the pump's infusion rate for particular activities is achieved through frequent SMBG and patient experience. The flexibility provided by insulin pumps allows individuals to benefit from the enjoyment and therapeutic advantages of a healthy, physically active lifestyle.

Bernard Zinman, MD, has developed recommendations for pump protection during different types of athletic activities.[19] Several types of pumps are waterproof or can be protected with a waterproof case, making them appropriate for use during water activities. However, the pump should be removed during vigorous water sports, such as surfing, diving, or water polo. Extra pump protection may be needed during contact sports such as basketball, football, and hockey. Athletes can use a sports guard case or protective padding or wear the pump in a position where it is protected, such as the small of the back. Persons participating in winter sports appear to use glucose more rapidly than those who are active in milder temperatures, necessitating more frequent glucose monitoring and greater adjustments of basal and bolus doses. Because insulin can freeze when exposed to cold temperatures, the pump and tubing must be protected during winter activities. Wearing appropriate clothing and placing the pump under the inner layer of clothing next to the body provide the best protection from extreme cold.

Guidelines for Specific Activities

Specific guidelines have been developed for individuals who wish to participate safely in different types of sports or other types of physical activity. This section deals briefly with weight training, walking, scuba diving, and high-altitude activities. Readers desiring detailed guidance on performing these activities or information about other kinds of exercise can consult *The Diabetic Athlete: Prescriptions for Exercise and Sports*, by Sheri Colberg.[17] Another valuable resource is the Web site of the Diabetes Exercise and Sports Association (www.diabetes-exercise.org).

Weight Training. Weight training mainly utilizes anaerobic energy sources, including stored phosphagens and muscle glycogen via the lactic acid system.[17] Many individuals can maintain blood sugar levels during weight lifting with few changes in their self-management regi-

men. Blood glucose levels may be stable or even rise when circulating insulin levels are lower (>3–4 hours since the last injection of short-acting insulin) or early in the morning, when insulin resistance is increased. At these times, weight lifters may need supplemental insulin to counter the rise in blood glucose levels. However, a prolonged weight-training session may result in significant glycogen depletion that may increase the risk for late-onset hypoglycemia. To avoid this, athletes should monitor their blood glucose levels carefully later in the day of a weight-training session and make the necessary corrections in insulin or diet. Athletes who do weight training in combination with an aerobic workout on a stationary cycle, rowing machine, or other type of exercise equipment may need to make regimen changes that are more substantial than those required for weight training alone. However, these changes are likely to be smaller than those required with aerobic exercise alone.

Walking. The effects of walking on blood glucose levels depend on the intensity and duration of the walking, the time of day, and circulating insulin levels during exercise.[17] For neutral protamine Hagedorn (NPH) users, the main effect of walking seems to come from circulating insulin levels at the time of exercise. Walkers who engage in moderate-paced walking (<4 mph) before their morning insulin injection may need no regimen changes if they walk for under an hour. For planned exercise later in the day, closer to an NPH peak, a 10% to 30% reduction in the morning NPH dose may be the best strategy. Walking for >1 hour at a rate of >4 mph requires more substantial changes. Long-acting insulin users who walk when circulating insulin levels are low (>3–4 hours after a meal) may need fewer changes than if they walk soon after a meal, when rapid-acting insulin levels are higher. No dietary adjustments may be needed for slow or short walks soon after a meal, but longer or faster walks may require 15 to 30 grams per hour of additional carbohydrates. For insulin pump users, a 25% reduction in the basal rate may be sufficient. More intense or extended walks may require a 50% basal reduction as well as reduced boluses for snacks and meals during and following the walk.

Scuba Diving. Scuba diving by individuals with diabetes has been studied intensively. Although this is a high-risk sport, there is no evidence that accidents occur more frequently in persons with diabetes than in the overall diving population.[20] Major challenges for divers with diabetes are that signs of decompression illness or gas embolism often resemble those of hypoglycemia, diving causes greater diuresis in adults with diabetes than in other adults, and swimming in cold water on consecutive days causes blood glucose to drop quickly, substantially reducing insulin requirements.[3,20] Individuals who use insulin should arrange to dive with a buddy who can recognize and treat hypoglycemia, inform the dive master that they have diabetes, store diabetes supplies on the boat but carry at least 2 tubes of glucose gel with them, avoid alcohol for 24 hours, drink at least 2.5 liters of fluid, dive after a meal, and start the dive hyperglycemic (blood glucose level 160–200 mg/dL), ensuring that the blood glucose level is not dropping.[3,20] Divers should stay in the water for <2 hours, limit their dive to <100 feet, and schedule no more than 3 consecutive days of diving and no more than 2 dives per day.[20] If hypoglycemia occurs during the dive, they should treat it before ascending. The Divers Alert Network (www.diversalertnetwork.org) provides detailed information on diving with diabetes.

High-Altitude Activities. High-altitude activities, such as hiking and rock-climbing, pose hazards for persons with and without diabetes, including foot injuries, dehydration due to sweating and high respiratory rates, limited availability of uncontaminated water, exposure to ultraviolet radiation, frostbite and hypothermia, avalanche, and lightning.[4,21] Participants may experience acute mountain sickness, cerebral edema, pulmonary edema, or retinal hemorrhage and lack access to immediate or advanced medical care.[21] Because mountain hiking and climbing are aerobic sports that last for many hours or days, insulin needs usually decrease substantially and carbohydrate consumption increases.[4] However, some athletes may need to increase their insulin doses above normal levels at high or extreme altitudes, despite increased levels of exercise and/or decreased food intake.[21] Important self-care practices are frequent monitoring of blood glucose levels and keeping a record of physiologic reactions to different levels of exertion.[4] Because some glucose meters are better suited for use at high altitudes than others, individuals who enjoy high-altitude activities may wish to investigate this feature before purchasing a meter.

Recognition of hypoglycemia can be difficult at high altitudes because stimulation of the sympathetic nervous system may result in a higher heart rate and sweating.[4] Poor appetite and nausea, which are common at high altitudes, can compromise food and fluid intake, precipitating hypoglycemic episodes.[4,21] Therefore, preprandial insulin should not be injected until food intake is assured.[21]

Insulin should be stored in an insulated box in a non-exposed place in the backpack on warm days and kept close to the body during cold weather.[4] At high altitudes, some glucose monitoring systems underestimate blood glucose results by up to 45% while others overestimate it by up to 35%, and it is hazardous to try to correct supposed under- or overestimated values. As previously mentioned, athletes who expect to engage in a significant amount of high-altitude exercise will probably wish to purchase a glucose meter that functions well under these conditions. At low temperatures, carrying glucose metering equipment next to the skin may prevent problems associated with meter and battery malfunction.[21]

Downhill skiers should adjust their insulin regimen and carbohydrate consumption based on the intensity and duration of their skiing, the altitude, and weather and snow conditions.[17] NPH users participating in all-day or intense skiing may need to reduce preprandial doses of short-acting insulin by 20% to 30%, reduce morning NPH doses (if taken) by 20% to 30% for afternoon activity, and supplement their diet with up to 15 grams of carbohydrate per hour. Long-acting insulin users may need to reduce doses of short-acting insulin by 10% to 30% for meals and consume 10 to 15 grams of additional carbohydrates per hour. Insulin pump users may need to reduce preprandial boluses by 10% to 30%, reduce their basal insulin rates by 2% to 50%, and consume 10 to 15 grams of extra carbohydrates per hour.

Case 1. Individual who participates in half-marathon walks

AY is a 62-year-old businessman with a 16-year history of type 2 diabetes. Two years ago, after gradually increasing his stamina and learning about his body's reaction to sustained and intense exercise, he participated in his first half-marathon walk to benefit children with cancer. He had been taking NPH insulin before breakfast and in the evening and a rapid-acting insulin analog before each meal for 3 years. At the time of the race, he was using

Figure 3. Calculating the Insulin and Dietary Modifications for the Patient in Case 1 During His Two Half-Marathon Walks[17]

First Walk: MDI Therapy

Usual Insulin Regimen

- 22 Units of NPH insulin before breakfast and in the evening
- 10 Units of rapid-acting insulin before each meal

Modified Regimen on the Day of the Walk

Insulin
- ~20% Reduction of morning NPH dose, to 18 units
- 30% Reduction of breakfast and lunch doses of rapid-acting insulin, to 7 units per dose
- ~10% Reduction of evening NPH dose, to 20 units

Diet
- 15 Gram increase in carbohydrate intake at breakfast
- 15 Gram per hour carbohydrate intake while walking

Second Walk: CSII Therapy Using a Rapid-Acting Insulin Analog

Modified Insulin Regimen

- 25% Reduction in prebreakfast bolus
- 30% Reduction in basal rate during walk

Diet
- 10 Gram per hour carbohydrate intake while walking

MDI = multiple daily injection; NPH = neutral protamine Hagedorn; CSII = continuous subcutaneous insulin infusion.

22 units of NPH insulin in the morning and evening and 10 units of a rapid-acting insulin analog before meals.

Based on the advice of his healthcare provider and his own experience, AY reduced his morning dose of NPH insulin by about 20%, from 22 units to 18 units (**Figure 3**). He reduced his breakfast dose of rapid-acting insulin analog by 30%, from 10 units to 7 units. He also reduced his evening dose of NPH insulin by about 10%, from 22 to 20 units. On the morning of the race, he increased his breakfast carbohydrate intake by 15 grams and consumed 15 grams of carbohydrate per hour while walking. AY felt well during the race, was delighted when he finished in the top 20% of his age group, and had no symptoms of hypoglycemia that evening or the next morning.

Shortly after his first half-marathon walk, AY switched to CSII therapy, using a rapid-acting insulin analog. He was pleased at the ease of transition to his insulin pump, appreciated the increased flexibility it gave him, and looked forward to the next year's half-marathon. Based on his experience during the year, AY reduced his pre-breakfast bolus by 25% and his basal rate during the walk by 30% (**Figure 3**). He consumed 10 grams per hour of carbohydrates during the race. Again AY finished in the top 20% of his age group and experienced no symptoms of hypoglycemia.

Take-Home Points

Individuals who have type 2 diabetes and use insulin should pursue intense, sustained aerobic exercise such as a half-marathon walk in the context of IIT, utilizing either MDI or CSII therapy. Aerobic exercise of more than brief duration and low intensity usually requires modification of the insulin regimen, carbohydrate intake, or both. Although guidelines have been developed for making these changes, they should be considered general recommendations only. Individuals who wish to engage in these forms of exercise should be guided by their healthcare provider and their own experience, including frequent SMBG. As for athletes without diabetes, gradual training and attention to adequate hydration are essential.

Travel

Introduction

Many factors, including missed meals, dietary changes, increased exercise, time-zone changes, stress, and travel-related illness or injury, can affect blood glucose levels during travel.[3] Major considerations for travelers include documenting their medication and supplies, being able to replace lost or damaged supplies, and adjusting insulin administration for time-zone changes. These and many other travel-related issues are discussed in *The Diabetes Travel Guide* by Davida F. Kruger, MSN.[3] In addition, the Web site of the International Society of Travel Medicine (www.istm.org) provides in-depth health and safety profiles of countries around the world, as well as a list of healthcare providers in foreign cities.

Documentation

Having complete and up-to-date documentation is invaluable if it is necessary to replace medication or other diabetes supplies and is especially important for frequent travelers and/or international travelers. One useful document is a letter from the healthcare provider stating that the traveler has diabetes and summarizing the medication regimen.[3] Another letter from the healthcare provider might summarize the type(s) of insulin used, the prescribed concentration and dose(s) of insulin, the size of the syringe, as well as information about any prescribed oral medications. It is also helpful for travelers to carry a copy of the prescription for each medication (using generic names) and piece of equipment.

Supplies

Travelers should have access to insulin, other diabetes supplies, and extra food and drink at all times.[3] It is important to keep diabetes supplies in a carrying case with an insulin cool pack if the insulin will be exposed to extremes of temperature or if the trip will last for more than 28 days. It is also important to have a system for bringing used syringes or pen needles home for disposal.

Obtaining Insulin Abroad

Because insulin names may be different in other countries (eg, a 70/30 mixture may be called 30/70), it is

important to read labels carefully.[3] Travelers using a newer insulin product may wish to contact the manufacturer prior to scheduled travel to determine whether the product is available in the destination country and what it is called in that country. If it is necessary to use U-40 insulin, the insulin concentration generally available in Europe and many other countries, a U-40 syringe should be used whenever possible. If a traveler must use U-40 insulin with a U-100 syringe, the usual dose should be multiplied by 2.5 to calculate the new dose. If U-100 insulin must be used with a U-40 syringe, the usual dose should be divided by 2.5.

Insulin Administration and Time-Zone Changes

Patients whose travel involves changes in time zones should discuss their regimen with their healthcare provider.[3] If the time change is 1 or 2 hours, insulin can usually be injected based on the new time. On the day of travel, insulin should be taken based on the home time. The local time should be used beginning the morning of the first full day at the destination. **Table 4** summarizes suggested insulin adjustments for time changes of ≥3 hours. The goals of these adjustments are to avoid the overlapping of long-acting insulin injections (eg, giving 2 doses of long-acting insulin 18 hours rather than 24 hours apart) and to begin using the destination time as soon as possible. For patients on an MDI regimen, it is relatively easy to bridge any disruption in the use of long-acting insulin by administering a correction dose of rapid-acting insulin. In this way, long-acting insulin can be given at an hour that makes sense in the new time zone.

Case 2: Patient who experiences a time change of 3 hours during west-bound travel

SW, a 66-year-old widow who lives near Philadelphia, Pennsylvania, will soon visit her sister, who has moved to Sacramento, California. SW has a 12-year history of type 2 diabetes and currently takes 20 units of NPH insulin before breakfast and before going to bed (between 9 PM and 10 PM). In addition, she takes 10 units of a rapid-acting insulin analog before breakfast, lunch, and dinner.

Table 4. Suggested Insulin Adjustments for Travelers with Time Changes of ≥3 Hours[3]

Direction of Travel	*Injection Frequency*	*Adjustment*
East	1	■ On your travel day, take insulin as you normally do or decrease it by 10% to 20% ■ On the first full day at your destination, wake on the local time schedule and take your usual insulin dose ■ Continue to take your insulin at the same time each day using the local time
	≥2	■ On your travel day, decrease the last daily dose of intermediate- or long-acting insulin by 20% ■ On the first full day at your destination, wake on the usual time schedule and take your usual insulin dose ■ Continue to take your insulin based on the local time
West	1	■ On your travel day, take your insulin as usual ■ Since the day will be extended, you may need an injection of the same insulin before dinner ■ The time of the second injection should be based on your home time and should be one third of your morning dose ■ Alternatively, take your usual morning injection based on your home time and, if you eat an extra meal, take an injection of rapid-acting insulin to cover the carbohydrate content of the meal
	≥2	■ On your travel day, take your breakfast insulin as usual ■ If you take insulin at lunchtime, take your usual dose based on your home time schedule ■ Take your usual dinnertime rapid-acting insulin at your dinner meal ■ If your last daily injection of intermediate- or long-acting insulin is usually at dinnertime, delay it by 3 hours and decrease the dose by 20% ■ If your last daily injection of intermediate- or long-acting insulin is usually at 9:00 PM to 10:00 PM, take this injection at the same time you would based on your home time and increase the dose by 10% ■ When you arrive at your destination, wake on the destination time and take your usual insulin doses based on your destination time schedule

She contacts her healthcare provider because she has not taken a trip involving time-zone changes since beginning insulin therapy. SW's healthcare provider explains that since her trip will involve a westbound change of 3 time zones, she will need to make some minor modifications to her regimen (**Table 5**).

SW's trip to California goes smoothly. Because she has the labels from her insulin vials that show the name of her insulin, the name of her healthcare provider, and the type of insulin used, she has no difficulty keeping her diabetes supplies with her on the plane. Her flight is late enough that she can eat breakfast at home, and she takes her lunch and dinner, snack food, and bottled water purchased at the airport with her. At 6:30 PM Sacramento time (9:30 PM Philadelphia time), SW takes her last daily injection of NPH insulin. Since her usual dose is 20 units and she needs to increase this dose by 10%, she takes 22 units. When SW reaches her sister's home, the family sits down to dinner. Because this is an extra meal for SW and she estimates that the carbohydrate content of her meal is 60 g, she administers 3 units of her rapid-acting insulin analog. The next morning, SW awakens at 7:00 AM California time and resumes her normal insulin regimen, based on the local time.

Take-Home Points

When planning travel that involves 3 or more time-zone changes, individuals with type 2 diabetes should seek the advice of their healthcare provider about modifications to their insulin regimen. The nature of these modifications will depend on whether the travel is eastbound or westbound and the type(s) of insulin that the individual is using. Travelers can minimize inconvenience during their trip by carrying the labels from their insulin vial(s) or box(es), keeping their diabetes supplies with them at all times, and having an ample supply of food and water with them.

Traveling with an Insulin Pump

Travelers who use insulin pumps can avoid problems by packing extra pump supplies, carrying the telephone number of the pump manufacturer, and taking rapid-acting insulin in a pen, as well as a vial of a long-acting insulin analog (detemir or glargine) or intermediate-acting (NPH) insulin in case the pump malfunctions.[3] If they do not have a plan for injecting insulin as an alternative to CSII therapy, they should speak to their healthcare provider before traveling and carry written instructions with them. If they carry a record of their basal and

Table 5. Modifications to the Insulin Regimen of the Patient from Case 2 Who Has a Change of 3 Hours During Westbound Travel[3]

Time	*Home*	*Travel*	*Destination*
Before breakfast	■ 20 Units NPH insulin ■ 10 Units rapid-acting insulin analog	■ 20 Units NPH insulin ■ 10 Units rapid-acting insulin analog	■ Wake on destination time ■ 20 Units NPH insulin ■ 10 Units rapid-acting insulin analog
Before lunch	■ 10 Units rapid-acting insulin analog	■ 10 Units rapid-acting insulin analog	■ 10 Units rapid-acting insulin analog
Before dinner	■ 10 Units rapid-acting insulin analog	■ 10 Units rapid-acting insulin analog	■ 10 Units rapid-acting insulin analog
Extra evening meal	■ None	■ 1 Unit rapid-acting insulin for each 15 g of carbohydrate	■ None
9 PM –10 PM	■ 20 Units NPH insulin	■ 22 Units NPH insulin (based on home time)	■ 20 Units NPH insulin (based on destination time)

NPH = neutral protamine Hagedorn.

bolus rates, they can reprogram their existing pump if their pump data are deleted or program a new pump if the old one breaks down. **Table 6** summarizes guidelines for traveling with an insulin pump.

Table 6. Adjusting the Insulin Pump for Time-Zone Changes[3]

- Set the insulin pump clock to the destination time zone during your trip
- Measure your blood glucose several times during the trip
- Bolus to cover snacks, meals, and elevated blood glucose levels
- Reset your multiple basal rates based on your blood glucose readings and the destination time zone when you arrive at your destination

Diet-Related Situations

Introduction

Many persons who have type 2 diabetes and use insulin find it difficult to maintain glycemic control when faced with irregular meal schedules. This difficult situation is compounded for individuals whose circadian rhythms are disrupted by shift work or repeated travel through multiple time zones. Another special situation that often arises is intentional weight loss. Although many persons with type 2 diabetes benefit from losing weight, embarking on a medically sound weight-reduction program may require changes to the insulin regimen.

Meal Planning for Irregular Schedules

Consistency in the timing as well as the carbohydrate content of meals is important for individuals with type 2 diabetes who are treated with fixed doses of insulin.[15] However, many persons have irregular meal schedules due to work, school, or family commitments. With the many delivery options now available, an insulin regimen can usually be developed to conform to an individual's meal routine and food choices.[15] Many persons with irregular meal schedules benefit from IIT, whether achieved through MDI or CSII therapy.[8] In both cases, the individual can calculate bolus insulin based on food intake, and meals and snacks can be customized to the individual's schedule and preferences in timing, meal size, and food types.

Monitoring of Carbohydrate Intake

According to a recent ADA position statement, monitoring of carbohydrates, whether by carbohydrate counting or experience-based estimation, is a key strategy in achieving glycemic control, and research has not demonstrated that one method of assessing the relationship between carbohydrate intake and blood glucose response is better than others.[15]

Carbohydrate counting permits a flexible eating schedule and increased dietary freedom for individuals receiving IIT.[8] With carbohydrate counting, foods are listed as carbohydrate choices based on the amount and not the source of the carbohydrate. After mastering basic carbohydrate-counting skills, individuals learn advanced skills, such as keeping food-intake records, using basal and bolus insulin to achieve target blood glucose levels, calculating a bolus insulin dose using insulin-to-carbohydrate ratios (ICRs), calculating an insulin sensitivity factor (ISF) to correct insulin doses when glucose levels are too high or too low before meals, and making adjustments for special situations. In addition to allowing flexibility in meal planning and scheduling, an advantage of carbohydrate counting is that it focuses on a single nutrient.

Despite its advantages, carbohydrate counting also has some disadvantages.[8] The increased flexibility in the selection of food and the timing of meals leads to weight gain in some individuals. Most people find weighing and measuring foods and keeping a food record burdensome. Because high-fat meals can cause delayed gastric emptying, leading to unpredictable food absorption, patients eating high-fat foods may need an adjustment in their bolus insulin amount or in the scheduling of their mealtime insulin to avoid early postprandial hypoglycemia and later, hyperglycemia. Because dietary fiber is not usually digested, if a food contains >5 grams per serving, the total amount of fiber must be subtracted from the total amount of carbohydrate before calculating an insulin dose.[8]

According to the most recent ADA position statement on nutrition, use of the glycemic index (GI) and glycemic load may provide a modest additional benefit over that observed when total carbohydrate is considered alone,[15]

and this position is supported by the findings of a meta-analysis of 14 randomized controlled trials that compared the effects of low-GI and high-GI diets on overall glycemic control.[22] A low-GI diet may improve diabetes management by lowering early postprandial hyperglycemia and decreasing the risk for postabsorptive hypoglycemia.[23] Many individuals with type 2 diabetes may find it too complicated or restrictive to adhere strictly to a low-GI diet. Nevertheless, persons with diabetes benefit from determining their individual glycemic response to various carbohydrate foods and carbohydrate-containing meals by monitoring their preprandial and postprandial blood glucose levels.[13]

Case 3. College student with an unpredictable schedule who uses carbohydrate counting to help with food choices

CV is a 21-year-old woman who was diagnosed with type 2 diabetes when she was 13 years old. She began using insulin 2 years ago, injecting 20 units of NPH insulin before breakfast and 20 units in the evening. While she lived at home, CV's mother was conscientious about preparing meals that met her dietary needs, but there was little variety to the family menu and CV did not participate in food selection or preparation. After graduating from high school, CV attended the local community college and continued to eat most of her meals at home.

Six months ago, CV transferred to a large urban university 200 miles from home. She was elated to be living on her own and amazed at the variety of food choices available on campus and at nearby restaurants. Although her part-time job at a 24-hour copy center had irregular hours, she enjoyed the opportunity to help the customers and troubleshoot the machines. Between the demands of school and work, the schedule and content of her meals was very erratic and she rarely found time to check her blood glucose level.

CV presented to the university health center after what she described as "an awful week." She was extremely tired and on 2 occasions felt lightheaded and thought she would faint. At that time her A1C was 8.6%.

Through the health center, CV began to work with a diabetes educator, who found that CV had little knowledge of the effects of food on blood glucose, carbohydrate sources, and meal planning. The diabetes educator helped CV design a meal plan to meet her specific needs.

To develop a better understanding of the impact of food on blood glucose, CV agreed to keep food diaries and blood glucose records. With the help of her diabetes educator, CV soon realized that MDI therapy was the best way for her to maintain the flexible lifestyle she craved without sacrificing glycemic control. She also understood that mastering carbohydrate-counting skills was crucial to successful MDI therapy.

CV switched from her twice-daily NPH insulin regimen to a regimen of 30 units of a long-acting insulin analog at night and 10 to 15 units of a rapid-acting insulin analog at mealtimes, depending on the carbohydrate content of her meals and her level of physical activity. She soon acquired the advanced skills needed to adjust the dose of her rapid-acting insulin analog to the amount of carbohydrate she would eat. She now enjoys learning about the nutrient content of exotic foods and was thrilled when her most recent A1C was 7.7%.

Take-Home Points

Individuals with irregular meal schedules benefit from IIT, whether delivered through MDI or CSII therapy. Mastery of carbohydrate-counting skills is a way to realize the benefits of IIT. Meal selection based on both the carbohydrate content and the GI of foods may provide a modest additional benefit over that achieved when total carbohydrate content is considered alone, but many individuals find it too complicated to use the GI.

Altered Circadian Rhythms

Many individuals with diabetes who work shift rotations or travel through multiple time zones have difficulty maintaining glycemic control because of changes in circadian rhythms.[8] Careful adjustment of insulin therapy is required for persons with altered circadian rhythms. CSII provides a means of enhancing the required flexible insulin delivery in these patients.

Case 4: Flight attendant who travels repeatedly through multiple time zones

RS is a 44-year-old woman with a 7-year history of type 2 diabetes. RS, who speaks fluent French and Italian and loves to travel, became a flight attendant as soon as she graduated from college. Her usual routes are between J.F. Kennedy International Airport in New York and London (5 time zones to the east) or Rome (6 time zones to the east).

One year ago, when she could no longer maintain glycemic control with oral medication, RS's healthcare provider advised her that it was time to begin insulin therapy. Initially, RS considered leaving her flight attendant job and becoming a trainer for her airline, but her healthcare provider and supervisor encouraged her to try CSII therapy first. RS reminded herself that she had developed many strategies for minimizing the effects of repeated back-and-forth travel through multiple time zones over the years. She knew that her body coped best with the disruptions to her circadian rhythms when she was conscientious about drinking water throughout the day, avoiding caffeine, eating 3 small meals and 2 snacks rather than 3 large meals, and meditating to help her fall asleep and refresh herself when fatigued.

After learning the basic principles of CSII therapy, RS researched the different types of insulin pumps. She was relieved to find that it would be relatively easy to reset the insulin pump clock, reprogram multiple basal rates, and administer bolus doses. Because her experience with oral diabetes medications had taught her that altered circadian rhythms could lead to sudden, unpredictable changes in blood glucose levels, she chose a model that offered a real-time continuous glucose monitoring component. RS adjusted quickly to her insulin pump and is pleased that CSII therapy with a rapid-acting insulin analog has given her more energy. Because of her travel schedule, she is considering the purchase of a back-up pump.

Take-Home Points

Disruptions in circadian rhythms make it difficult for persons with diabetes who work shift rotations or travel through multiple time zones to maintain glycemic control. CSII provides a means of enhancing the required flexible insulin delivery for these patients. Modern pumps are easily programmed to accommodate changes in schedule or time zones, and available models have a variety of features to meet the differing needs of persons with diabetes.

Weight Reduction

Short-term studies have consistently shown that moderate weight loss (5% of body weight) in individuals with type 2 diabetes is associated with decreased insulin resistance, improved measures of glycemia and lipemia, and reduced blood pressure.[15] Some research suggests that the beneficial effect of weight loss on blood glucose levels is greater in persons with early-onset type 2 diabetes than in those who have had diabetes for a longer period.[13] Evidence from rigorously designed studies suggests that structured, intensive lifestyle modification programs involving participant education, individualized counseling, reduced dietary energy and fat (~30% of total energy) intake, regular physical activity, and frequent participant contact are necessary to produce long-term weight loss of 5% to 7% of starting weight.[15] Exercise is a key component of weight-loss regimens for individuals with type 2 diabetes, especially because it improves insulin sensitivity independent of weight loss. Despite the great popularity of low-carbohydrate diets (those that restrict total carbohydrate to <130 grams per day), they are not recommended for individuals with type 2 diabetes, both because their benefits are unproven and because they eliminate many foods that are important sources of energy, fiber, vitamins, and minerals and are important for dietary palatability.

Many factors affect the extent of the modifications that should be made to an individual's insulin regimen during a weight-reduction program.[15] These include the amount of weight loss that is considered safe and realistic for that individual, the level of insulin resistance, and the type of physical activity (frequency, duration, and intensity) in which the individual is able and willing to engage. An individual who is not highly insulin resistant, achieves more rapid and substantial weight loss, and engages in regular physical activity of at least moderate intensity is more likely to require reductions in the insulin dosage than a highly insulin-resistant individual whose weight loss is extremely gradual and modest and who engages in minimal exercise. To ensure that the necessary dosage adjustments are made, the individual should perform frequent SMBG, especially at the beginning of the program, and remain in close contact with the healthcare provider. If they have not previously done so, healthcare providers should screen their patients for eating disorders as they prepare for a weight-loss program, since the lifetime prevalence rate of an eating disorder (binge-eating disorder, bulimia, anorexia, or eating disorder not otherwise specified [EDNOS]) in patients with type 2 diabetes is 9.5%.[24] As part of the educational component of the weight-reduction program, healthcare providers should emphasize that fasting does not have a role in healthy weight loss.

Cultural and Religious Practices

Introduction

In recent years, there has been increased awareness of the powerful impact that cultural and religious factors can have on self-management in individuals with type 2 diabetes.[25–27] Such factors may affect patients' willingness to make necessary lifestyle modifications, abide by prescribed drug regimens, and transition to insulin therapy. Many healthcare providers need to improve their cultural competence and adapt their education and treatment plans to the cultures of their patients.[25–29] For example, A. Enrique Caballero, MD, has documented cultural factors that contribute to the reluctance of many Latinos with type 2 diabetes to start using insulin.[25,26] He argues that prescribing a simple titration regimen using a once-daily long-acting insulin analog at bedtime has shown efficacy in improving glycemic control in many patients with type 2 diabetes, and that such an approach might be useful for Latinos as an introduction to insulin therapy and the foundation of a more comprehensive insulin regimen in the future.[25] Full discussion of the complex interaction between culture and/or religion and diabetes self-management is beyond the scope of this program, but we focus briefly on 2 areas: practices related to Ramadan among followers of Islam and those related to the winter holidays in many different cultures.

Diabetes Management and Ramadan

The physiological effects of fasting differ in healthy persons and persons with diabetes (**Table 7**).[30] During Ramadan, most of the world's >1 billion Muslims observe an absolute fast, consuming no food or water, between dawn and sunset.[30,31] Islam exempts persons who are sick or whose health may be jeopardized from fasting, but many of these individuals elect to fast despite this dispensation.[31] Following completion of a major epidemiological study on Ramadan fasting in individuals with diabetes, the Epidemiology of Diabetes and Ramadan 1422/2001 (EPIDAR) study[31] guidelines for fasting during Ramadan were developed.[30]

The EPIDAR study was a population-based, retrospective survey of patients with diabetes in 13 countries with sizable Muslim populations.[31] A total of 12,243 patients, 11,173 with type 2 diabetes, were included in the analysis. An objective of the study was to assess diabetes presentation during Ramadan and the potential effects of fasting on patient well-being and diabetes management. The study found that 86% of patients with type 2 diabetes reported fasting for part of Ramadan and 79% reported fasting for at least 15 days. Among insulin-treated patients, 64% maintained their usual dose, 24% decreased their dose, 8% increased their dose, and 3% stopped insulin completely. The mean incidence of hypoglycemia episodes leading to hospitalization was 0.03 per month during Ramadan compared with 0.004 per month during the preceding year; the mean incidence of hyperglycemia episodes leading to hospitalization was 0.05 per

Table 7. Physiological Effects of Fasting in Healthy Persons and Persons with Diabetes[30]

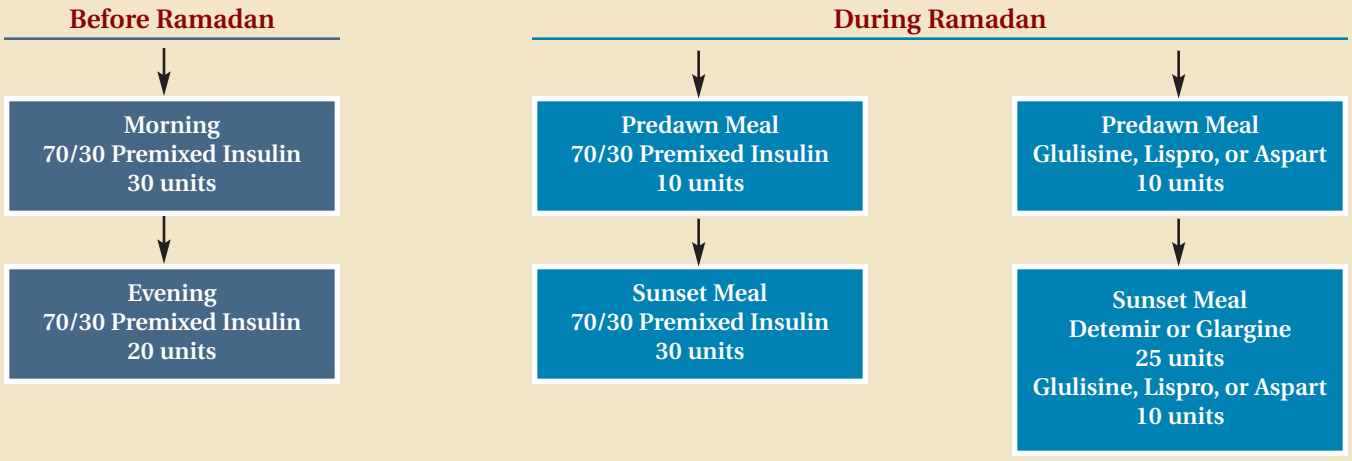
Population	*Physiological Effects*
Healthy persons	■ Circulating glucose levels tend to fall, leading to decreased insulin secretion ■ Levels of glucagon and catecholamines rise, stimulating the breakdown of glycogen, while gluconeogenesis is augmented ■ After several hours of fasting, glycogen stores become depleted and low levels of circulating insulin allow increased fatty acid release from adipocytes ■ Fatty acid oxidation generates ketones that can be used as fuel by skeletal and cardiac muscle, liver, kidney, and adipose tissue ■ Glucose is spared for continued utilization by the brain and erythrocytes
Persons with diabetes	■ A prolonged fast in the absence of adequate insulin can lead to excessive glycogen breakdown and increased gluconeogenesis ■ The severity of hyperglycemia depends on the extent of insulin resistance and/or deficiency

month during Ramadan and 0.01 per month during the preceding year (both, $P < 0.0001$). These findings emphasize the need for clinicians to provide patients with more intensive education before fasting, closer monitoring of blood glucose during fasting, and the development of guidelines for fasting in persons with diabetes.

Recently developed recommendations for managing diabetes during Ramadan specify that the management plan should be individualized.[30] Each patient should have a comprehensive medical assessment 1 to 2 months before Ramadan. At this time, necessary changes in diet and medication should be made, so that the patient begins fasting while following a stable, effective regimen. The patient and family should have educational counseling about self-care, and patients must have the means to monitor their blood glucose levels multiple times per day. The Ramadan diet should not differ significantly from a healthy and balanced diet, and the common practice of ingesting large amounts of foods rich in carbohydrates and fat, especially at the sunset meal (Iftar), should be avoided. The predawn meal (Suhur) should be eaten as late as possible before the start of the daily fast, and fluid intake should be increased during nonfasting hours. Usual levels of physical activity may be maintained, but excessive activity should be avoided, particularly during the last few hours before the sunset meal. Patients must immediately end their fast if they experience a blood glucose level <60 mg/dL, a blood glucose level <70 mg/dL in the first few hours after the start of the fast, or a blood glucose level >300 mg/dL.

A major objective of insulin regimens for use during Ramadan is to suppress hepatic glucose output to near-physiologic levels during the fasting period.[30] An effective strategy is the judicious use of intermediate- or long-acting preparations plus a rapid-acting insulin analog or short-acting insulin administered before meals. Using 1 injection of a long-acting insulin analog, such as insulin detemir or glargine, or 2 injections of NPH before sunset and predawn meals, may provide adequate coverage as long as the dosage of each injection is appropriately individualized. A single injection of an intermediate-acting insulin given before the sunset meal may provide acceptable glycemic control in patients with reasonable basal insulin secretion, because the peak action would be expected to occur at predawn, providing adequate insulin coverage for that meal. Most patients will still require short-acting insulin administered in combination with the intermediate- or long-acting insulin at the sunset meal to cover its large caloric load. Many patients may also need an additional dose of short-acting insulin at predawn. Use of a short-acting insulin analog, such as insulin aspart, glulisine, or lispro, instead of regular insulin before meals may be associated with less hypoglycemia and smaller postprandial glucose excursions. **Figure 4** provides an example of a change in the insulin regimen for an individual who fasts during Ramadan.

Figure 4. Example of a Change in the Insulin Regimen for an Individual Who Fasts During Ramadan[30]



Holiday Customs

Studies of patients representing diverse nationalities and cultures have shown that glycemic control often deteriorates during the autumn and winter, including the period of the winter holidays.[32,33] Reasons for this deterioration include consumption of a diet high in carbohydrates, fat, and salt; increased caloric intake; alcohol consumption; physical inactivity; travel; and stress.[32,33] Because poor glycemic control is often not reversed during warmer months, a yearly deterioration in control is likely to contribute to the steady increase in A1C that is frequently observed in individuals with type 2 diabetes (up to 2% over 10 years).[32] Elevations in systolic and diastolic blood pressure may also occur at this time.

For many individuals, excessive alcohol consumption is a major factor in this holiday-related deterioration in glycemic control. Alcohol inhibits gluconeogenesis and is therefore more likely to contribute to the development of hypoglycemia when glycogen stores are low, such as during the overnight fast.[34] Consistent intake of excessive amounts of alcohol, defined as ≥3 drinks per day, contributes to hyperglycemia.[12] The ADA recommends that adults with diabetes who use alcohol limit their daily intake to no more than 1 drink per day for women and 2 drinks per day for men.[15] To reduce the risk of nocturnal hypoglycemia, alcohol should be consumed with food. Blood glucose monitoring should be used to determine whether extra carbohydrate and/or reduction in insulin is needed to reduce the risk of hypoglycemia during the night or next morning following alcohol consumption the previous evening.[13] A moderate amount of alcohol, ingested with food, has minimal acute effects on plasma glucose and serum insulin concentrations, but carbohydrate coingested with alcohol (as in mixed drinks) may raise the blood glucose.[15]

Healthcare professionals can help patients avoid or mitigate the loss of glycemic control during the holiday season by emphasizing healthy food choices, the importance of abstinence from or moderate use of alcohol, the benefits of even moderate exercise, and the use of stress-reduction techniques. Short-term modification of the insulin regimen may also be appropriate for some patients. Resources for holiday meal planning can be found on the Web sites of the ADA (http://www.diabetes.org) and the Jewish Diabetes Association (http://www.jewishdiabetes.org).

Case 5: Individual concerned about losing glycemic control during Christmas visit to relatives

JP is a 52-year-old man with a 7-year history of type 2 diabetes. Five months ago, when his A1C was 8.5% despite oral medication, he started taking 40 units of a long-acting insulin analog at bedtime. Although JP had resisted the idea of beginning insulin therapy and refused to consider a regimen that involved more than 1 injection per day, he admitted that he had more energy and was pleased when his most recent A1C result was 7.8%.

In mid-December, JP contacted his healthcare provider about managing his diabetes during the Christmas season. He and his wife would be visiting his brother's family for several days, and JP described their holiday celebrations as noisy affairs with an abundance of rich food and alcohol.

JP's healthcare provider urged him to use his carbohydrate-counting skills and limit his consumption of high-fat foods. He cautioned JP to restrict his alcohol intake to no more than 2 drinks per day, to avoid mixed drinks, and to consume alcohol with food to reduce the risk of nocturnal hypoglycemia. He also urged him to take short walks to counteract some of the effects of rich food and a hectic environment and to monitor his blood glucose frequently.

With the help of his wife, JP followed his healthcare provider's instructions conscientiously until the final evening, when he continued to drink wine after dinner. When he measured his blood glucose at 8 PM, it was 220 mg/dL. At 10:30 PM, when he was preparing to take his insulin injection and go to bed, the reading was 165 mg/dL. Concerned that he was at risk for an episode of hypoglycemia, JP reduced his injection of long-acting insulin analog by 25%, to 30 units.

Take-Home Points

Loss of glycemic control is common during the winter holidays because of consumption of increased total amounts of food, as well as carbohydrate-rich and fatty foods, alcohol intake, travel, physical inactivity, schedule changes, and stress. In individuals with type 2 diabetes who use insulin, these seasonal disruptions can be managed most effectively with IIT, provided either by MDI or CSII regimens. For an individual like JP, who currently

uses a single bedtime injection of a long-acting insulin analog, diligent control of dietary and alcohol intake and moderate exercise are especially important.

Alcohol can have many negative effects in individuals with type 2 diabetes. Consistent consumption of excessive amounts of alcohol (>3 drinks per day) contributes to hyperglycemia, and the carbohydrate content of mixed drinks can also result in hyperglycemia. In contrast, as in the case of JP, consumption of alcohol without food can lead to hypoglycemia during the night or the next morning. Patients should use SMBG to determine whether they need to consume extra carbohydrates and/or decrease their usual insulin dose to reduce the risk of hypoglycemia following alcohol consumption.

Colonoscopy and Insulin Therapy

Introduction

The American Cancer Society (ACS) estimates that >150,000 new cases of colon and rectal cancer will be diagnosed in 2007, and that colorectal cancer will result in >52,000 deaths in 2007.[35] Studies have shown that individuals with diabetes have a 20%–60% increase in the risk of developing colorectal cancer, and that this increase is independent of obesity.[36] In addition, a study of patients with high-risk stage II and III colon cancer showed that, compared with patients without diabetes, patients with diabetes had significantly lower rates of overall survival (57% vs 66%, $P < 0.0001$), disease-free survival (48% vs 59%, $P < 0.0001$), and recurrence-free survival (56% vs 64%, $P = 0.012$).[37] The ACS recommends that, beginning at age 50, men and women receive periodic screenings for colorectal cancer, including a colonoscopy at least every 10 years.[35] Patients at moderate to high risk for colorectal cancer should talk with a healthcare provider about a different testing schedule. Given the associations between diabetes and colorectal cancer and adverse colorectal cancer–related outcomes, colonoscopy is especially important for individuals with diabetes.

Modifying the Insulin Regimen

In individuals who use insulin, preparation for a colonoscopy is greatly simplified if the procedure takes place in the morning rather than the afternoon.[38] Therefore, patients should arrange for the earliest possible appointment.

On the day before the colonoscopy, most individuals are instructed to consume only clear liquids. Because this restrictive diet does not include protein or fat, blood sugar levels are often much lower than usual. Patients may need to consume sugar-containing carbonated beverages and fruit drinks to provide calories throughout the day. Depending on the patient and his or her level of glucose control, the basal insulin dose should be continued or reduced by 20% to 30% and the prandial insulin doses given after eating should be based on the carbohydrate consumed and the premeal blood sugar level. The carbohydrate ratio and correction doses may need to be reduced by 25% to 50% to make up for the fact that only simple carbohydrates are eaten throughout the day. Because of the required disruptions to the customary diet, it is important for patients to check their blood sugar levels before meals, snacks, and bedtime on the day before the procedure. If they have a hypoglycemic reaction while preparing for the colonoscopy, they should treat it with apple juice or cola, glucose tablets, glucose gel, or sugar.[38]

Patients should check their blood sugar levels the first thing on the morning of the colonoscopy.[38] If they have not been scheduled for an early morning procedure, they should continue to check their blood glucose levels every 4 hours up to the time of the colonoscopy. Patients should take their glucose monitor and test strips with them to the hospital and check their blood glucose level as soon as possible after the procedure and whenever they feel that they might be experiencing hypoglycemia. They should inform the nurse, physician, or technician if they think they are having a hypoglycemic reaction prior to receiving anesthesia. In that situation, the nurse can use the IV access to treat the hypoglycemia. Some facilities also permit the use of glucose gel under those circumstances. However, eating glucose tablets during the fasting period before the procedure will lead to cancellation of the colonoscopy because of the threat of vomiting

Table 8. University of Michigan Health System Recommendations for Modifying the Insulin Regimen in Patients Undergoing Colonoscopy[*†‡38]*

Usual Insulin Regimen	*Modification*
One injection in the morning	■ Take one half of the usual dose of long-acting insulin[†] on the morning of the test ■ Take no short-acting insulin[‡] on the morning of the test ■ Take the other half of the long-acting and any regularly scheduled dose of short-acting insulin immediately after the test and eat your usual meal at that time
One injection of long-acting insulin in the evening	■ Take one half of the usual dose on the evening before the test ■ Take no short-acting insulin on the morning of the test
Two injections (morning and evening)	■ Take one half of the usual evening dose of long-acting insulin on the evening before the test ■ Take one half of the usual morning dose of long-acting insulin on the morning of the test ■ Take no short-acting insulin on the morning of the test ■ Take the other half of the usual morning dose of long-acting insulin after the test if the test ends before noon and eat your usual meal at that time ■ Resume your normal evening dose of insulin on the evening of the test day if the test is scheduled for or lasts into the afternoon
Two injections (morning and evening), plus short-acting insulin at lunchtime or bedtime	■ Follow the above instructions for two injections (morning and evening) ■ Take the bedtime short-acting insulin if needed ■ If the procedure is over by your usual lunchtime, take your short-acting insulin along with the remaining one half of your long-acting insulin with your lunch
Long-acting insulin in the evening and several injections of short-acting insulin during the day	■ Take one half of your usual dose of long-acting insulin the evening before the procedure ■ Take short-acting insulin if you are on clear liquids only and can replace the carbohydrates ■ Take no short-acting insulin the morning of the test ■ Take your usual short-acting insulin as soon as you can have a meal ■ Resume your usual dose of long-acting insulin in the evening

*These are general guidelines. Please call the healthcare provider who manages your diabetes with questions.
†The guidelines classify the following as long-acting insulins: NPH, 70/30, 75/25, insulin detemir, and insulin glargine.
‡The guidelines classify the following as short-acting insulins: Regular, insulin aspart, insulin glulisine, and insulin lispro.

secondary to anesthesia. Once the procedure is over, patients should have an insulin injection and eat as close to the usual time as possible.

Numerous guidelines have been developed for modifying the insulin regimen in preparation for a colonoscopy. Recommendations developed by the University of Michigan Health System,[38] which are particularly comprehensive, are presented in **Table 8**.

Case 6. Patient on an MDI regimen preparing for a colonoscopy

NG is a 51-year-old woman who was diagnosed with type 2 diabetes 12 years ago. Two years ago she began an MDI regimen consisting of 36 units of a long-acting insulin analog every evening and 10 to 15 units of a rapid-acting insulin analog with each meal. She is about to have her first colonoscopy and is apprehensive both because she has heard that the preparation is difficult and because she is concerned about managing her insulin regimen.

During her visit to the gastroenterologist who will perform her procedure, NG receives printed instructions for the colonoscopy preparation, as well as the insulin regimen modification guidelines used at the hospital where she will have the test. The gastroenterologist urges NG to contact her primary healthcare provider to ensure that following the hospital's insulin guidelines will be appropriate for her. The gastroenterologist also makes sure that NG is scheduled for an early-morning colonoscopy.

After her primary healthcare provider confirms that she should follow the hospital's guidelines for modifying her insulin regimen, NG prepares for her procedure. She is relieved to find that although the process is not pleasant, it is less difficult than she anticipated. On the morning

before the test, her fasting blood glucose level is 120 mg/dL. Because her breakfast will consist of 8 ounces of apple juice and one-half cup of regular Jello (47 grams of carbohydrates), she takes 7.5 units of insulin, half of her maximum dose, with her meal. Anticipating the disruption of her schedule the next day, she begins a vigorous morning of housecleaning immediately after breakfast. By 10:30 AM she begins to feel lightheaded and finds that her blood glucose level is 80 mg/dL. She feels better after drinking a 12-ounce can of regular ginger ale and continues cleaning at a more moderate pace until lunchtime, when her blood glucose level is 140 mg/dL. She has chicken broth, Jello, and a 12-ounce can of regular cola for lunch (60 grams of carbohydrates) and takes an additional 7.5 units of rapid-acting insulin at that time. At 4 PM, following the instructions given to her by her gastroenterologist, she alternates drinking the bowel prep solution and eating small amounts of regular Jello. Her blood glucose level is 130 mg/dL when she begins drinking the solution and 120 mg/dL when she goes to bed at 9:30 that evening. At bedtime, she takes 18 units of her long-acting insulin analog, one half of her usual dose.

When NG awakens at 5:30 the next morning, her blood glucose level is 105 mg/dL. Since she cannot eat breakfast, she does not have the usual injection of her short-acting insulin analog. She arrives at the hospital at 7:30 AM, her procedure begins on schedule, and afterwards the gastroenterologist assures her that the test did not reveal any polyps or other abnormalities. When NG tests her blood glucose level after recovering from anesthesia, she finds that it is 95 mg/dL. She drinks 8 ounces of apple juice and then gets dressed. NG is surprised at how well she feels at that point and responds enthusiastically when her husband suggests that they have lunch at a nearby restaurant. Before the meal, NG's blood glucose level is 115 mg/dL and she takes 10 units of short-acting insulin analog. By dinnertime, her blood glucose level is 135 mg/dL and she takes 15 units of short-acting insulin analog. At bedtime that evening, her blood glucose level is 120 mg/dL and she resumes her usual 36-unit dose of long-acting insulin analog.

Take-Home Points

Colonoscopy, an important part of the colorectal screening process for all adults over the age of 50 years, is especially important for individuals with diabetes, who have an elevated incidence of colorectal cancer and significantly poorer outcomes than the general population if they develop the disease. Because it includes curtailment of customary food intake, preparation for a colonoscopy necessitates modifications to the insulin regimen on the day before and the day of the procedure. The nature of these changes depends on the individual's usual regimen, the timing of the colonoscopy, the individual's activity level, and other factors. Although many medical centers have guidelines for insulin modification, following these guidelines should be approved by the patient's healthcare provider. Tailoring the insulin regimen is simplified if the patient has a morning rather than an afternoon colonoscopy.

Natural Disasters and Other Emergencies

Introduction

Hurricane Katrina, which struck the Gulf Coast of the United States on August 29, 2005, devastated the regional infrastructure, including the medical sector, and led to the displacement of ~1 million residents.[39,40] Events following the storm suggested that far better disaster-preparedness guidelines were needed for healthcare organizations, healthcare professionals, and persons with chronic diseases such as diabetes.[39] Approximately 11% of the population previously living in Orleans and Jefferson parishes, Louisiana, has diabetes, and many of these residents faced exceptionally difficult circumstances after the storm. Although the ADA Web site contained advice on disease management and the US Food and Drug Administration (US FDA) Web site provided information on the substitution of different types of insulin, few affected people had Internet access, and those who did rarely thought to seek help from these sources.

ADA Guidance for People with Diabetes in Emergency Situations

The ADA has issued several documents that contain useful guidance for people with diabetes in emergency situations.[41–44] Highlights are summarized in the following paragraphs.

All individuals with diabetes should prepare an emergency kit. Persons who use insulin should keep extra insulin (long- and short-acting) in an easily identified container in the refrigerator. Other emergency supplies should be stored in a readily identified, waterproof container in a place that is easy to reach. This part of the kit should contain 3 days' worth of insulin delivery supplies, oral medication, summary of medication regimen, lancets, an extra glucose monitor (with the battery stored separately to prevent corrosive damage), strips for the meter, extra batteries for the glucose monitor (and insulin pump), a quick-acting source of glucose, an extra glucagon emergency kit, extra athletic socks, a comfortable pair of walking shoes, and a list of emergency contacts. Family members and friends should know where this kit is kept. Persons with diabetes (and those without) should also keep ample supplies of healthful, nonperishable food and bottled drinking water. As always, they should wear medical identification that will enable emergency medical personnel to identify and address their needs. It is helpful to have "dog tags" that list the names of family members, contact information, and major medical conditions. Upon arrival at a shelter or other emergency location, persons with diabetes should ensure prompt evaluation by identifying themselves to a healthcare provider or representative of the Red Cross or another relief organization.

In emergency situations, ongoing hyperglycemia often results in dehydration, and sweating may exacerbate fluid loss. The best way to prevent dehydration is to drink clean water or non–carbohydrate-containing fluids. Individuals should be alert for symptoms of hypoglycemia, and keep something containing sugar with them at all times. It may be best not to strive to keep blood glucose levels as close to normal as possible, but to allow the glucose level to be somewhat higher. It is important to remember that requirements for insulin and other antidiabetic medications may be very different in someone who is experiencing major changes in diet and activity levels.

Individuals with diabetes should strive to avoid infections, especially foot infections. Precautions include not walking through contaminated water or injuring the feet in other ways, inspecting the feet regularly for injury, seeking immediate treatment for open wounds or signs of infection on any part of the body, and washing the hands conscientiously, using an alcohol-based product if soap and water are not available.

If one's usual type and brand of insulin is not available, using a different type or brand as directed by medical personnel is safe. If insulin is not available, carbohydrate consumption should be reduced if possible. Medications should be restarted cautiously when they become available, remembering that a person's need for a particular medication and dosage may have changed if significant weight loss has occurred or a person has gone without adequate food for a significant period of time. Pharmacies in affected areas may allow patients to obtain their medications without a prescription if they have pill containers. Many pharmaceutical companies and device manufacturers also provide assistance in emergency situations.

US Food and Drug Administration Advice

The US FDA has published guidelines on the use of medical devices, such as glucose meters, and insulin during emergency situations.[45,46] The following paragraphs summarize the content of these documents.

Individuals should maintain their device in a well-lit area so they can assess its performance. They should keep it in as clean and secure a location as possible, and always check it for pests before using it. Because heat and humidity can damage blood glucose meters and test strips, it is important to check the meter and test strip package insert for information on use during unusual heat and humidity. Quality-control checks should be performed to make sure the testing is accurate and reliable.

Guidelines for storing insulin should be followed as closely as possible (**Table 1**). Under emergency conditions, it might be necessary to use insulin that has been kept above 86°F, but insulin vials that have been exposed to extreme conditions should be discarded when properly stored insulin again becomes available. Insulin should be kept as cool as possible by keeping it away from direct heat and sunlight. It is important to avoid freezing the insulin if ice

Table 9. US Food and Drug Administration Recommendations for Insulin Switching During Emergency Conditions[46]

Product	*Recommendation for Switching*
Short-acting and rapid-acting insulins	■ One brand of Regular insulin (eg, Humulin R, Novolin R) may be substituted for another brand of Regular insulin and for rapid-acting insulins (eg, Humalog, NovoLog), and vice versa, on a unit-per-unit basis
Intermediate- and long-acting insulins	■ One intermediate-acting insulin product (eg, Humulin N, Novolin N) may be substituted for another intermediate-acting insulin product on a unit-per-unit basis ■ These insulins may also be substituted for long-acting insulins (eg, Lantus and Levemir) on a unit-per-unit basis, or vice versa. In this case, half of the NPH insulin dose should be given in the morning and half given in the evening
Insulin mixes	■ One insulin mix product (eg, Humulin 70/30, Humalog Mix75/25, Novolin 70/30, NovoLog Mix 70/30) may be substituted for another on a unit-per-unit basis ■ If no other insulin mix is available, patients should first substitute an intermediate- or long-acting insulin on a unit-per-unit basis relative to the intermediate-acting component of the mix (eg, approximately three fourths of the total unit dose of the mix in the examples given here). The total dose of NPH insulin should be split between morning and evening doses ■ If regular or rapid-acting insulins are also available, they may be used before major meals along with the intermediate- or long-acting insulin (dosed as above) in doses equivalent to approximately one fourth of the total dose of premixed insulin usually taken before that meal
Insulin pumps	■ Patients using insulin pumps who must switch to injected insulin may substitute an intermediate- or long-acting insulin for the 24-hour total basal dose of infused insulin on a unit-per-unit basis, always making sure that the total dose of NPH insulin is split between morning and evening doses ■ If Regular or rapid-acting insulin is also available, patients should administer mealtime insulin according to their previous system for calculating their bolus insulin doses

NPH = neutral protamine Hagedorn.

is used. Dry ice or cold packs are preferable to ice if there is danger of water contamination. Although switching insulin should always be done in consultation with a physician, the recommendations in **Table 9** should be considered if this is not possible under emergency conditions.

Case 7: Person in a coastal area whose insulin is damaged after a major summer storm

MC, a 76-year-old man with a 15-year history of type 2 diabetes, lives with his wife outside a small town on the Gulf Coast of Texas. For the past 2 years he has managed his diabetes with a premixed 70/30 insulin analog, taking 52 units with breakfast and 40 units with dinner. His community was severely damaged and lost power during a recent hurricane, and floodwater was knee-deep on the first floor of his house. As MC and his wife struggled to salvage furnishings and family memorabilia, daytime temperatures rose into the upper 90s. The couple soon ran out of bottled water and ate erratically—mostly peanut butter and crackers with diet cola. MC gave himself insulin injections from a warm vial when he remembered them. Although he eventually found his glucose meter, his test strips had been damaged by water and were unusable.

Three days after the storm, MC began to feel sick and his left foot was painful. Finally, when a Coast Guard boat passed their house, his wife summoned help and MC was taken to a Red Cross shelter at the local high school. When he reached the shelter, MC had a blood glucose reading of 340 mg/dL. Although the shelter had a stock of insulin that had been kept cool, only NPH and rapid-acting human insulin were available. A nurse explained that in the absence of premixed insulin, MC should take NPH insulin in the morning and evening and rapid-acting insulin before major meals (**Figure 5**). She said that his total dose of NPH insulin should be three quarters of his total daily dose of 92 units, or 69 units, with 38 units taken in the morning and 31 units taken in

Figure 5. Calculating the Insulin Substitution for the Patient in Case 7 Based on US Food and Drug Administration Recommendations[46]

Usual Insulin Regimen

Premixed 70/30 Insulin Analog
- 52 Units at breakfast + 40 units at dinner = 92 units

Emergency Substitute Regimen

NPH Insulin
- 3/4 of total daily dose of 92 units = 69 units
- 38 Units to be taken in the morning
- 21 Units to be taken in the evening

Rapid-Acting Insulin
- 1/4 of total daily dose of 92 units = 23 units
- 8 Units to be taken before breakfast and dinner
- 7 Units to be taken before lunch

NPH = neutral protamine Hagedorn.

the evening. She also said that his total dose of rapid-acting insulin should be one quarter of his total dose of 92 units, or approximately 23 units, with 8 units to be taken before breakfast and dinner and 7 units before lunch. When examination of his painful foot showed that a toe had become infected, MC began a course of antibiotics. After being persuaded that it was too dangerous for him to return to his flooded home, MC arranged to travel with his wife to his brother's house, 70 miles inland, where power, comprehensive medical care, and pharmacy services were available.

Take-Home Points

The ADA and the US FDA have issued guidelines to help individuals like MC reduce the dangers associated with natural disasters and other emergencies. They should store 3 days' worth of diabetes supplies in a weatherproof container, have a means of keeping insulin cool in hot weather (eg, with cold packs), and have access to healthful, nonperishable food. They should have an ample supply of bottled water and maintain their hydration. To minimize the danger of foot infections, they should avoid walking through contaminated water. If their regular type(s) of insulin are not available, they should switch to available insulins as directed by a healthcare provider or the US FDA.

Other Resources

Additional sources of information about health and safety during a disaster are the Web sites of the American Red Cross (http://www.redcross.org), the Federal Emergency Management Association (FEMA) (http://www.fema.gov), and the Department of Homeland Security (http://www.ready.gov). It is important to note that some pharmaceutical companies and device manufacturers will make their products available to patients who are displaced by natural disasters or other emergencies.

Summary and Recommendations

- Special situations, such as intensive exercise, travel, irregular mealtimes, weight-loss programs, religious or cultural practices, colonoscopy preparation, and natural disasters or other emergencies necessitate individually tailored insulin regimens for persons with type 2 diabetes.
- Selected persons in special situations benefit from IIT, whether achieved through MDI or CSII therapy.
- Depending on the type, intensity, and duration of the activity, persons who are engaging in more than moderate exercise may require a reduction in the insulin dose, intake of additional carbohydrates, or both.
- Many factors, including missed meals, dietary changes, increased exercise, stress, illness or injury, and time-zone changes, can affect blood glucose levels during travel. Insulin dosage adjustments are usually needed for time-zone changes of more than 3 hours.
- With the many delivery options now available, an appropriate insulin regimen can usually be developed to conform to an individual's meal routine and food preferences. Carbohydrate monitoring is a key strategy in achieving glycemic control in all patients with type 2 diabetes, including those with irregular schedules.
- Frequent blood glucose monitoring is important for individuals engaged in a comprehensive weight-loss program. Because weight loss and exercise independently reduce insulin resistance in persons with type 2 diabetes, a modification of the insulin regimen may be needed.
- In recent years, there has been an increased awareness of the powerful impact that religious and cultural factors can have on individuals with diabetes. Many healthcare providers need to improve their knowledge of religious practices and adapt their education and treatment plans to the beliefs and practices of their patients.
- Insulin-treated individuals with type 2 diabetes who choose to fast during Ramadan are at elevated risk for hypoglycemia and hyperglycemia. These patients require careful education and management, as well as an individualized insulin regimen.
- Deterioration in glycemic control is common during the winter holidays, and this deterioration can have a long-term impact. Healthcare providers can help patients avoid this problem by emphasizing healthy food choices, abstinence from or moderate use of alcohol, the benefits of even moderate exercise, and stress-reduction techniques. In some cases, a short-term modification of the insulin regimen may be necessary.
- Colonoscopy is especially important in persons with type 2 diabetes, since they are at increased risk for colorectal cancer and tend to have poorer outcomes than the general population if they develop this type of cancer. Many guidelines for modifying the insulin regimen have been developed, but patients can greatly simplify the preparation process by scheduling a morning colonoscopy.
- The experience of Hurricane Katrina has shown that patients with diabetes must make careful preparations for natural disasters and other emergency situations. The ADA and US FDA have developed helpful guidelines for diabetes self-care during disasters.

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Post-test

1. One of the shifts in fuel utilization that occurs as an athlete transitions from the early stages of exercise to exercise of greater duration and intensity is _____.

a. Nonesterified fatty acids become the main fuel source for muscle

b. The chief source of energy becomes muscle glycogen

c. The main origin of circulating glucose becomes gluconeogenesis

d. The balance of substrate usage shifts from carbohydrate oxidation to fat oxidation

2. In the absence of contraindications, the American Diabetes Association (ADA) recommends that individuals with type 2 diabetes do all of the following EXCEPT _____.

a. Engage in aerobic exercise but avoid resistance exercise

b. Participate in at least 150 minutes per week of moderate aerobic exercise

c. Consider having a graded exercise test with electrocardiogram monitoring

d. Perform resistance exercise 3 times per week

3. An effective strategy for reducing the risk of exercise-related hypoglycemia is _____.

a. Changing the insulin injection site frequently

b. Consuming 15 grams of carbohydrates before each exercise session

c. Injecting insulin into a muscle

d. Using frequent self-monitoring of blood glucose to anticipate changes in blood glucose levels

4. The type of exercise that usually requires the smallest modification of an individual's regimen of insulin administration and carbohydrate consumption is _____.

a. Weight lifting

b. Walking

c. Scuba diving

d. Downhill skiing

5. GR uses multiple daily injection therapy to manage her diabetes. She takes 38 units of a long-acting insulin analog each evening and 10 to 15 units of a rapid-acting insulin analog before each meal. After breakfast on Saturday morning, GR plans to take a brisk 7-mile walk with a friend. In addition to consuming up to 15 grams of carbohydrates per hour while walking, a likely change in her regimen is to _____.

a. Reduce her dose of long-acting insulin analog to 30 units on the evening before the walk and make no change to her breakfast dose of rapid-acting insulin analog

b. Reduce her dose of long-acting insulin analog to 30 units on the evening before the walk and reduce her breakfast dose of rapid-acting insulin analog to 8 units

c. Make no change to her dose of long-acting insulin analog on the evening before the walk and eliminate her breakfast dose of rapid-acting insulin analog

d. Make no change to her dose of long-acting insulin analog on the evening before the walk and reduce her breakfast dose of rapid-acting insulin analog to 8 units

6. BG takes 20 units of neutral protamine Hagedorn (NPH) and 10 units of rapid-acting insulin before breakfast, 10 units of rapid-acting insulin before lunch, and 20 units of NPH and 10 units of rapid-acting insulin before dinner. He is about to travel from Chicago to Paris, which involves a change of 6 time zones to the east. On his travel day, his predinner doses of insulin would likely be _____.

a. 16 units NPH, 8 units rapid-acting insulin on his home time

b. 16 units NPH, 10 units rapid-acting insulin on his home time

c. 24 units NPH, 12 units rapid-acting insulin on his home time

d. 24 units NPH, 10 units rapid-acting insulin on his home time

7. A major advantage of carbohydrate counting is that _____.

a. It is an effective substitute for intensive insulin therapy in most patients with type 2 diabetes

b. It permits a flexible eating schedule and increased dietary freedom

c. It usually results in weight loss

d. It makes it possible to plan meals without determining the fat content of food

8. The prevalence of eating disorders in persons with type 2 diabetes is approximately _____.

a. 1%

b. 5%

c. 10%

d. 25%

9. An especially problematic effect of fasting in individuals with diabetes is that _____.

a. Circulating glucose levels tend to fall, leading to decreased insulin secretion

b. Fasting in the absence of adequate insulin can result in excessive glycogen breakdown

c. Low levels of circulating insulin allow increased fatty acid release from adipocytes

d. Fatty acid oxidation generates ketones

10. MS plans to fast during Ramadan. His usual regimen is a 70/30 premixed insulin analog, given at a dose of 36 units in the morning and 24 units in the evening. He prefers to continue using this product during Ramadan. His likely regimen would be _____.

a. 12 units at sunrise and 36 units at sunset

b. 24 units at sunrise and 36 units at sunset

c. 18 units at sunrise and 24 units at sunset

d. 16 units at sunrise and 40 units at sunset

11. An accurate statement about the effects of alcohol in persons with type 2 diabetes is _____.

a. Alcohol is problematic because it promotes gluconeogenesis

b. Women with diabetes should have no more than 2 alcoholic drinks per day

c. Following evening alcohol consumption, it may be necessary to reduce the dose of bedtime insulin

d. As long as the amount of ingested alcohol is the same, individuals can choose either wine or mixed drinks

12. BK is scheduled for a morning colonoscopy. Her usual regimen is 20 units of NPH insulin in the morning and 16 units in the evening. In preparation for the procedure, her likely regimen would be _____.

a. 10 units of NPH insulin on the evening before the test, no insulin on the morning of the test, and 8 units after the test, before lunch

b. 8 units of NPH insulin on the evening before the test, 10 units on the morning of the test, and 10 units after the test, before lunch

c. 10 units of NPH insulin on the evening before the test, 8 units on the morning of the test, and 8 units after the test, before lunch

d. 10 units of NPH insulin on the evening before the test, 8 units on the morning of the test, and 8 units after the test, before lunch

13. According to the ADA, a person experiencing an emergency situation should _____.

a. Try to keep the blood glucose level as close to its usual level as possible

b. Keep the blood glucose level <150 mg/dL if possible

c. Try to keep the blood glucose level somewhat lower than usual

d. Allow the blood glucose level to be somewhat higher than usual

14. DA usually takes 36 units of a long-acting insulin analog in the evening. She was recently evacuated from her cabin in California because of wildfires and taken to an emergency shelter. The shelter had NPH but not long-acting insulin. DA's emergency regimen would likely be _____.

a. 36 units of NPH insulin in the evening

b. 40 units of NPH insulin in the evening

c. 18 units of NPH insulin in the morning and 18 units in the evening

d. 20 units of NPH insulin in the morning and 20 units in the evening

Strategies for Managing Special Situations in the Patient with Type 2 Diabetes

This evaluation and post-test may also be completed online at: http://www.MedEdToday.com/situations

The participant will be offered an opportunity to print a statement of credit upon successful completion of the post-test (score at least 75%) and evaluation.

Program Evaluation

How many hours ____ and minutes ____ did it take you to complete this CE program?
(The maximum time to complete this activity is 1 hour and 15 minutes)

Please indicate date of completion ____/____/_____

EFFECTIVENESS OF TEACHING/LEARNING METHOD *(Please circle one response per line.)*

Did the materials presented in this CE program meet the following learning objectives?

- Identify frequently occurring and uncommon special situations that necessitate individually tailored insulin regimens for persons with type 2 diabetes. ☐ Yes ☐ No
- Provide patient education regarding the benefits of frequent self-monitoring of blood glucose for persons with special situations. ☐ Yes ☐ No
- Select the appropriate insulin and insulin delivery methods for persons with special situations. ☐ Yes ☐ No
- Identify key resources that provide guidance for developing insulin regimens for persons with special situations. ☐ Yes ☐ No

This home study has contributed to my professional effectiveness and improved my ability to:

	Strongly Disagree				*Strongly Agree*
■ Optimize patients' care	1	2	3	4	5
■ Communicate with patients	1	2	3	4	5
■ Manage my practice	1	2	3	4	5
■ Improve my clinical skills	1	2	3	4	5

■ Other _____

Rate the overall clinical relevance of the program

	Poor				*Excellent*
To your practice needs:	1	2	3	4	5
Is the information timely/up-to-date?				☐ Yes	☐ No
Did the program meet your expectations?				☐ Yes	☐ No
Is the content relevant to your area of professional interest?				☐ Yes	☐ No
Do you feel this program covered the topic adequately?				☐ Yes	☐ No
Is the content useful to you in improving patient care?				☐ Yes	☐ No
Do you feel that the program was balanced, objective, and free of commercial bias?				☐ Yes	☐ No

If no, why not? _____

_____

_____

What one new thing did you learn today? _____

What barrier(s) outside of your control have an impact on patient outcomes? (check all that apply)

- ☐ Institutional
- ☐ Insurance/financial
- ☐ Lack of practice guidelines
- ☐ Other, please list. _____
- ☐ Lack of patient compliance/adherence
- ☐ Adverse side-effects of treatment
- ☐ Patient lack of knowledge regarding disease/treatment

What information would you like to see in future presentations that may help you address those barriers?

_____

Do you intend to change your patient care based upon information received in this activity? ☐ Yes ☐ No ☐ Not Sure

How will you modify your practice performance as a result of attending this program? _____

_____

Assess your level of commitment to making the modification to your practice stated above:

☐ Very committed ☐ Committed ☐ Somewhat committed ☐ Not very committed ☐ Do not expect to change practice

What recommendations do you suggest to improve this program? _____

_____

What topics would you like to see in future presentations? _____

_____

In order to assist us in measuring the outcomes of this educational activity, would you be willing to participate in a brief postactivity questionnaire? ☐ Yes ☐ No

If yes, please include your e-mail address here. _____

Post-Test Answer Grid *(Enter the correct answer.)*

1. ☐	4. ☐	7. ☐	10. ☐	13. ☐
2. ☐	5. ☐	8. ☐	11. ☐	14. ☐
3. ☐	6. ☐	9. ☐	12. ☐	

To obtain a statement of credit, you must complete the post-test with a score of at least 75%, complete the program evaluation, and mail or fax both the evaluation form and the answer key to the American Academy of CME, Inc. Your statement of credit will be mailed in 4 to 6 weeks.

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Skillman, NJ 08558

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Signature: _____

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